Textual borrowing in science summaries: upper-elementary and middle school students learning to write the language of science

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Abstract

In writing science summaries, student writers frequently borrow language fragments from source texts. While taking a text's ideas verbatim is commonly considered a failure in writers' expected use of their own words or even plagiarism, imitating "linguistic chunks" from skilled speakers is also an effective practice in language development. This study argues for the need to investigate textual borrowing (TB) from a developmental perspective. A total of 956 U.S. upper-elementary and middle school L1 students were administered a reading comprehension test, a written summary task, and a receptive academic language assessment. Multiple indices were generated to capture TB frequency, length, and one particular function of TB (i.e., definitions). Results revealed that 68% of summaries contained at least one incidence of TB. As expected, both TB frequency and length were negatively associated with reading comprehension and academic language skills. However, students in higher grades demonstrated significantly more and longer TB in comparison to their younger counterparts when summarizing the same passage. In addition, the frequency of borrowed word strings and the ratio of definitional borrowing were positively associated with summary writing quality, and the latter association was found to be stronger for students with higher academic language skills. Implications for pedagogy and future research are discussed.

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Introduction

Summary writing is a common academic task in various disciplines (Johns & Mayes, 1990; Wellington & Osborne, 2001). In particular, summarizing science texts is a challenging writing assignment for upper-elementary and middle school students. Successful summaries of science texts depend not only on processing new and abstract scientific knowledge but also on understanding and communicating this knowledge via the *language of science*, that is, the particular ways of using language to communicate knowledge and ideas in scientific communities (Fang, 2005; Halliday & Martin, 2003). This linguistic register differs in predictable and systematic ways from the language typically used for communication in everyday social interactions and is therefore typically unfamiliar to most early adolescents (Schleppegrell, 2001). Thus, for large portions of students, internalizing the technical and precise vocabulary, the structures used to densely and concisely convey information, and the stepwise organization of discourse characteristic of scientific texts is known to be challenging aspects of a gradual learning process (Galloway et al., 2019; Schleppegrell, 2004; Uccelli et al., 2015).

Textual borrowing is the term used to refer to the act—or product—of copying language fragments from a source text in source-based writing tasks across various academic contexts; this practice is not infrequent among novice writers (Cumming et al., 2016; Pennycook, 1996; Shi, 2004). On the one hand, copying language fragments verbatim from a source text is typically considered a failure for writers, who are expected to use their *own words*, or even a "transgressive act of plagiarism" if the source is not acknowledged (Pecorari & Petric, 2014, p. 269). On the other hand, borrowing fragments from "model texts" is also recognized as a "natural stage" or "necessary phase" of language learning (Currie, 1998, p. 10; Keck, 2006, p. 269) analogous to imitating linguistic chunks from more skilled speakers in oral language development, a process known to be core to first and second language development (Goldberg, 2006; Lieven et al., 2009).

The controversial issue of textual borrowing has been widely studied in the literature, but the vast majority of these studies focus on second language (L2) learners at the university level, with minimal research attention devoted to upper-elementary and middle school first language (L1) writers. Presumably, the strict institutional culture in universities that prohibits plagiarism combined with the significant challenge of writing in an L2 has led to this targeted interest (Flowerdew & Li, 2007; Pecorari, 2003; Price, 2002). Nevertheless, writing in ways that meet the linguistic and discursive expectations for school tasks is known to be a gradual and often challenging process, even for L1 learners. The development of academic writing tends to be especially salient throughout adolescence (Berman, 2007). Thus, we argue that textual borrowing is a phenomenon worth examining in upper-elementary and middle school L1 writers.

The question of the role of textual borrowing in upper-elementary and middle school L1 writing is important not only for shedding light on our understanding of the development of academic writing but also for informing educational practice. This line of research could inform questions such as the following: Should school

teachers or curricula consider textual borrowing a transgressive act of plagiarism under all circumstances and, consequently, prevent and dissuade students from engaging in this practice? Alternatively, should this practice perhaps be considered a nontransgressive strategic attempt to engage with the linguistic and discursive forms of particular disciplinary fields and thus one that ought to be welcomed or even encouraged—at least under certain parameters? The present study cannot plausibly answer these educational questions, as it does not investigate educational practices. However, this study is an initial attempt to find empirical evidence on the prevalence and role of textual borrowing in novice academic writers and has the long-term goal of informing educational practice.

The current study examines patterns of textual borrowing in science summaries produced by a cross-sectional sample of mostly English L1 students attending fourth to seventh grade at urban public schools in the U.S. and the associations of those patterns with students' reading and writing skills. A widespread assumption seems to be that verbatim copying from source texts is done by students with low text comprehension or linguistic skills or at least with an incipient understanding of the task of summarization. This study seeks to investigate and interrogate this assumption.

In the next sections, we briefly present our theoretical framework and the controversial views on textual borrowing reported in the literature. Then, after describing our study design, we present our findings on patterns of textual borrowing across grade levels and their associations with overall summary writing quality, students' reading comprehension, and students' receptive academic language skills. We close this article with a discussion of some preliminary pedagogical implications and lingering questions worthy of future exploration.

Literature review

Challenges in science summary writing

A summary is formally defined as "a condensed version, in one's own words, of the writing of someone else, a condensation that reproduces the thought, emphasis, and tone of the original" (McArthur, 1986, p. 50). Kintsch and van Dijk's theoretical model for summarization protocols (Kintsch & Van Dijk, 1978) outlines three critical steps in the summary writing process: comprehension, condensation, and production. To compose a high-quality summary, first, writers need to process the "microstructure of discourse" (p. 365) or the set of propositions that are semantically related and coherently structured. Second, in addition to comprehending the "explicit text base", writers need to make inferences about the "macrostructure of discourse" or condense topic sentences by deleting unimportant details and combining main ideas to form a superordinate proposition. Third, writers need to integrate schemas from these comprehension and condensation processes with their own productive linguistic resources to generate new text. A breakdown in any of these three steps of the process can lead to an inappropriate summarization of the original text (Johns & Mayes, 1990).

For elementary and middle school students, in comparison to summarization tasks encountered in English language arts classes (mostly narratives), the task of summarizing an informational science text can be particularly challenging. Unlike narratives or colloquial communication, science texts tend to be heavily endowed with lexico-grammatical resources that render their language particularly abstract, dense, and intricate (Biber & Conrad, 2009; Halliday & Martin, 2003).

Writing a summary entails cognitive skills (e.g., selecting the most important ideas and understanding their conceptual relations), as well as linguistic skills (involved in both comprehension and production). Furthermore, a condensed rendition of a scientific text is hypothesized to be supported by the writer's mastery of language resources prevalent in the scientific register but typically less frequent in informal conversations among youth. For instance, to concisely convey clear information, scientific register writers typically use precise vocabulary and morpho-syntactically intricate structures, e.g., a *two-wheeled vehicle propelled by pedals* versus *a thing that has two wheels and that you ride using pedals.*

To successfully comprehend, condense, and produce a science text, students need to deploy two sets of academic language skills: (1) *discipline-specific academic language skills*, which involve technical and scientific terms (e.g., *a wind turbine is a mechanical device designed to transform wind energy into electricity*), as well as circumscribed ways of scientific thinking and writing (e.g., defining a technical concept, explaining a scientific phenomenon, drawing a conclusion) (Fang, 2005); (2) *cross-disciplinary academic language skills*, which, in this study, we conceptualize as Core Academic Language Skills (CALS) (Galloway et al., 2019; Uccelli et al., 2015). Defined as a set of high-utility language skills commonly used in academic discourse across disciplines, CALS embody seven distinctive but interrelated domains, including skills in unpacking dense morphosyntactic structures (e.g., *a mechanical device [designed to transform wind energy into electricity]*), tracking participants and themes with the anaphoric resolution, organizing analytic texts using explicit discourse markers (e.g., *for example, on the other hand*), connecting ideas logically, understanding metalinguistic vocabulary (e.g., *hypothesize, generalization*), interpreting writers' viewpoints, and recognizing the academic register (see Uccelli et al., 2015 for a full description).

While proficiency in the language of science has been shown to be positively associated with the comprehension of science texts (Ardasheva & Tretter, 2017; August et al., 2016; Galloway et al., 2019; Spence et al., 1999), the relation between receptive academic language skills and students' science summary writing—more specifically, their textual borrowing patterns—has been relatively understudied.

Textual borrowing in source-based writing

The third stage outlined in Kintsch and van Dijk's model, namely, production, requires student writers to reconstruct the main ideas comprehended from the source text by condensing them into a new text. The academic language of science texts, however, is "difficult to comprehend and even harder to produce" (Snow, 2010, p. 450). Student writers frequently borrow language fragments from the source texts,

despite the ubiquitous and explicit instruction to students to "use your own words" in their writing.

Textual borrowing has been a sensitive and critical topic of discussion in studies on academic writing (Chandrasoma et al., 2004; Pecorari & Shaw, 2012; Pennycook, 1996; Shi, 2004; Weigle & Parker, 2012), but researchers have not yet reached a consensus regarding how it should be defined and dealt with in various academic settings. Some researchers view textual borrowing as a transgressive act of plagiarism that poses a major threat to academic integrity (Hyland, 2001). As part of the academic and ethical socialization of young scholars, to promote the appropriate attribution of ideas and protect intellectual property, universities, journals, and other organizations seek effective ways to detect plagiarism in the writings students assess or review (e.g., https://publicationethics.org/). Understandably and appropriately, many institutions give serious warnings and admonitions against the violation of plagiarism norms in all written assignments, assessments, and contributions of any sort.

Other researchers have sought to understand textual borrowing from a developmental perspective, specifically in L2 emerging writers. Some researchers describe textual borrowing as a "natural stage" (Currie, 1998, p. 10) or "a necessary phase through which developing writers must pass before they acquire more sophisticated ways of integrating sources into their writing" (Keck, 2006, p. 262). Through this developmental lens, studies have examined textual borrowing in relation to students' language proficiency and their familiarity with academic literacy. For instance, in a study examining Thai university L2 learners' summary writing, researchers found that less proficient L2 writers demonstrated more frequent borrowing of word strings from the sources than more proficient learners did (McDonough et al., 2014). Similar associations between lower language proficiency and more prevalent textual borrowing were also found in the source-based writing of L2 learners (Baba, 2009; Plakans & Gebril, 2012; Weigle & Parker, 2012). In their explanation of this association, researchers have noted that less proficient students, who lack the linguistic resources to paraphrase sources into precise, concise, and authoritative language often resort to textual borrowing as a "safe strategy" (Currie, 1998, p. 10) when they encounter the "seemingly superior text produced by the original authors" (Hirvela & Du, 2013, p. 96).

In addition to language proficiency, the level of familiarity with academic literacy and academic culture is another factor influencing practices of textual borrowing. One study tracked five history majors during their first year of college, revealing that with explicit guidance on academic literacy knowledge, students progressively moved from listing discrete bits of information borrowed from primary documents to integrating source content as interpreted evidence to build their own arguments (Young & Leinhardt, 1998). Another line of research compared practices of textual borrowing across different language and cultural groups, finding that L2 learners tended to borrow significantly more and longer language fragments from the source than their native English-speaking counterparts did (Keck, 2006; Shi, 2004). While language proficiency certainly plays a role in this discrepancy, researchers more often ascribe it to ideological differences in teachers' and students' perceptions of textual borrowing, as Western cultures privilege the notion of "textual ownership",

whereas Asian cultures value memorization as inherent to the nature of language learning (Pennycook, 1996).

Not surprisingly, the majority of the studies reviewed above were conducted among the L2 learner population at the university level (Cumming et al., 2016). However, summary writing is a challenging academic task that many native English-speakers also struggle with (Keck, 2014; Wellington & Osborne, 2001; Yang & Shi, 2003). Starting around 4th grade, students are required to comprehend and produce increasingly complex academic texts (Bailey, 2007; Schleppegrell, 2001). To date, little is known about how L1 writers in upper elementary and middle school adopt textual borrowing strategies in their summary writing. In an earlier study, Brown and Day (1983) compared fifth and seventh graders' written summaries with those composed by older high school and college students, concluding that the "copy-delete" strategy—the practice of copying important elements from the source and deleting unimportant ones—appeared to be the most frequent strategy adopted by younger writers. However, their study treated fifth and seventh graders as a homogeneous group, with little attention given to potential individual and cross-grade differences. To our knowledge, associations between textual borrowing and overall summary quality, reading comprehension, and receptive academic language skills remain unexamined.

The current study

The current study aims to investigate textual borrowing in a corpus of science summaries written by a sample of mostly English L1 students attending urban public schools (grades 4 to 7) in the U.S. The study was guided by the following research questions:

1. To what extent do students borrow text from the source passage in science summaries? Does the degree of textual borrowing in summaries vary by students' grade level?
2. Are patterns of textual borrowing in science summaries associated with (1) students' reading comprehension of the summarized science text and (2) students' receptive academic language skills?
3. Controlling for reading comprehension of the source passage and summary length, are measures of textual borrowing associated with summary writing quality? Do receptive academic language skills moderate this relation?

Informed by prior research as well as by widespread assumptions in education circles, we anticipated that students with a higher prevalence of textual borrowing would write lower-quality science summaries (as rated by teachers who were blind to the present study's research questions). We also anticipated that students in higher grades (presumably with a higher familiarity with academic literacy practices), those with higher reading comprehension of the source passage and those with higher academic language proficiency would display less frequent textual borrowing in their science summaries. With the goal of exploring whether borrowing with particular

Table 1 Sociodemographic characteristics of participants

	N (%)
Gender	
Female	521 (54.45)
Grade	
Grade 4	238 (24.90)
Grade 5	290 (30.33)
Grade 6	240 (25.10)
Grade 7	188 (19.67)
SES	
Free/reduced-price-lunch eligible	770 (80.63)
English proficiency designation	
English learners	83 (8.59)
Race/ethnicity	
Black/African American	342 (36.27)
White	294 (31.18)
Latinx	251 (26.62)
Asian	34 (3.61)
Native American/Alaskan Islander	8 (0.85)
Multiple races/ethnicities	13 (1.38)
Special education status	
Eligible for special education	113 (11.83)
Total	956

functions might be positively associated with summary writing quality, we further identified borrowed text from the definitions of scientific concepts. We hypothesized that students might strategically borrow definitional language verbatim from the source text and, in so doing, potentially strengthen the quality of their summaries, particularly if they had better academic language skills to deploy in their writing.

Methods

Sample

The sample was collected from a larger literacy intervention conducted in the Eastern U.S (Jones et al., 2016). Students in the current sample were all participants in the business-as-usual instruction in three school districts (12 schools; 95 classrooms), and consent and assent from all students and their guardians were obtained prior to data collection. As shown in Table 1, the sample contained 956 students, approximately balanced by gender and grade level. Due to the student population composition of urban public schools participating in the project, the majority of the sample were eligible for free/reduced-price lunch. Participants represented a variety of races and ethnicities. Based on school records, about 9% of the participants were identified as English learners, and 12% were eligible for special education.

Research measures

Two research instruments were administered to all participants:

Global Integrated Scenario-based Assessment (GISA) A 45-min, group-administered assessment, developed and validated by Educational Testing Services (ETS) to measure students' literacy skills and higher-order thinking skills (Sabatini et al., 2014). On a digital testing platform, participants were provided with a semi-authentic scenario specifying a purpose for reading (e.g., creating a website, studying for a test, or leading a group discussion) and a set of reading materials (e.g., websites, blogs, newspaper, etc.). Participants navigate through a series of structured activities that enable them to demonstrate a conceptual understanding of the content and literacy skills to decode, organize, and evaluate what they have read. This study focused on two sections of the GISA: (1) the reading comprehension test, and (2) the summary writing task.

(a) (*GISA reading comprehension* Participants first read a passage on science related topics (e.g., *Satellite, Wind Power*) and then answered a series of multiple-choice questions, assessing their comprehension of source passage content. A prior study on middle school students has revealed satisfactory psychometric properties of the instrument, including sufficient internal consistency ($\alpha = 0.89$) and a split-half reliability of 0.76. As the GISA forms were vertically-scaled, two grade-specific GISA forms were administered in the current study: the Satellites passage for 4–5 graders and the Wind Power passage for 6–7 graders.

(b) *GISA summary writing* After completing the reading comprehension task, participants were asked to summarize selected paragraphs of the same science text they had read. Participants were prompted to (1) include all (and only) main ideas from the source passage; (2) exclude personal opinions and information outside of the passage; (3) write in their own words without copying language from the source passage.

Core Academic Language Skills Instrument (CALS) A 50-min, group-administered assessment, designed and validated by the authors' research team (Galloway et al., 2019; Uccelli et al., 2015). The instrument contains eight tasks, each targeting a specific skill relevant for reading and writing complex academic texts, as outlined in the CALS construct (e.g., connecting ideas logically, interpreting writer's viewpoint, etc.). The CALS instrument has two vertically aligned forms: Form 1 was used for grades 4 to 6 ($\alpha = 0.90$, 49 items), and Form 2 was used for grade 7 ($\alpha = 0.86$, 46 items). CALS factor scores generated using Rasch Item Response Theory were used for analyses.

Coding and scoring summaries

Written summaries were collected digitally in plain text format. We corrected spelling mistakes in the original data for two purposes: first, so that all borrowed

texts could be accurately identified; second, so that human raters were not negatively biased by misspellings in the texts when scoring summaries for overall writing quality. The raw data with original spelling mistakes were saved in separate files. Then, the cleaned written data were coded and scored using the following procedure:

Textual borrowing coding Following prior research (Shi, 2004; Weigle & Parker, 2012), we adopted a coding scheme to identify words and word-strings borrowed verbatim from the source passage. This coding scheme was chosen as it allowed us to identify an "absolute minimum of borrowed words" (Shi, 2004, p. 178) from the source passage. Specifically, language fragments from students' summaries were coded as textual-borrowing (TB) if they met any of the following criteria:

- *Two-word TB* the combination of two content words (i.e., nouns, verbs, adjectives, and some adverbs) borrowed from the source passage. Such examples include "mechanical device" (*adj + noun*), "generator converts" (*noun + verb*), "move slowly" (*v + adv*), etc. In contrast, the combination of a content word and a functional word (e.g., pronouns, prepositions, conjunctions, articles, and auxiliaries) or two functional words were not coded as TB. For instance, phrases such as "you look" (*pronoun + verb*), "moves in" (*verb + prep*), "on rocket" (*prop + noun*) were not coded even if they were identical with phrases in the source passage. However, one exception to this general rule involved excluding from this TB coding the few central scientific concepts newly introduced in the passage (usually as noun phrases) because referring to these concepts was unavoidable in summary (for the *Wind Power* passage, these included: *wind turbine, wind farms, wind energy, wind resource potential;* for the *Satellite* passage: *natural satellites, artificial satellites, weather satellites, research satellites, solar system).*
- *Three-word TB* Strings of three consecutive words borrowed from source texts when they formed a meaningful phrase or clause. A phrase is defined as a group of words with an obligatory head word and optional dependents, such as noun phrases (e.g., *a mechanical device)*, preposition phrases (e.g., *into wind energy)*, and verb phrases (e.g., *predict weather patterns*) (Finch, 2016). A clause is defined as a syntactic unit containing a unified predicate that expresses a single activity, event, or state (e.g., *It generates electricity.*) (Berman & Slobin, 1994, p. 440). Those that did not form a meaningful phrase or clause (e.g., *you look into, scientists call this)* were not coded.
- *Longer-string TB* All strings of four consecutive words borrowed from the source texts that "formed some kind of syntactic unit" (Shi, 2004, p. 178).
- *References* TBs were coded to indicate whether the author marked in any way that they came directly from the source passage, either through quotation marks or explicit referential language (e.g., *the passage says […]).*
- *Definitional TB* Among all borrowed words, a special code was added if the borrowed words were part of the definitions in the source texts (e.g., *a wind farm is a collection of wind turbines that […])* because they were considered to serve

a special function in science summaries that were different from other types of borrowing.

Textual borrowing indices Two research assistants received a thorough training of the coding scheme and independently coded all written summaries. The comparison of their coding showed an agreement of 86%, and all disagreements were resolved through discussion. After the coding was finalized, we generated four TB indices to quantify patterns of textual borrowing in each text. In Table 2, we provide detailed definitions and explanations with a coded example.

Writing quality scoring Aligned with the NAEP writing assessment framework (2011), a 6-point holistic rubric was used to evaluate the writing quality of summaries. This rubric included four dimensions: (1) *Organization*: whether the summary was organized coherently at the text and paragraph levels; (2) *Accuracy*: whether the summary provided accurate information from the source text; (3) *Coverage*: whether the summary covered key information from the source text; (4) *Clarity*: whether the summary conveyed information in a precise and understandable manner.

Based on the rating on each of these four dimensions, human raters (trained researchers with prior experience as ELA or science teachers and blind to the study research questions) assigned an overall writing quality score. The rubric included three additional data-driven tools to guide scorers: (1) a content-idea-unit map outlining the main idea units of the source text; (2) a minimal summary scheme describing the main organizational structure of the source text; (3) anchor texts for each quality level carefully selected and discussed during the training session. High inter-rater reliability was achieved on approximately 20% of the data (190 summaries) as indicated by a Kendall's coefficient of 0.99, $p < 0.0001$.

Data analysis

After examining descriptive statistics of all TB indices as well as students' reading comprehension, CALS and summary writing quality scores, we conducted the following steps to address the three research questions. First, to examine TB patterns across grades (RQ1), we conducted a series of analyses of variance (ANOVA) with each TB index as the dependent variable and grade level as the independent variable. Next, we investigated pairwise correlations for TB indices, reading comprehension and CALS (RQ2). Finally, we built a series of multi-level models to explore predictive associations between TB indices and writing quality, controlling for students' sociodemographic characteristics, reading comprehension, and summary length. The role of CALS in moderating these relations was also examined. As the sample was recruited from 12 schools and 95 classrooms, we chose the mixed-effect approach to account for the unobservable differences at the classroom- and school-levels. First, we adopted two-level models with random intercepts at the classroom-level, which allowed us to partition the influence of the classroom instructional context on students' summary writing practices. Second, we treated schools as fixed effects by including 11 dummy-coded variables to control for school differences. All variables were transformed to a

Table 2 Textual borrowing indices and an annotated example

Index	Definition	TB in the example
TB_words_ratio	Ratio of all words borrowed verbatim from source text divided by total number of words in summary	39/136 = 0.29
TB_words_ratio (def.)	Ratio of words borrowed verbatim from the definitions in source text	22/136 = 0.16
TB_strings_frequency	Frequency of word strings (e.g., two-word, three-word or longer fragments of contiguous words) borrowed from source text	4
TB_strings_length	Average number of words per string borrowed	(12 + 2 + 10 + 17)/4 = 10.25

A coded example

Electricity can be created in a variety of ways such as ***wind farm is collection of wind turbines that, together can generate a large amount of electricity***. And another thing is that wind can be used for recreational purposes such as flying kites or sailing, it can also be used to [**generate electricity**] with help of machines called ***wind turbines***. Electricity can be generated using many different sources. Winds are caused by the uneven heating of the earth's surface is made up of different types of land and water, it absorbs the sun's heat at different rates. **__A wind turbine is a mechanical device designed to transform wind energy into electricity. Large wind turbines that are used to generate electricity for entire towns or cities are mounted on tall towers__**

Bold words indicate all borrowed words; bold and underlined words indicate words borrowed from the definitions in the source text; and bold and italic words indicate scientific terms borrowed from the source text but excluded from coding

Table 3 Descriptive statistics of reading comprehension (GISA), receptive academic language skills (CALS), and holistic writing quality of summaries by grade

	Grade 4 M (SD)	Grade 5 M (SD)	Grade 6 M (SD)	Grade 7 M (SD)
ReadComp (GISA)	957.89 (53.85)	979.79 (59.27)	995.51 (81.37)	1003.54 (90.23)
AcadLang (CALS)	0.32 (0.97)	0.74 (1.09)	1.18 (1.17)	1.29 (1.13)
SumQuality	2.72 (1.18)	2.98 (1.26)	3.26 (1.27)	3.56 (1.42)

Table 4 Means, standard deviations, and one-way analyses of variance by grade in textual borrowing indices

GISA form	Grade 4 Satellites	Grade 5			Grade 6 Wind power	Grade 7		
	M (SD)	*M (SD)*	*F*	*p*	*M (SD)*	*M (SD)*	*F*	*p*
Word token	44.21 (29.13)	49.45 (29.50)	**4.17**	**0.04***	77.20 (34.88)	77.89 (35.98)	0.04	0.84
% of summaries with TB	0.66 (0.48)	0.70 (0.46)	0.98	0.32	0.70 (0.64)	0.64 (0.48)	1.77	0.18
TB_words_ratio	0.25 (0.20)	0.29 (0.22)	**3.90**	**0.05***	0.17 (0.12)	0.21 (0.16)	**4.07**	**0.04***
TB_words_ratio (def.)	0.03 (0.09)	0.07 (0.15)	**9.37**	**0.002****	0.07 (0.10)	0.10 (0.12)	**5.96**	**0.02***
TB_strings_freq	1.96 (1.21)	2.12 (1.41)	1.41	0.24	1.67 (1.04)	1.80 (1.04)	1.06	0.30
TB_strings_length	5.62 (3.74)	6.72 (4.34)	**6.34**	**0.01****	8.32 (4.20)	9.45 (6.83)	**3.04**	**0.08~**

~p < .10; * p < 0.05; **p < 0.01; ***p < 0.001

z-metric (mean = 0; standard deviation = 1) to present standardized regression coefficients. Analyses were performed in Stata/MP 15.1.

Results

Patterns of reading and writing skills and textual borrowing across grades

Table 3 shows clear cross-grade variations. As expected, students in higher grades demonstrated higher scores in reading comprehension (GISA), receptive academic language skills (CALS), as well as human-rated science summary writing quality.

Table 4 displays descriptive statistics of cross-grade patterns of textual borrowing (TB) in the sample.[1] Students in higher grades produced longer summaries, with a

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[1] We compared students summarizing the same passage (grades 4–5; Satellites; grades 6–7: Wind Power) as TB patterns can be influenced by the content and textual features of specific source texts.

Table 5 Pairwise correlations for study variables

	GISA	CALS	Quality	Form	Length	w.ratio	w.def	s.freq
Assessments								
ReadComp (GISA)	1.00							
AcadLang (CALS)	0.77**	1.00						
Essay measures								
SumQuality	0.52**	0.53**	1.00					
Form (WP)	0.22**	0.30**	0.22**	1.00				
Length (token)	0.38**	0.36**	0.53**	0.44**	1.00			
TB indices								
words_ratio	−0.30**	−0.28**	−0.09*	−0.22**	−0.21**	1.00		
words_ratio_def	−0.14**	−0.09*	0.09*	0.10*	0.01	0.56**	1.00	
string_freq	0.06	0.06	0.31**	−0.14**	0.32**	0.49**	0.21**	1.00
string_length	−0.14**	−0.11**	0.07	0.26**	0.30**	0.52**	0.51**	0.07

$\tilde{}\,p < .10$; $*p < 0.05$; $**p < 0.01$; $***p < 0.001$

significant difference between 4 and 5th graders. About 70% of summaries in 5th and 6th grade contained some degree of textual borrowing. This portion was slightly lower in 4th grade (66%) and 7th grade (64%), but the differences across grades were not statistically significant. Surprisingly, among the total of 650 summaries containing TB incidences, only 11 were explicitly marked with quotation marks or through textual markers, such as *the text says…, it is said…*

The analyses of the four TB indices revealed that overall students at higher grade levels borrowed more and longer language fragments from the source texts compared to their younger counterparts. Specifically, on average, 29% of words in 5th graders' summaries were borrowed from the source passage, which was 4% higher than those written by 4th graders summarizing the same passage ($F = 3.90$, $p = 0.05$). Similarly, on average, 21% of the words in 7th-grade summaries and 17% in 6th-grade summaries were borrowed verbatim, and this difference was also statistically significant ($F = 4.07$, $p = 0.04$).

Older students tended to borrow more definitional language; that is, the language used to define key scientific terms. Older students also borrowed significantly longer word strings. For instance, the average TB strings length in 5th graders' summaries was 6.72 words per string which was more than one word longer than the 4th-grade average ($F = 6.34$, $p = 0.01$). This difference was not significant in the older grades. Finally, TB strings frequency did not differ across grades.

Pairwise correlations

Table 5 shows pairwise correlations between TB indices and students' reading comprehension assessment scores (GISA), receptive academic language scores (CALS Instrument), and human-rated science summary writing quality. First, positive and moderate bivariate associations between the four TB indices (which ranged from 0.21 to 0.56) suggested that these indices measured related but distinctive TB

Table 6 Multi-level regression analysis examining the relation between TB indices and science summary writing quality, and the moderation effect of CALS

	Model 1	Model 2	Model 3	Model 4
Fixed effect				
Grade	0.14˜	0.09	0.06	0.07
Form (WP=1)	−0.44**	−0.26	−0.24	−0.25
Reading comprehension (GISA)	0.35***	0.36***	0.21***	0.21***
Essay length (token)	0.43***	0.32***	0.32***	0.32***
Text borrowing indices				
TB words ratio		−0.09	−0.07	−0.07
TB words ratio (def)		0.13***	0.12***	0.12***
TB strings freq		0.24***	0.23***	0.22***
TB strings length		−0.01	−0.01	−0.01
Academic language (CALS)			0.22***	0.22***
Interaction				
TB words ratio (def)×CALS				0.06*
Intercept	−0.13	0.03	0.16	0.11
Random effect				
Level 2	−1.63***	−1.53***	−1.56***	−1.58***
Level 1	−0.36***	−0.41***	−0.42***	−0.42***
Goodness of fit				
AIC	1454.72	1404.71	1275.24	1273.51
BIC	1535.3	1503.2	1376.14	1378.8

Fixed-effects for schools were omitted from the table for clearer presentation

˜$p<.10$; *$p<0.05$; **$p<0.01$; ***$p<0.001$

patterns. Second, TB indices were in general negatively associated with students' reading comprehension and receptive academic language skills. Specifically, three out of the four TB indices (i.e., TB_words_ratio, TB_words_ratio_definition, and TB_strings_length) were negatively and significantly associated with GISA scores with their correlation coefficients ranging from −0.30 to −0.14, indicating that students with lower reading comprehension skills tended to borrow a higher proportion of words and longer word strings from source texts. Similar negative correlations could also be found between TB indices and CALS scores. Third, the association between textual borrowing and overall writing quality varied across different TB indices. Whereas writing quality displayed a negative association with the proportion of borrowed words ($r=−0.09$, $p=0.03$), it was positively associated with the borrowing of definitional language ($r=0.09$, $p=0.01$) and word strings ($r=0.31$, $p<0.001$).
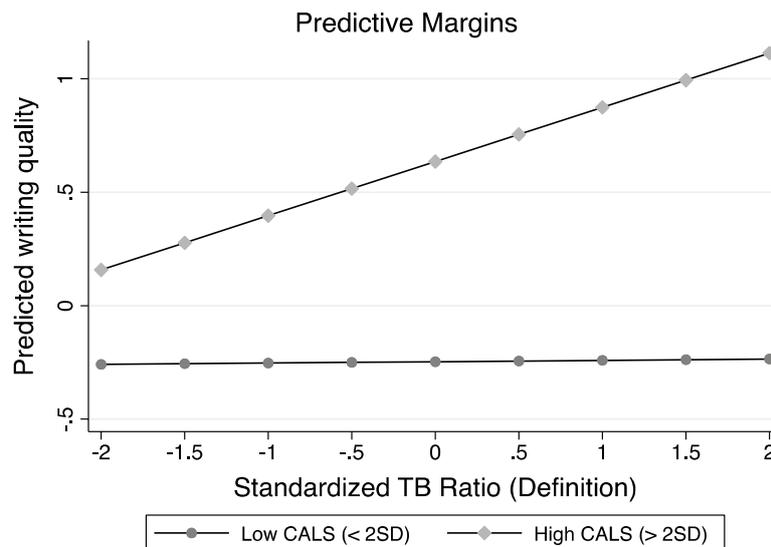
Associations between textual borrowing and writing quality

Table 6 displays the results from a multi-level regression analysis investigating the contribution of textual borrowing to overall summary writing quality. In Model 1, we first entered all control variables predicted to be associated with summary writing quality on the basis of prior research, including students' grade and reading comprehension, passage form (Wind Power or Satellites) and summary length. This baseline model showed, as expected, that grade and reading comprehension were positively associated with summary writing quality overall. Controlling for other variables, the effect of form was negative, which means that the Wind Power passage (grades 6–7) resulted in overall lower quality scores than that of the Satellite passage (grades 4–5). Higher writing quality was also associated with summary length. Demographic characteristics (i.e., gender, free/reduced-price-lunch eligibility, English proficiency designation, special education status) were included in the baseline model, but none displayed significant associations with the outcome variables, presumably given the scarce variability in these characteristics. Thus, they were removed from subsequent analysis for model parsimony.

In Model 2, we entered four TB indices at the same time to explore their relative predictive power of the variability in overall writing quality. Though these four indices were positively associated with each other, the highest pairwise association (between TB words ratio and TB strings length) was 0.52, which was not high enough to cause concerns for multi-collinearity. Model 2 results revealed that two TB indices were positively predictive of overall writing quality: TB words ratio of definitional language and frequency of TB strings, with a standardized regression coefficient of 0.13 ($p < 0.001$) and 0.24 ($p < 0.001$), respectively. The four added TB indices in Model 2 explained a significant amount of variance in overall writing quality (Model 1 vs. Model 2 Likelihood-ratio test: $chi^2(4) = 58.01$, $p < 0.001$).

CALS as a significant moderator

In Model 3, we entered students' Core Academic Language Skills (as measured by CALS Instrument) as an important predictor, given its strong association with both school reading comprehension and writing proficiency in prior research, and more specifically, its strong correlation with summary writing quality. Consistent with previous research, CALS was found to be significantly predictive of summary writing quality, such that a 1-*SD* difference in CALS was associated with a 0.22-*SD* increment in summary writing quality scores. More interestingly, we found that CALS played a significant role in moderating the association between one of the TB indices (i.e., TB_words_ratio (def.) and writing quality. As illustrated in Fig. 1, the association between TB of definitional language and summary writing quality varied by students' CALS level. Specifically, for students with higher CALS (e.g., more than 2-*SD* above the sample mean), a positive association between TB of definitional language and summary writing quality was detected; in contrast, for students with lower CALS (e.g., more than 2-*SD* below the sample mean), the association was almost nonexistent.

Predictive Margins

Fig. 1 Core Academic Language Skills moderate the relationship between ratio of definitional textual borrowing and summary writing quality

Illustrating strategic textual borrowing

In this section, we briefly discuss a few examples to illustrate the quantitative findings reported above. First, we specifically zoom in on summary definitions and then compare two summaries rated by teachers as high versus low quality.

Borrowing definitional language As stated in the results section, students in higher grades borrowed more definitional language than their younger counterparts when summarizing the same source text. Moreover, controlling for a variety of covariates, borrowed definitional language positively contributed to summary writing quality, in particular for students with higher academic language proficiency. The examples below illustrate differences across students in definitions of key scientific concepts from the source text. Below, we present the original definition of "wind turbine" from the *Wind Power* source text, along with examples of this definition as presented by two students in their summaries. As observed below, the first definition did not include any textual borrowing, whereas in the second definition, 30% of the words were borrowed.

Source-text definition:

"A ***wind turbine*** is a mechanical device designed to transform wind energy into electricity."

Summary definition #1 [male, grade-6 student, low CALS]:

"A wind machine is a thing that spins around every day." [no TB]

Summary definition #2 [female, grade-6 student, high CALS]:

"A ***wind turbine*** is a **<u>mechanical device</u>** made to **<u>transform wind energy</u>** to electrical energy. [TB words ratio: 5/15=30%]

As can be observed, in the first summary definition, the student defines the concept fully through his "own words", as explicitly requested by the summary task. Through his own words, however, the student paraphrases the definition in a way that lacks linguistic precision (i.e., *machine* instead of *turbine* is used to refer to the object*;* the nonspecific term *thing* is used instead of a precise superordinate) and, while the information provided is accurate information, important content is left out (*spins around every day* instead of *transform wind energy into electricity*).

In contrast, in the second definition, five out of 15 words were borrowed from the source-text definition. Whereas a short fragment that displays a 30% rate of borrowing might raise a red flag, we could argue that this student applied text borrowing strategically. First, the writer seems to recognize the significance of the borrowed two-word string as conveying an essential superordinate category (*mechanical device*) and seems to strategically borrow *almost verbatim* another key element—the function of wind turbines (*transform wind energy into electrical energy*). Second, the writer was likely aware that she did not have alternative lexical or syntactic resources in her own linguistic repertoire to paraphrase these expressions with the expected precision and conciseness. The student writer, however, seemed clearly aware of the necessity of paraphrasing (when possible) as indicated by her effort to change "*transform wind energy into electricity*" to "*transform wind energy to electrical energy*". In an effort to describe these observed textual patterns across our sample, we refer to these selective and minimally paraphrased brief chunks of text as *strategic borrowing.*

Textual borrowing as predictive of summary writing quality. To illustrate how *strategic textual borrowing* contributes to summary quality, here we compare the TB patterns of two summaries: one rated by teachers to be of low quality (Summary 1) versus another rated a high quality (Summary 2).

Summary 1 A low-quality summary example and its TB indices

Large wind turbines that are used to generate electricity for entire towns or cities are mounted on tall towers. At 100 feet or more above ground, they can take advantage of faster and more consistent wind flows. The electricity they produce can be transmitted along power lines to where it can be used by people and businesses. In some states **the wind blows more during the winter time.** That is a good thing when comes to these **seasonal variations.** In places with a more warmer climate people use energy for air conditioners. In places with a more colder climate they use the energy for heat

TB measures

TB_words_ratio: 63/105=0.6

TB_words_ratio (def): 0/105=0

TB_strings_freq.: 3

TB_strings_length: 63/3=21

Bold words indicate all borrowed words; bold and underlined words indicate words borrowed from the definitions in the source text; and bold and italic words indicate scientific terms borrowed from the source text but excluded from coding.

Summary 2 A High-quality summary example and its TB indices

<u>**A wind turbine is a type of mechanical device**</u> that uses blades, just **like the propellers on an airplane. A wind turbine is designed to transform the wind energy into electricity.** A *wind turbine*'s electricity can be sometimes **transmitted along power lines** so people can use it in businesses. <u>**A wind farm is a collection of wind turbine's that can make a large amount of electricity.**</u> When a wind farm is built the location must be **chosen carefully** because it should be built in an area that has **strong steady winds** which is also called ''*wind resource potential*''

TB measures

TB_words_ratio: 44/99 = 0.44

TB_words_ratio (def): 22/99 = 0.22

TB_strings_freq.: 8

TB_strings_length: 32/8 = 4

Bold words indicate all borrowed words; bold and underlined words indicate words borrowed from the definitions in the source text; and bold and italic words indicate scientific terms borrowed from the source text but excluded from coding

In Summary 1, 60% of the words were borrowed, but none of them were part of definitions in the source text. Whereas only three strings were borrowed, the average string length was 21, with the longest string consisting of 57 words borrowed verbatim from the source text. No particular consideration of discourse functions or information relevance seems evident in this summary's borrowed fragments.

In contrast, Summary 2 contained 32 borrowed words (32%), with 19 of those directly borrowed from the definitions presented in the source text (i.e., *wind turbine*, *wind farm)*. Contrary to the few longer borrowed strings of Summary 1, Summary 2 presents more and shorter borrowed strings (8 strings; with a mean of 4 words/string) and the TBs conveyed seemingly strategically selected important information from the source text. Interestingly, most TB choices include collocations frequent in academic writing (*a collection of…, transmitted along, chosen carefully, a large amount of…).* If internalized, these linguistic chunks would expand this student's academic language, reading and writing proficiencies.

Comparing the CALS scores obtained by the writers of the two summaries above: the writer of Summary 1 had a CALS score of 0.33 (0.48 SD below the sample mean) – ECALS 504, whereas the writer of Summary 2 had a CALS score of 3.16 (2 SD above the sample mean). The differences in these two writers' skills in recognizing essential discourse elements (i.e., definitions) in the source text and then integrating them in summaries might illustrate the important role of CALS in moderating the relation between definitional TB and summary writing quality.

Discussion

In this study, we examined textual borrowing (TB) in science summary writing in a cross-sectional sample of upper-elementary and middle school students in the eastern U.S. We analyzed four TB indices that captured the proportion, the frequency, the average length, and one particular function of textual borrowings (i.e., definitions) in students' science summaries. There were three main findings from this study. First,

consistent with our hypothesis, both TB frequency and length were negatively associated with reading comprehension and receptive academic language skills. Second, contrary to our hypothesis, students in higher grades (those with higher reading and writing proficiency, as indicated by the GISA and CALS assessment scores) demonstrated significantly more and longer TB than their younger counterparts when summarizing the same passage. Third, after controlling for a range of covariates, the frequency of TB strings was found to be positively associated with summary writing quality, as was the ratio of definitional TB, specifically for students with higher academic language proficiency. These findings are discussed in the following section with regard to their theoretical and practical implications.

Textual borrowing and summary writing quality

This study contributes to a line of research that conceptualizes TB—or, more precisely, some forms of TB—as potentially strategic and effective in expanding academic language and literacy resources (Lancia, 1997; Pytash & Morgan, 2014). Inspired mostly by prior L2 research, the present study investigated the role of TB in the writing quality of science summaries and explored whether, counter to widespread expectations, TB would be associated with the quality of a summary in some instances. In fact, as our findings revealed, higher proportions of borrowed words alone did not support higher quality. Instead, the positive contribution of TB detected requires a more nuanced analysis and calls for a cautious discussion.

First, the prominent textual borrowing documented (i.e., of the 956 summaries, 650, or 68%, contained some TB) might partially reflect what has been described as developing writers' perception of summarization as a "copy-delete" task: "when required to write a summary … [students] appeared to treat the task as one of deciding [whether] to include or delete elements that actually occurred in the surface structure of the original text" (Brown & Day, 1983, p. 3). These authors found that the "copy-delete" strategy characteristic of younger writers (grade 5 and 7) was radically different from the "transformational rules of condensation" (p. 2) adopted by older high school and college students. From this perspective, "strategic TB" offers evidence of students strategically selecting information that they consider important to include in their summaries, which constitutes one positive step forward in becoming a skilled summary writer.

However, the challenge for researchers and educators alike becomes identifying strategic TB or the "legitimate appropriation of language" (Shi, 2004, p. 191) when the majority of students' TB might indeed be nonstrategic. Our approach in this study was to generate a variety of TB indices and to code specifically for the TB of definitional language, which proved to be an insightful approach. Not only did older students in this study borrow significantly more definitional language than their younger peers, but this borrowed definitional language contributed significantly to the quality of summaries, particularly for students with better academic language skills. Older and more skilled writers presumably have higher register and genre awareness and thus are likely to have internalized the expectations of precision and conciseness in academic summaries (Berman, 2007; Qin & Uccelli, 2020; Uccelli

et al., 2015). They are also more likely to be aware of their own language resources and might recognize that they lack alternative vocabulary or syntactic structures in their own linguistic repertoire that could help them paraphrase textual fragments into another precise and concise passage of academic language. Interestingly, those with higher metalinguistic development might be the ones who opt to resort to what has been described as the "safer ground" of textual borrowing (Currie, 1998; Hirvela & Du, 2013). The positive contribution of TB string frequency to summary quality suggests that several strings—presumably minimally paraphrased, strategically selected academic collocation chunks (as we observed in Summary 2)—supported the quality of the summaries. These findings are aligned with those of previous L2 studies suggesting that TB can contribute to writing quality via enhanced lexical diversity (Gebril & Plakans, 2016) and stylistic variety (Petrić, 2012). Minimal paraphrasing (as illustrated above in Summary 2) has been characterized in prior L2 research and research with college students as "patchwriting" or the attempt of developing writers to employ the target discursive style using their own grammatical skills (Flowerdew & Li, 2007; Howard, 1995). Our findings document this particular strategic borrowing practice in L1 upper-elementary and middle school students for the first time (to our knowledge).

Textual borrowing and academic language proficiency

Academic language skills played a significant role in moderating the relation between definitional TB and summary writing quality. Several skills in the CALS (Uccelli et al., 2015) framework might be relevant in scaffolding students' recognition, comprehension, and production of definitional information in summaries. Taking the wind turbine passage as an example, student writers first need to rely on their *skills in organizing analytic texts* to divide the whole passage into two distinctive sections and identify the two definitions leading each one (i.e., *wind turbine* and *wind farm*). Definitions in science texts are usually composed of extended noun phrases that pack complex information into dense structures known as nominalizations (Fang, 2005; Halliday & Martin, 2003). Thus, the comprehension of the definition of "wind turbine", for instance, then requires students to use their *skills in unpacking dense morphosyntactic structures* to identify the head noun (i.e., *device*), the premodifier (i.e., *mechanical*), and the postmodifier (i.e., *designed to transform…*). Finally, students need to use their *metalinguistic skills* and *connecting ideas skills* to integrate these definitions into their own writing to form a coherent summary. Thus, it is not surprising that the predictive relation between definitional TB and writing quality was stronger for students with higher CALS than for students with lower CALS.

These study findings hint at the tension many student writers and their teachers face in learning and teaching how to summarize academic texts. While students are explicitly told to "write in their own words", they are also gradually aware that they need to acquire and reproduce a somewhat "fixed canon of knowledge and a fixed canon of terminology to go with it" (Pennycook, 1996, p. 213). Instead of the widespread consideration of textual borrowing in school, regardless of its nature and

function, always as an infringement of integrity rules, the present findings lead us to hypothesize that strategic textual borrowing seems worth of further exploration as a potentially fruitful language learning strategy, that may be promising in fact if intentionally leveraged in instructional practices. Analogous to the learning of linguistic chunks in early first or foreign oral language development (Goldberg, 2006; Lieven et al., 2009), some students perhaps intuitively engage in and benefit from strategic TB while others, perhaps in their efforts to comply with the requirement of using their own words might indeed be missing on important opportunities to learn academic language, to display what they may understand, and to communicate effectively. Certainly, these are only hypotheses raised by this study and only future research will be able to elucidate TB patterns further and shed light on their role in students' academic language development.

Limitations and implications

The current findings should be interpreted with considerations of several limitations. First, we only coded verbatim textual borrowing but did not analyze textual borrowing with different levels of modifications or reformulation as done in previous studies (Keck, 2006; Shi, 2004). More differences across grades might have emerged if we had coded for such distinctions. Second, given that students at different grade levels summarized different passages, we were limited in our exploration of developmental trends. Third, we can only speculate about the reasons behind students' TB. Interviews or think-aloud activities with students discussing their TB patterns would have been insightful but were not available for this study.

Despite limitations, the current study provides informative inferences for educators and researchers. The finding that textual borrowing is a prevalent phenomenon that is not limited to the L2 learning context (Keck, 2014; Wellington & Osborne, 2001; Yang & Shi, 2003), reveals that even L1 students can struggle with the academic language of reading and writing at school (Snow & Uccelli, 2009). Therefore, during the summarization process, many rely on the vocabulary, syntactic structures, organizational patterns, and writing style of the source text. Teachers should recognize the linguistic and cognitive challenges of summarization tasks, and future studies might investigate the potential of summarization tasks as learning opportunities to expand students' knowledge of the language resources and discursive expectations of the academic register, perhaps via strategic TB.

Of course, above and beyond textual borrowing, one central goal of education is to support students to become knowledgeable in disciplinary content and proficient language users who can construct critical and original ideas and communicate them through precise, concise, and organized language, yet language that allows for flexibility and creativity. To achieve this goal, we could draw more questions than conclusions from this single exploratory study. For instance, how should textual borrowing be defined and dealt with, particularly in classrooms with emerging academic language learners? When teachers see students borrow chunks of texts from a textbook or an article they have just read in their summaries or argumentative essays, what kind of feedback should be provided? When teachers ask students to

paraphrase source texts "into your own words", how is this instruction interpreted by students at different levels of academic language proficiency? Finally, what scaffolding is best in supporting students in the use of their "own words" as they also expand and gradually appropriate additional language resources frequently used and pragmatically effective in academic communities? We hope that the preliminary insights from this study will encourage other researchers to pursue these questions.

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