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The relationship between cognitive skills and reading comprehension of narrative and expository texts: A longitudinal study from Grade 1 to Grade 4

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Abstract

Following the increased emphasis on expository text in early grades, this study examined narrative and expository reading comprehension growth in a sample of children who were followed longitudinally from grades 1 to 4, with the goals of explaining potential differences in children's overall performance and growth of narrative and expository text comprehension and identifying the cognitive factors that distinctly contribute to comprehension for each text type. We hypothesized that differences in reading comprehension growth of narrative and expository texts would be explained by various cognitive factors, specifically those related to executive functions (EF; e.g., working memory, planning/organization, shifting, and inhibition). At four annual time points, children (n= 94) read, retold (Recall), and answered questions (CompQ) about expository and narrative passages. Growth curve modeling was used to explore reading comprehension development across the two types of text. On average, results showed that children scored better on reading comprehension of narrative passages than they did on expository passages across all time points. After controlling for socioeconomic status (SES), vocabulary in 1st grade predicted 4th grade comprehension scores (Recall) for both narrative and expository passages, while word reading efficiency (WRE) in 1st grade predicted 4th grade comprehension scores (CompQ) for expository passages only. Additionally, WRE was associated with the growth of expository reading comprehension: children with higher WRE showed a faster growth rate for expository CompQ. The contribution of EF to text comprehension was largely confined to expository text, although planning and organization (measured using a direct cognitive assessment) in 1st grade also predicted 4th grade comprehension scores for narrative text Recall. For expository text

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comprehens ion, working memory, planning and organization, shifting, and inhibition (measured using a parent rating scale), predicted reading comprehension outcomes. Critically, 1st grade shifting and inhibition not only predicted 4th grade expository text comprehension (CompQ), but also modulated its growth rate: children with stronger shifting and inhibition had faster rates of growth. Together, these findings suggest that expository reading comprehension is (1) more difficult than narrative reading comprehension and (2) is associated with unique cognitive skills.

Keywords

executive function; narrative text; expository text; reading comprehension

1 Introduction

In 2017, the Nation's Report card (U.S. Department of Education National Assessment of Educational Progress; NAEP) found that two thirds of 4th grade students in the United States performed below proficient, which is concerning given that poor reading performance in elementary grades tends to persist well into secondary education (Ferrer et al., 2015; Hernandez, 2011). With the introduction of the Common Core Standards and heightened focus on preparing students to be college and career ready, along with narrative text, students are being exposed to an increased amount of expository text in early grades (Jeong, Gaffney, & Choi, 2010; Moss, 2008). However, narrative and expository texts have important structural differences. Narrative texts describe the characters' experiences, usually follow a predictable development of events, are structured in a temporal sequence, and make use of everyday vocabulary (Medina & Pilonieta, 2006). On the other hand, expository texts are written to inform a reader and give details about a topic (Weaver & Kintsch, 1991) and do not necessarily follow a timeline and often include technical vocabulary not frequently encountered in daily life (Medina & Pilonieta, 2006). Interestingly, though narrative and expository texts differences have substantial implications for educational practice, most reading comprehension theories do not explicitly address text type, and, compared to the vast reading comprehension literature, relatively few studies (especially longitudinal ones) have specifically focused on text type. Nonetheless, reading comprehension theories and the empirical literature provide a basis for generating hypotheses about differential demands across text types.

1.1 Reading Comprehension Theories

The well-known developmental model of reading, the Simple View of Reading (SVR; Hoover & Gough 1990), emphasizes key processes that are foundational for reading comprehension (i.e., word-level abilities and listening/language comprehension). It has been established that these two processes are critical elements for reading comprehension success (Catts, Fey, Zhang, & Tomblin, 1999; Cutting & Scarborough, 2006; Joshi, Williams, & Wood, 1998; Share & Leikin, 2004). For instance, in a longitudinal study, Kim, Wagner, and Lopez (2012) found that oral reading rate and accuracy for lists of words and texts in first graders predicted their later development of reading comprehension. These results align with those obtained by Ribeiro, Cadime, Freitas, and Viana (2016). They found that in a sample of 159 Portuguese children in second and fourth grade, timed isolated word reading (or word reading efficiency, WRE) was the strongest predictor of reading comprehension. In addition to WRE, a close relation between phonological awareness (PA) and reading comprehension development (via word-level processing) has been systematically observed (Engen & Høien, 2002; Kjeldsen, Kärnä, Niemi, Olofsson, & Witting, 2014). Although PA is not explicitly addressed in the SVR, it is tightly linked to reading outcomes (presumably through word-level processing), and is therefore an important predictor of longitudinal outcomes of reading. For example, Kirby, Parrila, and Pfeiffer (2003) found that early PA most strongly predicted reading development in the first two years of school and that children with weak PA were most likely to develop reading difficulties by fifth grade. Similarly, a multitude of studies have confirmed that the other component of the SVR (listening comprehension) is critical for reading comprehension, particularly as children get older (e.g., Joshi, Williams, & Wood, 1998).

While the SVR provides a basis for hypothesizing that there will be fundamental common predictors across both narrative and expository text as related to decoding and language processes (Hoover & Gough, 1990), the SVR does not address the role of text characteristics, nor does it capture how background knowledge is assimilated with information in the text (Francis, Kulesz, & Benoit, 2018). With regard to text characteristics, the vocabulary used in narrative and expository texts has been found to vary by text type (Gardner, 2004). This is an important consideration, given that children’s vocabulary knowledge is often considered as part of the language component of the SVR (e.g., Catts, Fey, Zhang, & Tomblin, 1999) and is closely linked to background knowledge (Francis, Kulesz, & Benoit, 2018), which is generally thought more important for expository versus narrative text (Best, Floyd, & McNamara, 2008). Indeed, according to Gardner’s analyses (2004), the major lexical difference between narrative and expository reading materials used in upper-elementary education (10- and 11-year-old children) is vocabulary. Specifically, children’s narrative texts tend to utilize a greater proportion of high-frequency words, while expository texts tend to use a greater proportion of more specialized vocabulary words (i.e. academic language and unique words). These findings suggest that narrative texts place fewer lexical demands on children than expository texts do. Therefore, children’s vocabulary level is an important factor to consider when exploring the possible differences between narrative and expository text comprehension. Similarly, the Reading Systems Framework (RSF, Perfetti & Stafura, 2014, see also Verhoeven & Perfetti, 2008) highlights the role of vocabulary in reading comprehension through its focus on a well-developed lexicon. Thus, the current literature supports the supposition that understanding of word meanings or vocabulary knowledge facilitates reading comprehension; however, the degree to which vocabulary may vary across text type, over development, is less understood.

While the SVR and the RSF centrally emphasize the importance of word-level and language processes in reading comprehension, theories stemming from the traditional discourse processing framework emphasize higher order cognitive processes as important for reading comprehension, including the role of background knowledge and cognitive control processes (see McNamara & Magliano, 2009 for a review). Especially applicable to studying narrative versus expository text processing within the context of developing readers are the Landscape Model (LM; Van den Broek, Young, Tzeng, & Linderholm, 1999) and the structure Building Framework (Gernsbacher, 1991). The LM highlights the need for readers to integrate new information from text into prior knowledge using, in part, strategic processes, there fore implicitly tying in a role of executive function (EF), or a "collection of top-down control processes" (Diamond, 2013, p. 136), and encompasses such skills as working memory, shifting, inhibition, and planning and organization - most of which have been implicated in empirical studies of reading comprehension (Christopher et al., 2012; Cirino, et al., 2019; Locascio, Mahone, Eason, & Cutting, 2010; Sesma, Mahone, Levine, Eason, & Cutting, 2009; Spencer, Richmond, & Cutting, 2019). More specifically, the LM captures the EF concepts of working memory and shifting as being key processes as a reader navigates text (Van den Broek et al., 1999). As a general cognitive process, working memory involves holding information in mind while performing one or more mental operations (Diamond & Ling, 2016). As such, working memory is critical for being able to integrate new with old information, which is an active process during text comprehension. Indeed, along with the LM, working memory is implicated in most theories in the traditional discourse processing framework (McNamara & Magliano, 2009), and a multitude of empirical studies have shown that working memory is predictive of reading comprehension (Cain, Oakhill, & Bryant, 2004; Christopher et al., 2012; Cutting, Materek, Cole, Levine, & Mahone, 2009; Sesma et al., 2009).

Shifting, another EF implicated in discourse processing theories, in general refers to the ability to flexibly shift attention between mental sets, operations, or tasks and has been proposed to form the foundation for EF and problem-solving (Diamond, 2013). Specifically within the context of reading comprehension, the LM describes a shifting landscape between more passive (less conscious) versus active (conscious) processes as information from the text either assimilates into background knowledge or causes the reader to reintegrate information. Similar to the LM, the structure Building Framework (SBF; Gernsbacher & Faust, 1991) also incorporates shifting, suggesting that a reader needs to shift text representations to be able to develop a new substructure of the mental model. It may be that shifting mediates the relation between existing vocabulary (or the lexicon within background knowledge representations) and the acquisition of new knowledge during reading comprehension (e.g., Cartwright, Marshall, Dandy, & Isaac, 2010).

In addition to shifting, inhibition is theorized to play a role in reading comprehension (e.g. Gernsbacher & Faust, 1991; Kieffer, Vukovic, & Berry, 2013; Nouwens, Groen, & Verhoeven, 2016). As a general process, inhibitory control helps children stop an impulsive response in favor of a more adaptive behavior. This specific EF emerges rapidly during early childhood, and is thought to be foundational for EF development (Diamond, 2013). Thus it follows that it would be important for reading comprehension, in terms of being able to actively suppress dominant responses (e.g., Altemeier, Abbott, & Berninger, 2008; Kieffer et al., 2013). Indeed, the SBF (Gernsbacher, 1991) highlights the role of inhibition, postulating that if irrelevant information activated (consciously or unconsciously) in memory is not sufficiently suppressed, comprehension will suffer. Given the role of background knowledge in expository text, the role of inhibition may therefore be particularly important for expository, versus narrative, text processing.

In sum, discourse processing reading comprehension theories support the idea that interactions among multiple sources of information occur during reading comprehension, therefore supporting the supposition that narrative and expository text comprehension involves core characteristics (such as those outlined in the SVR model), as well as potentially differential reliance on vocabulary and higher order cognitive processes such as EF. Given that these models suggest greater EF-related demands for integrating new information into existing background knowledge (e.g., shifting [LM and SBF] and inhibition [SBF]), it would follow that expository text comprehension growth would place more demands on EF than narrative text comprehension growth. However, whether there are different contributions of core characteristics and/or EF based on text type to reading comprehension growth has not been examined.

1.2 Empirical Studies Examining Distinctions in Text Type

The idea that comprehension of narrative and expository texts have distinct demands on a reader comes from two streams of empirical studies: (1) those showing that narrative text is generally easier to comprehend than expository text and (2) those finding cognitive skills (e.g., vocabulary, EF) differentially contribute to reading comprehension by text type (Best, Floyd, & McNamara, 2008; Diakidoy, Stylianou, Karefillidou, & Papageorgiou, 2005; Eason et al., 2012; Haberlandt & Graesser, 1985; McNamara, 2013; Muijselaar et al., 2017; Santos et al., 2017). For instance, Best and colleagues (2008) found that narrative texts are generally easier than expository texts to comprehend. Similarly, Barth, Tolar, Fletcher and Francis (2014) found that *narrativity,* a continuous measure of the degree to which a text is narrative (Graesser, McNamara, Louwerse, & Cai, 2004) had a strong effect on passage reading fluency, with faster reading rate and higher accuracy positively correlating with narrativity (accounting for 34% of the variance when considered without other text features).

To understand text type distinctions, studies (all cross-sectional) have examined whether differences in readers' cognitive skills can explain the discrepancies between narrative versus expository reading comprehension. For example, Yildirim, Yildiz and Ates (2011) explored whether vocabulary was a predictor of reading comprehension across text types in 120 fifth graders. Results showed that compared to narrative text comprehension, vocabulary was a stronger predictor of expository text comprehension. Best et al. (2008) examined the influences of decoding skills and background knowledge on 3rd graders' comprehension of narrative and expository texts and showed that narrative text comprehension was most influenced by decoding skills, while expository text comprehension was most influenced by background knowledge, which is commonly linked to vocabulary (Cromley & Azevedo, 2007). Additionally, Eason and colleagues (2012) showed that higher order skills (EF), including inferencing, as well as planning and organizing, a component of EF presumably linked to reading comprehension ability by impacting the ability to navigate and organize text during reading (e.g., Locascio et al., 2010; Sesma et al., 2009), contributed to comprehension of expository text, but not to narrative text comprehension in 10-14 year olds. The contribution of planning and organizing to expository over narrative text may possibly reflect the greater need for conceptualization of reading goals and formulation of steps to achieve those goals in expository text. Nevertheless, the aforementioned studies were not longitudinal, and therefore do not account for the increased complexity of both text types across the elementary grades, especially expository texts, as students move into the later elementary grades (3rd and 4th grades).

Although it is known that word-level skills, vocabulary, and EF have an impact on reading comprehension (Christopher et al., 2012; Cutting et al., 2009; Spencer, Gilmour et al., 2019; Spencer, Richmond et al., 2019), not all studies are in agreement that distinctions in the contribution of these skills are different across text types, especially for linguistic skills such as word reading efficiency (WRE) and vocabulary. For example, Santos et al. (2017) found that narrative and expository reading comprehension were similarly associated with vocabulary in 2nd, 3rd, and 4th graders (correlations between vocabulary and narrative reading comprehension ranged from 0.28-0.38, similar to those with expository reading comprehension (0.25-0.49). Similarly, when examining the dimensionality of reading comprehension items in almost 1,000 fourth graders, Muijselaar et al. (2017) found that reading comprehension was a one-dimensional construct (i.e., a general reading comprehension factor explained more variance than separating narrative and expository text), and that cognitive predictors were not distinct in relation to text type; however, the cognitive predictors were relatively limited and consisted only of WRE, vocabulary, and working memory. Therefore, whether other higher order cognitive skills (various EFs) might have differentiated between comprehension of text types is unclear.

1.3 Current Study

Analyzing reading comprehension growth longitudinally is a strong method for exploring cognitive factors that predict reading development, particularly in terms of whether there are distinct developmental patterns for narrative versus expository text. To date, no studies have explored differential contributions of EF (either using direct measures of children's performance or parent questionnaires) to narrative versus expository text comprehension growth, while also accounting for factors known to influence reading comprehension (vocabulary, WRE, PA). The current study addresses this gap in the literature by examining narrative and expository reading comprehension growth in a longitudinal sample of children (grades 1 to 4) and identifying the cognitive factors that distinctly contribute to the comprehension of each text type. More specifically, we asked: 1) are individual differences present in the growth patterns of narrative and expository text comprehension? 2) if so, do WRE, PA, and vocabulary differentially explain the individual differences in the growth patterns for narrative versus expository text? 3) does EF add any explanatory value beyond other known predictors of comprehension growth? and, 4) do different components of EF predict growth in narrative versus expository text?

With respect to the first question, we hypothesized that the individual differences in growth patterns for both narrative and expository texts would be significant from 1st grade to 4th grade, since children with different cognitive skills would exhibit different growth rates as established by other studies. With regard to the second question, in line with SVR and RSF, it was expected that the WRE, PA, and vocabulary would largely determine the individual differences in the development of reading comprehension for both types of texts. But, consistent with the supposition of Gardner (2004), it was expected that the contribution of vocabulary to expository reading comprehension would be stronger than to that of narrative reading comprehension. With regard to the last two questions, aligning with discourse processing theories, especially the LM and SBF models, we expected EF to add extra explanatory value beyond other predictors both in predicting narrative and expository text comprehension growth. However, given that prior findings emphasized the stronger relation of EF and expository text versus EF and narrative text comprehension, we hypothesized in the current study that EF would have a larger contribution to expository text comprehension growth than to narrative text comprehension growth. With the generally more varied and complex structure of information presented in expository text, we anticipated that facility with mentally navigating, organizing, and manipulating pieces of information is in greater demand than with narrative text, thus tapping working memory and planning/organizing aspects of EF. In addition, because of the complicated structure of expository text and the need to suppress and assimilate new knowledge into background knowledge, we expected that shifting and inhibition would be important EF components to predict growth in expository text comprehension.

2 Method

2.1 Sample

One hundred forty children (75 females) were selected from public schools in one urban school district, one urban/rural school district, and several private/Catholic schools within and near a large metropolitan city in the southern United States. Students (with parental consent and student assent) were screened for reading ability in schools and invited to participate in the in-lab study if they met study criteria. Participants represented the full range of reading ability, with an oversampling of children considered to be potentially at-risk for reading difficulties. All participants were native English speakers with normal/corrected hearing and vision. Each participant gave written assent and the parent/guardian gave written consent at the beginning of the multi-component study, with procedures carried out in accordance with the Institutional Review Board. Participants received $75 for participation.

Children were tested each of the four years at about the same time point each year. At Time 1, the sample's mean age was 7.43 (*SD* = 0.34); in the following years, the mean age was 8.45, 9.45, and 10.45, respectively. Two parents reported their children had language disorders, and 10 reported that their children had Attention Deficit Hyperactivity Disorder (ADHD). Participants were not excluded for ADHD, provided they could sustain attention for testing. For the current study, the following measures were selected from a larger battery of tests.

2.2 Measures

Reading comprehension—The Qualitative Reading Inventory (QRI-**5**; Leslie & Caldwell, 2011) was used to assess reading comprehension. Children read aloud grade-level narrative and expository passages ranging in length from 250–785 words. At each time point, children read two passages (one narrative, one expository) and listened to two passages (one narrative, one expository). Modality was counterbalanced so that half of the participants read a given passage and the other half listened to the passage. Only the two passages that children read were included in the present study. Comprehension was assessed through an open-ended retell (Recall) and short-answer comprehension questions (CompQ). Retellings were scored based on the percentage of idea units recalled from a passage checklist (i.e., the ratio of the number recalled to the total). CompQs, which the QRI designates as either explicit or implicit, were scored based on a scoring template. Level 1 (Time 1) of the QRI-5 has 6 comprehension questions (4 explicit and 2 implicit questions) for each passage, regardless of text type. Levels 2-4 (Times 2-4) have 8 comprehension questions (4 explicit and 4 implicit questions) for each passage. CompQs were scored based on the percentage of correct answers (i.e., ratio of the correct answers to the total number of questions). Because different reading outcomes have been shown to rely on different cognitive skills (Spencer, Gilmour et al. 2019), both Recall and CompQ were used to provide a comprehensive picture of reading comprehension performance.

Although the QRI-5 is not a normed test, it is correlated with normed standardized measures of reading comprehension, therefore having evidence of convergent validity (Keenan, Betjemann, & Olson, 2008). The correlations between the QRI-5 and the Peabody Individual Achievement Test and Woodcock Johnson Passage Comprehension subtest are 0.44 and 0.45, respectively, and instructional level, as identified by QRI, correlates with performance on standardized tests of reading achievement (Leslie & Caldwell, 2011). Internal consistency reliability (Cronbach’s alpha) calculated on the current sample for the passages used in this study ranged from α = .73-82.

To further characterize the text-based features of the two text types, we examined the QRI-5 passages on text features as conceptualized by discourse theory (CohMetrix, Graesser, McNamara, & Kulikowich, 2011) and an in house measure of decoding difficulty (as used in Nguyen, Del Tufo, Saha, Pickren & Cutting., in press; Spencer, Gilmore et al., 2019). The results of this analysis (see Appendix A) were consistent with other studies that have reported that narrative texts have low referential cohesion and are composed of more frequent words than those used in expository text, while expository (science) texts are composed of rarer words but have increasing overlap in words and concepts (i.e., referential cohesion; McNamara et al., 2011). Text levels were consistent with grade levels and were “harder” with each subsequent grade level on text feature metrics, including Flesch-Kincaid Grade level. Thus, while the QRI-5 is not normed, the passages are grade leveled; as such, similar performance each year would indicate that a child was progressing as expected, while an increase would mean that a child was exceeding expected levels of comprehension from the prior year, and vice versa with a decreasing score. In that sense, the QRI-5 is similar to a normed test in terms of interpretation (i.e., a child who received 80% correct on CompQ in 1^{st}, 2^{nd}, 3^{rd} and 4^{th} grades would be growing in reading comprehension at a consistent level for each of those grades).

Word-level

Phonological awareness (PA): The Comprehensive Test of Phonological Processing (CTOPP; Wagner, Torgesen, & Rashotte, 1999) PA composite score was used to assess PA, and consists of Elision (EL) and Blending Words (BW). EL requires repeating a verbally presented stimulus word while omitting a sound. BW requires blending separately presented phonemes into a whole word. Each subtest’s raw scores are converted to age-based scaled scores; scaled scores are then combined into a PA composite score. Across ages 5-17, test-retest reliability for PA ranges between .79-.84.

Word reading efficiency (WRE): Isolated word reading fluency was measured using the two subtests of the Test of Word Reading Efficiency (TOWRE: Phonemic Decoding and Sight Word Efficiency, Torgesen, Rashotte, & Wagner, 1999). A list of pseudowords (Phonemic Decoding) or real words (Sight Word Efficiency) that progress in difficulty is shown, and students read aloud as many of the pseudowords/real words as possible within a 45-second period. The number of pseudowords/real words pronounced correctly constitutes each subtest's raw scores, which are then converted to age-based standard scores, and then combined into a composite score. The manual reports reliability between .90-.99.

Vocabulary—The Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999)'s vocabulary subtest was used to measure word knowledge, verbal concept formation, and fund of knowledge. Examinees verbally define and/or describe a word orally presented to them The average reliability coefficients for the WASI-II subtests for children (6-16 years of age) range from .86-.92.

Executive function—Generally, there are two approaches to measuring EF, either direct cognitive assessment or parent rating scales/questionnaires. In the current study, EF was assessed both ways.

Meta-cognition and Behavioral Regulation: Parents/guardians were administered the BRIEF for school-age children (5-12 years; Gioia, Isquith, Guy, & Kenworthy, 2000). This instrument measures meta-cognition and regulatory behaviors in children and adolescents with 86 items in 8 non-overlapping clinical scales, which are divided into two broad indexes: Met a-Cognition (MC: Monitor, Organization of Materials, Plan/Organize, Working Memory, Initiate) and Behavioral Regulation (BR: Emotional Control, Shift, Inhibit). Each item is graded on a scale of 1 (never) to 3 (often). Raw scores are converted to age-based standard scores. High scores reflect worse EF abilities. Internal consistency ranges from .80-,98 and test-retest reliability is .82.

Planning and Organizing: The Delis-Kaplan Executive Function System (D-KEFS, Delis, Kaplan, & Kramer, 2001) Tower Test was used as a direct measure of planning and organizing. During this task, the participant moves five discs across three pegs to match a visual model in as few moves as possible, while adhering to a specific set of rules; of note, direct measures of Plan/Organize have previously been implicated in reading comprehension (Eason et al., 2012). Internal consistency for the D-KEFS Tower Test ranges from .43 to .84 for the age range in the present study; test-retest reliability was reported as .51 (Delis et al., 2001). Age-based scaled scores (total correct standard scores) were used for analyses. Of note, the Tower Test overlaps with the BRIEF questionnaire's planning and organizing scale that is part of the MC index For reading ease, we heretofore refer to the DKEFS Tower Test as a *D*irect Assessment of *P*lanning and *O*rganizing (D-P/O) and the BRIEF Plan/Organize scale as a *Q*uestionnaire Assessment of *P*lanning and *O*rganizing (Q-P/O).

Socioeconomic Status (SES)—SES was included as a covariate of no interest, given its known impact on reading achievement (Kieffer, 2012). SES represents the social standing or class of an individual or group, and was measured by a parental survey that included participant-reported marital status, education level, employment status, and household income in the past year (Bornstein & Bradley, 2003; Hollingshead, 1975).

2.3 Procedure

Participants attended in-lab evaluation sessions annually for four years. Time 1 measures included in analyses were vocabulary, PA, WRE, the QRI-5, and the D-KEFS Tower, along with BRIEF rating scales and SES. QRI-5 measures were obtained at approximately the same time during Times 2-4. Assessments were administered by trained staff and graduate students working as research assistants, all of whom had prior experience working with school-age children. Testers underwent 40 hours of training and participated in fidelity checks prior to testing. Assessment score sheets were scored by three different scorers. Testing sessions were audio recorded and inter-rater reliability checks were conducted on 20% of testing sessions.

2.4 Statistical Analyses

HLM 7.0 (Hierarchical Linear Model; http://www.ssicentral.com/hlm), a way to analyze longitudinal data with multiple measurements nested within individuals, was used to examine reading comprehension outcomes at Time 4 and changes over time, as well as the influence of cognitive skills on these findings. Initial analyses fit separate unconditional models (i.e., no predictors other than time) for reading comprehension (RC) of narrative and expository text (Raudenbush & Bryk, 2002). In the models below, t_i represents a student's RC score at time t, expressed as a linear function of time; π_{0i} is student i's intercept parameter (the student's expected score at the final test); π_{1i} is the slope of the line relating RC to time for child i, and $e_{ti}$is random error. The Level-2 model includes student-level estimates (i.e., β_{00} and β_{10}) as fixed effects and r_{0i} and r_{1i} are random effects. The four time points were coded as −3, −2, −1 and 0, in which "0" indicated the last/fourth time point.

Level 1: $RC_{ti} = \pi_{0i} + \pi_{1i}\,(TIME) + e_{ti}$

Level 2: $\pi_{0i} = \beta_{00} + r_{0i}$

$\pi_{1i} = \beta_{10} + r_{1i}$

After unconditional models, conditional models examined the role of cognitive predictors in reading comprehension outcomes and individual growth rates, first entering Time 1 SES (Model 1), then Time 1 Vocabulary, PA, and WRE (Model 2), and, finally Time 1 EF variables (Model 3, see below). Since EF contained three different measures, BR or MC and the D-P/O, separate conditional models were run for *each* EF predictor. This allowed examination of the unique contribution of MC, BR, and D-P/O to the development of the narrative or expository reading comprehension ability, respectively. Of note, if either of the MC or BR scores were found to be a significant predictor of narrative or expository reading comprehension's intercept or slope, a second level of analysis examined which individual MC (e.g., Initiate, Q-P/O, Working Memory) or BR scales (e.g., Inhibit, Shift) were driving the prediction; these separate follow up analyses were needed to avoid multicollinearity.

Model 3:

Level 1: $RC_{ti} = \pi_{0i} + \pi_{1i}\,(TIME) + e_{ti}$

Level 2: $\pi_{0i} = \beta_{00} + \beta_{01}(SES) + \beta_{02}(vocabulary) + \beta_{03}(PA) + \beta_{04}(WRE) + \beta_{05}(BR/MC/D\text{-}P/O) + r_{0i}$

$\pi_{1i} = \beta_{10} + \beta_{11}(SES) + \beta_{12}(vocabulary) + \beta_{13}(PA) + \beta_{14}(WRE) + \beta_{15}(BR/MC/D\text{-}P/O) + r_{1i}$

2.5 Missing Data

Students were excluded from analyses if they did not attend at least two testing sessions (32.8% of the sample), resulting in N=94 (one with a language disorder and 7 with ADHD) in the HLM analyses. Independent sample *t* tests were used to compare the excluded versus included students. All comparisons were non-significant except for one: CompQ for narrative text (included children scored slightly higher than excluded ones, $t = 3.05$, $p=.003$ (0.73 vs. 0.59).

3 Results

3.1 The descriptive features of all variables

Table 1 contains means and standard deviations for all variables. Pair-wise *t*-tests revealed no significant differences between the two text types for Recall at Time 1 ($t < 1$), but CompQ scores were significantly different ($t = 5.50$, $p < .001$). For the other three time points, consistent with the literature (Best et al., 2008; Diakidoy et al., 2005; Haberlandt & Graesser, 1985), narrative comprehension (Recall and CompQ) was significantly higher than expository comprehension (all $t > 3.40$, $p < .001$).

3.2 The development of narrative and expository reading comprehension across four years

For narrative texts, the fixed effects analysis revealed a significant positive coefficient between time and Recall score, meaning that children's Recall for narrative texts increased over time. The correlation between time and CompQ was not significant, meaning that children performed similarly on CompQ for narrative texts at each time point. Results of random effects analyses showed that the individual differences in narrative text comprehension (Recall and CompQ) at the final time point were significant, and the growth rate (slope) for CompQ was also significant, indicating that children had variable final reading scores and developmental patterns. See Table 2.

For expository text comprehension, the fixed effects analysis revealed no significant relationship between time and Recall or CompQ, indicating expository text comprehension remained stable over time. However, both the intercept and slope were significant in the random effects analysis, indicating that not all children shared the same developmental pattern. See Table 2.

3.3 The factors associated with individual development patterns for narrative text comprehension

After controlling for SES, the intercept for vocabulary was significant for both narrative Recall and CompQ. On average, children with better vocabulary at Time 1 had higher narrative reading comprehension scores at Time 4. Not surprisingly, children from higher SES families had higher reading scores at Time 4. To examine the effects of EF, D-P/O, MC or BR were individually added into the model, after controlling for SES, vocabulary, WRE, and PA. Results showed that D-P/O in the first year predicted the final narrative text Recall score. The incremental contribution was around 4% ($\Delta R^2 = 0.4$). No other significant effects of EF were found. No significant predictors of slope were found. See Table 3.

3.4 The factors associated with individual development patterns in expository text comprehension

After controlling for SES, Time 1 vocabulary positively predicted the expository Recall score at Time 4, and Time 1 WRE positively predicted expository CompQ score at Time 4. Additionally, children with higher WRE exhibited faster growth rates in CompQ performance. Furthermore, both D-P/O and BR at Time 1 were significant predictors of Time 4 expository Recall. The unique contribution for D-P/O was 5.1% ($\Delta R^2 = 0.051$) and the unique contribution of BR was 8.2% ($\Delta R^2 = 0.082$). Both MC and BR predicted the change of expository CompQ scores at Time 4 (intercept); BR was also found to predict the growth rate (slope). The unique contribution was 9% ($\Delta R^2 = 0.09$) for MC (Intercept), 25.7% ($\Delta R^2 = 0.257$) for BR (Intercept), and 35.2% ($\Delta R^2 = 0.352$) for BR (slope).

To determine which specific components of MC and BR were driving the contributions to expository CompQ and BR to expository Recall, we examined the effects of the individual subscales. Results showed that the Working Memory and Q-P/O subscales of MC and the Shift and Inhibit subscales of BR at Time 1 predicted the expository CompQ score at Time 4. The growth (slope) of expository CompQ was also significantly predicted by Shift and Inhibit, and the Shift scale from the BR at Time 1 contributed to expository Recall at Time 4. See Table 4.

4 Discussion

In the present study, we built on the current literature on how reading comprehension specific to text type develops during elementary school by exploring potential differences in children's reading comprehension growth for narrative and expository texts from 1st to 4th grade. This is a critical issue as curricula are increasingly incorporating expository texts at earlier grades (Jeong et al., 2010; Moss, 2008) and expectations for children to learn from expository *and* narrative texts are emphasized in state standards (e.g., Common Core Standards, 2010). While previous longitudinal studies of reading comprehension, particularly those utilizing developmental models, have demonstrated the contributions of vocabulary, WRE, and PA to reading comprehension growth, these skills have rarely been analyzed within the context of considering text type, and none have included EF, despite its importance as suggested by various empirical studies and discourse theory-based models of reading comprehension.

4.1 Development of narrative and expository texts and individual differences

The current results are consistent with previous findings that children have better narrative relative to expository text comprehension across 1st through 4th grades (Best et al., 2008;

Diakidoy et al., 2005; Haberlandt & Graesser, 1985). Text type, characterized by text structure and content, has been identified as an important factor impacting text difficulty, with narrative text considered to be less difficult than expository text because the former draws on everyday experiences and commonly uses familiar words (Best et al., 2008; Garcia & Cain, 2014; McNamara et al., 2011). In the present study, findings suggested that there were not significant differences, on average, in students' comprehension of expository and narrative text – in other words, each year they attained similar percentages correct on the reading comprehension outcomes for the grade level texts they read. The one exception to this was Recall for narrative texts, which showed increases over time; these findings may be explained by the fact that children tend to be exposed to narrative text from early ages and consequently may be able to retell them with increasing proficiency as they get older (Jeong et al., 2010; Moss, 2008). While on average expository and narrative text comprehension were similar, both generally found to be more *variable* during development (both Recall and CompQ). Individual differences in growth rate and at Time 4 were statistically significant in expository text comprehension (Recall and CompQ), indicating that not all children showed similar growth patterns. These findings are consistent with most reading comprehension theories' emphases on individual differences, and support the idea that individual differences in cognitive processes would predict reading comprehension development. For example, across the SVR, RSF, LM and SBF, word-level factors, vocabulary, and processes that align with the construct of EF (e.g., shifting, inhibition) are hypothesized (explicitly or implicitly) to determine individual differences in reading comprehension (McNamara & Magliano, 2009). However, few studies have actually examined how these cognitive processes contribute to reading comprehension across text types, over time.

4.2 Vocabulary and WRE: Individual differences

Our finding that the individual differences in the final time point (Time 4) were significant for both narrative and expository text comprehension suggests that earlier cognitive skills could explain some of these individual differences. Findings indeed revealed that 1^{st} grade linguistic skills (WRE and vocabulary) predicted children's reading comprehension in 4^{th} grade. PA did not contribute unique variance in predicting reading comprehension outcomes; however, given its close relation with word-level processes, it is likely that WRE captured any variance that PA may have contributed (indeed, in the current study, the two were highly correlated; $r = .55$, $p < .05$).

WRE and vocabulary's contribution to reading comprehension, however, varied depending on text type and reading outcome (CompQ or Recall). Vocabulary predicted reading comprehension for three out of the four reading comprehension outcomes (CompQ and Recall for narrative texts, and Recall for expository texts). These findings lend support to the RSF (Perfetti & Stafura, 2014; Verhoeven & Perfetti, 2008), which emphasizes the role of vocabulary knowledge and the need for a well-developed mental lexicon for adequate reading comprehension. Findings also align with empirical studies; for example, Muter, Hulme, Snowling, and Stevenson (2004), found that second graders' reading comprehension was predicted by their word identification, vocabulary, and linguistic skills measured at school entry (two years prior). Similarly, our findings showed that 1^{st} grade vocabulary predicted both narrative and expository text Recall, as well as narrative CompQ, at the final testing time.

Prior research is inconsistent about whether the effects of vocabulary on reading comprehension depends on text type. Although Yildirim et al. (2011) concluded that vocabulary was a stronger predictor of expository text comprehension than of narrative text comprehension, Santos et al. (2017) found both narrative and expository reading comprehension were similarly associated with vocabulary. This discrepancy across studies may be due to differences in participants' ages. Yildirim et al. (2011) studied fifth-grade students, whereas Santos et al. (2017) and the current study included 1st through 4th graders. In the United States, students depend on expository texts more for learning more in later grades than in early elementary school (Kelley & Clausen-Grase, 2010). Since expository texts are written about a wide range of content areas (e.g., science, mathematics, social studies), they frequently include unique and novel words/concepts, which in turn, could place a high demand on vocabulary knowledge. In fact, research has shown that the role of word -level skills decreases when children become more experienced readers, while the role of vocabulary in reading comprehension increases around 4th grade (Verhoeven & Leeuwe, 2008). Therefore, vocabulary may show similar effects across text types for younger readers, especially when reading comprehension is assessed by Recall, which requires retrieving vocabulary, because they may have less developed and differentiated vocabulary/lexicon items for each text type than older readers. In this case, one would expect that vocabulary would differentially predict text type in later grades than the ones in the current study (i.e., as children move into middle school). Nevertheless, our findings suggest that from 1st to 4th grade, vocabulary is of substantial importance for reading comprehension, especially when assessed by retelling, across time, regardless of text type.

First grade WRE was also a critical factor in determining reading comprehension growth and at 4th grade, but only for expository text comprehension (CompQ). Surprisingly, WRE did not predict narrative text comprehension growth or at 4th grade. WRE may be more useful for predicting outcomes in beginning readers, but not after children become skilled readers, which concurs with our finding that WRE did not predict 4th grade narrative text reading, which is consistent with the findings of Kim et al. (2012). However, while the aforementioned account may explain our lack of findings with regard to WRE and narrative text comprehension, it does not explain why WRE was specifically linked to expository comprehension. It may be that expository text comprehension is harder and has more content-specific academic words than narrative reading comprehension; thus, students might rely more on decoding and how efficiently they can actually read the words. Indeed, Kaya and Yıldırım (2016) found that text reading fluency, which captures both word recognition accuracy and text reading speed, had tighter linkages to expository versus narrative text comprehension in a sample of 100 4th graders.

Of note, in all of our analyses we controlled for SES prior to adding WRE, PA, and vocabulary into the model, something many studies do not do. SES is known to have overlapping variance with both WRE and vocabulary (Paleologos & Brabham, 2011). Indeed, when we removed SES from our models, findings revealed that the overall pattern was that *both* WRE and vocabulary were statistically significant predictors of reading comprehension, regardless of text type (see Appendix B). However, even after removing SES, WRE continued to only predict expository text *growth* (CompQ), suggesting that it has a unique role in predicting expository comprehension that is not yet well understood. Taken together, our results suggest that it will be important for future studies to further examine how early word-level processes may differentially predict growth for reading comprehension across different text types.

4.3 The contribution of EF to reading comprehension

In addition to vocabulary, WRE, and PA, we examined the contribution of EF to reading comprehension outcomes and growth. Findings revealed that the 1st grade EF measures were largely predictive of expository, but not narrative, comprehension at 4th grade. Specifically, the Working Memory and Q-P/O subscales of MC predicted expository CompQ in 4th grade, along with the Shift and Inhibit scales of BR; additionally, Shift predicted expository but not narrative text Recall. In contrast, only one of the 1st grade EF measures predicted narrative comprehension in 4th grade: D-P/O (which was also predictive of expository text Recall). These findings are well aligned with prior studies' findings showing a role for various components of EF in predicting reading comprehension in general (e.g., Christopher et al., 2012; Cutting et al., 2009; Spencer, Richmond et al., 2019), but with a greater emphasis for EF in expository versus narrative reading comprehension (Eason et al., 2012). For example, Eason et al. (2012) found that planning and organizing contributed to expository multiple-choice question comprehension whereas word-level and language processes contributed to all types of texts among 10-14 year old children. In the current study, we also found that planning and organization (Q-P/O), along with working memory, predicted expository, but not narrative, reading comprehension (CompQs). It has been observed that in expository text, the same words tend to be used multiple times in order to relate sentences together and promote development of a situation model (McNamara et al., 2011). Perhaps this need for integration makes it more difficult for a reader to identify the proper section of text needed to answer a question, because searching for words in the text that match the question may yield multiple possibilities, thus taxing readers' planning, organization, and working memory processes.

In addition to planning, organization, and working memory, 1st grade shifting and inhibition predicted expository comprehension (CompQ) at 4th grade. This indicates that the more that 1st graders are able to easily shift between tasks and inhibit responses, the better their 4th grade reading comprehension outcomes will be. Importantly, not only did shifting and inhibition predict 4th grade expository text comprehension, but also both of these EFs specifically predicted expository text comprehension *growth* (CompQ). The ability to shift attention is generally an important characteristic for complex tasks, such as multitasking and finding novel, adaptable solutions to changing demands (Ionescu, 2012), along with being a useful factor in fostering efficient problem solving and creativity (Vartanian & Goel, 2007). Within the context of reading comprehension, shifting ould facilitate reading comprehension development by enhancing the ability to focus on some ideas while simultaneously ignoring (inhibiting) other ideas and/or prior knowledge (Diamond, 2013); these processes would presumably enable faster growth in expository reading comprehension, perhaps by facilitating expansion of background knowledge, which is known to be important for expository reading comprehension (Best, et al., 2008; Kendeou & van den Broek, 2007). Expository text comprehension could also place more demands on needing to deliberately applying attentional flexibility (shifting) because it is generally more difficult than narratives, and the content is often less familiar to children (Best et al., 2008). Of note, the fact that 4th grade expository text comprehension was predicted by 1st grade shifting abilities, regardless of the way reading comprehension was measured (Recall or CompQ), and that it contributed to growth of expository reading comprehension suggests that it may be a particularly key EF ability for reading comprehension development, as the LM and SBF would predict.

In terms of our finding of the contribution of inhibition to predicting CompQs, reading comprehension requires suppressing (inhibiting) irrelevant information in order to focus on relevant text information. More generally, studies have shown that inhibition is an important mediator of children's early emotional control skills and their eventual school success (Trentacosta & Izard, 2007). Studies have shown that children with stronger inhibitory control show better performance on concurrent measures of mathematics and letter knowledge (Blair & Razza, 2007). For expository text in particular, it may be that irrelevant information needs to be inhibited so that new information about a topic can be integrated into memory and/or existing background knowledge, which would be especially important for expository reading comprehension growth.

Together our findings with regard to shifting and inhibition lend support to the models of LM and SBF, which emphasize the effects of these two EFs in reading comprehension (McNamara & Magliano, 2009). Notably, we measured shifting and inhibition in the current study as conscious processes. However, shifting between passive processes and active processes (according to the LM) and shifting to develop a new substructure of the mental model and inhibiting a concept (according to the SBF) may be or may be not a conscious process (Gernsbacher, 1991; Van den Broek et al., 1999). Similarly, suppressing irrelevant information while reading text may or may not be a conscious inhibitory process, which is something that future studies will need to explore. However, overall, the current study further elucidates how these two EFs predict reading comprehension development, in that they appear to be specifically important for expository over narrative text comprehension.

Of note, the above EF findings were largely confined to reading comprehension outcomes as measured by CompQs, although shifting predicted expository Recall as well. Interestingly, the direct measure of children's 1st grade planning and organizing skills (D-O/P) predicted *both* narrative and expository text Recall in 4th grade. The fact that D-O/P predicted both narrative and expository reading comprehension for the Recall outcome was somewhat unexpected as a prior study showed that a direct measure of planning and organization (similar to the D-P/O in the current study) predicted expository, but not narrative, comprehension (Eason et al., 2012). One possibility for the discrepant findings is that we tracked the predictive effect of the direct measure of planning and organization from Grade 1 to 4, while Eason et al. (2012) examined its role in reading comprehension among students at a single time point in the middle school years. Additionally, Eason et al. (2012) used only multiple-choice questions to assess reading comprehension, and did not have the retelling measure that the current study had. Prior studies have shown that the cognitive requirements of text retelling place high demands on EF-related processes (Tannock, Purvis, & Schacher, 1993). Consequently, it may be that regardless of text type, for this age range, the cognitive processes captured in the direct measure of planning and organization are needed in order to organize information in order to retell text.

It is also important to note that the EF components measured by the parent questionnaires tend to emphasize observable behavior and therefore may be less reflective of the cognitive aspects of EF that are captured by the direct measure of planning and organization. Therefore, it may be that these cognitive aspects of EF (as measured by the planning and organization direct measure) become increasingly important to expository text comprehension as children move into adolescence. While the current study was not able to test this hypothesis, future studies will need to unpack the nature of our somewhat conflicting findings by further probing the impact of assessing EF using direct measures versus parental questionnaires when predicting reading comprehension across text types; furthermore, it will be important to conduct such studies comparing the developmental time-frames of 1st-4th grades versus middle school grades, when studies have shown that direct measures of planning and organization are still developing, even though other measures of EF have reached an asymptote (Welsh, Pennington, & Groisser, 1991).

In summary, our findings indicate that expository text comprehension places demands on a variety of EFs. Shifting and inhibition in particular not only predicted 4th grade outcomes (for CompQ), but also predicted expository text comprehension *growth*. Additionally, 1st grade shifting abilities uniquely predicted expository comprehension at 4th grade, regardless of how reading comprehension was measured (CompQ or Recall). Of note, the direct planning and organization measure predicted both expository and narrative Recall, suggesting that this way of assessing reading comprehension in this age group may be particularly demanding, regardless of text type. Theoretically, our study adds to the literature in that it suggests that current models of reading comprehension may need to explicitly consider the role of text type. Practically, our results indicate that reading expository text requires distinct cognitive skills that are different than those required to process narrative texts. Therefore, practitioners and researchers should continue to consider the development of EF throughout elementary school years when addressing comprehension problems or delays, especially when the focus of reading instruction switches from narrative to expository text.

4.4 Limitation and Future Directions

There are some important limitations to consider when interpreting our findings. First, shifting, inhibition, and working memory were all measured indirectly via parental report, which may capture more outward EF behaviors, but less of the cognitive aspects of EF. Additionally, although we included a direct assessment of children's planning and organizing ability (D-KEFS; Delis et al., 2001) along with a parental report of planning and organizing ability, we found that the direct versus parental assessment of planning and organization were sensitive to the way reading comprehension was measured, and produced somewhat conflicting findings. Indeed, given the low and insignificant correlation between the Tower Test and the BRIEF scores (Table 1), it appears that the direct and narrowly focused Tower Test may be distinct from the general behavior patterns observed by parents in the broader scope of day-to-day life as reported in the BRIEF. Therefore, future research should consider how direct versus indirect measures of EF affect reading comprehension. Second, studies should examine how various text features (e.g., syntactic complexity of the text) impact reading comprehension growth, along with the way reading comprehension is measured. Our reading comprehension measures were off-line only; online measures may capture comprehension processes more comprehensively, particularly in terms pinpointing text junctures for which specific cognitive skills may be especially important. Third, we only included 1st grade word reading abilities, vocabulary, and EFs. These skills, especially EFs, continue to develop during the later elementary and middle school years, corresponding to the maturation of the frontal lobes in adolescence (Welsh et al., 1991); thus, their ongoing measurement should be considered. Fifth, while the QRI-5 correlates with standardized measures of reading comprehension, QRI-5 scores are not scaled, and therefore findings indicate performance relative to others in the sample, versus the population more generally. Finally, some children in current study were at-risk for reading difficulties. Although this makes the sample more representative of the general school population, future research should consider how cognitive factors that differentially predict reading comprehension growth across text types interact with varying levels of reading ability.

5 Conclusion

In summary, our study provides novel insights into the role of various cognitive predictors of narrative versus expository text comprehension growth. Along with confirming previous findings that narrative texts are generally easier to comprehend than expository texts, we found that expository text comprehension at 4th grade can be predicted by 1st grade WRE and various EFs. Critically, shifting and inhibition uniquely predicted expository text comprehension *growth*. Finally, we found that vocabulary and direct cognitive measures of planning and organization are essential predictors of reading comprehension regardless of text type for oral recall or retelling - a classic measure of reading comprehension performance. These findings therefore provide important insights into how EF relates to different ways of capturing reading comprehension across narrative and expository texts.

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Appendix A

Table 1

Summary of Text Characteristics of Narrative and Expository Passages

Text type	**Narrative**						**Expository**							
Time	**Timel**	**Time2**	**Time3**	**Time4**	**M**	**SD**	**Timel**	**Time2**	**Time3**	**Time4**	**M**	**SD**	***P***	**Cohen's *d***
Celex word frequency (log)	3.19	3.16	3.08	3.01	3.11	0.11	3.13	3.06	2.94	2.87	3.00	0.11	0.02	1.05
Number of words	233.00	329.00	338.00	278.00	294.50	49.72	81.00	223.50	244.00	281.50	207.50	83.15	0.01	1.30
Words per sentence	8.17	9.30	11.88	9.47	9.70	1.54	6.14	8.98	11.07	11.89	9.52	2.57	0.82	0.08
Syllables per word	1.17	1.22	1.24	1.35	1.25	0.08	1.12	1.20	1.22	1.33	1.22	0.09	0.20	0.49
Narrativity (z score)	0.41	1.36	0.94	0.67	0.84	0.42	0.67	−0.11	0.13	−0.50	0.05	0.52	0.03	0.99
Syntactic simplicity (z score)	1.69	1.28	1.11	1.89	1.49	0.47	2.84	1.44	1.42	0.71	1.60	0.94	0.79	0.10
Word concreteness (z score)	2.21	1.10	1.66	0.83	1.45	0.85	2.19	2.28	1.81	1.72	2.00	1.05	0.21	0.49
Referential cohesion (z score)	2.67	0.18	0.27	−0.64	0.62	1.43	4.96	0.97	1.12	0.66	1.93	2.02	0.03	0.95
Deep cohesion (z score)	0.70	0.71	0.67	1.12	0.80	0.60	−0.48	0.15	1.69	0.30	0.42	0.97	0.42	0.30
Verb cohesion (z score)	1.60	0.04	−0.49	−0.49	0.17	1.11	1.80	0.90	−0.49	−0.01	0.55	0.99	0.28	0.41
Flesch reading ease	97.44	94.08	89.92	82.84	91.07	6.05	100.00	96.16	92.64	82.59	92.85	7.79	0.18	0.54
Flesch-Kincaid grade level	1.45	2.44	3.67	4.06	2.91	1.15	0.46	2.08	3.09	4.69	2.58	1.78	0.42	0.29
Coh-Metrix L2 readability	31.91	23.97	20.63	23.87	25.10	5.41	56.73	30.12	21.20	22.67	32.68	15.51	0.11	0.64
Decoding difficulty	2.01	2.08	2.15	2.41	2.16	.17	2.09	2.13	2.13	2.27	2.16	.08	.94	0.06

Note. Means and SDs of indices are derived from the values across all passages classified as narrative or expository in the QRI. Celex word frequency: log frequency of content words in the passage (nouns, adverbs, adjectives, & main verbs in the passage); Number of words: total number of words in the passage; Words per sentence: total number of words in the passage divided by total number of sentences in the passage; Syllables per word: mean number of syllables per content word in the passage; Narrativity: the extent to which the passage conveys a story (larger value) versus informational text (smaller value); Syntactic simplicity: it reflects the degree to which the sentences in the text contain fewer words and use simple, familiar syntactic structures, which are less challenging to process by the reader. Word concreteness: ratings of word concreteness based on Medical Research Council (MRC) Psycholinguistics Database (Coltheart, 1981); Referential cohesion: refers to overlap in content words between local sentences; high cohesion text contains words and ideas that overlap across sentences and the entire text, forming explicit threads that connect the text for the reader. Deep cohesion: this dimension reflects the degree to which the text contains causal, intentional, and temporal connectives. Verb cohesion: The average polysemy of content words, the verb overlaps in adjacent sentences and in the latent semantic analysis. Flesch reading ease: measures text difficulty using average words per sentence and average syllables per word in the passage; Flesch-Kincaid grade level: provides a grade level for a text based on average words per sentence and average syllables per word in the passage. Coh-Metrix L2 Readability: Global score based on individual Coh-Metrix metrics, including cohesion, word frequency, and syntax. Decoding difficulty: in house metric of decoding difficulty that captures various aspects of phoneme-grapheme correspondence, such as probability of grapheme making a certain phoneme (see Nguyen et al., in press; Spencer, Gilmore et al., 2019). *P* value: the comparison between narrative and expository texts. Of the eight expository passages, six were descriptive, one had a compare/contrast text structure, and one had a sequence structure. Of the eight narrative passages, six were fictional stories and two were biographies.

Appendix B

Table 1.

Prediction of Narrative Reading Comprehension (not controlling for SES)

	Intercept				Slope			
Nar-Recall	***Coefficient***	***SE***	***t***	ΔR^2	***Coefficient***	***SE***	***t***	ΔR^2
1.+WRE, PA				0.135				*n.s.*
WRE	0.1920	0.0951	2.02 *		−0.0387	0.0517	−0.75	
PA	0.1470	0.1141	1.29		−0.0307	0.0653	−0.47	
2.+Vocabulary	0.2972	0.1278	2.33 *	0.061	−0.0499	0.062	−0.81	*n.s.*
3.+D-PO	0.1837	0.0921	1.99 *	0.036	0.0579	0.0394	1.47	*n.s.*
3.+MC	0.0639	0.1419	0.45	*n.s.*	0.1118	0.0553	1.02	*n.s.*
3.+BR	−0.0601	0.1722	−0.34	*n.s.*	0.0764	0.0511	1.49	*n.s.*
Nar-CompQ								
l.+WRE, PA				0.177				*n.s.*
WRE	0.0036	0.0016	2.19 *		0.0002	0.0007	0.34	
PA	0.0008	0.002	0.41		−0.0007	0.0009	−0.76	
2.+Vocabulary	0.0045	0.0021	2.13 *	0.103	0.0004	0.0009	0.44	*n.s.*
3.+D-PO	0.001	0.0015	0.66	*n.s.*	0.0002	0.0009	0.24	*n.s.*
3.+MC	−0.0019	0.0015	−1.24	*n.s.*	−0.0012	0.0008	−1.39	*n.s.*
3.+BR	−0.0015	0.0019	−0.79	*n.s.*	−0.0007	0.0011	−0.61	*n.s.*

Note: Intercept: the individual difference in the final test; Slope: individual difference in growth rate; SES = socioeconomic status; WRE= word reading efficiency; PA= phonological awareness; D-P/O = Direct Assessment of Planning and Organizing; MC = Meta-Cognition; BR = Behavioral Regulation; *n.s.* = the unique contribution is not significant;

* $p < 0.05$;

** $p < 0.01$;

*** $p < 0.001$.

Table 2

Prediction of Expository Reading Comprehension (not controlling for SES)

	Intercept				Slope			
Exp-Recall	***Coefficient***	***SE***	***t***	ΔR^2	***Coefficient***	***SE***	***t***	ΔR^2
1.+WRE, PA				0.385				*n.s.*
WRE	0.3314	0.0845	3.92 ***		0.0385	0.0559	0.68	
PA	0.0272	0.1099	0.24		−0.0369	0.0694	−0.53	
2.+Vocabulary	0.4417	0.1092	4.04 ***	0.365	−0.0025	0.0632	−0.04	*n.s.*
3.+D-P/0	0.1826	0.0838	2.18 *	0.059	0.0481	0.0501	0.95	*n.s.*
3.+MC	−0.0423	0.1133	−0.37	*n.s.*	0.0948	0.081	1.17	*n.s.*
3.+BR	−0.2547	0.0988	−2.57 *	0.078	−0.0262	0.0648	−0.4	*n.s.*
Shift	−0.299	0.092	−3.24 **	0.111	−0.0723	0.0651	−1.11	*n.s.*

	Intercept				Slope			
Exp-Recall	***Coefficient***	***SE***	***t***	**ΔR²**	***Coefficient***	***SE***	***t***	**ΔR²**
Exp-CompQ								
1.+WRE, PA				0.540				0.280
WRE	0.01	0.0017	5.73***		0.0027	0.0009	3.06**	
PA	−0.0024	0.0024	−1.02		−0.002	0.0011	−1.74	
2.+Vocabulary	0.0037	0.0025	1.47	*n.s.*	−0.0017	0.0012	−1.34	*n.s.*
3.+D-P/0	0.0011	0.0019	0.6	*n.s.*	0.0002	0.0009	0.26	*n.s.*
3.+MC	−0.0041	0.0021	−1.92*	0.060	−0.0008	0.0012	−0.71	*n.s.*
Working Memory	−0.004	0.0019	−2.05	0.067	−0.0009	0.001	−0.89	*n.s.*
Q-P/O	−0.0051	0.0018	−2.79**	0.083	−0.001	0.0011	−0.99	*n.s.*
3.+BR	−0.0087	0.0018	−4.64***	0.285	−0.0039	0.0009	−4.37***	0.362
Shift	−0.0076	0.002	−3.83***	0.189	−0.004	0.0009	−4.42***	0.324
Inhibit	0.0077	0.0018	−4.13***	0.221	−0.0032	0.001	−3.06**	0.235

Note: Intercept: the individual difference in the final test; Slope: individual difference in growth rate; SES = socioeconomic status; WRE= word reading efficiency; PA= phonological awareness; D-P/O = Direct Assessment of Planning and Organizing; MC = Meta-Cognition; BR = Behavioral Regulation; Q-P/O = Questionnaire Assessment of Planning and Organizing; *n.s.* = the unique contribution is not significant; Based on the Model 2, individual MC and BR scales were put into Model 3, respectively; Working Memory, Q-P/O, Shift, and Inhibit each contributed unique variance

* $p < 0.05$

** $p < 0.01$

*** $p < 0.001$.

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Highlights:

1. Narrative texts are generally easier to comprehend than expository texts.
2. Vocabulary and planning/organizing are essential predictors of reading comprehension, regardless of text type, especially for oral recall.
3. Expository text comprehension has unique demands that rely on word reading efficiency, shifting, and inhibition.

Table 1

Summary of Intercorrelations, Means, and Standard Deviations for Predictor Variables and Text Type within and across each Time.

	Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Mean	SD	n
1	D-KEFS	–															97.38	12.79	94
2	BRIEF_BR	−.12	–														47.76	10.81	94
3	BRIEF_MC	−.12	.72**	–													50.97	11.28	94
4	TOWRE	.05	−.33**	−.41**	-												107.62	14.41	94
5	WASI-II	.07	−.17	−.24*	.55**	-											55.01	11.16	94
6	CTOPP	−.03	−.23*	−.20	.55**	.42**	-										103.82	12.58	94
7	SES	.04	−.14	−.06	.42**	.28**	.37**	-									3.94	0.87	94
8	BR_Inhibit	−.05	.87**	.70**	−.33**	−.17	−.22*	−.17	-								49.67	10.58	94
9	BR_Shift	−.12	.84**	.65**	−.38**	−.23*	−.21*	−.11	.62**	-							46.65	10.62	94
10	BR_EC	−.13	.88**	.52**	−.16	−.06	−.17	−.08	.58**	.65**	-						47.74	11.14	94
11	MC_Initiate	−.01	.61**	.89**	−.36**	−.19	−.19	.01	.63**	.51**	.44**	-					51.79	10.84	94
12	MC_WK	−.13	.61**	.90**	−.46**	−.32**	−.25*	−.13	.58**	.60**	.43**	.74**	-				51.69	12.58	94
13	MC_Q-P/O	−.19	.64**	.93**	−.46**	−.26*	−.16	−.13	.58**	.64**	.47**	.78**	.83**	-			50.84	12.03	94
14	MC_MO	−.06	.53**	.64**	−.14	−.06	−.05	.12	.52**	.41**	.44**	.57**	.45**	.42**	-		51.90	9.25	94
15	MC_Monitor	−.14	.66**	.86**	−.21*	−.08	−.14	−.01	.72**	.53**	.44**	.75**	.66**	.77**	.50**	-	49.17	11.01	94
Time 1																			
	Nar-Recall	.0 7	−.30**	−.28*	.34**	.41**	.29**	.32**	−.37**	−.25*	−.15	−.18	−.34**	−.23*	−.18	−.21*	30.71	16.87	94
	Exp-Recall	.04	−.18	−.27*	.26*	.35**	.22*	.21*	−.28**	−.15	−.06	−.24*	−.30**	−.20	−.18	−.23*	29.63	17.76	94
	Nar-CompQ	.01	−.08	−.07	.28**	.32**	.29**	.14	−.05	−.06	−.10	−.05	−.12	−.03	−.03	.01	73.00	22.84	94
	Exp-CompQ	.02	.06	−.13	0.2	.43**	.31**	.27**	.00	.08	.08	−.12	−.18	−.15	.02	−.09	55.45	30.15	94
Time 2																			
	Nar-Recall	.03	−.20	−.08	.33**	.41**	.32**	.41**	−.18	−.22*	−.14	−.22*	−.30**	−.20	−.16	−.15	36.89	16.76	92
	Exp-Recall	.13	−.19	−.19	.19	.31**	.14	.27**	−.23*	−.18	−.08	−.21*	−.25*	−.30**	−.06	−.25*	30.61	16.07	92
	Nar-CompQ	.11	−.10	−.01	.34**	.28**	.28**	.37**	−.02	−.14	−.12	.03	−.15	−.16	.12	.01	70.52	16.22	92
	Exp-CompQ	.10	−.19	−.12	.34**	.33**	.08	.36**	−.19	−.23*	−.09	−.18	−.27**	−.30**	−.15	−.15	49.86	17.92	92

	Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Mean	SD	n
Time 3																			
	Nar-Recall	.05	−.19	−.13	.33**	.32**	.28**	.40**	−.17	−.20	−.14	−.06	−.22*	−.15	−.05	−.15	40.29	15.80	93
	Exp-Recall	.07	−.22*	−.02	.42**	.50**	.25*	.38**	−.23*	−.25*	−.12	−.06	−.26*	−.24*	.01	−.11	28.97	14.09	93
	Nar-CompQ	.09	−.16	−.05	.33**	.35**	.21*	.34**	−.22*	−.10	−.09	−.14	−.19	−.15	.04	−.05	70.83	21.68	93
	Exp-CompQ	0.09	−.30**	−.07	.42**	.35**	.16	.30**	−.27**	−.26*	−.21*	−.18	−.26*	−.31**	−.06	−.18	59.81	25.79	93
Time 4																			
	Nar-Recall	.23*	−.15	.01	.23*	.32**	.21	.24*	−.14	−.19	−.11	−.02	−.16	−.09	.13	−.10	35.56	14.94	81
	Exp-Recall	.24*	−.34**	−.04	.35**	.45**	.21	.28*	−.24*	−.39**	−.28*	−.15	−.29**	−.24*	−.10	−.19	26.74	12.88	81
	Nar-CompQ	.07	−.15	.09	.26*	.35**	.21	.13	−.24*	−.23*	−.05	−.26*	−.26*	−.28*	−.12	−.25*	66.67	20.54	81
	Exp-CompQ	.06	−.43**	.01	.46**	.41**	.24*	.34**	−.43**	−.42**	−.30**	−.27*	−.41**	−.42**	−.19	−.20	50.00	28.44	81

Note. D-KEFS = Delis-Kaplan Executive Function Tower Test total correct standard score; BRIEF_BR = Behavior Rating Inventory of Executive Function - Behavioral Regulation composite standard score; BRIEF_MC = Behavior Rating Inventory of Executive Function- Meta-Cognition composite standard score; TOWRE = Test of Word Reading Efficiency Sight Word Efficiency subtest standard score; WASI-II = The Wechsler Abbreviated Scale of Intelligence- Vocabulary Subtest standard score; CTOPP = The Comprehensive Test of Phonological Processing - phonological awareness subtest score; SES = Socioeconomic status; BR_ = Individual scale of BR; MC_ = Individual scale of MC; EC = Emotional Control; WK = Working Memory; Q-P/O = Plan/Organization; MO = Organization of Materials. Nar-Recall = narrative retelling score; Exp-Recall = expository retelling score; Nar-CompQ = narrative short-answer comprehension question score; ExpQs = expository short-answer comprehension question score. Recall and CompQ are measured in percentages.

* $p < 0.05$;

** $p < 0.01$.

Table 2

Developments of Narrative and Expository Reading Comprehension and Individual Differences in Growth

Growth		***Coefficient***	***SE***	***t***
Nar-Recall	Slope	1.7423	0.588	2.96**
Nar-CompQ	Slope	−0.0188	0.0096	−1.91
Exp-Recall	Slope	−1.087	0.6345	−1.70
Exp-CompQ	Slope	−0.0072	0.0122	−0.59
Individual differences		***Variance***	***SD***	χ^2
Nar-Recall	Intercept	89.1751	9.4432	168.08***
	Slope	2.2341	1.4947	99.43
Nar-CompQ	Intercept	0.0173	0.1313	168.68***
	Slope	0.0031	0.056	138.71**
Exp-Recall	Intercept	51.5473	7.1796	139.6**
	Slope	9.7123	3.1164	124.67*
Exp-CompQ	Intercept	0.0301	0.1736	173.28***
	Slope	0.004	0.0628	132.52**

Note: Nar-Recall = narrative retelling score; Exp-Recall = expository retelling score; Nar-CompQ = narrative short-answer comprehension question score; ExpQs = expository short-answer comprehension question score. Recall and CompQ are measured in percentages.

* $p < 0.05$;

** $p < 0.01$;

*** $p < 0.001$.

Table 3

HLM analysis of Cognitive skills on the Development of Narrative Reading Comprehension

	Intercept				Slope			
Nar-Recall	***Coefficient***	***SE***	***t***	**ΔR^2**	***Coefficient***	***SE***	***t***	**ΔR^2**
1.+SES	5.6312	1.6745	3.63	0.229	−0.562	0.7223	−0.778	*n.s.*
2.+Vocabulary, WRE, PA				0.064				*n.s.*
Vocabulary	0.2847	0.1282	2.22*		−0.0246	0.0618	−0.80	
WRE	0.0175	0.1209	0.14		−0.0152	0.0580	−0.26	
PA	0.0374	0.1159	0.32		−0.0246	0.0619	−0.39	
3.+D-P/0	0.1763	0.0869	2.03*	0.04	0.0582	0.0393	1.48	*n.s.*
3.+MC	0.0196	0.1493	0.13	*n.s.*	0.1162	0.0556	1.09	*n.s.*
3.+BR	−0.0517	0.1605	−0.32	*n.s.*	0.0816	0.0506	1.61	*n.s.*
Nar-CompQ								
1.+SES	0.0627	0.0204	3.07**	0.14	0.0034	0.0138	0.24	*n.s.*
2.+Vocabulary, WRE, PA				0.17				*n.s.*
Vocabulary	0.0044	0.0021	2.06*		0.0004	0.0092	0.42	
WRE	0.0015	0.0017	0.88		0.0001	0.0008	0.07	
PA	−0.0005	0.0019	−0.29		−0.0009	0.0009	−1.00	
3.+D-P/0	0.0009	0.0015	0.62	*n.s.*	0.0002	0.0009	0.23	*n.s.*
3.+MC	−0.0024	0.00116	−1.52	*n.s.*	−0.0013	0.0009	−1.47	*n.s.*
3.+BR	−0.0014	0.0019	−0.72	*n.s.*	−0.0006	0.0011	−0.54	*n.s.*

Note: Intercept: the individual difference in the final test; Slope: individual difference in growth rate; SES = socioeconomic status; WRE= word reading efficiency; PA= phonological awareness; D-P/O = Direct Assessment of Planning and Organizing; MC = Meta-Cognition; BR = Behavioral Regulation; *n.s.* = the unique contribution is not significant

* $p < 0.05$

** $p < 0.01$

*** $p < 0.001$.

Table 4

HLM analysis of Cognitive skills on the Development of Expository Reading Comprehension

	Intercept				Slope			
Exp-Recall	***Coefficient***	***SE***	***t***	**Δ*R*²**	***Coefficient***	***SE***	***t***	**Δ*R*²**
1.+SES	5.4594	1.352	4.04***	0.319	0.2967	0.5776	0.51	*n.s.*
2.+Vocabulary, WRE, PA				0.467				*n.s.*
Vocabulary	0.4325	0.1097	3.94***		−0.0029	0.0634	−0.04	
WRE	0.1213	0.0952	1.27		0.0395	0.0618	0.63	
PA	−0.1129	0.1177	−0.95		−0.052	0.0747	−0.69	
3,+D-P/O	0.1749	0.0837	2.09*	0.051	0.0468	0.0495	0.95	*n.s.*
3.+MC	−0.0847	0.1113	−0.76	*n.s.*	0.0928	0.0825	1.12	*n.s.*
3.+BR	−0.2388	0.0944	−2.53*	0.082	−0.0182	0.0649	−0.28	*n.s.*
Shift	−0.3024	0.0835	−3.62***	0.098	−0.0666	0.0654	−1.02	*n.s.*
Exp-CompQ								
1.+SES	0.1102	0.0283	3.88***	0.222	0.0095	0.0116	0.82	*n.s.*
2.+Vocabulary, WRE, PA				0.401				0.342
Vocabulary	0.0036	0.0025	1.42		0.0017	0.0012	1.34	
WRE	0.0077	0.0021	3.61***		0.0034	0.0010	3.25**	
PA	−0.0041	0.0025	−1.64		−0.0019	0.0012	−1.6	
3,+D-P/O	0.0010	0.0019	0.53	*n.s.*	0.0002	0.0009	0.24	*n.s.*
3.+MC	−0.005	0.002	−2.48*	0.090	−0.0009	0.0012	−0.79	*n.s.*
Working Memory	−0.0045	0.0019	−2.40*	0.085	−0.0009	0.0010	−0.95	*n.s.*
Q-P/O	−0.0057	0.0017	−3.24**	0.108	−0.0012	0.0011	−1.14	*n.s.*
3.+BR	−0.0085	0.0017	−4.81***	0.257	−0.0038	0.0009	−4.22***	0.352
Shift	−0.0077	0.0018	−4.28***	0.185	−0.0039	0.0008	−4.39***	0.316
Inhibit	−0.0073	0.0018	−4.02***	0.190	−0.0031	0.0010	−2.94**	0.225

Note: Intercept: the individual difference in the final test; Slope: individual difference in growth rate; SES = socioeconomic st atus; WRE= word reading efficiency; PA= phonological awareness; D-P/O = Direct Assessment of Planning and Organizing; MC = Meta-Cognition; BR = Behavioral Regulation; Q-P/O = Questionnaire Assessment of Planning and Organizing; *n.s.* = the unique contribution is not significant; Based on the Model2, individual MC and BR scales were put into Model 3, respectively; Working Memory, Q-P/O, Shift, and Inhibit each contributed unique variance;

* $p < 0.05$;

** $p < 0.01$

*** $p < 0.001$.