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Text Exposure Predicts Spoken Production of Complex Sentences in 8- and 12-Year-Old Children and Adults

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There is still much debate about the nature of the experiential and maturational changes that take place during childhood to bring about the sophisticated language abilities of an adult. The present study investigated text exposure as a possible source of linguistic experience that plays a role in the development of adult-like language abilities. Corpus analyses of object and passive relative clauses (Object: *The book that the woman carried*; Passive: *The book that was carried by the woman*) established the frequencies of these sentence types in child-directed speech and children's literature. We found that relative clauses of either type were more frequent in the written corpus, and that the ratio of passive to object relatives was much higher in the written corpus as well. This analysis suggests that passive relative clauses are much more frequent in a child's linguistic environment if they have high rates of text exposure. We then elicited object and passive relative clauses using a picture-description production task with 8- and 12-year-old children and adults. Both group and individual differences were consistent with the corpus analyses, such that older individuals and individuals with more text exposure produced more passive relative clauses. These findings suggest that the qualitatively different patterns of text versus speech may be an important source of linguistic experience for the development of adult-like language behavior.

Keywords: sentence production, children, relative clause, corpus analysis, text exposure

A fundamental question in the language acquisition literature is how children's language comprehension and production abilities, over time, come to attain the more complex character exhibited by adults. Many aspects of adult-like behavior emerge years after a behavior is initially exhibited, suggesting that behavior changes to become more like that of an adult as a child develops greater memory or other capacities and/or accumulates experience with language.

This pattern of gradual development is evident in word choice. When children begin to use a particular word or construction, they are not necessarily using it in an adult-like manner. They often over- or underextend it, by either using it to refer to entities or situations to which it does not apply, or failing to use the word in appropriate contexts (Bowerman, 1978; Clark, 1978; Kay & Anglin, 1982; Rescorla, 1980). Over time, children's behavior gradually comes to mimic that of adults (Ameel, Malt, & Storms, 2008; Hudson Kam & Edwards, 2008; Saji et al., 2011). This gradual change suggests that the accumulation of experience, often over years or decades, may be an important driver of language development.

Shifts over time are not only characteristic of children's lexical choices, but syntactic choices as well. De Marneffe, Grimm, Arnon, Kirby, and Bresnan (2012) investigated children's production of the two forms of English dative sentence structures (e.g., *give Mary a book, give a book to Mary*). The two dative forms are known to vary in adult English speakers as a function of a number of properties of the utterance, including the length of phrases in the sentence, animacy of the elements, and whether another dative form was recently uttered (Bresnan, Cueni, Nikitina, & Baayen, 2007). De Marneffe et al. (2012) aimed to investigate whether children's alternation between the two forms was similar to adults' and whether children's utterance choices were similarly affected by a complex mix of factors. Analyzing child and child-directed utterances from the Child Language Data Exchange System (CHILDES) corpus, they found that like adults' utterances, children's dative choices were influenced by a complex interaction of factors, though children appeared to weigh the factors somewhat differently than adults do. They interpreted these patterns as supporting experience-based development of children's control over syntactic structures.

There are a number of hypotheses for why language choices, especially the syntactic choices we investigate here, change across development. These hypotheses are largely driven by findings in the adult and child sentence comprehension literatures, in which hundreds of studies have investigated why certain sentences are

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harder to comprehend than others. Potential explanations for why some sentences are harder to comprehend or produce than others fall into two broad categories: Syntactic Complexity/Memory approaches and Experience-Based approaches. These two perspectives have important implications for how children acquire adult-like language abilities.

Syntactic Complexity/Memory Approaches to Sentence Processing

There is a long history linking syntactic complexity and the difficulty of language comprehension. For example, syntax-memory approaches to relative clause processing proposed that relative clauses reflect inherent processing differences between different structure types, largely driven by different memory demands imposed by different structure types. Many studies have contrasted sentences containing object relative clauses as in (1a), where the head noun, *the student*, is the object of the verb (the one who was helped) with sentences containing subject relative clauses (1b) where the head noun, *the student*, is the subject of the verb (the one who helped). The higher degree of difficulty of object relative clauses for both adults and children has historically been attributed to memory demands thought to be inherent in sentences of different types (Bartek, Lewis, Vasishth, & Smith, 2011; Gibson, 1998; Grodner & Gibson, 2005; Just & Carpenter, 1992; King & Just, 1991). The object relative clauses in (1a) require the comprehender to hold the head noun, *student*, in memory until the word *helped*, where the comprehender learns what action the student took part in, while in the subject relative case, the duration with which the head noun must be maintained in memory is much shorter. Thus, on this view object relatives (1a) are inherently more taxing of working memory than subject relatives (1b), owing to the longer noun-verb dependencies in (1a).

1a: Object Relative: The student who the teacher helped finished the assignment.

1b: Subject Relative: The student who helped the teacher finished the assignment.

This hypothesis shaped early work with children's comprehension of relative clauses as well. A number of studies have contrasted children's abilities to act out subject versus object relative clauses using toy animals with sentences such as "The pig kissed the horse that jumped over the sheep." These tasks are typically quite difficult for children, with accuracies around 30% to 80% for 5-year-olds, depending on the type of relative clause tested, and accuracies less than 10% in some conditions for 4-year-olds (de Villiers, Flusberg, Hakuta, & Cohen, 1979; Goodluck & Tavakolian, 1982; Sheldon, 1974, 1977). Subject relative clauses are generally easier than object relative clauses (de Villiers et al., 1979; Fluck, 1978; Goodluck & Tavakolian, 1982; Roth, 1984; though there is some variability in that finding, Sheldon, 1974, 1977). These patterns are similar to comprehension patterns found with adults, and consistent with a syntactic complexity approach. This work is often interpreted to suggest that processing requirements vary by type of embedding, and that children's difficulty with comprehending and producing these structures reflect the high processing demands of certain types of relative clauses exceeding the low processing or memory capacity of young children.

Experience-Based Accounts

In contrast to these memory-based approaches, other work has argued that experience plays a central role in language abilities (MacWhinney & Bates, 1989; Seidenberg & MacDonald, 1999). A large body of work suggests that statistical learning of one's linguistic environment is a critical factor of comprehension abilities, as distributions in the linguistic environment predict comprehension difficulty. These approaches explore why language producers tend to favor some structures over others, creating frequency asymmetries (Gennari, Mirković, & MacDonald, 2012; Montag & MacDonald, 2014), and they suggest that the frequency asymmetries of the relative clause structures in sentence 1a and 1b predict comprehension difficulty (Gennari & MacDonald, 2009; MacDonald & Christiansen, 2002; Reali & Christiansen, 2007; Roth, 1984). That is, the higher memory demands and comprehension difficulty for object relative clauses compared to subject relatives stem from comprehenders' comparative lack of experience with the rarer object relative structure, which leads comprehenders to misinterpret it (Gennari & MacDonald, 2008). Consistent with this view, increasing comprehenders' experience with object relative clauses improves comprehension rates for both children (Roth, 1984) and adults (Wells, Christiansen, Race, Acheson, & MacDonald, 2009). The present study also aims to better understand the contributions of prior linguistic experience, but in this case we examine the effect on production, not comprehension. In particular, we examine the effect of a child's comprehension experience with various types of complex sentences on their abilities to produce these sentences themselves.

Recently, some memory-based accounts of relative clause comprehension have incorporated an experience component (e.g., Levy, Fedorenko, & Gibson, 2013), and some researchers have suggested that there should be a rapprochement between the two views, as when Scontras et al. (2014) suggested that "most researchers currently maintain that both a memory component and a probabilistic grammar component are needed in any complete model of language understanding." While a two-component system could take many forms, the general claim differs in two crucial ways from an experience-based account. First, as noted above, memory based accounts hold that object relatives like (1a) inherently have higher memory demands than subject relatives like (1b), and other factors, such as experience, are independent of this constant. In contrast, the experience account does not claim any inherently higher working memory demand of (1a) versus (1b), so that given sufficient experience, it would not be surprising to find that even young children produce the supposedly demanding object relative clauses. Second, whereas the experience and memory components are separable in the two-factor view, proponents of the experience-based view have argued that the computational capacity of a system cannot be separated from its experience (Gennari & MacDonald, 2008; MacDonald & Christiansen, 2002; McClelland & Elman, 1986). For example, computational simulations of relative clause comprehension (MacDonald & Christiansen, 2002) and production (Fitz, Chang, & Christiansen, 2011) find that the models gain processing capacity with experience, despite the fact that these models have no separate working memory component. A key feature of these experience-based systems is that learning occurs over many "grains" of detail, not just the structural contrast shown in (1a and 1b). We next consider some of that detail, in

preparation for considering children's relative clause experiences in speech and text.

Factors Affecting Relative Clause Difficulty

Whereas syntax/memory based accounts have focused on the structural contrast illustrated in (1a and 1b), other researchers have identified a number of lexico-syntactic combinations that greatly affect the ease with which sentences containing relative clauses are comprehended and the ease or frequency with which they are produced. Table 1 provides a partial summary of this previous work to demonstrate the importance of these variables to the study of relative clause production and comprehension. The present study will track these factors in child and adult-directed input as part of our analysis for how reading could change a child's experience with relative clause usage. These variables are: Animacy of the head noun (the noun modified by the relative clause), whether or not the relative clause was preceded by a relative pronoun (e.g., *The book that I read* vs. *The book I read*), and in the case of object relatives, animacy of the embedded noun and type of embedded noun (pronoun or full noun phrase, e.g., *The book she read* vs. *The book the student read*). Within passive relatives, the presence/absence of an agent "by phrase" varies with a number of factors in language production (e.g., *The ball that was caught* vs. *The ball that was caught by the man*). All of these relative clause properties have been extensively investigated, and previous work has documented their effects on both sentence production and comprehension.

As Table 1 shows, a great deal is known about the distributions of these lexico-syntactic combinations in adult speech and adult corpora, as well as how these distributions are tied to comprehension behavior. The dominant results in the table are that several factors affect speakers' choices of relative clauses to express their meanings, thereby affecting the frequency of alternative forms (left

Table 1
Important Lexico-Syntactic Properties and Their Relationship to Relative Clause Production and Comprehension in Previous Adult Production and Comprehension Research

	Production (including corpus analyses)	Comprehension
Animacy of head NP	Main findings: Inanimate head nouns tend to be more frequent than animate head nouns in object relative clauses. When describing something animate, producers gravitate to passive relatives instead. Gennari & MacDonald, 2008, 2009; Gennari, Mirković & MacDonald, 2012; Mak, Vonk, & Schriefers, 2002; Montag & MacDonald, 2014; Roland, Dick, & Elman, 2007	Main findings: Object relative clauses with inanimate head nouns are easier to comprehend than those with animate head nouns (frequent lexico-syntactic pairings are easier to comprehend than rare pairings). Gennari & MacDonald, 2008, 2009; Mak, Vonk, & Schriefers, 2002; Traxler, Morris, & Seely, 2002; Traxler, Williams, Blozis, & Morris, 2005; Weckerly & Kutas, 1999
Relative pronoun use	Main findings: Relative pronouns are used either when the upcoming relative clause is difficult to plan or contains unpredictable material. Ferreira & Dell, 2000; Jaeger, 2010; Montag & MacDonald, 2014; Race & MacDonald, 2003; Roland, Dick, & Elman, 2007; Temperely, 2003	Main findings: In ORCs, relative pronouns aid comprehension when preceding embedded full NPs subjects, hurt comprehension when preceding embedded pronoun subjects (frequent lexico-syntactic pairings are easier to comprehend than rare pairings). Fodor & Garrett, 1967; Hakes & Cairns, 1970; Race & MacDonald, 2003; Staub, 2010
Embedded noun type (full NP or pronoun)	Main findings: Object relative clauses with embedded relative pronoun subjects are more frequent than those with embedded full NPs. Reali & Christiansen, 2007; Roland, Dick, & Elman, 2007; Roland, Mauner, O'Meara, & Yun, 2012	Main findings: ORCs with embedded relative pronoun subjects are easier to comprehend than those with embedded full NPs (frequent lexico-syntactic pairings are easier to comprehend than rare pairings). Gordon, Hendrick, & Johnson, 2001; Kaan, 2001; Mak, Vonk, & Schriefers, 2006, 2008; Reali & Christiansen, 2007; Roland, Mauner, O'Meara, & Yun, 2012; Warren & Gibson, 2002
Embedded noun animacy	Main findings: Speakers avoid object relative clauses with embedded inanimate subjects; instead choose passive relatives in those situations. Gennari & MacDonald, 2008, 2009	Main findings: Embedded inanimate nouns are more difficult to comprehend than embedded animate nouns (frequent lexico-syntactic pairings are easier to comprehend than rare pairings). Gennari & MacDonald, 2008, 2009; Mak, Vonk, & Schriefers, 2006; Traxler, Morris, & Seely, 2002; Traxler, Williams, Blozis, & Morris, 2005; Weckerly & Kutas, 1999
Agent omission in passive relatives	Main findings: Speakers more often omit agents when they are semantically similar to the patients. Speakers more often include agents with be-passives than get-passives. Gennari et al., 2012; Thompson, Ling, Myachykov, Ferreira, & Scheepers, 2013	No studies

Note. NP = noun phrase; ORC = object relative clause.

column of the table), then in the rightmost column, that more frequent sentence forms are associated with a greater ease of comprehension. What remain unknown, however, is key information about how these patterns develop—the frequencies of these lexico-syntactic combinations in child-directed speech and texts, and consequences of those frequencies for production and comprehension. The present study will give an indication as to how these variables vary with the modality (written or spoken) of child-directed input, which will allow us to better understand the sorts of experiences that children might have with these properties known to affect production and comprehension behavior in adults.

While to date there has been no large scale corpus analysis of these lexico-syntactic combinations in child-directed language, recent work suggests that even very young children tend to produce the combinations common in adult speech. Diessel and Tomasello (2000) investigated the productions of five children (from the CHILDES corpus), from the age of about two to about five and found that children's relative clause productions tend to contain a high proportion of object relative clauses, despite the fact that object relatives are the ones that are classically thought to be the more syntactically complex type of relative clause, compared with other relative clause types. This high rate of object relatives in child speech appears to owe to high rates of certain kinds of object relative clauses in children's input and suggests that like adults, children seem to be sensitive to the lexico-syntactic combinations that tend to be used in child-directed speech (Diessel & Tomasello, 2000, 2005; Kidd, Brandt, Lieven, & Tomasello, 2007). For example, children tend to produce object relative clauses with inanimate head nouns and embedded pronouns, such as *the book that I read*. This lexico-syntactic combination is common in adult speech as well (Reali & Christiansen, 2007; Roland, Dick, & Elman, 2007). These patterns suggest that early relative clause behavior closely tracks experience that children have with these relative clause types (or at least, experience we predict based on the experience we know that adults have), consistent with other work that finds that children's production choices tend to closely match their linguistic input (Cameron-Faulkner, Lieven, & Tomasello, 2003; Huttenlocher, Vasilyeva, Cymerman, & Levine, 2002; Lieven, 2010; Lieven, Pine, & Baldwin, 1997; Naigles & Hoff-Ginsberg, 1998).

An additional consideration when investigating the effect of experience on behavior that is often overlooked is that the nature of experience itself changes across childhood. In children, one factor that contributes to qualitative shifts in experience is the onset of literacy, and the increase in text exposure that follows. By better understanding the shift in experience that is marked by the onset of literacy and the increase in text exposure, we can obtain a better estimate of a child's linguistic experience and make better predictions for how we expect language behavior to change over time as a consequence as this change in experience.

The effect of text exposure on vocabulary development is well established. Vocabulary in spoken and written language tends to be different, with a greater representation of rarer words in written over spoken texts (for a review, see Akinnaso, 1982, and Chafe & Tannen, 1987; DeVito, 1966) regardless of the age of the participants in the spoken conversation (Hayes, 1988; Hayes & Ahrens, 1988). In line with these data, text exposure, often in the form of shared book reading between caregivers and young children, is associated with increased vocabulary (Farrant & Zubrick, 2012; Ninio, 1983; Sénéchal & LeFevre, 2002; Sharif, Rieber, & Ozuah, 2002), and reading is associated with larger vocabulary size in both grade-school-age children (Cunningham & Stanovich, 2001; Krashen, 1989; Nagy, Herman, & Anderson, 1985) and adults (Cunningham & Stanovich, 1991). Thus, the linguistic experience encountered through reading seems to be an important source of new vocabulary words, and it appears to contribute to vocabulary growth in both children and adults.

Consistent with these reading-vocabulary relationships, several studies have identified relationships between text exposure and syntactic knowledge. Cameron-Faulkner and Noble (2013) found that picture books used in shared book reading with young children tend to contain more complex sentences than child-directed speech, suggesting that shared book reading may be an important source of language experience for children, especially for sentence types that may be otherwise rare in child-directed speech. Similarly, individuals with more years of formal education and individuals who read more often exhibit superior language comprehension abilities, particularly in construction involving passives, which are more frequent in written language, and other complex constructions (Dąbrowska, 2012; Street & Dąbrowska, 2010). These results are not definitive, but they are consistent with the view that text exposure may be an important predictor of linguistic ability and an important source of individual differences within native speakers of a single language.

Taken together, these studies suggest that text exposure broadens the range of vocabulary and structures that children encounter and thus may enrich their linguistic knowledge and skill, especially in children's use of words or structures that are more frequent in written than in spoken language. Our focus here is on relative clauses and the words that are associated with them, because these sentence structures are ones that appear to need substantial time for children to master. Although Table 1 shows some of the extensive research on production and comprehension of relative clauses in adults, we know far less about relative clause input to children. We do not know the distributions of the different relative clause types in child-directed speech, the relationship between structures and lexical choices, how these distributions might be different in child-directed speech versus texts, and how both of these patterns are different from adult-directed speech and text. Knowing these distributions would allow us to predict language behavior based on differences between written and spoken corpora and a speaker's degree of exposure to these qualitatively different statistics.

In the present study, the complex sentence abilities we investigate are children's implicit production choices over various types of relative clauses, which are known to develop gradually. A finding that text exposure has a significant effect on spoken language abilities would have important implications for language acquisition. The emergence of literacy is generally not investigated as a possible source of experience that contributes to language development, but if the types of sentence structures used in written and spoken language vary, then input from texts could be a source of qualitatively different statistics. If so, this result would provide further evidence that language abilities, specifically syntactic abilities, are shaped by experience with one's linguistic environment, in contrast to accounts which posit innate constraints on the timetable of linguistic development or structural difficulty (Jackendoff, 2002; Lidz, Waxman, & Freedman, 2008; Pinker, 1984).

To investigate the effect of experience on production choices, we proceeded in two steps. First, we conducted two corpus analyses to allow us to estimate the distributions of several different types of relative clauses in children's input. The first corpus analysis investigated speech input, and the second addressed relative clauses in children's texts, allowing us to compare the distributions of structures in the two modalities. To foreshadow these results somewhat, we find substantial differences in relative clause input in speech and reading, such that it would be reasonable to hypothesize that variations in amount of reading would result in variations in the nature of relative clause knowledge. With these data in hand, we assessed 8- and 12-year-old children's and adults' text exposure and their use of relative clauses in a sentence production task that has previously been used to elicit various types of relative clauses in adults (Gennari et al., 2012; Montag & MacDonald, 2014). We analyzed the nature of the child and adult productions with respect to the various factors in Table 1 and related these data to the speakers' linguistic experience, as assessed by age (for children) and levels of text exposure. This design allows us to investigate the degree to which individual differences in children's and adults' skill in using relative clauses, as reflected by their utterance choices during production, is linked to their levels of reading experience.

Corpus Analysis 1: Analysis of Child-Directed Speech

In both the corpus analyses and the production study, we investigated three different relative clause forms that are commonly used to convey the same general meaning, which are illustrated in (2a–c). 2a is an object relative (the same structure as in 1a), in which the relative clause verb *scolded* is in the active voice, and (2b–c) are passive forms with auxiliary verbs *be* and *get*, respectively.

2a: Object Relative: The student who the teacher scolded finally finished the assignment.

2b: Be-Passive Relative: The student who was scolded by the teacher finally finished the assignment.

2c: Get-Passive Relative: The student who got scolded by the teacher finally finished the assignment.

These three relative clause forms are interesting for several reasons. First, adult speakers' choice of active (object) versus passive relatives is finely tuned to several lexical and discourse conditions. For example, passive relatives are much more common when describing something animate than something inanimate. Some researchers have suggested that adults' use of these alternative forms in different lexical and discourse environments is at least in part motivated by reducing production difficulty (Gennari et al., 2012; MacDonald, 2013). Thus skilled use of relative clauses includes the flexible deployment of the alternative active and passive structures. It is unclear when children develop this skill or when they begin to receive linguistic input (varying use of actives vs. passives in different environments) that could allow them to develop the skill. Passive relatives, which are a form of subject relative, are generally considered less complex than the object relatives, but some studies suggest that passives are rare in children's speech (Street & Dąbrowska, 2010), and so they may be rare within relative clauses as well. Second, the contrast between be-passives (2b) and get-passives (2c) is interesting because adults tend to produce get- and be-passives in subtly different contexts (Carter & McCarthy, 1999; Hundt, 2001; Thompson, Ling, Myachykov, Ferreira, & Scheepers, 2013), and these forms also occur with different frequencies in written and spoken language, with get-passives much more common in spoken language and be-passives much more common in written language (Biber, Johansson, Leech, Conrad, & Finegan, 1999; Collins, 1996). Thus, the choice of a get- or a be-passive may reflect both the degree to which children and adults can flexibly apply patterns in their linguistic environment to production choices, as well as their relative experience with written and spoken language.

These questions are the focus of the two corpus analyses. Corpus Analysis 1 begins with an investigation of object relatives, be-passive relatives, and get-passive relatives in child-directed speech.

Corpus

We used a subset[1] of the parsed CHILDES (MacWhinney, 2000) corpus, which contained a total of 1.12 million words of adult speech to children between the ages of 6 months and 5 years.

Method

To extract relative clauses, the CLAN program (a program used to analyze CHILDES and other corpora in that format) was used to extract all complement modifications, of which relative clauses are one type. All sentences containing object and passive relative clauses were then extracted by hand from the set of complement modifications. These relative clauses were then coded for the factors identified in Table 1: Animacy of the head noun, whether or not the relative clause was preceded by a relative pronoun, and in object relatives, animacy of the embedded noun and type of embedded noun (pronoun or full noun phrase). Passive relatives were coded for whether an agent was specified in a by-phrase (e.g., *by the teacher*) or whether this phrase was absent.

Results

We identified 383 child-directed object relative clauses and only three passive relative clauses in this corpus. The object relative clauses apportioned by the coding features are shown in Appendix A. Both raw frequencies and tokens per million noun phrases (NPs) are provided.

This result, that object relatives are overwhelmingly more frequent than passive relatives in child-directed speech, is consistent with corpus analyses of relative clause use in adult-to-adult speech (Roland, Dick, & Elman, 2007), where object relatives are also common. The similarity goes beyond the active/passive proportions: Roland et al.'s analyses of relative clause use in speech between adults find both that object relative clauses tend to more often modify inanimate nouns than animate nouns, and tend to contain pronoun subjects (embedded pronoun NPs, as in *the book I read*). Appendix A shows that both of these patterns are present

[1] The CHILDES corpora used were Bates, Bernstein, Bliss, Bloom (1970), Bloom (1973), Bohannon, Brent, and Brown.

in the child-directed object relative clauses as well. However, the overall rate of relative clauses is much lower in child directed speech (CHILDES: 1,879 object and 14.7 passive per million NPs) than adult directed speech (Average of BNC-spoken and Switchboard corpora: 14,608 object and 2,848 passive relatives per million NPs; Roland et al., 2007). Thus, one shift in experience across development appears to be relative clause frequency, although the absence of a corpus containing speech to older children leaves information about this trajectory incomplete. Another potential difference in experience could be systematic differences between written and spoken language, which would provide readers with qualitatively different experience with these sentence types. Speech and writing often have different goals and are produced in different environments, which can affect the nature of language used in the two genres. For example, speech is often about entities in the world that are visible or at least familiar to all conversation participants, so that the need for clarifications and modifications (including relative clauses) can be different than in writing, which is typically not about entities currently visible to the reader. To our knowledge, an analysis of complex structures in children's literature has not previously been performed. Corpus Analysis 2 investigates relative clause usage in child-directed texts, which will allow us to investigate how relative clause use differs both from child-directed speech and adult-directed literature, to better understand how patterns of relative clause experience may shift as a child becomes literate, and as a literate child becomes a literate adult.

Corpus Analysis 2: Analysis of Children's Literature

Corpus

The corpus used for this analysis was the juvenile literature[2] accessible in the COCA (Corpus of Contemporary American English) corpus (Davies, 2008-). This corpus consists of 2.40 million words of text intended for children aged 4–16 years. It consists of fiction and nonfiction magazine articles as well as excerpts from children's novels. It contains a total of 1,708 documents (articles, excerpts, etc.) from 97 different sources (magazine and book titles). All texts are intended for children to read themselves, not for a caregiver to read to them.

Method

Target age of document coding. The 97 different sources contained in the corpus were each coded for the intended age of the child audience. The recommended ages for book titles were retrieved from the Barnes and Noble Web site (www.bn.com). Recommended ages for magazines were retrieved from the Web sites of the magazines themselves. When the target age of a source contained a range, the mean age was used. For example, if the recommended age was listed as "ages 8–12," "10" was coded as the target age for that source. In cases in which recommended ages were given as grade levels, these grade levels were converted to ages such that first grade = 6 years, second grade = 7 years, and so forth.

Relative Clause Coding. The COCA corpus is tagged, but not parsed, so part of speech tags were used to extract possible relative clauses. Appendix B contains the search terms used to extract possible relative clauses. All object relative and passive relative clauses were then selected by hand from these candidate sentences. It is not possible to directly search for relative clauses with only part of speech tags, so we opted to cast a wide net, and then eliminate irrelevant sentences by hand. Because the corpus was not parsed and we relied on sequences of part of speech tags to find relevant sentences, one type of relative clause that we were unable to extract was relative clauses with embedded nouns modified by an adjective (e.g., The *book that the tall woman read*). We do not believe that our results are significantly affected by this omission, because modified embedded noun phrases like these were rare in our analysis of CHILDES, where were we able to extract all object relatives of this type.

The relative clause sentences we identified were then coded for the same features as were the relative clauses extracted from the spoken corpus. This coding allowed us to document systematic differences in not only the overall rate of object and passive relatives in written and spoken language, but also document many other properties of sentences containing relative clauses that are known to affect patterns of production and comprehension.

Results

In total, 3,300 object relative and 1,242 passive relative clauses were extracted. Appendix C gives the raw number and frequency per million NPs of object and passive relative clauses, apportioned by our coding criteria. There were no get-passives in this corpus, which is consistent with the finding that get-passives tend to be a feature of spoken language (Biber et al., 1999; Collins, 1996). We first analyze how relative clause input varies across intended age of the reader, followed by more detailed analysis of the same relative clause properties coded in Corpus Analysis 1.

Juvenile literature texts by target age groups. We observed a difference in absolute rate of relative clause use within individual texts of child-directed literature aimed at children of different ages. In only this analysis, sources containing texts designed for atypical populations (e.g., low literacy children reading below grade level) were not included, as were sources that did not contain at least 5,000 total words, as those very small sources may not contain an accurate estimate of the number of relative clauses in a document of that sort. Thirty-two sources were included in this analysis. Figure 1 shows the mean frequency of object relative clauses per 1,000 words of text, by the age of the intended audience of that written source. We were unable to calculate the frequency per million NPs, as we report elsewhere, because we were not able to calculate the total number of NPs in each source text.[3] There was a significant correlation between the rate of relative clause usage in the texts and intended age for the text, $r(29) = 0.39$, $p < .05$, suggesting that authors writing for children may accommodate

[2] In the version of COCA used in these analyses (updated June 6, 2012) about a quarter of the documents categorized as juvenile literature were miscategorized and were not actually juvenile literature. All reported data removes these irrelevant documents.

[3] The COCA corpus provides word counts for the individual source documents but does not allow the user to limit a search to an individual document. Thus, we were unable to obtain NP counts by source document, only a NP count for the entire Juvenile Literature subset of COCA. As a methodological note, because a quarter of the documents in COCA-Juvenile were miscategorized and removed, and we were unable to obtain NP counts by document, we approximated the total number of NPs by taking a proportion of the total NPs relative to the proportion of correctly categorized words to total number of words in the corpus.

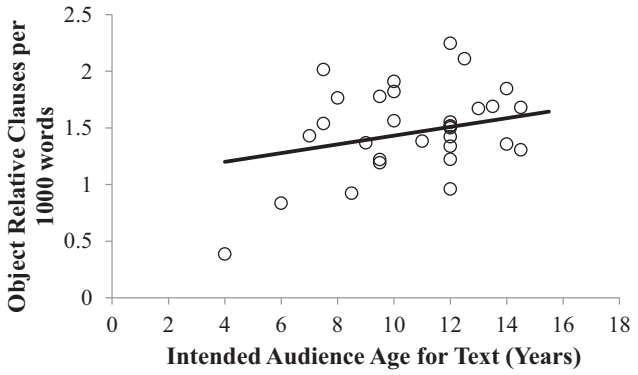

Figure 1. The frequency of object relative clauses by the intended age of the corpus document. Relative clauses tend to be more frequent in reading material intended for older audiences. For reference, there were about 0.34 object relative clauses per 1,000 words in Corpus Analysis 1.

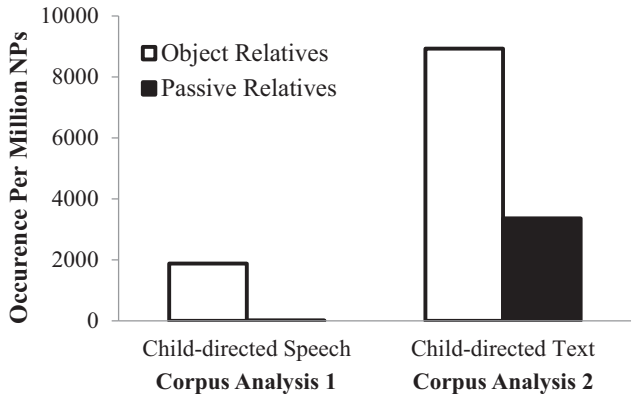

Figure 2. Occurrence of object and passive relative clauses per million NPs. The overall rate of both types of relative clauses is higher in child-directed text, as is the ratio of passive to object relatives. Raw values are presented in Table 2.

their intended audience either by limiting the number of complex sentences (at least relative clauses) in documents intended for younger audiences and/or by discussing topics less in need of relative clause modification. This effect of audience age is consistent with findings in spoken language, where the rate of relative clause use in Corpus Analysis 1 is lower than the rate observed in adult-directed speech (Roland et al., 2007).

We found no correlation between frequency of passive relatives and target age of the written source, $r(29) = -0.095$. Although the source of null findings cannot fully be known, this result may reflect the fact that there were fewer passive relatives overall and fewer sources contained any passive relatives, so this measure was likely too noisy to obtain any interpretable results.

All juvenile literature results. A key question in this article is how children's linguistic experience changes over time, both within an input type (spoken, written) and via the shift in input proportions that arises when a child begins reading. One important difference between the child-directed spoken and written corpora is that the overall rate of relative clause utterances is much higher in the written sources, as illustrated in Figure 2, which shows a substantial increase in relative clause usage in child-directed text compared with the child-directed speech from Corpus Analysis 1.

Beyond the overall rate of relative clauses increasing in texts over speech, a second important difference between speech and text that Figure 2 illustrates is that the relative frequencies of object and passive relatives vary between the written and spoken domains (raw counts), $\chi^2(1) = 133.0$, $p < .001$, $\varphi = 0.16$. In the child-directed speech from Corpus Analysis 1, object relatives were much more common than passive relatives—a ratio of 128:1. In child-directed text, however, the two types become more similarly distributed, so that there are about 2.7 object relatives for each passive relative in the child-directed texts. These data suggest that not only are children receiving more experience with relative clauses of any type from written language, but that the nature of that experience is changing, in that children disproportionately receive additional experience with passive relatives from text exposure. This result suggests that children who are preliterate or are poor readers have substantially less experience with relative clauses, especially passive relative clauses, compared with their peers who may read more often.

These results are consistent with previous work on the distributions of relative clauses in adult-directed written texts, and they make a number of novel contributions to our understanding of the distributions of relative clauses in child-directed language. First, we find that the relative rates of passive to object relative clauses is quite different than in previous investigations of adult written corpora. Figure 3 shows the proportions of object and passive relative utterances in our two corpora and the five adult-directed corpora investigated by Roland et al. (2007). Numeric ratios and raw counts are presented in Table 2. An important pattern across these seven corpora is that all written corpora contained higher proportions of passive relatives than all spoken corpora, even the child-directed written corpora (COCA vs. Switchboard raw counts), $\chi^2(1) = 145.1$, $p < .001$, $\varphi = 0.16$; COCA vs. BNC-Spoken raw counts: $\chi^2(1) = 133.0$, $p < .001$, $\varphi = 0.05$. Further, within each domain (written or spoken) the child-directed corpus contained the smallest proportion of passives. These patterns suggest that there are substantial changes in children's input over time.

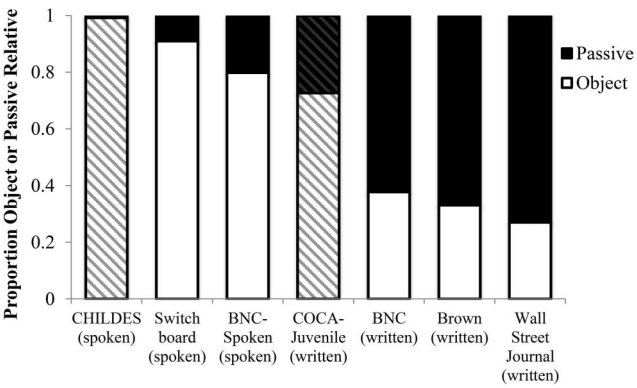

Figure 3. Proportion of utterances that were object or passive relatives. Striped bars show data from Corpus Analyses 1 and 2. White/black solid bars show data from Roland et al. (2007). The left-most three bars represent spoken corpora (CHILDES, Switchboard, and BNC-Spoken) and the right-most four bars show data from written corpora (COCA-Juvenile, BNC, Brown, and *Wall Street Journal*).

Table 2
Summary of Frequencies of Relative Clause Types Across Seven Corpora

	Ratio of object relatives to passive relatives	Percentage of object relatives that are reduced	Percentage of passive relatives that are reduced
COCA-juvenile	2.7 (8,925:3,359)	87.1%	88.3%
CHILDES	**128 (1,879:14.7)**	**79.4%**	**66.6%**
BNC	0.6 (8,393:13,848)	65.0%	77.5%
BNC-spoken	**4.0 (18,286:4,615)**	**78.9%**	**62.5%**
Brown	0.5 (6,722:13,600)	70.6%	78.9%
Switchboard	**10.1 (10,930:1,081)**	**48.6%**	**72.1%**
Wall Street Journal	0.4 (5,187:14,012)	65.3%	91.3%

Note. Boldface rows represent spoken corpora. The top two corpora summarize data from Corpus Analysis 1 and 2. The bottom five corpora summarize data reported in Roland, Dick, and Elman (2007). Parentheses include incidence per one million noun phrases. Reduced object relatives omit the relative pronoun (e.g. *that, who*). Reduced passive relatives omit both the relative pronoun and the auxiliary verb (e.g., *who was, that got*).

First, even without text exposure, an individual's exposure to passive relative clauses will increase, as adult-directed speech tends to contain more passive relatives than child-directed speech. Second, in both childhood and adulthood, the proportion of passive relatives that an individual might encounter in speech is much lower than the proportion an individual encounters through text, so that even child-directed text contains higher rates of passives than adult-directed speech. This result shows that the shift to receiving increasing linguistic input via reading should have substantial changes on children's relative clause experiences.

Beyond counts and ratios of object and passive relative clauses, Table 2 also shows that relative clauses in the written and spoken domains differ on a number of other dimensions that are important in the development of skilled use of relative clauses (see Table 1). As summarized in Table 2, there were slightly higher rates of reduced (relative pronoun omitted) object relative clauses than Roland et al. (2007) found in their adult corpora, but almost identical rates of reduced passive relatives. This higher rate of pronoun omission may be because of a higher rate of object relatives with embedded pronoun subjects (Switchboard: 90.4%; Brown: 40.8% vs. CHILDES: 97.7%; COCA: 92.5%), which both our analysis and previous work (Elsness, 1984; Roland et al., 2007; Temperley, 2003) suggests are less likely be preceded by a relative pronoun. We also replicate the same general pattern reported in Roland et al., that the rate of relative pronoun omission tends to be higher in written than in spoken language. This is consistent with theories suggesting that speakers can strategically (though unconsciously) choose to include relative pronouns during times of production difficulty, often when the upcoming phrase is long or complex, to give themselves time to plan that upcoming phrase (Ferreira & Dell, 2000; Montag & MacDonald, 2014; Race & MacDonald, 2003). Relative pronouns are more common in spoken language, where presumably the online pressures to maintain fluency and produce language quickly are more pronounced.

Finally, we investigated the rate of agent omission in sentences containing passive relative clauses (e.g., *the boy who got pushed,* omitting the by-phrase *by Mary*). We found that agents were rarely included in sentences containing passive relative clauses. None of the three passive relative tokens found in our CHILDES speech sample specified agents, and only 14.7% of the sentences containing passive relative clauses in COCA-Juvenile Literature included agents. This pattern is consistent with previous work (Biber, 1988; Roland, Dick, & Elman, 2007) and may reflect the fact that though object and passive relatives can potentially convey similar messages, speakers may choose the passive form to allow them to omit the agent, for example when the agent of the event being described is less important or less focus-worthy to the message (Montag & MacDonald, 2014; Thompson, Ling, Myachykov, Ferreira, & Scheepers, 2013) or when agent omission reduces production difficulty for the speaker (Gennari et al., 2012). These observations suggest that the flexible use of object relatives versus passive relatives (with and without agents) is part of the skill that develops in English speakers producing and comprehending relative clauses.

Discussion

To our knowledge this is the first corpus analysis to explicitly investigate reading material intended for children, and we expect that it will aid future study of children's production and comprehension of complex sentences, beyond the research here. Our analyses suggest that at least with respect to relative clause usage, children's literature is statistically intermediate between adult-directed spoken language and written language. An important step in future research would be to assess the trajectory of relative clause usage in speech to older children, comparable with the age range in the written corpus. To our knowledge, no sizable parsed corpus of speech to older children currently exists, and thus, it is possible that some of the differences we have observed between child-directed speech and child-directed text owe to the age of the intended audience and not the spoken versus written modality. Indeed the data in Figure 1 show that at least in the written modality, there are clear effects of age. However, we do not believe that the absence of older child-directed speech input severely compromises the main findings of shifts in relative clause frequency and distribution of relative clause types, because the adult-directed speech data provide important evidence about the end-point of age effects. The data in Figure 2 show that child-directed text already contains a higher proportion of passive relatives than adult-directed speech, making it clear that when children become readers, their linguistic input changes in important ways.

Prediction for Production Behavior

With these data in hand, we turn to relative clause production in children and adults. The analyses in Corpus Analysis 1 and 2 yield

several predictions for production of relative clauses. First, children should produce fewer passive relatives than adults, because this form is rare in child directed input, particularly child-directed speech. Note that this experience-based prediction runs counter to predictions made by many previous studies of relative clause development in children. Theories that emphasize the greater working memory load or greater syntactic complexity of object relative clauses predict that children should avoid the complex object relative constructions and produce the simpler passive relatives (a form of subject relative, typically thought to be easier than object relatives). A second experience-based prediction relates to text exposure: Because passive relatives are much more common in child text than in child-directed speech, as well as in adult text than in adult-directed speech, individual differences in measures of text exposure should correlate with passive relative usage in children and adults. A third prediction is that children should use more relative pronouns in their utterances than adults do. Spoken language tends to contain more relative pronouns than written language does, so children will have encountered a greater proportion of relative clauses with relative pronouns before they start reading.

Our production experiment investigated text exposure and production choices of adults and 8- and 12-year-old children in a relative clause production task. If children make choices that reflect the experience with these sentence types they have accumulated in their lifetime, their productions should be consistent with the predictions made by comparing child and adult written and spoken corpora.

Experiment: Production of Complex Sentences

Participants

Thirty undergraduates at the University of Wisconsin-Madison participated in exchange for course credit in an introductory psychology course. All were native speakers of American English. Thirty 8-year-old children (15 female; mean age 8 years, 3 months; *SD* 7.4 months; range 6 years, 11 months, to 9 years, 1 month) and 30 12-year-old children (nine female; mean age 12 years, 2 months; *SD* 4.8 months; range 11 years, 3 months, to 12 years, 11 months) in the Madison, Wisconsin, area participated in exchange for a $10 gift card. All were native speakers of American English.

Materials

Eighteen verbs that can each take both an animate or inanimate grammatical object were selected. Color pictures were created that illustrated each of these 18 verbs. In each picture, there were two instances of that particular verb, once acting upon an animate grammatical object and once acting upon an inanimate grammatical object. These grammatical objects were the target items in the experiment. For example, the picture for the verb "throw" (see Figure 4) incorporated both a man being thrown and a ball being thrown. The animacy of these target items was an independent variable of the experiment. Additional information about these items can be found in the supplementary materials of Gennari et al. (2012).

In addition to the 18 test pictures, there were 26 filler pictures for a total of 44 trials. These items differed from the items used in Montag and MacDonald (2014) in two ways. First, we used two fewer test trials because we deemed two test pictures too violent for use with young children. Second, we reduced the number of filler trials to shorten the experiment to a length (20–30 min) more appropriate for children.

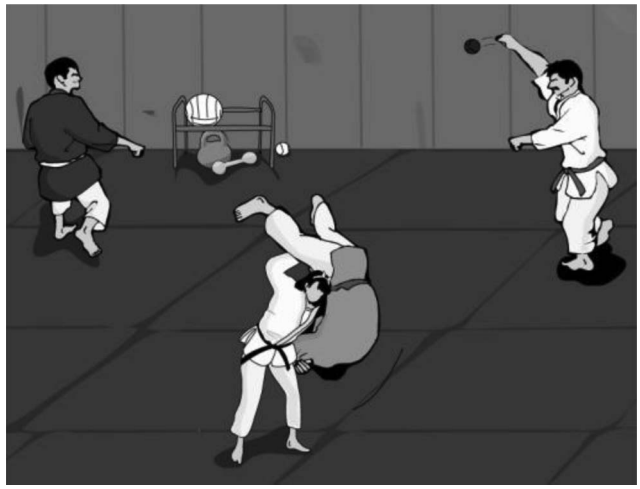

Figure 4. Test picture for verb "throw."

To elicit relative clauses, spoken questions were recorded that asked participants to describe a particular target person or object in the picture. For example, questions corresponding to Figure 4 would be "Who is wearing orange?" for the animate *man* target and "What is red?" for the inanimate *ball* target. There is more than one man in the picture and more than one ball, so the participants needed to modify the target noun to sufficiently differentiate the target from the other items in the picture. Relative clauses are a good option for speakers to provide this disambiguating modification. For example, for the target item *man* in this picture, a good response to "Who is wearing orange?" would be "the man (who is) being thrown by the woman" or "the man (that) the woman is throwing," because these responses distinguish the target man from other men in the picture. For filler trials, participants were asked to describe what a particular person was doing or identify a particular object. Although the test pictures and questions were created such that participants needed to produce a relative clause with a verb as their response to completely answer the question, filler pictures and questions were created so that participants had no reason to use a relative clause in their responses. All spoken materials were recorded in a quiet room by a native English speaker.

Additional materials were used to gauge text exposure in children and adults. For adults we used the Author Recognition Test developed by Acheson, Wells, and MacDonald (2008). This Author Recognition Test is an updated version of the test originally developed by Stanovich and West (1989). Acheson et al. found that performance on this task correlated reliably with college students' ACT English and Reading subscores. For children, we created a title recognition task appropriate for 8- and 12-year-old children. It was a modified version of the title recognition task of Cunningham and Stanovich (1991), updated to reflect the books that children read now, and taking care to eliminate any books that

have been made into popular movies.[4] The test is contained in Appendix D.

Procedure

In the relative clause production task, detailed instructions with a cover task were created to encourage speakers' use of relative clauses to respond to spoken questions. Participants were told that the experiment was about interpreting pictures, and that their responses would be shown to a later group of participants who would try to guess which pictures their responses described. They were told that because colors or clothing might be changed, or items in the picture might be rearranged, describing the actions in which the people and objects were taking part would be the best strategy to use to complete the task. All three age groups were presented with the same instructions, but the experimenter read the instructions aloud to the 8-year-olds while the text was presented on the screen.

In each trial, a color picture appeared on the screen. After three seconds, participants heard a question asking about the target person or object in the picture and answered the question by speaking into a microphone. Each participant saw nine pictures with a question about an animate patient (e.g., the man being thrown in Figure 4) and nine pictures with a question about inanimate themes (e.g., the ball in Figure 4). Different sets of participants saw each half of the animate-inanimate target pairs, so that participants saw each picture only once. Test and filler trials were pseudorandomized such that there was always at least one filler trial between any two test trials. In previous studies with this design (Montag & MacDonald, 2014), trials were excluded in which the participant failed to produce a relative clause with a verb (e.g., giving responses such as *The man in the middle*), even if they successfully produced a relative clause upon being corrected by the experimenter (typically in these cases, the experimenter had to point out the nontarget entity). These corrected trials were included in this analysis, as the younger children often failed to notice the nontarget distracter entity. We opted to include these trials for the older children and adults as well to keep the tasks and inclusion criteria as similar as possible. In line with this inclusion criterion, if a participant failed to produce a response that included a verb with a relative clause because they failed to notice a competitor entity, the experimenter pointed out the competitor and asked the participant to try again and make sure to distinguish the target entity from the competitor. If the participant failed to produce a relative clause with a verb after being corrected twice, the trial was skipped.

After the production task, participants performed the Author Recognition Test (adults) or Title Recognition Test (children).

Results

Out of a possible score of 65, the average score on the adults' Author Recognition Task was 10.0 ($SD = 4.7$), which reflects the number of correct identifications minus the number of false alarms (nonauthors identified as authors). The Title Recognition Test was scored in the same manner; out of a possible score of 30, the average score for 8-year-olds was 4.2 ($SD = 3.2$) and the average score for 12-year-olds was 12.6 ($SD = 4.7$). As expected, 12-year-olds scored significantly higher on the Title Recognition Test than 8-year-olds, $t(58) = 8.07$, $p < .001$.

Spoken responses that did not contain a relative clause were excluded from the production data. For adults, 84 trials were excluded, affecting 18.5% of animate and 12.6% of inanimate trials. This rate of exclusion is comparable to that in previous studies (Gennari et al., 2012; Montag & MacDonald, 2014) and reflects the fact that participants were never explicitly instructed to use relative clauses; the discourse and task demands are merely designed to make them a viable option for speakers. The exclusion rate was similar for 12-year-olds, with 83 trials excluded, affecting 20.0% of animate and 10.7% of inanimate trials. For 8-year-olds, the rate of excluded trials was higher, with159 trials excluded, affecting 35.6% of animate and 23.3% if inanimate trials. The most frequently excluded trails were those in which participants: failed to produce a relative clause with a verb that felicitously distinguished the target item from competitors, even after being corrected (*The blue tennis shoes*), felicitously described the target, but without a transitive action verb (*The guy that is upside down*; *The man getting a hug*), described the wrong entity or produced an uninterpretable response (*The lady in the orange is a vase*).

Valid responses were coded as being an object or passive relative clause. Passive responses were further coded as being either a be-passive, or a get-passive. Figure 5 shows the proportion of total valid utterances that contained an object relative or either type of passive relative clause.

In the sections that follow, we report a series of analyses by group (age) and individual differences (by text exposure and age) to address several aspects of our data. First, we investigate the shifts in usage of structure by age group. Second, we investigate the effects of individual differences in text exposure on structure choice and, third, we investigate group differences in finer-grained details of speakers' production choices (relative pronoun use and agent-dropping in passive utterances). All analyses were performed using mixed-effects logistic regression (glmer) analysis (Baayen, Davidson, & Bates, 2008) with the lme4 package version 1.0–4 (Bates, Maechler, Bolker, & Walker, 2013) in R (version 3.0.2). In all analyses, random intercepts for item and participant were included. Whenever possible, the maximal random effect structure was used (Barr, Levy, Scheepers, & Tily, 2013). If the maximal model failed to converge, we report the fullest model that converged. All predictor variables that could be centered were centered.

Age effects in structure choice. We first analyzed the effect of age (linear contrast trend; 8-year-olds = −1, 12-year-olds = 0, adults = 1) and animacy (Inanimate = 0, Animate = 1) on the choice of active versus passive relative clauses (Active = 0, Passive = 1). We found an overall effect of age group such that older speakers produced more passive relatives ($\beta = 1.04$, $SE = 0.41$, $z = 2.56$, $p = .01$; full model). Further, all age groups showed an effect of animacy on their use of active object relatives versus passive relatives such that speakers produced more passive relatives in response to animate targets ($\beta = 6.62$, $SE = 0.56$, $z = 11.77$, $p < .001$). There was no interaction between age group and animacy. As shown in Figure 5, speakers produced more passive

[4] In the interval since this test was developed, at least one book title on the list (*The Giver*) has been made into a movie. We recommend that researchers using this test remove or make substitutions for any movie-related items.

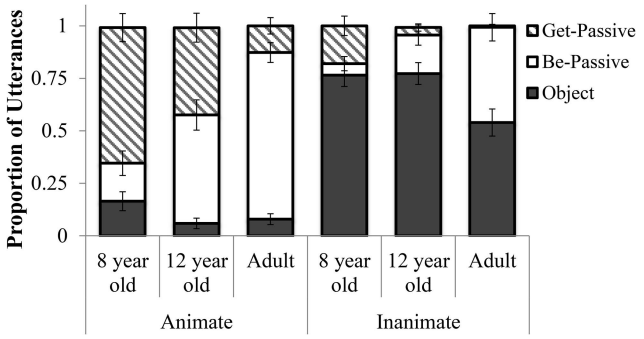

Figure 5. Proportion of object, be-passive and get-passive utterances, by animacy of the target noun, for 8-year-olds, 12-year-olds, and adults. The four passive relatives (all by 12-year-olds) that did not contain either a be or get verb (e.g., *The ball thrown by the man*) are not included in this graph though they are included in all analyses.

relatives utterances of any type when describing animate entities. When describing animate targets, adults produced 92.0% (*SD* = 14.1) passive utterances and when describing inanimate targets, produced 46.4% (*SD* = 35.4) passive utterances. These numbers are comparable with the production frequencies reported in Montag and MacDonald (2014) and Gennari et al. (2012). Eight- and 12-year-old children produced, respectively, 83.0% (*SD* = 25.6) and 94.1% (*SD* = 13.7) passive relative clauses when describing animate targets and 23.5% (*SD* = 29.7) and 22.7% (*SD* = 28.6) passive productions when describing inanimate targets.

Speakers of different ages not only differed in their proportion of passive relative utterances, but in the *type* of passive utterance as well. This task afforded the production of either be-passives (*The man being thrown by the woman*) or get-passives (*The man getting thrown by the woman*). We next analyzed all trials on which speakers produced a passive utterance, using age and animacy to predict the choice of be- or get-passives (get-passive = 0, be-passive = 1). Older speakers produced a greater proportion of passive utterances containing be-passives than younger speakers ($\beta = 6.02$, $SE = 0.80$, $z = 7.56$, $p < .001$; full model, age coded as a linear contrast trend) and all speakers produced relatively fewer be-passives in response to animate target nouns ($\beta = -3.64$, $SE = 0.74$, $z = -4.90$, $p < .001$). Further, there was a significant age by animacy interaction such that the effect of age group was greater for the animate than inanimate target nouns ($\beta = -3.68$, $SE = 1.05$, $z = -3.51$, $p < .001$). Of the passives that 8-year-olds produced, few were be-passives (20.3%, *SD* = 34.6 animate; 24.5%, *SD* = 39.8 inanimate). Twelve-year-olds were more split between get-passives and be-passives (54.7%, *SD* = 40.6 animate; 77.2%, *SD* = 39.0 inanimate) and adults produced mostly be-passives (85.2%, *SD* = 23.8 animate; 97.8%, *SD* = 10.4 inanimate).[5] These production frequencies are visualized in Figure 5.

These findings, that passive relative use, and within passives, be-passive use, increase with age is consistent with the hypothesis that children's productions more closely track the distributions of spoken language than adults' productions do. Our corpus analyses show that passive relative clauses are more frequent in written language, and previous work suggests that get-passives tend to occur only in spoken language while be-passives dominate written language (Biber et al., 1999; Carter & McCarthy, 1999; Collins, 1996) and these text-biased constructions are indeed more frequent in the speech of older participants. For additional support for the hypothesis that text exposure contributed to relative clause production choices, we performed individual differences analyses that allowed us to investigate the independent contributions of age and text exposure on production choices.

Individual differences in text exposure and production. In two separate models, one for adults (see Table 3) and one for children (see Table 4), we show that text exposure (as measured by the Author Recognition Task) in adults and both chronological age and text exposure (as measured by the Title Recognition Task) in children predicted production choices. These effects were in the direction predicted by the corpus analyses. Table 3 summarizes a model in which we predicted adults' production choices with target noun animacy and text exposure. Adults with more text exposure produced more passive utterances than adults with less text exposure, which is the predicted direction of results, given the finding that passive relatives are more common in written than in spoken language.

We also found that both chronological and age and text exposure are associated with a greater proportion of passive utterances in children. Chronological age and text exposure were highly correlated, $r(58) = 0.73$, so to investigate the effects of both in a single model, we first computed the residuals of chronological age on text exposure. This provided a variable that refers to the extent to which a child's text exposure is greater or less than what would be predicted given that child's chronological age. We then included both chronological age (in months; centered) and these text exposure residuals, along with target animacy in the same model to identify the contributions of these factors to production choices. The results are summarized in Table 4. We found only a marginal main effect of age, despite finding significant group differences between the three age groups reported above, in an analysis that did not include text exposure. The significant animacy by chronological age and animacy by text exposure residuals show that older children and children with more text exposure produced more passive utterances, but only for animate targets. As can be seen in Figure 5, the proportion of active versus passive utterances did not change for inanimate targets from 8- to 12-year-olds, both of which showed lower rates of passive usage than adults. The longer learning trajectory for the inanimates may reflect the different degrees of tolerance for object relatives in child-directed text for animate and inanimate head nouns. Our corpus analysis showed that for animate heads with full noun phrase embedded subjects (the sentences most like the pictures in the present study), passive relatives were overwhelmingly more common than object relatives. For inanimate heads, the pattern in child-directed text is more mixed, and indeed in our picture description studies, we have repeatedly found that adults are nearly evenly split between active and passive forms for inanimate targets (adults in Figure 5 here, see also Gennari et al., 2012; Montag & MacDonald, 2014). Thus, children's structure choice input is more variable for inanimates

[5] Passives that were not be-passives were almost all get-passives as there was a very low rate of passives in which the speaker did not use either auxiliary verb (e.g., *The ball thrown by the man*). These utterances accounted for less than 1% of 8- and 12-year-olds' passive utterances to animate targets and 3.6% of 12-year-olds' passive responses to inanimate targets.

Table 3
Effect of Text Exposure on Structure Choice in Adults: Results of Mixed-Effects Logistic Model (Jaeger, 2008) Predicting Structure Choice of Object Relative (Reference Group) or Passive Relative by Animacy of the Target Noun and Text Exposure, Both Centered

	Coefficient	*SE*	*z*	*p*	Random slope
Intercept	1.94	0.47	4.09	<.001*	
Animacy	4.31	0.55	7.81	<.001*	s, i[a]
Text exposure	0.21	0.10	2.13	<.05*	
Animacy × Text Exposure	−0.14	0.12	−1.24	<1	

[a] This and all models contained random intercepts for subjects (s) and items (i). Random slopes were selected to build the fullest model that converged.
* $p < .05$.

than animates, which may have a role in their longer path to adult-like patterns here. Future work is necessary to better understand this Animacy × Text Exposure interaction, and the role of regularities at both large and small grain sizes in speech and text.

In summary, these results show that both older individuals and individuals with a greater degree of text exposure produced more passive relative utterances in this production task. Notably, and in contrast to some claims that object relative clause are more syntactically complex than passive relatives, it was the object relatives that were more frequent in younger individuals and in individuals with less text exposure. This result is entirely unexpected if children's utterances are driven by syntactic complexity metrics, but they are consistent with an experience-based account of language acquisition and use and consistent with the corpus analyses, which show far greater use of object relatives than passive relatives in speech to children.

We were unable to perform an analysis of individual differences in the choice of get- or be-passives, because limiting our analyses to only passive utterances left us with too few utterances to obtain reliable results, and because (particularly in adults) there was little variability in get- or be-passive choice.

We now turn to analyses of group differences (8-year-olds, 12-year-olds, and adults) for finer-grained details of participants' relative clause productions: relative pronoun use and agent omission in passive utterances. Because power limitations prevented us from investigating individual differences of these finer-grained details, the next analyses address group differences.

Relative pronoun use. As noted in Table 1, a number of researchers have noted that speakers often include relative pronouns when the upcoming relative clause is difficult to plan (Ferreira & Dell, 2000; Montag & MacDonald, 2014; Race & MacDonald, 2003). To investigate group differences in the production of relative pronouns, we used production response structure (object or passive relative) and age (−1, 0, 1 linear contrast trend analysis) to predict relative pronoun use or omission. The results are summarized in Table 5. All three groups produced more relative pronouns preceding object relative clauses than passive relative clauses, which is consistent with previous studies with adults (Montag & MacDonald, 2014). Further, there was a significant linear effect of age group, such that younger speakers produced more relative pronouns than older speakers. Animacy of the target entity did not affect relative pronoun use (comparison of models including and excluding animacy, $\chi^2(4) = 1.60$, $p = .81$, and was excluded from the model. These patterns are illustrated in Figure 6.

One potential explanation for why children produce more relative pronouns than adults is that children have more experience with the statistics of spoken language relative to written language. Spoken language contains more relative pronouns, so children are merely reproducing this higher rate of relative pronouns on this account. A second potential explanation beyond the scope of our corpus analyses is that relative pronouns can be used strategically to provide speakers with more planning time (Ferreira & Dell, 2000; Montag & MacDonald, 2014; Race & MacDonald, 2003), so

Table 4
Effect of Text Exposure and Age on Structure Choice in Children: Results of Mixed-Effects Logistic Model Predicting Structure Choice of Object Relative (Reference Group) or Passive Relative by Animacy of the Target Noun (Centered) Chronological Age in Months (Centered) and Text Exposure Residuals

	Coefficient	*SE*	*z*	*p*	Random slope
Intercept	0.96	0.42	2.33	<.05*	
Animacy	6.22	0.54	11.59	<.001*	i
Chronological age	0.02	0.01	1.73	<.1	
Text exposure residuals	−0.06	0.10	−0.64	<1	
Animacy × Chronical Age	0.04	0.02	2.58	<.01*	
Animacy × Text Exposure residuals	0.23	0.10	2.20	<.05*	
Chronical Age × Text Exposure residuals	0.01	0.004	1.33	<1	
Animacy × Chronical Age × Text Exposure residuals	−0.004	0.004	−0.92	<1	

Note. i = item.
* $p < .05$.

Table 5
Relative Pronoun Use: Results of Mixed-Effects Logistic Model Predicting Relative Pronoun Usage by Response Structure (Centered) and Linear Contrast Trend of the Three Age Groups Investigated

	Coefficient	*SE*	*z*	*p*	Random slope
Intercept	2.20	0.34	6.42	<.001*	
Response structure	−3.11	0.45	−6.92	<.001*	s, i
Age (linear contrast trend)	−1.23	0.42	−2.93	<.01*	i
Response Structure × Age	−1.12	0.59	−1.89	<.1	

Note. s = subject; i = item.

perhaps children are using relative pronouns strategically and need that extra planning time more because they have less practice with sentence production. The present study cannot distinguish between these two alternatives, and indeed they are not mutually exclusive; both may play a role in relative pronoun use in both children and adults.

Agent omission in passives. A major feature of passive utterances is the option to omit the agent of the action, as in *the ball that was thrown*, versus the full form *the ball that was thrown by the man*. Gennari et al. (2012) argued that adults take advantage of the option to omit agents under conditions of similarity-based interference, and Gennari et al. and Montag and MacDonald (2014) found that there were higher rates of agent omission in animate conditions (where the agent and patient of the action are semantically similar, e.g., woman-man) than in inanimate conditions, which have dissimilar agents/themes (e.g., man-ball). Our analyses addressed whether children also produced these production patterns. It is unclear whether children choose to produce or not produce these optional phrases, and whether or not their choices align with those of adults.

The rates of agent omission within passive utterances are shown in Figure 7. Table 6 shows the results of a logistic mixed-effects model using Animacy (centered) and Age (the dummy coded contrast of 8-year-olds vs. both 12-year-olds and adults) to predict agent omission in passive utterances. We opted to code age as a comparison of 8-year-olds versus 12-year-olds and adults rather than as the linear contrast trend that we had used previously. This is because as shown in Figure 7, we clearly find a nonlinear pattern of results, and coding age as a linear variable obscures the relationship between age and animacy. First, as evident in both Figure 7 and Table 6, 8-year-olds omit agents more often than both other groups. This may be at least partially because get-passives more often occur with omitted agents than be-passives (Carter & McCarthy, 1999; Collins, 1996) so we would indeed predict a higher rate of agent-omission in 8-year-olds, who produce more get-passives.

Further, the significant interaction between Animacy and Age reflects the fact that both 12-year-olds ($z = 3.80$, $p < .001$) and adults ($z = 1.93$, $p < .06$) more often omitted agents when describing animate entities, but 8-year-olds showed no effect of animacy ($z = -1.14$, $p < 1$). This age-related effect of animacy may reflect other age-related abilities in online sentence production, such as the ability to omit agents at times of production difficulty (Gennari et al., 2012). Agent omission may then reflect a choice that speakers make online to make the production process easier, much like the optional use of relative pronouns, as noted above. The flexibility of production choices that speakers can strategically use to ease the burden of production planning may not be something that younger children can take advantage of. Perhaps they are not yet familiar with this aspect of language flexibility, or perhaps they are not yet skilled enough producers to take advantage of this flexibility.

Discussion

Adult and child group differences and individual differences in production choices are consistent with differences between written

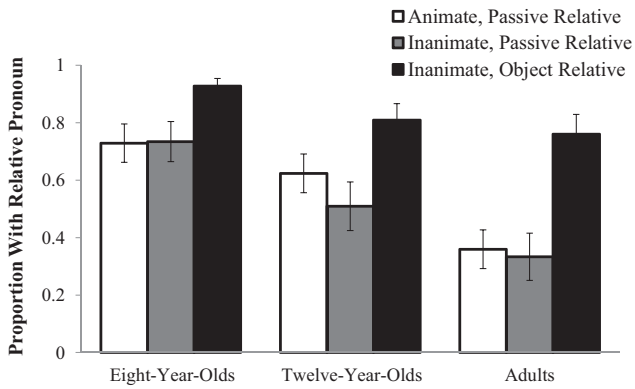

Figure 6. Relative pronoun use by age group, target animacy and structure produced.

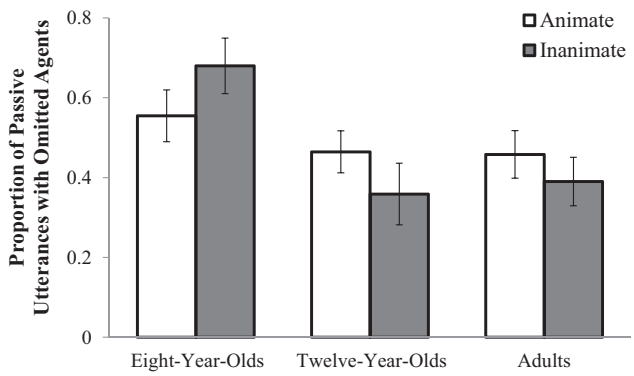

Figure 7. Proportion of passive relative clauses with omitted agents across the three age groups investigated.

Table 6
Agent Omission: Results of Mixed-Effects Logistic Model Predicting Agent Omission by Animacy (Centered) and Age Group (8-year-olds vs. All Others) in Passive Utterances

	Coefficient	*SE*	*z*	*p*	Random slope
Intercept	0.25	0.38	0.65	<1	
Animacy	0.72	0.38	1.90	<.1	s, i
Age (8 vs. all)	0.77	0.19	4.12	<.001*	i
Animacy × Age	−0.80	0.25	−3.19	<.01*	

Note. s = subject; i = item. Model used was the full model (random slope for age by subject would be uninterpretable).
* $p < .05$.

and spoken language. Older speakers and speakers with more text exposure tended to make production choices more similar to the patterns of written language. This finding is consistent with experience-based accounts of language and suggests that individuals are sensitive to even fine-grained patterns in their linguistic environments, to the extent that the different patterns in written and spoken language affect speaker's productions. This is also evidence of transfer effects between the spoken and written domains. To some extent, statistics encountered in comprehension (e.g., reading) have consequences for performance in production, supporting a long-term learning account of plan reuse or structural priming (e.g., Chang et al., 2006).

Additional studies are necessary to confirm the causal role of text exposure in production choices; it is possible that children who are better readers or read more often also have parents who read more often, so their greater proportion of passive relative clauses does not stem from their text exposure, but the greater proportion of passive relative clauses in their parents' speech. There are many other differences in experience that might covary with text exposure, so future studies should aim to identify exactly which differences between individuals with more and individuals with less text exposure actually affected production choices. In particular, an important avenue for future research is the contributions of two different kinds of text exposure—shared book reading with parents versus the child's independent reading, as well as how these contributions affect language use over time.

General Discussion

The goal of this research was to investigate the effects of written language exposure on spoken language production. Whereas the majority of studies addressing individual differences in reading ability have addressed the role of text exposure in *comprehension*, our study is unusual in that it addresses the role of prior comprehension experience (text exposure) on language production. Our work combined corpus analysis estimates of the shifts in lexico-syntactic distributions that appear to accompany reading with an investigation of the consequences of those shifts on language production.

In the corpus analyses, we found an overall higher rate of relative clause use in written than in spoken language, as well as a much higher ratio of passive to object relatives in written language. In the sentence production experiment, we investigated production choices of object or passive relative clauses in a picture description task, with 8- and 12-year-olds, and adults. We found three important results concerning the relationship between text exposure and spoken production. First, age and text exposure both contributed to production choices, and the systematic differences in object and passive relative clause use in written and spoken child-directed and adult-directed language predicted reliable variance in production choices made by participants of different ages. Second, we found that older participants produced fewer relative pronouns (e.g., *that, who*) than younger participants, a result that is consistent with differences between written and spoken language, but also consistent with the explanation that younger children either need to strategically use relative pronouns more often than older children and adults, and/or may not be using relative pronouns strategically, that is, omitting them when they do not need extra planning time. The idea that younger children are not using relative pronouns strategically is consistent with our third finding, that 12-year-olds and adults, but not 8-year-olds, strategically omit agents when uttering passive relative clauses with animate head nouns, where there is more semantic interference between nouns that when the head noun is inanimate.

This study suggests that implicit production choices are influenced by prior comprehension experience, consistent with comprehension-to-production priming studies in the laboratory in both adults (e.g., Bock, Dell, Chang, & Onishi, 2007) and children (Huttenlocher, Vasilyeva, & Shimpi, 2004). Notably, the text exposure results in the current study suggest that specifically reading comprehension can influence (or "prime") spoken production and as such suggests that literacy affects not only skills in reading and writing but also affects spoken language skill. This evidence of transfer across modalities introduces a potential puzzle regarding the nature of register shifts more generally, where "register" refers to different forms of language, including syntactic and lexical choices, that producers use in different settings—formal writing, casual speech, speech to children, and so forth. On the one hand, individuals are clearly sensitive to patterns of different registers and can adjust their language appropriately, so that, for example, their speech may differ from their writing on many dimensions. On the other hand, the present study suggests that language users also generalize over registers and modalities, so that experience with written text can influence spoken utterances. At least some of these register differences may stem from the different types of messages conveyed in different registers, so that, for example, short relative clauses with pronouns are useful for many messages that people often convey in speech, as in *the movie I saw . . .*, while more lengthy relative clause forms with full noun phrases are useful to convey messages common in writing, as in *One factor that contributes to qualitative shifts in experience across childhood . . .* (an example from the introduction of this article). Nonetheless, an important topic for future research concerns how languages users are both

sensitive to register variation yet also seem to generalize over different registers. These results are similar to many in perceptual learning tasks, in which some tasks afford generalization to similar tasks while others yield more specific, task-dependent learning (Ahissar & Hochstein, 1997; Green & Bavelier, 2003; Poggio, Fahle, & Edelman, 1992; Shipstead, Redick, & Engle, 2012).

The notion of a spoken and written language register is consistent with Snow's hypothesis that shared book reading with children facilitates learning to read by exposing children to the decontextualized language of writing (Snow, 1983, 1991). Here we suggest that an additional means by which reading to a child may support future literacy, or early reading practice may support more advanced reading skills, is by providing linguistic experience that a child may not encounter had they not been exposed to texts. Although we have described the text exposure effects here as reflecting children's own reading, children also experience the statistics of written language when adults read books to them. If the distribution of relative clauses in the sorts of books that parents read to very young children are more similar to those of the sorts of books children read to themselves once they learn how to read, then the linguistic experience that young children receive by being read to could significantly affect language development, well before children learn to read themselves. The corpus analyses suggested that the rate of relative clause use may be higher in even the books aimed at the youngest readers than in the child-directed speech in CHILDES, but it is unclear if this pattern would hold for books that that are intended to be read to a child by a caregiver. On the one hand, because these books are intended for an even younger audience, they may contain simpler language. On the other hand, because the readers of these books are caregivers, not beginning readers, the language may be more complex than that of books intended for young children who are learning to decode and read for themselves. Subsequent work investigating the contribution of books read to children long before literacy emerges could provide further insight into the developmental trajectory of word and sentence acquisition. By acknowledging qualitative and quantitative differences between text and speech, and between different types of speech and text, we can better understand the contributions of both sources of input, not only to both early and adulthood literacy outcomes, but also to production and comprehension across development and even through adulthood.

Subsequent work also should inform us about children's growing expertise as language producers, but based on the data present in this study, we cannot draw any conclusions about how children learn to use language flexibly to alleviate production difficulty. Presumably children must learn which features of language can be used strategically to make production easier, and the emergence of this strategic language use is not at all understood. Understanding how this production ability develops is crucial for our understanding of how children learn to produce language, and what adults must have learned to exhibit the behavior they do. Despite these unanswered questions, this study is the first step toward understanding production choices in late childhood and furthers our understanding of how linguistic experience shapes language abilities.

The finding that both written and spoken language experience affect language behavior suggests a blurred line between child language acquisition and adult language use. There does not seem to be a "final adult state" that all individuals approach as they either age, or gain experience (Elman, 2001; Ramscar, Hendrix, Love, & Baayen, 2013; Seidenberg & MacDonald, 1999). Rather, behavior is affected by experience even in adulthood, as the degree of experience with written language predicts different patterns of behavior. This observed effect on production complements studies showing effects of reading experience on comprehension in adulthood, including comprehension of relative clauses (Wells et al., 2009). Crucially, the evidence is consistent with theories that posit that changes between early and late childhood are mechanistically similar to the changes throughout adulthood (Elman et al., 1996). In all cases, increased text exposure predicts a pattern of production choices that more resembles patterns of written language. Adults who are not ardent readers may struggle with the unusual object relative clauses used in typical psycholinguistic experiments (those that have animate head nouns, which are rare in corpora but common in psycholinguistic experiments). There is no evidence that at some age, some stable linguistic competence is attained, but rather language behavior changes in accordance with linguistic experience throughout the lifetime. An important caveat to these claims is second language acquisition, however, where extensive experience in adulthood still need not yield native-like abilities (Newport, 1990, but cf. Flege, Yeni-Komshian, & Liu, 1999. Thus, we see the experience-based results in the present studies as strong evidence for an important role of experience, yet there is also abundant evidence that the effects of experience interact with other phenomena.

The claims for lifelong learning in experience-based accounts of language are relevant to issues addressed in the introduction, namely what it is that is being learned via language use and how the nature of that learning changes over time. For example, in this article, we have phrased the effects of text exposure on relative clause production not only at the level of the sentence type (e.g., active vs. passive relative clauses) but also with some finer grained distinctions that must be learned from the input, such as the proportion of different types of relative clauses modifying animates versus inanimates. Given the prior research summarized in Table 1, our investigations of the varieties of relative clause experience were a logical starting point for our study of the effect of text exposure on complex sentence use. However, we do not mean to imply that relative clause expertise is supported only by relative clause experience. A number of computational studies have suggested that mastery of relative clauses owes not only to relative clause experience itself but also to experience with "neighboring" structures that share important lexico-syntactic regularities with relative clauses (Fitz et al., 2011; Hsiao & MacDonald, 2013; MacDonald & Christiansen, 2002). Those studies did not explicitly investigate the neighbor structures that should contribute to children's use and comprehension of passive relative clauses, but experience with main clause passives (e.g., *The man was thrown by the woman*) would seem to be an important contributor to passive relative clause mastery, as would other subject relative forms with *be*-verbs, such as *The book that was on the table.* Thus, while the relative clause comprehension experience we have studied is certainly critical to mastery of production of these structures, we expect that these and other related sentence forms should mutually reinforce each other. Indeed, previous work suggests that the accuracy with which children can repeat different relative clause types is related to children's familiarity with simple sentences that share similarity with those relative clause sentence (Diessel & Tomasello, 2005). We extend this hypothesis to propose that an individual's familiarity with different structures within a neighborhood can be shifted by differ-

ences in degree of experience with written and spoken language, so that as the shapes of these neighborhoods shift even through adulthood, so do patterns of sentence production.

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Appendix A

Object Relative Clauses in CHILDES

Table A1
Summary of Object Relative Clauses in CHILDES

	With relative pronoun			No relative pronoun			
	Animate head noun	Inanimate head noun	Total	Animate head noun	Inanimate head noun	Total	Grand total
Embedded full NP	0 (0)	3 (14.7)	3 (14.7)	0 (0)	6 (29.4)	6 (29.4)	9 (44.2)
Animate	0 (0)	2 (9.8)	2 (9.8)	0 (0)	4 (19.6)	4 (19.6)	6 (29.4)
Inanimate	0 (0)	1 (4.9)	1 (4.9)	0 (0)	2 (9.8)	2 (9.8)	3 (14.7)
Embedded pronoun	3 (14.7)	73 (358.2)	76 (372.9)	21 (103.0)	277 (1,359.1)	298 (1,462.1)	374 (1,835.0)
Animate	3 (14.7)	72 (353.3)	75 (368.0)	21 (103.0)	275 (1,349.3)	296 (1,452.3)	371 (1,820.3)
Inanimate	0 (0)	1 (4.9)	1 (4.9)	0 (0)	2 (9.8)	2 (9.8)	3 (14.7)
Grand total	3 (14.7)	76 (372.9)	79 (387.6)	21 (103.0)	283 (1,388.5)	304 (1,491.6)	383 (1,879.2)

Note. NP = noun phrase. The head noun is the noun being modified by the relative clause, and the embedded noun (full NP or pronoun) is the noun within the relative clause. Thus, in *The ball that the girl kicked*, the head noun is *the ball* and the embedded full NP noun is *the girl.* Parentheses contain number of RC tokens per million NPs. Summary statistics of passive relative clauses are not presented because only three passive tokens were found. All 3 (14.7 per million NPs) passive relative clauses modified inanimate head nouns and did not specify agents. One contained a relative pronoun.

(*Appendices continue*)

Appendix B

COCA-Juvenile Literature Search Terms

Table B1
Search Terms Entered Into COCA to Retrieve All Object and Passive Relative Clause Candidates

[VERBLIST] refers to the following items:
[vd*]
[be] → was|is|'s|be|are|were|been|'m|'re|am|being
[have]
[100 most frequent verbs in each part of speech code not listed above]

Passive relatives	With relative pronouns	No relative pronouns
	[get] [vvn]	[n*] [vvn] [50 most frequent prepositions]
	Was [vvn]	[n*] [VERBLIST]
	is [vvn]	
	's [vvn]	Missing object modifying passive relatives
	Be [vvn]	[VERBLIST] [n*] [vvn]
	Are [vvn]	[VERBLIST] [a*] [n*] [vvn]
	Were [vvn]	[VERBLIST] [d*] [n*] [vvn]
	Been [vvn]	[VERBLIST] [p*] [vvn]
	'm|'re [vvn]	
	am|being [vvn]	
Object relatives	With relative pronouns	
	[n*] that|who|whom|which [n*]	
	[n*] that|who|whom|which [a*]	
	[n*] that|who|whom|which [p*]	
	[n*] that|who|whom|which [d*]	
	No Relative Pronouns	
	Embedded Full NP	With embedded pronouns
	Articles	[n*] [pn1]
	[n*] his|her|my|your|their	[n*] [pnqv]
	|our|its|thy|yer|thine	[n*] [pnx1]
	[n*] the [n*] [v*] [VERB LIST]	[n*] [pph1]
	[n*] a	[n*] [pphs1]
	[n*] an|no|every	[n*] he
	Determiners	[n*] she
	[n*] [da*]	[n*] he/she
	[n*] [db*]	[n*] [pphs2]
	[n*] [dd]	[n*] [ppis1]
	[n*] [dd1]	[n*] [ppis2]
	[n*] [dd2]	[n*] [ppy]
	Nouns	
	[n*] [nn] [VERB LIST]	
	[n*] [nn2] [VERB LIST]	
	[n*] [np1] [VERB LIST]	Missing object-modifying ORCs
	[n*] [nna]	[VERBLIST] [n*] the [n*] [v*]
	[n*] [nnb]	[VERBLIST] [a*] [n*] the [n*] [v*]
	[n*] [nn?2]	[VERBLIST] [d*] [n*] the [n*] [v*]
	[n*] [np2]	[VERBLIST] [p*] the [n*] [v*]
	[n*] [npd*]	
	[n*] [npm*]	

(*Appendices continue*)

Appendix C

Object and Passive Relative Clauses in COCA-Juvenile Literature

Table C1
Summary of Object Relative Clauses in COCA Juvenile Literature

	With relative pronoun			No relative pronoun			
	Animate head noun	Inanimate head noun	Total	Animate head noun	Inanimate head noun	Total	Grand total
Embedded full NP	4 (10.8)	75 (202.8)	79 (213.7)	13 (35.2)	154 (416.5)	167 (451.7)	246 (665.3)
Animate	4 (10.8)	60 (162.3)	64 (173.1)	11 (29.8)	131 (354.3)	142 (384.1)	206 (557.1)
Inanimate	0 (0)	15 (40.6)	15 (40.6)	2 (5.4)	23 (62.2)	25 (67.6)	40 (108.2)
Embedded pronoun	34 (92.0)	313 (846.5)	347 (938.5)	447 (1,208.9)	2260 (6,112.4)	2707 (7,321.3)	3054 (8,259.8)
Animate	32 (86.5)	311 (841.1)	343 (927.7)	445 (1,203.5)	2237 (6,050.1)	2682 (7,253.7)	3025 (8,181.4)
Inanimate	2 (5.4)	2 (5.4)	4 (10.8)	2 (5.4)	23 (62.2)	25 (67.6)	29 (78.4)
Grand total	38 (102.8)	388 (1,049.4)	426 (1,152.2)	460 (1,244.1)	2414 (6,528.9)	2874 (7,773.0)	3300 (8,925.1)

Note. NP = noun phrase. Parentheses contain number of relative clause tokens per million NPs.

Table C2
Summary of Passive Relative Clauses in COCA Juvenile Literature

	With relative pronoun			No relative pronoun			
	Animate head noun	Inanimate head noun	Total	Animate head noun	Inanimate head noun	Total	Grand total
Agent specified	3 (8.1)	14 (37.9)	17 (46.0)	17 (46.0)	148 (400.3)	165 (446.3)	182 (492.2)
No agent	33 (89.3)	95 (256.9)	128 (346.2)	161 (435.4)	771 (2,085.2)	932 (2,520.7)	1060 (2,866.9)
Grand total	36 (97.4)	109 (294.8)	145 (392.2)	178 (481.4)	919 (2,485.5)	1097 (2,966.9)	1242 (3,359.1)

Note. Parentheses contain number of relative clause tokens per million noun phrases. All 1,242 passive relatives were be-passives, and there were no tokens of get-passives in the corpus.

Appendix D

Title Recognition Test

Below is a list of book titles. Some of them are the names of real books and some are not. Please put a check mark next to the one that you know for sure are real books. There is a penalty for guessing, so you should check only the names you know for sure are real books. (Real book titles are in bold.)

____***The Giver***
____*The Last Shoe*
____***The Phantom Tollbooth***
____***Esperanza Rising***
____*The Rollaway*
____***Walk Two Moons***
____*Don't Go Away*
____*Hot Top*
____***The Moon Over the High Street***
____***To Kill a Mocking Bird***
____***The BFG***
____*He's Your Little Brother!*
____***Encyclopedia Brown, Boy Detective***
____***Hatchet***
____*Sadie Goes to Hollywood*
____*Skateboard*
____***The House of the Scorpion***
____***Flat Stanley***
____***Faith, Hope and Ivy June***
____*The Missing Letter*
____***My Father's Dragon***
____*Wicked Witches Don't Win*
____***Frindle***
____***Island of the Blue Dolphins***
____*Joanne*
____*Number the Days*
____***Bunnicula Strikes Again!***
____***Wringer***
____***From the Mixed-Up Files of Mrs. Basil E. Frankweiler***

(*Appendices continue*)

____*The Schoolhouse*
____*It's My Room*
____*Sarah Jones and the Giant Spiders*
____***Stellaluna***
____***Animal Farm***
____***Tales of a Fourth Grade Nothing***
____*The Hideaway*
____*Year of the Yellow Daisies*
____***Sarah, Plain and Tall***
____*Don't Let Clouds Get You Down*
____***Poppleton in Winter***
____***A Wrinkle in Time***
____***Thank You, Mr. Falker***
____***Sideways Stories From Wayside School***
____*Curious Jim*
____***A Year Down Yonder***
____***Uglies***
____*The Long Drought*
____***Roll of Thunder, Hear My Cry***
____***Junie B Jones Smells Something Fishy***
____*How I Lost My Dog*

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