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Language and cognitive predictors of text comprehension: Evidence from multivariate analysis

Young-Suk Kim
Language and Cognitive Predictors of Text Comprehension: Evidence from Multivariate Analysis

Abstract

We examined, using data from children in South Korea (N = 145, mean age = 6.08), how low level language and cognitive skills (vocabulary, syntactic knowledge, and working memory) and high level cognitive skills (comprehension monitoring and theory of mind [ToM]) are related to listening comprehension and whether listening comprehension and word reading mediate the relations of language and cognitive skills to reading comprehension. Low level skills predicted comprehension monitoring and ToM, which in turn predicted listening comprehension. Vocabulary and syntactic knowledge were also directly related to listening comprehension whereas working memory was indirectly related via comprehension monitoring and ToM. Listening comprehension and word reading completely mediated the relations of language and cognitive skills to reading comprehension.

Key words: Theory of mind, listening comprehension, reading comprehension, text comprehension, comprehension monitoring, syntax, vocabulary, working memory
Successful text comprehension involves constructing a coherent mental representation, referred to as the situation model. According to the construction-integration model of text comprehension (Kintsch, 1988, 1994; Kintsch & Rawson, 2007; van Dijik & Kintsch, 1983), mental representation of text is composed of three levels: (1) the first and lowest level is the surface code or linguistic level, which consists of words and phrases in the text itself; (2) the second level is the textbase representation, which consists of initial, elementary propositions as expressed by the text; and (3) the highest level of text representation is the situation model, which is “a mental model of the situation described by the text” (p. 211, Kintsch & Rawson, 2007). These mental representations have been hypothesized to be hierarchical in that the situation model is built upon the textbase representation, which is, in turn, is based on the surface code.

If text comprehension involves multiple representations, then language and cognitive processes associated or needed for different levels of representation are likely to differ (Kintsch, 1988; Kintsch & Rawson, 2007). Studies have shown that multiple skills are involved in text comprehension including vocabulary, syntactic knowledge, working memory, comprehension monitoring, and inference making (Cain, 2007; Cain, Oakhill, & Bryant, 2004; Dickinson, Golinkoff, & Hirsh-Pasek, 2010; Florit, Roch, Altoe, & Levorato, 2009; Florit, Roch, & Levorato, 2014; Hannon & Daneman, 2001; Kendeou et al., 2009). However, these studies tended to focus on a few language and cognitive skills, providing piecemeal evidence. Importantly, previous studies did not use the multilevel representations of language and cognitive skills at low and high levels, which can be examined using a multivariate analysis framework. Finally, previous studies examined either ‘listening’ comprehension or ‘reading’ comprehension, but not both of them together along with multiple language and cognitive skills.
The construction-integration model is about text comprehension without differentiating oral vs. written texts. However, in the field, comprehension of oral texts and written texts has been examined separately. As a result, relations among listening comprehension, reading comprehension, and language and cognitive skills are not clear. In the present study, we addressed these gaps by investigating (1) how low level language and cognitive skills are related to high level cognitive skills, and (2) how low level language and cognitive skills, and high level cognitive skills are related to listening comprehension (see Figure 1), and (3) whether, and if so, how listening comprehension and word reading mediate the relations of these language and cognitive skills to reading comprehension (see Figure 2). Low level (or foundational) language and cognitive skills included vocabulary, syntactic knowledge, and working memory, and high level cognitive skills included comprehension monitoring and theory of mind. These questions were addressed using data from Korean-speaking beginning readers. Note that the term text comprehension is used to refer to both listening and reading comprehension while listening comprehension and reading comprehension are used to specifically refer to comprehension of oral texts and written texts, respectively.

**Low Level Language (Vocabulary and Syntactic knowledge) and Cognitive Skills (Working Memory), and Textbase Representation**

The textbase representation is constructed by forming and inferring elementary propositions based on lexical wording and syntactic structures of the text (i.e., the surface code; Kintsch, 1988). To do this, language skills such as vocabulary and syntactic knowledge would be necessary to process the meanings of words and phrases in the text. Not surprisingly, evidence supports the relation of children’s vocabulary size to listening comprehension (Florit et al., 2009; Kendeou, Bohn-Gettler, White, & van den Broek, 2008; Tompkins, Guo, & Justice, 2013) and
reading comprehension (Seigneuric & Ehrich, 2005; see NICHD, 2000, for a review). While foundational, vocabulary itself is not sufficient. Children’s syntactic knowledge is needed as well (Oakhill, Cain, & Bryant, 2003) because meaning is encoded through arrangement of words and phrases. Children’s syntactic knowledge was shown to be related to sentence processing (Pizzioli & Schelstraete, 2013), listening comprehension (Tunmer, 1989), and reading comprehension (Catts, Adlof, & Weismer, 2006). In fact, vocabulary and syntactic knowledge have been described as foundational language skills for listening comprehension (Lepola, Lynch, Laakkonen, Silven, & Niemi, 2012).

In the present study, working memory was hypothesized as a foundational and low level cognitive skill that contributes to the textbase representation and potentially the situation model. Working memory involves simultaneous storage and active manipulation of information (Baddeley & Logie, 1999; Gathercole, Pickering, Ambridge, & Wearing, 2004; Unsworth & Engle, 2007; see Baddeley, Eysenck, & Anderson, 2009, for a review), and has been hypothesized as a foundational cognitive skill that supports higher level cognitive skills such as comprehension monitoring and inference making (e.g., Oakhill, Hartt, & Samols, 2005; Slade & Ruffman, 2005). Working memory would be needed for construction of initial propositions (i.e., the textbase representation) because one needs to temporarily store linguistic information in the text while processing and integrating it with new linguistic input. Furthermore, working memory has been suggested to play an important role in constructing the situation model as holding and manipulating information is necessary for integrating propositions and establishing local coherence (e.g., within a sentence) and global coherence (e.g., across sentences and text; Cain et al., 2004; Daneman & Merikle, 1996; Graesser, Singer, & Trabasso, 1994). Adult readers with high working memory capacity were able to integrate information across the text whereas
readers with low working memory capacity showed difficulties juggling between global and local coherence (Whitney, Richie, & Clark, 1991). Evidence suggests that working memory makes a unique contribution to listening comprehension (Floit et al., 2009; Was & Woltz, 2007) and reading comprehension for children in middle elementary grades and upper grades and adults (Cain et al., 2004; Chrysochoou, Bablekou, & Tsigilis, 2011; Seigneuric & Ehrlich, 2005).

**Higher Order Cognitive Skills (Comprehension monitoring and Theory of mind) and the Situation Model**

The highest level of representation, situation model, requires construction of propositions as well as integration of adjacent propositions based on the textbase representation (Graesser et al., 1994; Whitney et al., 1991). The textbase representation contains initial, explicit (or literal) yet potentially incoherent propositions (Kintsch, 1988). Therefore, incoherence among propositions needs to be evaluated and resolved to establish the coherent situation model, and the process of evaluating and resolving incoherence requires high level cognitive skills.

In the present study, comprehension monitoring and theory of mind were hypothesized to be higher order cognitive skills required for constructing a coherent situation model. Comprehension monitoring refers to the ability to reflect on and evaluate one’s own comprehension of text (Baker, 1984; Cain et al., 2004; Kinnunen, Vauras, & Niemi, 1998; Ruffman, 1999; Oakhill, Hartt, & Samols, 2005). Since comprehension monitoring involves not only construction of propositions but also evaluation of constructed propositions, it likely to be relevant to evaluating incoherence of initial propositions. In comprehension monitoring tasks, the child is asked to identify any inconsistencies or contradictions in the text (Baker, 1985; Beal, 1990; Cain et al., 2004; Kim & Phillips, 2014), and this ability has been shown to be related to reading comprehension (Baker, 1985; Oakhill et al., 2005; Ruffman, 1999). Interestingly, the
majority of previous studies about comprehension monitoring involved written texts (comprehension monitoring in reading) and its relation to reading comprehension (Beal, 1990; Block & Pressley, 2002; Cain et al., 2004; Pressley, Johnson, Symons, McGoldrick, & Kurita, 1989; National Institute of Child Health and Human Development, 2000). Consequently, we have limited understanding about how comprehension monitoring in oral context is related to listening comprehension. A few extant studies suggest that English-speaking children in primary grades do not spontaneously detect or identify inconsistent information presented in oral texts (Kim & Phillips, 2014; Markman, 1977), and children with language impairment have poorer performance in oral comprehension monitoring than typically developing children (Skarakis-Doyle, Dempsey, & Lee, 2008). Furthermore, oral language comprehension monitoring was moderately related to standardized listening comprehension tasks for English-speaking children in kindergarten and first grade (.43 ≤ rs ≤ .55) (Kim & Phillips, 2014).

ToM is typically defined as the ability to infer others’ mental states to make sense of and predict behavior (Howlin, Baron-Cohen, & Hadwin, 1999). ToM has been studied widely as a contributing factor to language acquisition such as syntactic (de Villiers & Pyers, 2002), semantic-pragmatic (Shields, Varley, Broks, & Simpson, 1996), and figurative language (e.g., Caillies & Sourn-Bissaoui, 2008; Norbury, 2005). On the other hand, oral language skills have been studied as a contributing factor to ToM development (e.g., acquisition of mental state verbs such as ‘think’ and ‘believe,’ and complement grammatical structure such as ‘I believe that …’, Astington & Jenkins, 1999; de Villiers, 2000; Pyers & Senghas, 2009). In fact, oral language and ToM have been suggested to have a reciprocal relation (de Villiers, 2000).

Constructing a coherent situation model is likely to rely on the high order complex social reasoning skill, ToM, because the situation model requires making inferences across initial
propositions to establish local and global coherence (Kintsch, 1988). Understanding alternative viewpoints and making predictions based on different viewpoints (i.e., ToM) requires making inferences and connections, and integrating various propositions in the text. Previous studies suggested a unique contribution of inference skill to listening comprehension and reading comprehension (Cain et al., 2004; Kendeou et al. 2008; Lepola et al., 2007; Tompkins et al., 2013). Therefore, inference-making captured in ToM tasks might be related to listening comprehension. Additionally, ToM might be important for constructing the situation model beyond inference-making skills because many narrative stories require individuals to understand beliefs, thoughts, and intentions of interlocutors, storytellers, and story characters. Therefore, not only inference-making but also the social cognitive aspect captured in ToM might contribute to establishing the situation model.

These higher level cognitive skills capture processes “beyond literal meaning of clauses and sentences” (p. 230, Perfetti et al., 2007) and are hypothesized to be built on the previously noted fundamental, low level skills. For instance, word meaning retrieval was hypothesized to be necessary for comprehension monitoring and inference making (Perfetti et al., 2007), and syntactic knowledge was hypothesized to help children to detect and correct reading errors and, thus, facilitate comprehension monitoring (Oakhill et al., 2003). Working memory was also hypothesized to be important to comprehension monitoring because comprehension monitoring difficulties among poor comprehenders in reading were more apparent when inconsistent information was nonadjacent (Yuill, Oakhill, & Parkin, 1989) and poor comprehenders had lower working memory capacity than did good comprehenders (Oakhill et al., 2005). Furthermore, semantic-pragmatic skills and syntactic skills (e.g., syntactic complements [I think that …]); see Schick, de Villiers, de Villiers, & Hoffmeister, 2007; Slade & Ruffman, 2005) and
working memory are related to ToM (Carlson, Moses, & Breton, 2002; Slade & Ruffman, 2005). Expanding these previous studies, we examined relations among language and cognitive skills adopting the framework of multilevel mental representations of text. In other words, we examined whether high level skills completely mediate the relation between low level skills and listening comprehension, or alternatively, whether low level skills have direct relations to listening comprehension in addition to indirect relations via high level cognitive skills. Although studies have shown the role of vocabulary, syntactic knowledge, and working memory in listening comprehension (e.g., Floit et al., 2009; Kendeou et al., 2008; Was & Woltz, 2007), it remains unclear whether their relations to listening comprehension are completely or partially mediated by higher order skills such as comprehension monitoring or ToM.

**Relation of Language and Cognitive Skills to Reading Comprehension**

Emerging evidence suggests that the language and cognitive skills noted above (with an exception of ToM) are important to reading comprehension, which is defined for the purpose of the study as “the process of simultaneously extracting and constructing meaning through interaction and involvement with written language” (p. 11, Snow, 2002). In fact, the majority of studies about language and cognitive skills involved in text comprehension have been about ‘reading’ comprehension, not ‘listening’ comprehension (e.g., Cain, 2007; Cain et al., 2004; Catts et al., 2006; Chrysochoou et al., 2011; Daneman & Carpenter, 1980; Oakhill et al., 2005; Seigneuric & Ehrlich, 2005). A critical question, therefore, is the path of influence of these language and cognitive skills on reading comprehension. A well-known model of reading comprehension, the simple view of reading, states that reading comprehension is a function of listening comprehension and word reading (Hoover & Gough, 1990). This model has been supported widely in several languages with varying orthographic depths such as English,
Chinese, Spanish, and Korean (Johnston & Kirby, 2006; Joshi, Tao, Aaron, & Quiroz, 2012; Vellutino, Tunmer, Jaccard, & Chen, 2007). Dissociation and independent contributions of word reading and listening comprehension have been examined with typically developing children as well as children with dyslexia (e.g., see Kendeou et al., 2009; Tunmer & Greaney, 2010). The simple view of reading, then, assumes a complete mediation model such that the influences of language and cognitive skills on reading comprehension is indirect via listening comprehension and word reading (see Figure 2a). In contrast, according to the multicomponent view of reading (Cain, 2009; Cain et al., 2004), multiple skills such as vocabulary, working memory, comprehension monitoring, and inference-making contribute to reading comprehension.

Therefore, an alternative model is that these language and cognitive skills might be related to reading comprehension over and above listening comprehension and word reading (Figure 2b). However, the complete mediation vs. partial mediation has rarely been evaluated. A recent study by Vellutino and his colleagues (2007) is an exception and showed that listening comprehension and word reading completely mediated the relations of linguistic skills such as vocabulary and syntactic knowledge to reading comprehension, using data from English-speaking children in grades 2 and 3, and grades 6 and 7. Note, however, that Vellutino et al. did not include high level cognitive skills in the present study (i.e., comprehension monitoring and ToM).

According to Baron and Kenny (1986), “a given variable may be said to function as a mediator to the extent that it accounts for the relation between the predictor and the criterion” (p. 1176). A full, complete mediation is when the relation of the predictor and the criterion becomes statistically non-significant once the mediator is in the model. In partial mediation, both the predictor and mediator are related to the criterion. Mediation analysis is an attempt to describe a causal chain of relations, using correlational data (Baron & Kenny, 1986; Jose, 2013) although it
is important to note that causal inferences cannot be drawn in mediation models. The question in the present study was whether the reported influence of the language and cognitive skills (e.g., vocabulary and working memory) on reading comprehension (e.g., Cain et al., 2004; NICHD, 2000) is via listening comprehension and word reading. In both complete and partial mediation models (see Figures 2a and 2b), low level language and cognitive skills (i.e., vocabulary, syntactic knowledge, and working memory) were hypothesized to predict word reading as well as high level cognitive skills. It has been suggested and emerging evidence supports that word reading is predicted by children’s vocabulary (Oullette, 2006; Vellutino et al., 2007), syntactic knowledge including grammatical morphology (Kim, Apel, & Al Otaiba, 2013; Kuo & Anderson, 2006), and working memory, phonological working memory in particular (Bishop & Snowling, 2004; Vellutino et al., 1997). In contrast, high level cognitive skills (i.e., comprehension monitoring and ToM) were allowed to covary with word reading to detect any potential relations although there is no theoretical basis for the relations (see Figures 2a and 2b).

**Present study**

The following were specific research questions in the present study:

1. How do low level language and cognitive skills (vocabulary, syntactic knowledge, and working memory) relate to high level cognitive skills (i.e., comprehension monitoring and ToM)? Do the high level cognitive skills completely mediate the relations of low level language and cognitive skills to listening comprehension?

2. Do listening comprehension and word reading completely or partially mediate the relations of the language and cognitive skills to reading comprehension?

These questions were addressed using data from kindergartners in Korea. Unlike kindergartners in the US context who are not expected to have developed sufficient reading comprehension to
be measured, typically developing kindergartners in Korea are expected, and previous studies confirmed, that they have sufficient reading skills. Therefore, data from kindergartners in South Korea are appropriate for the present study (see below for further details).

Method

Participants

A total of 148 kindergarten children (77 boys; mean age = 6.08; SD = .12) in South Korea participated in the study. Previous studies have shown that four- and five-year-old Korean-speaking children from various socio-economic backgrounds can read words and comprehend passages (e.g., Kim, 2009, 2011 Kim, Park, & Wagner, 2014). In fact, children in Korea are expected to have foundational literacy skills at school entry in first grade, and early literacy instruction is typically provided to pre-kindergarten (or kindergarten year 1) and kindergarten aged children in the school and/or via widely available home visit programs (Kim et al., 2014). Furthermore, a fairly transparent alphabetic orthography of the Korean language (called Hangul) might be an additional explanation for kindergarten-aged children’s ability to read and comprehend passages.

Kindergarten in South Korea is not part of formal education, but kindergarten attendance is virtually the norm (Kim, 2011). Kindergarten education is offered in public and private institutes, and the children in the present study were from a single private institute. Data on socio-economic status were not available from individual children, but according to the school personnel and the neighborhood, the sample children were from middle class families. Korea is highly homogenous in terms of ethnic composition with less than 5% of ethnic minority. All the children in the present study were monolingual Korean speakers without any hearing or language impairments. Children in the present study were assessed 5 months into kindergarten.
Measures

Children were assessed on their vocabulary, syntactic knowledge, working memory, ToM, comprehension monitoring, listening comprehension, reading comprehension, and word reading. No standardized and normed assessments were available in Korean and thus, measures were developed and/or adapted from previous studies with Korean-speaking children and English-speaking children. Details of many tasks are found in previous studies. Unless otherwise noted, children’s responses were scored dichotomously (1 = correct; 0 = incorrect) for each item. Reliabilities of all the tasks are shown in Table 1. Note that the reliability of listening comprehension task 1 is relatively low (.64), but its impact is minimized due to the use of a latent variable approach.

Listening comprehension. Three tasks were used to assess children’s listening comprehension. The first two tasks were used in a previous study (Kim et al., 2014) and were adapted from the Listening Comprehension Scale of the Oral and Written Language Scales (OWLS; Carrow-Woolfolk, 1995) and Paragraph Comprehension subtest of Comprehensive Assessment of Spoken Language (CASL; Carrow-Woolfolk, 1999). In the first task, children were asked to point to the picture that best described the heard sentences. There were 34 test items with 2 practice items. In the second task, children were asked to identify a picture that best described the answer to the question based on the short stories they heard. There were 19 test items with 1 practice item. In the third task, the child heard a story about two friends (106 words) and was asked seven comprehension questions related to characters, main events, a problem, a resolution, and key details.

Vocabulary. The Peabody Picture Vocabulary – 4th edition (Dunn & Dunn, 2007) was adapted, similar to a previous study (Kim, 2009). Adaptation included selection of words that fit
the Korean context. In this task, the child heard a word and was asked to identify a corresponding picture out of four options. The task included 51 items with increasing difficulty that had accompanying color illustrations. Task administration stopped after 6 consecutive incorrect responses.

**Grammatical knowledge.** Children’s grammatical knowledge task was composed of error detection, error correction, and completion of an unfinished sentence. In the error detection and correction part, the child was asked to identify whether the sentence they heard was correct or incorrect, and if incorrect, the child was asked to correct the sentence. Explanations were provided using 3 practice items. Grammatical errors involved grammatical markers, tense, and postpositions, and there were 12 experimental items (9 incorrect sentences). In the grammatical completion part, the child heard a sentence, and was asked to complete the sentence based on the preceding sentence. There was 1 practice item in which correct answer and explanations were provided and 5 experimental items in which correct answers or explanations were not provided. Therefore, there were a total of 17 experimental items in the grammatical knowledge task. A total possible maximum score was 26 because 1 point was given per correct response for 12 grammatical error identification; 1 point for correcting 9 incorrect sentences; and 1 point for each of the 5 sentence completion items.

**Theory of mind.** First and second-order false belief scenarios were employed. There were four first-order scenarios, involving locations of a cake, drawing, a birthday gift, and content of a snack box (Gwon & Lee, 2012). The first three involved change of location stories, and the last one was an appearance-reality task (or unexpected identity) using a snack box that is highly familiar to children in Korea. One second-order false belief scenario involved different types of bread sold in a bakery, which was adapted from a previous study with English-speaking
(Kim & Phillips, 2014). The second-order task examined the child’s ability to infer a story character’s mistaken belief about another character’s knowledge. In all the tasks (except for the snack box task), the assessor presented a series of illustrations to the child and explained the context, followed by the assessor’s questions (see Cailies et al., 2012 for further description about first- and second-order ToM tasks). There were three questions in each of the four first-order tasks, and six questions in the second-order task with a total of 18 items (3x4+6).

**Comprehension monitoring.** An inconsistency detection task was adapted from Baker (1984) and Cain et al. (2004), and a similar adapted task has been used with English-speaking kindergartners (Kim & Phillips, 2014). The child was asked to identify whether the story made sense or not, and if the story did not make sense, the child was asked to provide a brief explanation. An example of an inconsistent item is as follows: “Sooji’s favorite color is blue. She wears blue every day. Sooji has blue pants, and even blue shoes. Sooji likes to have everything purple!” An example of a consistent and coherent story is as follows: “Minhyung is five years old. He only likes chocolate milk. He pours cool milk into a cup every evening. Minhyung’s favorite milk is chocolate milk.” The meaning of “not making sense” was explained during practice items. There were 4 practice items and 15 experimental items. Feedback and explanations were provided in the practice items. Consistent (7 items) and inconsistent stories (8 items) were randomly spread across items. For the eight inconsistent stories, the accuracy of children’s explanation was also dichotomously scored, and thus, a total possible score was 23 (15+8).

**Working memory.** The listening span task, similar to the sentence span task (Cain et al., 2004), was adapted to Korean. In this task, the child was asked to do two things. First, after each sentence was presented, the child was to identify whether the heard sentence is correct or not
(Yes/No response). Second, after hearing all the sentences (e.g., 2 sentences), the child was to identify the first words in the sentences they heard. The sentences were statements involving common knowledge (e.g., Birds fly in the sky). In listening span tasks in English and European languages, children are asked to identify the last word in each sentence (e.g., Cain et al., 2004; Florit et al., 2009). However, this was modified in Korean as identifying the first word in each sentence because in Korean last words are always verbs because of the SOV sentence structure in Korean. Verbs in Korean are always inflected, which tend to be long and have the same or similar final inflections in a given context. Therefore, sentence final words (i.e., verbs with highly similar inflections) were deemed inappropriate for the task. First words in the task were all nouns. There were four practice items and 15 experimental items. Children’s yes/no responses regarding the veracity of the statement were not scored, but their responses on the first words in correct order were given a score of 2 per item, and responses including the first words in incorrect order was given 1 point. Therefore, a total possible maximum score was 30.

**Reading comprehension.** Three previously used tasks were employed (Author, 2011, 2014). In the first two tasks, the child was asked to read short passages (112 and 158 words, respectively) and asked to answer comprehension questions about characters, events, problems, and resolutions (six and seven questions, respectively, in each story). The last task was an oral cloze task, which had been adapted from the Passage Comprehension subtest of Woodcock Johnson-III (Woodcock, McGrew, & Mather, 2001). In this task, the child was asked to read sentences or short passages and to provide missing words. There were 3 practice items and 21 test items.

**Word reading.** A total of 5 tasks were used: two word reading accuracy, one pseudoword reading accuracy, and two word reading efficiency tasks. The two word reading
accuracy tasks were modified from a previous version with additional words (Kim, 2011), and children were asked to read aloud words of increasingly difficulty. There were 3 practice items and 39 experimental items in each word reading accuracy task. In the pseudoword reading task, children were asked to read nonwords (Authors, in press). There were 3 practice items and 50 experimental items. In the word reading efficiency task, children were asked to read words of increasing difficulty as fast and accurately as possible within 40 seconds. There were 45 words in each task.

**Procedures**

Children were assessed by trained research assistants individually in a quiet room in the school. Research assistants were early childhood educators with extensive experiences with children, including language and literacy assessments. Assessment battery was administered in typically four sessions with each session 25 to 30 minute long. When a child showed signs of fatigue, assessment was discontinued and resumed at another time.

**Data Analysis Strategy**

Confirmatory factory analysis (CFA) and structural equation modeling were primary data analytic strategies. Children’s listening comprehension, reading comprehension, and word reading were assessed using multiple measures and latent variables were created for these variables using CFA employing MPLUS 7.1 (Muthen & Muthen, 2013). Factor loadings were all adequate (see Figures 3 & 4). Latent variable approach is preferred because latent variables capture common variables among observed variables (also called indicators), which minimized the influence of measurement error (Kline, 2005). The language and cognitive skills were assessed by single measures for each construct, and therefore, observed variables were used for these language and cognitive skills. Structural equation models were fitted to address the two
research questions. Model fits were evaluated by using the following multiple indices: Chi-square statistics, comparative fit index (CFI), the Tucker-Lewis index (TLI), Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), root mean square error of approximation (RMSEA), and standardized root mean square residuals (SRMR). Typically, RMSEA values below .08, CFI and TLI values equal to or greater than .95, and SRMR equal to or less than .05 indicate an excellent model fit (Hu & Bentler, 1999), and TLI and CFI values greater than .90 are considered to be acceptable (Kline, 2005). AIC and BIC values are primarily used to compare the relative fit of models.

To address the first research question, two alternative models were tested. The first was a complete mediation model in which the high level cognitive skills were hypothesized to completely mediate the relations between low level language and cognitive skills to listening comprehension (Figure 1a). The second was a partial mediation model where low level language and cognitive skills were hypothesized to have direct relations to listening comprehension as well as indirect relations via high level cognitive skills (Figure 1b).

Two alternative models were also compared to address the second research question. In the first model, listening comprehension and word reading was hypothesized to completely mediate the relations between language and cognitive skills to reading comprehension (Figure 2a). In the second model, language and cognitive skills have both direct relations to reading comprehension as well as indirect relations via listening comprehension and word reading (Figure 2b).

Results

Descriptive Statistics and Preliminary Analysis
Table 1 displays means, standard deviations, minimum, maximum, and reliabilities. Although there is no normative information for these measures, children’s mean performances on the previously used tasks such as listening comprehension and the reading comprehension tasks are highly similar to those by kindergartners from similar backgrounds (Kim et al., 2014). However, some ceiling effects were observed in the word reading accuracy task 2 such that 36 children (approximately 24%) scored the maximum possible of 39. Note that when the analysis was conducted without word reading accuracy measures, the results were essentially the same as what is reported in the article. In contrast, reading comprehension tasks 1 and 2 had slight floor effects. Specifically, with a symmetric distribution, approximately 16% of the sample (n = 24) are expected to score below 1 standard deviation, which corresponds to a score of .41 in the reading comprehension task 1. In the present study, 43 children scored 0 compared to the expected 24. Distributions of the other variables approached symmetric.

Correlations among measures are presented in Table 2. All the three listening comprehension measures were moderately to fairly strongly related with one another (.46 ≤ rs ≤.61). Similar magnitudes have been reported in a previous study with Korean-speaking kindergartners (Kim et al., 2014) and English-speaking kindergartners and first graders (Kim & Phillips, 2014). Cognitive skills were somewhat weakly to moderately related to each other (.30 ≤ rs ≤ .55), which is similar to previous studies with older English-speaking children (Cain et al., 2004; Oakhill et al., 2003). Language skills, vocabulary and syntactic knowledge were moderately related (r = .50) in the present study, similar to what was observed for English-speaking children (Dunn & Dunn, 2007). ToM and comprehension monitoring were also moderately to fairly strongly related to listening comprehension (.46 ≤ rs ≤.61) and moderately to reading comprehension (.42 ≤ rs ≤ .52). Working memory was weakly to moderately related
to other tasks (.19 ≤ rs ≤ .39). ToM, comprehension monitoring, vocabulary, and syntactic knowledge were moderately related to listening comprehension and reading comprehension (.42 ≤ rs ≤ .60). Similar magnitudes have been reported with prekindergartners and kindergartners in Italian (Florit et al., 2009, 2014), which also has a relatively transparent orthography. Word reading skills were moderately to strongly related to one another (.56 ≤ rs ≤ .97).

**Research Question 1: Relations of Language and Cognitive Predictors to Listening Comprehension**

Two alternative models, complete mediation and partial mediation, were fitted and compared. Children’s age was initially included but it was not statistically significant in the models and thus, not included in the final models presented in the article. The model fit for the complete mediation model (Figure 1a) was as follows: χ² (13) = 43.47, p < .001; CFI = .92; TLI = .85; AIC = 6021.55; BIC = 6114.47; RMSEA = .126 (.086 - .168); and SRMR = .068. The model fit for the partial mediation model (Figure 1b) was excellent: χ² (10) = 13.87, p = .18; CFI = .99; TLI = .98; AIC = 5997.95; BIC = 6099.86; RMSEA = .051 (.00 - .11); and SRMR = .025. Chi-square difference test supports that the partial mediation model is superior: Δ χ² = 29.6; Δdf = 3; p < .001. Standardized path coefficients of the partial mediation model are shown in Figure 3. Comprehension monitoring and ToM were both independently but relatively weakly related to listening comprehension (βs = .30, ps < .001) after accounting for the other variables in the model. Vocabulary and syntactic knowledge were also independently but relatively weakly related to listening comprehension (γ = .27, p < .001 for vocabulary and γ = .24, p = .002 for syntactic knowledge) as well as to comprehension monitoring (γ = .24, p = .001 for vocabulary and γ = .38, p < .001 for syntactic knowledge) and ToM (γ = .27, p = .001 for vocabulary and γ = .28, p = .001 for syntactic knowledge). Working memory was relatively weakly related to
comprehension monitoring ($\gamma = .24$, $p < .001$) and ToM ($\gamma = .17$, $p = .023$), but was not related to listening comprehension ($\gamma = -.04$, $p = .54$) after accounting for the other variables in the model. The amount of total variance explained in each outcome was as follows: .42 in comprehension monitoring, .30 in ToM, and .74 in listening comprehension.

**Research Question 2: Relations of Language and Cognitive skills to Reading**

**Comprehension**

The complete mediation (Figure 2a) model had a good fit to the data: $\chi^2 (86) = 165.81$, $p < .001$; CFI = .97; TLI = .96; AIC = 12113.32; BIC = 12311.14; RMSEA = .079 (.061 - .097); and SRMR = .044. The partial mediation model (Figure 2b) also had a good fit: $\chi^2 (81) = 162.39$, $p < .001$; CFI = .97; TLI = .95; AIC = 12119.90; BIC = 12332.70; RMSEA = .082 (.064 - .101); and SRMR = .044. The model fits were not statistically different in chi-square difference testing: $\Delta \chi^2 = 3.42$; $\Delta df = 5$, $p = .64$. However, AIC and BIC statistics indicate that the complete mediation model is preferred ($\Delta \text{BIC}$ greater than 10 strongly indicates that the model with smaller BIC statistics is a better fitting model; see Raftery, 1995). In addition, when there is no statistical difference (in the case of chi-square testing), unless theory otherwise suggests, a parsimonious model is preferred. Therefore, the complete mediation model was chosen as the final model based on the parsimony principle and the AIC and BIC statistics. Results for the complete mediation model are presented in Figure 4. Listening comprehension was moderately related to reading comprehension ($\beta = .37$, $p < .001$) and word reading was fairly strongly related to reading comprehension ($\beta = .72$, $p < .001$) after accounting for the other variables in the model. Vocabulary was weakly related to word reading ($\gamma = .20$, $p = .009$) and syntactic awareness was moderately related to word reading ($\gamma = .42$, $p < .001$) whereas working memory was not ($\gamma = .12$, $p = .10$). Comprehension monitoring and ToM did not covary with word reading ($ps > .15$). A
total of 76%, 35%, and 91% of variance in listening comprehension, word reading, and reading comprehension, respectively, were explained by the included variables.

**Discussion**

The primary goal of the present study was to expand our understanding of linguistic and cognitive foundations of text comprehension. We fitted and compared theoretically based models (1) to examine the relations of low level language and cognitive skills to higher order cognitive skills, and to listening comprehension; and (2) to examine whether mechanism of the influence of language and cognitive skills on reading comprehension is entirely via listening comprehension and word reading, or whether any of the language and cognitive skills are related to reading comprehension over and above listening comprehension and word reading.

Overall the results of the present study partially support the hierarchical structure of language and cognitive processing – low order language and cognitive skills predict high order cognitive skills, which, in turn, predict discourse level listening comprehension. The present findings confirm previous studies which showed that semantic and syntactic language skills underpin comprehension monitoring (Oakhill et al., 2003) and ToM (Carlson et al., 2002; de Villiers, 2000; Schick et al., 2007; Slade & Ruffman, 2005), and suggest that vocabulary and syntactic knowledge are indeed foundational language skills. However, vocabulary and syntactic knowledge were also directly related to listening comprehension as well as indirectly via comprehension monitoring and ToM. Therefore, vocabulary and syntactic knowledge are the foundational skills for constructing propositions needed not only for higher order cognitive skills but also building the situation model at the discourse level (i.e., listening comprehension) over and above high level cognitive skills. This is in line with the lexical quality hypothesis (Perfetti, 2007; Perfetti & Stafura, 2014), which states that one’s representational lexical quality including
semantic, syntactic, and morphological features of a word is the key to meaning integration in comprehension, and suggests the importance of the foundational language skills to listening comprehension.

Working memory was also independently related to comprehension monitoring and ToM, confirming previous studies about the role of working memory in comprehension monitoring (Oakhill et al., 2005) and ToM (Carlson et al., 2002; Slade & Ruffman, 2005). In contrast to vocabulary and syntactic knowledge, however, the relation of working memory to listening comprehension was completely mediated by comprehension monitoring and ToM. This finding is discrepant from a previous study which found that working memory was independently related to listening comprehension (Florit et al., 2009). This discrepancy is likely due to the fact that Florit et al.’s study included vocabulary and short term memory and did not include high order cognitive skills. The present findings suggest that working memory is a foundational cognitive skill that is important to comprehension monitoring and ToM, and its influence on listening comprehension is largely indirect via these higher order cognitive skills. It has been hypothesized that working memory is important for integrating most recent information with existing information to establish local coherence and global coherence in text comprehension (Whitney et al., 1991). Our findings suggest that the processes of integration and building coherence are captured in higher order cognitive skills, comprehension monitoring and ToM, and thus working memory does not make a direct contribution to listening comprehension once these higher order skills are taken into consideration.

The hypotheses about the role of comprehension monitoring and ToM in listening comprehension were supported in the present study. Once initial propositions are constructed, they have to be evaluated and integrated with other propositions to establish local and global
coherence (Graesser et al., 1994; Kintsch, 1988; van den Broek, 1994). Therefore, children’s ability to evaluate their own comprehension and to infer one’s intentions and behaviors facilitates integration of information to construct the situation model. These results are in line with previous studies about the role of comprehension monitoring in reading comprehension (Cain et al., 2004; Oakhill et al., 2005), but further extends by showing the relation of comprehension monitoring to listening comprehension and by showing the unique role of ToM in listening comprehension. As noted above, ToM is the ability to make inferences about what others think and make predictions about their behaviors. Therefore, ToM captures inference making as well as complex social reasoning skill, which might be particularly important for understanding story characters’ as well as authors’ intentions and thoughts. Inference making has been hypothesized to be important for constructing the situation model (Kintsch, 1988) and has been shown to be important to listening comprehension for English-speaking children (Lynch & van den Broek, 2007; Tompkins et al., 2013), French-speaking children (Bianco et al., 2010), and Dutch-speaking children (Lepola et al., 2007) and to reading comprehension in English (Cain et al., 2004; Kendeou et al. 2008). Therefore, it will be informative to examine in a future study about how ToM and inference-making skills are related to each other and to listening comprehension – whether ToM and inference making essentially measure a similar skill that is related to listening comprehension or they measure similar and yet distinctive constructs, and if so, how they are related to listening comprehension.

The skills included in the present study explained a fairly large amount of variance in listening comprehension, 74%. This is similar to a recent study with English-speaking children in kindergarten and first grade, which showed that theory of mind, comprehension monitoring, inhibitory control, vocabulary, and age explained 82% of variance in listening comprehension
In comparison, Florit and her colleagues’ (2009, 2014) studies with Italian-speaking children showed that approximately 44 to 54% of variances in listening comprehension were explained by vocabulary, inferential skills, context use, short-term memory, and working memory.

The present findings also showed that listening comprehension and word reading completely mediate the relation of language and cognitive skills to reading comprehension, suggesting that multiple skills such as working memory, vocabulary, syntactic knowledge, comprehension monitoring, and ToM influence reading comprehension via listening comprehension and word reading. Thus, the chain of influence of the language and cognitive skills on reading comprehension appears to be via listening comprehension and word reading. In addition, a large amount of variance, 91%, in reading comprehension was explained by the two component skills, listening comprehension and word reading. Similar results have been reported, particularly by studies employing using a latent variable approach, with children in grades 1, 2, 3, and 4 (Kim, Wagner, & Foster, 2011; Lonigan, 2013). In comparison, when using observed variables, the amounts of variance explained by listening comprehension and word reading were smaller, ranging from .47 to .50 for English-speaking children in grades 2, 3, and 4; from .57 to .60 for Spanish-speaking children in grades 2 and 3, respectively; and .25 and .42 for Chinese-speaking children in grades 2 and 4, respectively (Joshi et al., 2012).

Although not the primary focus, it is worth noting that in the present study word reading was fairly strongly related to reading comprehension whereas listening comprehension was moderately related to reading comprehension. These findings reflect that the participating children are still in the relatively beginning phase and are in line with another aspect of the simple view of reading: the relative weights of word reading and listening comprehension vary
as a function of children’s developmental level of reading skills such that word reading dominates the relation in the beginning phase whereas listening comprehension dominates the relation in the advanced phase (Hoover & Gough, 1990).

**Limitations, Implications, and Conclusion**

The findings from the present study are from young children at a relatively beginning phase of reading development in Korean. Many previous studies of reading comprehension in English, particularly those that examined language and cognitive component skills, were conducted with children in grades 2 and older whereas children in the present study were in kindergarten. Therefore, future efforts are warranted to replicate the present findings with children in various phases of reading developments (e.g., more advanced). Second, reduced variances due to some ceiling and floor effects might have influenced the results. Third, replications in various languages and orthographies will be informative. Fourth, the current findings are concurrent and correlational. The directions of relations in the present study were based on theoretical models, but bidirectional relations have been hypothesized for a relation between ToM and oral language skills (e.g., Astington & Jenkins, 1999; de Villiers, 2000). Therefore, longitudinal studies as well as experimental studies are needed to determine directional and causal nature of relations examined in the present study. Finally, although latent variables were used for constructs such as listening comprehension, reading comprehension, and word reading, observed variables were used for other language and cognitive skills. Future studies with latent variables for the language and cognitive skills are needed.

In summary, the present study confirmed that multiple language and cognitive processes are involved in text comprehension. The study further showed that low and high order skills are directly and indirectly involved in listening comprehension, and listening comprehension and
word reading completely mediate the relations of these language and cognitive skills to reading comprehension, at least for the Korean-speaking kindergartners in the present study. Note again that although the study examined causal paths of influences, the correlational nature of the present study does now allow us to make any causal claims, which requires experimental studies. Nonetheless, we believe that these results, combined with previous studies, offer preliminary, yet important implications. First, reading comprehension interventions should not wait until children develop reading skill as listening comprehension is an important precursor to reading comprehension. Instead, assessments for prereaders should include listening comprehension as well as low level and higher level language and cognitive skills. Furthermore, it is imperative to attend to multiple language and cognitive skills in instruction. Although many efforts on language intervention focused on vocabulary (e.g., Coyne, McCoach, & Kapp, 2007; Silverman, 2007), the present findings suggest that while important, emphasis on vocabulary may be too narrow, and a broader, multi-component approach is necessary (see Dickinson et al., 2010; National Early Literacy Panel, 2008). Studies have shown that language and cognitive skills included in the present study such as vocabulary, ToM, and comprehension monitoring are malleable (Bianco et al., 2010; Guajardo & Watson, 2002), and thus, future efforts are needed to develop, implement, and examine the impact of a multi-component intervention on children’s listening comprehension and its consequent impact on reading comprehension.

Acknowledgements
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### Table 1 Descriptive Statistics

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Note: *test-retest reliability with 7 days apart. Min = Minimum Max = Maximum
Table 2. Correlations among measures

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Note: LC = Listening comprehension, Comp monitor = Comprehension monitoring, RC = Reading comprehension, WRE = Word reading efficiency

All the coefficients were statistically significant at .05 level.
Figure Captions

Figure 1. Two alternative models of hypothesized relations among low order language and cognitive skills such as vocabulary (Vocab), syntactic knowledge (Syntax), and working memory (WM), and high order cognitive skills such as comprehension monitoring (Comp monitor) and theory of mind (ToM). 1a. Complete mediation model; 1b. Partial mediation model

Figure 2. Two alternative models of the relations of vocabulary (Vocab), syntactic knowledge (Syntax), working memory (WM), comprehension monitoring (Comp monitor), theory of mind (ToM), listening comprehension, and word reading to reading comprehension. 2a. Complete mediation model; 2b. Partial mediation model. In both models, the covariances were allowed between comprehension monitoring and ToM, and word reading, but not shown to reduce complexity of the figure.

Figure 3. Standardized structural regression weights representing the magnitude of the relations of vocabulary (Vocab), syntactic knowledge (Syntax), working memory (WM), comprehension monitoring (Comp monitor), and theory of mind (ToM) to listening comprehension. Note. Solid lines represent statistically significant paths and dotted lines statistically nonsignificant paths.

Figure 4. Standardized structural regression weights representing the magnitude of relations among vocabulary (Vocab), syntactic knowledge (Syntax), working memory (WM), comprehension monitoring (Comp monitor), theory of mind (ToM), listening comprehension, reading comprehension, and word reading. Note. Solid lines represent statistically significant paths and dotted lines statistically nonsignificant paths.
Figure 1.
Figure 2a.

Figure 2b.
Figure 3.
Figure 4