Expanding the developmental models of writing: A direct and indirect effects model of developmental writing (DIEW)

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Abstract

We investigated direct and indirect effects of component skills on writing (DIEW) using data from 193 children in Grade 1. In this model, working memory was hypothesized to be a foundational cognitive ability for language and cognitive skills as well as transcription skills, which, in turn, contribute to writing. Foundational oral language skills (vocabulary and grammatical knowledge) and higher-order cognitive skills (inference and theory of mind) were hypothesized to be component skills of text generation (i.e., discourse-level oral language). Results from structural equation modeling largely supported a complete mediation model among four variations of the DIEW model. Discourse-level oral language, spelling, and handwriting fluency completely mediated the relations of higher-order cognitive skills, foundational oral language, and working memory to writing. Moreover, language and cognitive skills had both direct and indirect relations to discourse-level oral language. Total effects, including direct and indirect effects, were substantial for discourse-level oral language (.46), working memory (.43), and spelling (.37), followed by vocabulary (.19), handwriting (.17), theory of mind (.12), inference (.10), and grammatical knowledge (.10). The model explained approximately 67% of variance in writing quality. These results indicate that multiple language and cognitive skills make direct and indirect contributions, and it is important to consider both direct and indirect pathways of influences when considering skills that are important to writing.

Keywords

developmental model; simple view of writing; not-so-simple view of writing; cognitive; oral language; direct; indirect

Writing is one of the most complex tasks (Olive, 2004), drawing on a large number of language and cognitive skills. Two prominent models of developmental writing with empirical support include the simple view of writing and not-so-simple view of writing. According to the simple view of writing, writing is a product of two necessary skills, transcription and ideation (also called text generation; Berninger et al., 2002; Juel, Griffth, & Gough, 1986). The not-so-simple view of writing expanded the simple view of writing in two ways. First, executive function and self-regulatory processes (e.g., attention, goal setting, reviewing) were included, in addition to text generation and transcription skills

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(Berninger & Amtmann, 2003; Berninger & Winn, 2006). Second, working memory was hypothesized to be at the center of these three components (text generation, transcription, and self-regulation), needed for accessing long term memory during planning and composing process and short term memory during review process (Berninger & Winn, 2006).

Although highly informative, these two models lacked specificity about component skills, particularly for text generation and relations among component skills. In the present study, our goal was to expand the developmental models of writing by investigating component skills of text generation, and their relations to writing quality. To this end, we used data from beginning writers to test a direct and mediated model of text generation (i.e., discourse-level language), and four different variations of the direct and indirect effects models of writing (DIEW).

Developmental models of writing and component skills of writing

As writing requires written texts, transcription – the process and physical acts of representing sounds to written symbols, including spelling and handwriting skills (McCutchen, 2000) – is necessary. Lack of accuracy and fluency in transcription skills constrain writing by interfering with higher-order skills such as planning and content generation (Bourdin & Fayol, 1994; Graham, Berninger, Abbott, Abbott, & Whitaker, 1997; McCutchen, 2000). Much evidence has supported the importance of transcription skills in writing (Abbott & Berninger, 1993; Berninger, Abbott, Abbott, Graham, & Richards, 2002; Berninger et al., 1997; Graham et al., 1997; Graham & Harris, 2000; Kim et al., 2011; Kim, Al Otaiba, Sidler, & Greulich, & Puranik, 2014; Kim, Al Otaiba, Wanzek, & Gatlin, 2015; Kim, Park, & Park, 2015; Limpo & Alves, 2013; McCutchen, 1996).

Ideation or text generation includes generation and organization of ideas (Juel et al., 1986). Text generation necessarily involves oral language representation (Kim et al., 2011; Berninger et al., 2002; McCutchen, 2006) because generated preverbal ideas and thoughts have to be encoded into oral language before being transcribed into written texts Therefore, text generation is operationalized as oral language skills. Accumulating evidence has indeed indicated the relation of oral language skills to writing (e.g., Shanahan & Lomax, 1986). Individual differences in vocabulary (Coker, 2006) and grammatical knowledge (Olinghouse, 2008) were related to writing for children in primary grades. Similarly, oral language composed of vocabulary and grammatical knowledge was independently related to writing for primary-grade children after accounting for transcription skills (Kim et al., 2011, 2014). Furthermore, discourse-level oral language was related to writing after accounting for spelling (Juel et al., 1986; Kim, Al Otaiba et al., 2015) and sentence and reading comprehension (Berninger & Abbott, 2010).

Both the simple view and not-so-simple view of writing have been highly useful as a framework for understanding development of writing skills. However, some critical aspects of these models are underspecified, particularly with regard to interrelations among component skills and pathways of influences of component skills on writing. This under-specification is most prominent with text generation. Although text generation has been

described as a complex (Juel et al., 1986) and dynamic process where ideas are produced and represented as language in memory (Berninger, 2000) at the word, sentence, and discourse level (Berninger et al., 2002), no further details are elaborated with regard to skills that contribute to text generation (or oral language generation). This contrasts sharply to a greater specification about skills involved in transcription processes, including phonological processing, orthographic knowledge (e.g., print experience, phoneme-grapheme correspondences), and morphological skills (Berninger et al., 2002; Juel et al., 1986). In fact, when Juel and her colleagues (1986) examined the simple view of writing, they included component skills of spelling (phonological awareness and exposure to print) and pathways of their influences. They found that phonological awareness and exposure to print were directly related to a phonological decoding skill, which directly influenced children's spelling, which, in turn, was directly related to writing. These results suggest that there are multiple component skills necessary for a transcription skill, spelling, and some have direct relations, whereas others have indirect relations to spelling. Critically missing in Juel et al.'s (1986) study, however, was component skills of text generation, which was operationalized as a discourse-level oral language production. An understanding about component skills of discourse-level oral language is critical to the expansion of our knowledge about skills involved in writing development, and has important implications for instruction and assessments. Specifically, a precise understanding about component skills of discourse-level oral language would inform what skills need to be assessed and targeted in instruction in order to improve discourse-level oral language as well as writing.

Component skills of discourse-level oral language

Discourse-level oral language refers to comprehension and production of multiple utterances or extended text such as conversations, and narrative and informational oral texts (Kim & Pilcher, in press; McGee & Richgels, 1996). Growing evidence indicates that discourse-level oral language is a higher-order skill that draws on a multitude of language and cognitive skills, including foundational oral language skills (vocabulary and grammatical knowledge; Florit, Roch, & Levorato, 2011, 2014; Kim, 2015, 2016; Sénéchal, Ouellette, & Rodney, 2006; Tunmer, 1989); foundational cognitive skills (working memory, inhibitory control; Daneman & Merikle, 1996; Florit, Roch, & Levorato, 2009; Kim, 2014, 2015, 2016); and higher-order cognitive skills (e.g., inference and theory of mind; Kendeou, Bohn-Gettler, White, & van den Broek, 2008; Kim, 2015, 2016; Kim & Phillips, 2014; Lepola, Lynch, Laakkonen, Silvén, & Niemi, 2012; Strasser & del Rio, 2014; Tompkins, Guo, & Justice, 2013).

According to theoretical models of discourse comprehension and production, there are three levels of mental representations: the situation model, textbase, and surface code (e.g., Fletcher & Chrysler, 1990; Graesser, Singer, & Trabasso, 1994; Kintsch, 1988; van Dijk & Kintsch, 1983). The situation model is the interlocutor's representation of the events, actions, and characters (what the text is about; van Dijk & Kintsch, 1983), and is the highest level of mental representation. The situation model is built on textbase representation (propositional representation – what is expressed in the text), which then requires surface code representation (linguistic input of the text such as words and phrases – how something is expressed in the text). The situation model is more than an assembly of propositions, and

requires linking propositions across the text and to general background knowledge in order to integrate and infer meanings and establish a coherent whole (Graesser et al., 1994; Kintsch, 1988; van Dijk & Kintsch, 1983; van den Broek, Risden, Fletcher, & Thurlow, 1996).

Recently Kim (2016) proposed and tested the direct and mediated model of discourse-level language, in which different language and cognitive skills are mapped onto the three levels of mental representations, and are hypothesized to be directly and indirectly related to discourse-level oral language (see Figure 1 for a conceptual model). For the process of establishing global coherence (i.e., situation model), higher-order cognitive skills such as inference and theory of mind are important (Kim, 2015, 2016; Kim & Phillips, 2014). Furthermore, vocabulary, grammatical knowledge, working memory, and attentional control are necessary for constructing initial propositions (i.e., textbase representation; Kim, 2015, 2016). Note that in this conceptual model, although all the foundational language and cognitive skills are necessary for surface code representation, working memory and attentional control are hypothesized to be foundational cognitive skills necessary for any learning tasks, including vocabulary and grammatical knowledge. The direct and mediated models of discourse-level language fit data very well for discourse comprehension for elementary grade children (Kim, 2015, 2016) such that discourse-level language comprehension (i.e., listening comprehension) was directly predicted by higher-order cognitive skills (e.g., inference, theory of mind, and comprehension monitoring), which, in turn, were directly predicted by foundational oral language (vocabulary and grammatical knowledge) and cognitive skills (working memory) (Kim, 2015, 2016). Furthermore, working memory was also directly related to vocabulary and grammatical knowledge, as well as discourse-level oral language over and above foundational oral language and higher-order cognitive skills (Kim, 2016).

Present study

Building on this growing evidence about discourse-level oral language, and previous studies about component skills of writing (e.g., transcription skills, working memory, and language skills), the primary goal in the present study was to unpack the nature of relations between various language and cognitive skills and writing for beginning writers. To achieve this goal, we first examined the direct and mediated relations of component skills of discourse-level language production. If discourse-level oral language is an upper-level skill that draws on several language and cognitive component skills, then an important corollary is how all these component skills, including discourse-level oral language, language and cognitive component skills (e.g., working memory, vocabulary, grammatical knowledge, inference, and theory), and transcription skills, fit into the developmental models of writing. For instance, vocabulary and grammatical knowledge were shown to be related to writing (Kim et al., 2011, 2014; Olinghouse, 2008). If this is the case, would they then be directly related to writing over and above discourse-level oral language, or would their relations be primarily mediated by discourse-level oral language?

Additionally, how are higher-order cognitive skills such as inference and theory of mind related to writing? Are they related to writing, and if so, are their relations direct or primarily

mediated via discourse-level oral language? Although developmental models of writing did not explicitly specify the roles of higher-order cognitive skills in writing and novice learners tend to rely on less-sophisticated knowledge-telling strategies (Bereiter & Scardamalia, 1987), successful writing, even for beginning writers, might draw on higher-order cognitive skills such as reasoning and perspective taking (e.g., writing for audience; also called metacognitive control, see McCutchen, 1988). In coherent written compositions, ideas within the text are tightly connected with each other and presented in a logical fashion. This would require a writer's reasoning and inferencing skill. Likewise, good writers develop an understanding about the needs of their audience (Engler, Raphael, Anderson, Anthony, & Stevens, 1991) and modulate language accordingly (McCutchen, 1988). Even young children showed planning for a specific audience by adapting oral text production considering audience's needs (e.g., Cameron & Wang, 1999; De Temple, Wu, & Snow, 1991; Littleton, 1998; McCutchen, 1988). Therefore, it is reasonable to speculate that a higher-order cognitive skill, theory of mind, would relate to writing. Theory of mind refers to one's knowledge of the mental status of others (thoughts and emotions) and perspective taking, and is typically assessed by false belief tasks (see Astington & Jenkins, 1999; de Villiers, 2000; Howlin, Baron-Cohen, & Hadwin, 1999; Norbury, 2005). In a typical false belief task, the child listens to a series of events and connects the events to infer characters' cognitive statuses, and thus requires an understanding of different perspectives (Kim, 2015; Kim & Phillips, 2014; Comay, 2009).

In order to investigate the nature of language and cognitive component skills and their relations to writing, we evaluated four different variations of the direct and indirect effects models of writing (DIEW). The DIEW model is built on the extant developmental models, such as the simple view and not-so-simple view of writing, but extends them by explicitly hypothesizing direct and indirect relations among components skills and their relations to writing based on theory and empirical evidence. Prior to fitting the DIEW model, we first examined the relations of language and cognitive skills to discourse-level oral language (Figure 1). As noted above, working memory was hypothesized to be a foundational cognitive ability necessary for any learning tasks including vocabulary and grammatical knowledge (see Figure 4). We then investigated the relations of higher-order cognitive skills to writing after accounting for transcription skills (spelling and handwriting) and working memory (Figure 2). Finally, four alternative models of DIEW (Figures 3a, 3b, 3c, and 3d) were fitted and compared. In the first model (Figure 3a, a complete mediation model), discourse-level oral language and transcription skills (spelling and handwriting fluency) were hypothesized to completely mediate the relations of oral language and cognitive component skills to writing. Discourse-level oral language was hypothesized to be directly predicted by higher-order cognitive skills (inference and theory of mind), and directly and indirectly predicted by foundational oral language skills (vocabulary and grammatical knowledge), and the foundational cognitive skill (working memory). In an alternative partial mediation model, vocabulary and grammatical knowledge (Figure 3b) and higher order skills (Figure 3c) were, respectively, hypothesized to have direct relations to writing over and above discourse-level oral language and transcription skills.

The final DIEW model (Figure 3d) tested whether working memory is directly related to writing after accounting for its contribution to all other component skills. As writing requires

coordinating multiple processes such as generating ideas and transcribing those ideas into written products, writing places a great demand on working memory (Berninger, 2000; Kellogg, 1996; Kellogg, Olive, & Piolat, 2007; McCutchen, 2006). Working memory is necessary to support transcription processes (Berninger et al., 2010), particularly when transcription is not automatic (McCutchen, 1996). Fluent transcription skills would allow working memory to be available for higher-level cognitive processes, such as planning and revising (McCutchen, 2006) and text generation and linguistic encoding (Bereiter & Scardamalia, 1987; Hayes & Chenoweth, 2007; Kellogg, 1996). Furthermore, working memory has been shown to be critical to vocabulary development (Gathercole & Baddeley, 1990a, b, 1993; Gathercole et al., 1999), grammatical knowledge (Kim, 2015, 2016), higher-order cognitive skills (Carlson, Moses, & Breton, 2002; Kim, 2015, 2016; Slade & Ruffman, 2005), and discourse-level oral language (Kim, 2015, 2016; Strasser & del Rio, 2014). Taken together, these studies suggest that working memory is a foundational cognitive capacity for transcription as well as text generation processes. In order to explicitly test the pathway of influence of memory to writing, a direct path from working memory to writing was tested after accounting for all the other language and cognitive component skills.

Method

Participants

A total of 193 children in Grade 1 from 41 classrooms in 9 schools (50% boys; mean age = 6.68; SD = .48) in the outheastern region of the United States participated in the study. Children with identified intellectual disabilities were excluded from the study and there were no other selection criteria. The sample reflects consented children from each class and was composed of approximately 43% Caucasians, 34% African Americans, 6% Hispanics, 6% Asian Americans, and 7% mixed race. Approximately 6% were designated as English language learners and 29% were eligible for free and reduced lunch. The school districts' records indicated that 1% of these children had language impairment, 2% had speech impairment, and 2% had multiple learning disabilities. The participating schools used explicit instruction on reading using *Imagine it!* (Bereiter, 2010), but no formal district-wide curriculum was used in writing.

Measures

Reliability estimates for the included tasks are reported in Table 1, and most were in the acceptable to excellent range. Unless otherwise noted, children's responses were scored dichotomously (1 = correct; 0 = incorrect) for each item, and all the items were administered to the child.

Writing—Children were administered two prompts from previous studies (Kim, Al Otaiba, Sidler, & Greulich, 2013; Kim et al., 2014, 2015; McMaster, Du, & Pestursdottir, 2009; McMaster et al., 2011). In the first writing task, the children were asked to write about a time something unusual or interesting happened when they got home from school. Children were provided with the prompt "One day when I got home from school…" on the ruled writing paper (One day hereafter). This task was significantly and moderately related to other standardized and normed writing tasks such as the Wechsler Individual Achievement

Test Essay Composition task, and the Woodcock-Johnson Writing Fluency task (Kim, Al Otaiba et al., 2015). In the second prompt, the children were provided with the beginning of a story about a child who discovers a castle that appeared overnight. They were then told to write a story about who the child met and what happened inside the castle (Castle hereafter). Children were given fifteen minutes for each prompt.

Children's written compositions were scored for writing quality, using a modified version of the 6 + 1 Trait Rubric. Writing quality is typically operationalized as the extent and clarity of idea development and organization (e.g., Kim, Al Otaiba, et al., 2015; Graham, Berninger, & Fan, 2007; Graham, Harris, & Chorzempa, 2002; Graham, Harris, & Mason, 2005; Hooper, Swartz, Wakelly, de Kruif, & Montgomery, 2002; Olinghouse, 2008) and a recent study has shown that 4 of the 6+1 Traits (i.e., idea development, organization, sentence fluency, and word choice) capture a single dimension (Kim et al., 2014). In the present study, the extent of idea development was scored on a scale of 1 to 5 (see Appendix A), similar to a previous study (Kim et al., 2014). Compositions with detailed and rich ideas were rated higher than those with lower quality idea development. Inter-rater reliabilities (Cohen's kappa) were established with 45 written compositions for each prompt (a total of 90) and were .73 for the One day prompt and .82 for the Castle prompt.

Working memory—The listening span task (Florit et al., 2009; Kim, 2015, 2016) was used. The children were presented with a sentence and asked to identify whether the heard sentence was correct or not. After hearing sentences, they were asked to recall the last words in the sentences. All the sentences involved common knowledge familiar to children (e.g., Pigs can fly). Testing was discontinued after three consecutive incorrect responses. There were 4 practice items and 14 test items. Children's yes/no responses regarding the veracity of the statement were not scored, but their responses on the last words in correct order were given a score of 2, and correct responses in incorrect order were given a score of 1. Therefore, the total possible maximum score was 28.

Spelling—An experimental dictation task was developed, piloted, and used in order to capture the ability to spell words that are relevant to children in Grade 1 (e.g., CVC, CVCe words, vowel digraphs). In this task, the children were asked to spell target words accurately. Target words were presented in isolation, in a sentence, and in isolation again. There were a total of 20 items.

Handwriting fluency—Children were asked to accurately copy a sentence, *The quick brown fox jumps over the lazy dog*, as many times as possible in 1 minute. This sentence is a pangram which includes every letter of the English alphabet at least once, and has been used as a measure of handwriting fluency (e.g., Connelly, Gee, & Walsh, 2007; Wagner et al., 2011; Zhan, McBride-Chang, Wagner, & Chan, 2014) and was related to writing quality (Wagner et al., 2011; Zhan et al., 2014). Children's responses were scored by counting the number of letters copied correctly.

Vocabulary—The Expressive Vocabulary Test – 2nd Edition (Williams, 1997) was used. The children were asked to identify pictured objects or provide synonyms. Test administration discontinued after six consecutive incorrect items.

Grammatical knowledge—The Grammaticality Judgement task of the Comprehensive Assessment of Spoken Language (CASL; Carrow-Woolfolk, 1999) was used. This task is normed for children in Grades 2 and above, and therefore a few easy items were developed modeling the items in the CASL. These items were then piloted and used in the first few items. In other words, the items in this task included a few experimental items as well as items in the Grammaticality Judgement Task of CASL. Children's performance on the Grammaticality Judgement Task was related to Syntax Construction ($r = .66$) and Grammatical Morphemes ($r = .66$) (Carrow-Woolfolk, 1999). In this task, the children heard a sentence (e.g., *The children are run*) and were asked whether the sentence was grammatically correct. If grammatically incorrect, the child was asked to correct the sentence. There were 3 practice items and 20 test items. Test administration discontinued after 5 consecutive incorrect items. Of the 20 test items, 17 items included grammatically incorrect sentences (see the example above), and for these items, a total 2 points were possible (1 for identifying grammatical inaccuracy, and 1 for accurately correcting the sentence). Therefore, the total possible maximum in the grammatical knowledge task was 36.

Inference—The Inference task of CASL (Carrow-Woolfolk, 1999) was used. Similar to the grammaticality judgement task described above, this task is normed for children in Grade 2 and above, and therefore, several easy items were developed, piloted, and used in the first few test items. In this task, the children were asked to infer information from heard sentences based on their background knowledge. They heard 2–3 sentence stories, and were asked a question that required inference based on background knowledge. For instance, the children heard "*Mother called to four-year-old Sandra and says 'Be sure to bring your bathing suit. And don't forget your shovel and bucket.' Where are they going?*" The correct responses include "to the beach" or "to go swimming" or something similar. There were 2 practice items and 25 test items. Test administration discontinued after five consecutive incorrect items. Performance on the Inference task was reported to be strongly related to the Nonliteral language task ($r = .73$; Carrow-Woolfolk, 1999).

Theory of mind—One first-order false belief scenario and two second-order false belief scenarios were used (Kim, 2015; Kim & Phillips, 2014). The first-order task examines the child's ability to infer a story character's mistaken belief whereas the second-order task examines the child's ability to infer a story character's mistaken belief about another character's knowledge (See Caillies & Sourn-Bissaoui, 2008 for further details). The first-order false belief task involved the location of a basketball in school, and the other two second-order tasks involved the context of a bake sale and going out for a birthday celebration. The assessor presented stories to the children using a series of illustrations, followed by the assessor's questions. There were a total of 16 questions.

Discourse-level oral language—The Test of Narrative Language (TNL; Gillam & Pearson, 2004) and an experimental expository task were used. In the TNL test, only story 1 (Task 1) has a retell task. However, in the present study, we adapted the TNL test so that the children were asked to retell three narrative stories (Tasks 1, 3 & 5) after they heard each story. The experimental expository task was composed of three expository passages (85

words, 76 words, and 140 words, respectively) from the Qualitative Reading Inventory-5 passages (Leslie & Caldwell, 2011). Titles of the passages were *Air*, *The brain and the five senses*, and *Changing matter*. After listening to each passage, the children were asked to retell each story.

Children's retell was recorded using a digital recorder, Olympus VN 8100 pc, and was transcribed verbatim following Systematic Analysis of Language Transcription (SALT; Miller & Iglesias, 2006) guidelines. Children's retell quality was evaluated using transcribed data. Narrative retell quality was determined by the extent to which key narrative elements (e.g., main characters, setting, events, problem, and resolution) and key details were included (e.g., Barnes, Kim, & Phillips, 2014; Scott & Windsor, 2000). Narrative quality using this approach was moderately related to discourse comprehension (Barnes et al., 2014; Scott & Windsor, 2000). Children's performance on each element was rated on a scale of 0–3, with the exception of the resolution element for Task 1, which was on a scale of 0–2. The children received 0 for no inclusion of the story elements, 1 for a partially correct or implicitly stated element, 2 for a correct but imprecise statement, and 3 for a precise statement. For expository retell, the number of a priori identified key details (each worth a point) was counted. Inter-rater reliability was estimated using 40 transcripts and Cohen's kappa (see Table 1).

Procedures

Children were assessed by rigorously trained research assistants in a quiet space in the school. Assessment battery was administered in several sessions and each session was approximately 30 to 40 minutes. Writing, spelling, and handwriting fluency tasks were administered in a group setting (3–4 children), and the other tasks were individually administered.

Data Analysis Strategy

Confirmatory Factory Analysis and Structural Equation Modeling (SEM) were primary data analytic strategies, using MPLUS 7.1 (Muthen & Muthen, 2013). Latent variables were created for writing and discourse-level oral language. The language (e.g., vocabulary), cognitive skills (e.g., inference), and transcription skills were assessed by single measures for each construct, and therefore observed variables were used. Model fits were evaluated by the following indices: chi-square statistics, comparative fit index (CFI), the Tucker-Lewis index (TLI), root mean square error of approximation (RMSEA), and standardized root mean square residuals (SRMR). Excellent model fits include RMSEA values below .08, CFI and TLI values equal to or greater than .95, and SRMR equal to or less than .05 (Hu & Bentler, 1999). TLI and CFI values greater than .90 are considered acceptable (Kline, 2005). Model fits were compared using chi-square differences for nested models.

Results

Descriptive statistics

Table 1 displays descriptive statistics. Children's mean performance on the normed and standardized task, vocabulary, was in the average range. In the other experimental measures,

there was sufficient variation around the means, and skewness and kurtosis values were in the accepted range. Subsequent analysis was conducted using raw scores.

Table 2 shows bivariate correlations between measures. All the tasks were somewhat weakly to moderately related to writing measures (.25 ≤ rs ≤ .51). Working memory was also weakly to moderately related to all other skills (.24 ≤ rs ≤ .42). Correlations between other measures were in the expected range and direction. Multivariate normality was tested using Henze-Zirkler's Multivariate Normality Test (Henze & Zirkler, 1990), and results indicated that multivariate normality assumption was met (HZ = .995, p = .14).

Direct and mediated model of discourse-level language

The model shown in Figure 1 fit the data very well: χ^2 (4) = 5.67, p = .23, CFI = 1.00, TLI = .98, RMSEA = .048, SRMR = .016. As shown in Figure 4, theory of mind (β = .27, p = .003), vocabulary (γ = .26, p = .007), and working memory (γ = .18, p = .02) were directly related to discourse-level oral language, whereas inference (β = .19, p = .058) and grammatical knowledge (γ = .08, p = .39) were not. Inference and theory of mind were predicted by vocabulary, grammatical knowledge, and working memory (ps ≤ .04). Approximately 61% of total variance in discourse-level oral language was explained by the included language and cognitive skills.

The relations of higher-order cognitive skills to writing quality

In order to examine the relation of higher-order cognitive skills (inference and theory of mind) to writing, the model shown in Figure 2 was fitted to the data. Model fit was excellent: χ^2 (17) = 28.76, p = .04, CFI = .99, TLI = .98, RMSEA = .06, SRMR = .017. As shown in Figure 5, inference (β = .27, p = .003) was independently related to writing, whereas theory of mind (β = .08, p = .36) was not, after accounting for spelling, handwriting fluency, and working memory. A total of 59% of variance in writing was explained.

Testing the DIEW models

Four alternative DIEW models shown in Figures 3a to 3d were tested. In all these models, covariances were allowed between component skills (e.g., vocabulary and grammar; vocabulary and spelling). Exceptions were between higher-order cognitive skills (inference and theory of mind) and transcription skills because of nonsignificance in preliminary analysis.

The complete mediation model (Figure 3a) fit the data well: χ^2 (24) = 41.33, p = .02, CFI = .98, TLI = .95, RMSEA = .062 (.027–.093), SRMR = .031. The partial mediation models also had good fit to the data: χ^2 (22) = 40.74, p = .0088, CFI = .98, TLI = .94, RMSEA = .067 (.033–.10), SRMR = .031 for the model in Figure 3b; and χ^2 (22) = 39.37, p = .01, CFI = .98, TLI = .95, RMSEA = .065 (.030–.097), SRMR = .030 for the model in Figure 3c; and χ^2 (23) = 41.21, p = .011, CFI = .98, TLI = .95, RMSEA = .065 (.031–.096), SRMR = .031 for the model in Figure 3d. Chi-square difference tests showed no differences between these models (0.12 ≤ χ^2 ≤ 1.96; 1 ≤ df ≤ 2, .16 ≤ p ≤ .73). Furthermore, in the partial mediation models, the direct paths from the component language and cognitive skills to writing were, respectively, nonsignificant (ps ≥ .19; see Appendix B). Therefore, based on

parsimony and the chi-square test results, the complete mediation model (Figure 3a) was chosen as the final model.

Figure 6 displays standardized path coefficients of the complete mediation model. Discourse-level oral language ($\beta = .46$, $p < .001$), spelling ($\beta = .37$, $p < .001$), and handwriting fluency ($\beta = .17$, $p = .047$) were all directly related to writing quality. Discourse-level oral language was directly predicted by the two higher-order cognitive skills, inference ($\beta = .21$, $p = .035$) and theory of mind ($\beta = 26$, $p = .003$). Vocabulary ($\beta = .42$, $p < .001$) and working memory ($\beta = .19$, $p = .012$) were also directly related to discourse-level oral language after accounting for all the other variables in the model. Inference and theory of mind were predicted by vocabulary ($\beta s = .42$ & .26, ps .001), grammatical knowledge ($\beta s = .29$ & .28, $ps < .001$), and working memory ($\gamma s = .12$ & .20, ps .04). Vocabulary and grammatical knowledge were predicted by working memory ($\gamma s = .40$ & .40, $ps < .001$). Working memory also predicted spelling ($\gamma = .39$, $p < .001$) and handwriting fluency ($\gamma = .23$, $p = .001$). A total of 67% of variance in writing and 62% of variance in discourse-level oral language were explained.

Table 3 displays direct, indirect, and total effects of the component skills. The largest effects were found for discourse-level oral language (.46), working memory (.43), and spelling (.37), followed by vocabulary (.19), handwriting (.17), theory of mind (.12), inference (.10), and grammatical knowledge (.10).

Discussion

The primary aim of the study was to examine direct and indirect relations of language and cognitive component skills to writing. Based on the simple view of writing and not-so-simple view, we hypothesized that text generation and transcription are necessary for writing development. Furthermore, we specified component skills of discourse-level oral language based on growing evidence, and examined the nature of their relations to writing.

The direct and mediated model of discourse-level language fit the data very well, such that foundational language and cognitive skills and higher-order cognitive skills were directly and indirectly related to discourse-level oral language. Although inference did not quite reach the conventional statistical significance ($p = .058$), the overall structure of relations found in the present study is in line with previous studies (Kim, 2015, 2016). These results indicate that the discourse-level oral language is an upper-level skill, predicted by not only the ability to use vocabulary and to combine words to represent meanings (grammatical knowledge), but also by higher-order cognitive skills to connect propositions, and to understand other's thoughts and take perspectives (Florit, Roch, Altoè, & Levorato, 2009; Florit et al., 2014; Kendeou et al., 2008; Lepola et al., 2012; Strasser & del Rio, 2014; Tompkins, Guo, & Justice, 2013). Furthermore, higher-order cognitive skills are predicted by foundational language and cognitive skills, convergent with previous studies (Carlson, Moses, & Breton, 2002; Kim, 2015, 2016; Kim & Phillips, 2014; Slade & Ruffman, 2005). It is worth noting that previous investigations of component skills of discourse language involved 'comprehension,' whereas in the present study we expanded it to discourse language 'generation' or 'production.' Convergent results for comprehension and production

are in line with the direct and mediated model in Figure 1 and the construction-integration model (Kintsch, 1988), as both of these models incorporate comprehension and production at the discourse level.

When it comes to the direct and indirect relations model of writing (DIEW), a complete mediation model described the data best. Discourse-level oral language and transcription skills (spelling and handwriting fluency) had direct relations to writing. In contrast, all the other language and cognitive component skills were indirectly related to writing via discourse-level oral language and transcription skills. Moreover, discourse-level oral language had a substantial -and in fact, the largest - direct effect on writing (.46). Transcription skills also had sizeable effects on writing (.37 for spelling and .17 for handwriting fluency).

Working memory was found to be a foundational cognitive skill for component language and cognitive skills. It was directly related to foundational oral language skills (vocabulary and grammatical knowledge), higher-order cognitive skills (inference and theory of mind), and transcription skills (spelling and handwriting fluency). Furthermore, it appears that working memory constrains discourse-level oral language even after accounting for the effects of foundational oral language and higher-order cognitive skills. Producing coherent oral text at the discourse level places a great demand on working memory, as the interlocutor has to temporarily hold propositions and ideas while simultaneously generating and interconnecting ideas for flow and logic. Importantly, however, working memory was no longer directly related to writing once all the language and cognitive skills were accounted for. Despite its indirect nature, though, the total effect of working memory on writing was substantial (.43), suggesting that working memory is one of the important cognitive abilities that underpin writing skill.

The present findings also revealed that a higher-order cognitive skill, inference, was independently related to writing, after accounting for theory of mind and transcription skills, suggesting that children's ability to connect ideas and propositions to background knowledge is important to writing quality. As stated above, interconnecting propositions and ideas are important for establishing global coherence across the text. Although novice writers may not exhibit the sophisticated writing strategies found in expert writers (e.g., elaborated planning or revising), children's inferencing ability appears to be important to writing quality. However, these results do not negate the importance of theory of mind to writing, as it appears that the effect of theory of mind on writing is largely indirect, shared with inference (see fairly strong bivariate correlation, $r = .61$).

Our findings further highlight that the effects of higher-order cognitive skills are primarily mediated by discourse-level oral language skill. In a similar vein, the relations of foundational oral language skills (such as vocabulary and grammatical knowledge) to writing were completely mediated by discourse-level oral language. Although previous studies have shown the relations of vocabulary and grammatical knowledge to writing after accounting for transcription skills (Kim et al., 2011, 2014; Olinghouse, 2008), these studies did not include discourse-level oral language skills.

The DIEW model is in line with the simple view and not-so-simple view of writing, but expands them in several important ways. First, the model explicitly specified direct and indirect relations among component skills and their relations to writing. In particular, discourse-level oral language and transcription skills are upper-level skills that subsume a complex array of component skills. A large body of previous studies has shown component skills of transcription skills (Apel, Wilson-Fowler, Brimo, & Perrin, 2012; Bourassa, Treiman, & Kessler, 2006; Deacon & Bryant, 2005; Kim, 2010; Kim, Apel, & Al Otaiba, 2013; Nagy, Berninger, Abbott, Vaughan, & Vermeulen, 2003; Roman, Kirby, Parrila, Wade-Woolley, & Deacon, 2009; Treiman, 1993), and the present study showed component skills of discourse-level oral language, in line with recent evidence (Kim, 2015, 2016; Lepola et al., 2012; Tompkins et al., 2013). Although the hypothesis that writing draws on two skills, discourse-level oral language and transcription skills, might appear to be too simple, a close look reveals a complex picture of multiple skills involved in these two upper-level skills. Second, in the DIEW model, working memory was explicitly hypothesized to be a foundational cognitive capacity that supports other component skills. The present study indicates its essential role in other component skills, and showed that its relation to writing is primarily mediated by other component skills. Third, in the DIEW model, writing component skills are hypothesized to be correlated and not orthogonal (also see Hayes, 1996 for a similar view). For instance, foundational oral language skills such as vocabulary and grammatical knowledge have been shown to be correlated (Brimo, Apel, & Fountain, in press; Conboy & Thal, 2006; Hagtvet, 2003; Kim, 2015, 2016). Similarly, these oral language skills have also been correlated with transcription skills (Cunningham & Stanovich, 1991; Kim, Apel, et al., 2013; Yeong, & Liow, 2011). Therefore, these skills are dissociable but correlated.

Limitations, Implications, and Conclusion

The results of the present study should be interpreted with the current design in mind such as included predictors and sample. Several limitations and related future directions are worth noting. First, it would have been ideal to include other known predictors of writing. In particular, the not-so-simple view of writing specifies self-regulatory factors such as attention and goal setting, and therefore, future studies including these factors would be informative. Whether these skills form a separate factor or their contributions to writing are indirect via discourse-level oral language and transcription skills is an open question. For instance, a recent study suggested that the relation of attentional control to discourse-level oral language is primarily indirect via other component skills (e.g., vocabulary and grammatical knowledge; Kim, 2016). Second, due to practical constraints, we were not able to administer multiple measures per construct and use latent variables, which is ideal. Third, reliabilities estimate of working memory (.76) and theory of mind (.79) did not quite reach the typically desired value of .80[1].

Future directions include replicating the present findings with children in different developmental phases of writing. As children develop their writing skills, the nature of

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[1]For Cohen's kappa values used for writing and discourse-level oral language skills, .61-.80 are considered substantial and .81–1.00 as almost perfect agreement (Cohen, 1960).

relations and relative importance of various component skills might vary. For instance, the relations of higher-order cognitive skills to oral language and to writing might be stronger for older children as their cognitive skills are further developed and writing tasks become more demanding. Moreover, it would be informative to replicate the present study with a larger sample size. Although the sample size was overall sufficient to detect patterns of relations, some nonsignificant relations (e.g., inference to discourse-level language; see Figure 4) might be partly due to the sample size. Finally, in the present study, we examined the DIEW model for writing quality (operationalized as idea development). An important way to expand the DIEW model is to examine the relations of component skills to different writing outcomes. For instance, recent studies have shown that writing quality and productivity are associated but separable dimensions (Kim et al., 2014; Kim, Al Otaiba et al., 2015; Puranik, Lombardino, & Altmann, 2008; Wagner et al., 2015), and the relation of component skills to writing varies for different writing outcomes (Kim et al., 2014; Kim, Al Otaiba et al., 2015).

The present findings offer some preliminary yet important implications. First, there is a complex array of potential sources of breakdown in writing development. Therefore, in order to find out locus of writing failure, discourse-level oral language and transcription skills should be assessed and targeted in instruction – children may be weak in discourse-level oral language or transcription skills, or in both. Importantly, further assessments can be conducted to find out sources of weaknesses in discourse-level oral language and/or transcription skills, and provide targeted instruction based on the child's profiles of strengths and weaknesses. For transcription skills, phonological, orthographic, and morphological awareness can be included (Apel et al., 2012; Bourassa et al., 2006; Deacon & Bryant, 2005; Kim, 2010; Kim et al., 2013; Nagy et al., 2003; Treiman, 1993). For discourse-level oral language skill, instruction and assessment should include skills such as vocabulary, grammatical knowledge, and higher-order cognitive skills such as making inferences and perspective-taking. Vocabulary has received much attention as part of oral language assessment and instruction (e.g., Biemiller, & Boote, 2006; Baumann & Kame'enui, 2004; Coyne, McCoach, & Kapp, 2007; Graves, 2006; McKeown, M.G., & Kucan, 2002; Silverman & Hartranft, 2015). Although vocabulary is highly important, the present study, as well as growing evidence, indicates that more multi-faceted systematic attention beyond vocabulary would be beneficial to improve discourse-level oral language.

Together with previous studies, findings of the present study show a complex array of skills that contribute to writing, and thus, development of writing is likely to require development of multiple language and cognitive skills. Future longitudinal studies are warranted.

References

Abbott RD, Berninger VW. Structural equation modeling of relationships Among developmental skills and writing skills in primary- and intermediate-grade writers. Journal of Educational Psychology. 1993; 85:478–508.

Apel K, Wilson-Fowler EB, Brimo D, Perrin NA. Metalinguistic contributions to reading and spelling in second and third grade students. Reading and Writing: An Interdisciplinary Journal. 2012; 25:1283–1305.

Astington J, Jenkins J. A longitudinal study of the relation between language and theory of mind development. Developmental Psychology. 1999; 35:1311–1320. [PubMed: 10493656]

Baker L. Children ' s effective use of multiple standards for evaluating their comprehension. Journal of Educational Psychology. 1984; 76:588–597.

Barnes A, Kim Y-S, Phillips B. The relations of proper character introduction to narrative quality and listening comprehension for young children from high poverty schools. Reading and Writing: An Interdisciplinary Journal. 2014; 27:1189–1205.

Baumann, JF., Kame'enui, EJ. Vocabulary instruction: Research to practice. New York: The Guilford Press; 2004.

Beck, IL., McKeown, MG., Kucan, L. Bringing words to life. NY: The Guilford Press; 2002.

Bereiter, C. Imagine it!. Columbus, Oh: SRA/McGraw-Hill; 2010.

Bereiter, C., Scardamalia, M. The Psychology of Written Composition. Hillsdale, NJ: Lawrence Erlbaum Associates; 1987.

Berninger VW. Coordinating transcription and text generation in working memory during composing: Automatized and constructive processes. Learning Disability Quarterly. 1999; 22:99–112.

Berninger VW, Abbott RD. Discourse-level oral language, oral expression, reading comprehension, and written expression: Related yet unique language systems in grades 1, 3, 5, and 7. Journal of Educational Psychology. 2010; 102:635–651. [PubMed: 21461140]

Berninger VW, Abbott RD, Abbott SP, Graham S, Richards T. Writing and reading: Connections between language by hand and language by eye. Journal of Learning Disabilities. 2002; 35:39–56. [PubMed: 15490899]

Berninger VW, Abbott RD, Swanson HL, Lovitt D, Trivedi P, Amtmann D. Relationship of word- and sentence-level working memory to reading and writing in second, fourth, and sixth grade. Language, Speech, and Hearing Services in Schools. 2010; 41:179–193.

Berninger, V., Amtmann, D. Preventing written expression disabilities through early and continuing assessment and intervention for handwriting and/or spelling problems: Research into practice. In: Swanson, H.Harris, K., Graham, S., editors. Handbook of Learning Disabilities. New York: The Guilford Press; 2003. p. 323-344.

Berninger VW, Vaughn KB, Graham S, Abbott RD, Abbott SP, Rogan LW, Brooks A, Reed E. Treatment of handwriting problems in beginning writers: Transfer from handwriting to composition. Journal of Educational Psychology. 1997; 89:652–666.

Berninger, VW., Winn, WD. Implications of advancements in brain research and technology for writing development, writing instruction, and educational evolution. In: MacArthur, C.Graham, S., Fitzgerald, J., editors. Handbook of writing research. New York: Guilford; 2006. p. 96-114.

Biemiller A, Boote C. An effective method for building meaning vocabulary in primary grades. Journal of Educational Psychology. 2006; 98:44–62.

Bourassa DC, Treiman R, Kessler B. Use of morphology in spelling by children with dyslexia and typically developing children. Memory & Cognition. 2006; 34:703–714. [PubMed: 16933775]

Bourdin B, Fayol M. Is written language production more difficult than oral language production? A working memory approach. International Journal of Psychology. 1994; 29:591–620.

Brimo D, Apel K, Fountain T. Examining the contributions of syntactic awareness and syntactic knowledge to reading comprehension. Journal of Research in Reading. in press.

Caillies S, Sourn-Bissaoui S. Children's understanding of idioms and theory of mind development. Developmental Science. 2008; 11:703–711. [PubMed: 18801126]

Cain K, Oakhill J, Bryant P. Children's reading comprehension ability: Concurrent prediction by working memory, verbal ability, and component skills. Journal of Educational Psychology. 2004; 96:31–42.

Cameron CA, Wang M. Frog, where are you? Children's narrative expression over the phone. Discourse Processes. 1999; 28:271–280.

Carlson SM, Moses LJ, Breton C. How specific is the relation between executive function and theory of mind? Contributions of inhibitory control and working memory. Infant and Child Development. 2002; 11:73–92.

Cohen J. A coefficient of agreement for normal scales. Educational and Psychological Measurement. 1960; 20:37–46.

Coker DL. Impact of first-grade factors on the growth and outcomes of urban schoolchildren's primary-grade writing. Journal of Educational Psychology. 2006; 98:471–488.

Comay, J. Unpublished dissertation. University of Toronto; 2009. Individual differences in narrative perspective-taking and theory of mind.

Conboy BT, Thal DJ. Ties between the lexicon and grammar: Cross-sectional and longitudinal studies of bilingual toddlers. Child Development. 2006; 77:712–735. [PubMed: 16686797]

Connelly V, Gee D, Walsh E. A comparison of keyboard and handwritten compositions and the relationship with transcription speed. British Journal of Educational Psychology. 2007; 77:479–492. [PubMed: 17504558]

Coyne MD, McCoach DB, Kapp S. Vocabulary intervention for kindergarten students: Comparing extended instruction to embedded instruction and incidental exposure. Learning Disability Quarterly. 2007; 30:74–88.

Cunningham AE, Stanovich KE. Tracking the unique effects of print exposure in children: Associations with vocabulary, general knowledge, and spelling. Journal of Educational Psychology. 1991; 83:264–274.

Daneman M, Merikle PM. Working memory and language comprehension: A meta-analysis. Psychonomic Bulletin & Review. 1996; 3:422–433. [PubMed: 24213976]

Deacon SH, Bryant PE. What young children do and do not know about the spelling of inflections and derivations. Developmental Science. 2005; 8:583–594. [PubMed: 16246249]

De Temple JM, Wu S-F, Snow CE. Papa pig just left for pigtown: Children's oral and written picture descriptions under varying instructions. Discourse Processes. 1991; 14:469–495.

de Villiers, JG. Language and theory of mind: What are the developmental relationships?. In: Baron-Cohen, S.Tager-Flusberg, H., Cohen, D., editors. Understanding other minds: Perspectives from developmental cognitive neuroscience. 2nd. Oxford, UK: Oxford University Press; 2000. p. 83-123.

Engler CS, Raphael TE, Anderson LM, Anthony HM, Stevens DD. Making strategies and self-talk visible: writing instruction in regular and special education classrooms. American Educational Research Journal. 1991; 28:337–372.

Fletcher CR, Chrysler ST. Surface forms, textbases, and situation models: recognition memory for three types of textual information. Discourse Processes. 1990; 13:175–190.

Florit E, Roch M, Levorato MC. Listening text comprehension of explicit and implicit information in preschoolers: the role of verbal and inferential skills. Discourse Processes. 2011; 48:119–138.

Florit E, Roch M, Levorato MC. Listening text comprehension in preschoolers: A longitudinal study on the role of semantic components. Reading and Writing: An Interdisciplinary Journal. 2014; 27:793–817.

Florit E, Roch M, Altoè G, Levorato MC. Listening comprehension in preschoolers: The role of memory. British Journal of Developmental Psychology. 2009; 27:935–951. [PubMed: 19994487]

Gathercole SE, Baddeley AD. Phonological memory deficits in language disordered children: Is there a causal connection? Journal of Memory and Language. 1990a; 29:336–360.

Gathercole SE, Baddeley AD. The role of phonological memory in vocabulary acquisition: A study of young children learning new names. British Journal of Psychology. 1990b; 81:439–454.

Gathercole, SE., Baddeley, AD. Working memory and language. Hove: Erlbaum; 1993.

Gathercole SE, Service E, Hitch GJ, Adams A, Martin AJ. Phonological short-term memory and vocabulary development: Further evidence on the nature of the relationship. Cognitive Psychology. 1999; 13:65–77.

Gillam, RB., Pearson, NA. Test of Narrative Language. Austin, TX: PRO-ED; 2004.

Graesser AC, Singer M, Trabasso T. Constructing inferences during narrative text comprehension. Psychological Review. 1994; 101:371–395. [PubMed: 7938337]

Graham S, Berninger VW, Abbott RD, Abbott SP, Whitaker D. Role of mechanics in composing of elementary school students: A new methodological approach. Journal of Educational Psychology. 1997; 89:170–182.

Graham S, Berninger VW, Fan W. The structural relationship between writing attitude and writing achievement in first and third grade students. Contemporary Educational Psychology. 2007; 32:516–536.

Graham S, Harris KR. The role of self-regulation and transcription skills in writing and writing development. Educational Psychologist. 2000; 35:3–12.

Graham S, Harris KR, Chorzempa BF. Contribution of spelling instruction to the spelling, writing, and reading of poor spellers. Journal of Educational Psychology. 2002; 94:669–686.

Graham S, Harris KR, Mason L. Improving the writing performance, knowledge, self-efficacy of struggling young writers: The effects of self-regulated strategy development. Contemporary Educational Psychology. 2005; 30:207–241.

Graves, MF. The vocabulary book: Learning and instruction. New York; Newark, DE; Urbana, IL: Teachers College Press; International Reading Association; National Council of Teachers of English; 2006.

Hagtvet BE. Listening comprehension and reading comprehension in poor decoders: Evidence for the importance of syntactic and semantic skills as well as phonological skills. Reading and Writing: An Interdisciplinary Journal. 2003; 16:505–539.

Hayes, JR. A new framework for understanding cognition and affect in writing. In: Levy, CM., Ransdell, S., editors. The science of writing: Theories, methods, individual differences, and applications. Mahwah, NJ: Erlbaum; 1996. p. 1-27.

Henze N, Zirkler B. A class of invariant and consistent tests for multivariate normality. Communication in Statistics - Theory Methods. 1990; 19:3595–3617.

Hooper SR, Swartz CW, Wakely MB, de Kruif REL, Montgomery JW. Executive function in elementary school children with and without problems in written expression. Journal of Learning Disabilities. 2002; 35:57–68. [PubMed: 15490900]

Howlin, P., Baron-Cohen, S., Hadwin, J. Teaching children with autism to mind read. Chichester, UK: John Wiley; 1999.

Hu L-T, Bentler PM. Cutoff criteria for fit indices in covariance structure analysis. Conventional criteria versus new alternatives. Structural Equation Modeling. 1999; 6:1–55.

Juel C, Griffith PL, Gough PB. Acquisition of literacy: A longitudinal study of children in first and second grade. Journal of Educational Psychology. 1986; 78:243–255.

Kellogg, RT. A model of working memory in writing. In: Levy, CM., Ransdell, SE., editors. The science of writing. Mahwah, NJ: Erlbaum; 1996. p. 57-71.

Kellogg RT. Training writing skills: A cognitive developmental perspective. Journal of Writing Research. 2008; 1:1–26.

Kellogg RT, Olive T, Piolat A. Verbal, visual, and spatial working memory in written langauge production. Acta Psychologica. 2007; 124:382–397. [PubMed: 16822473]

Kendeou P, Bohn-Gettler CM, White MJ, van den Broek P. Children's inference generation across different media. Journal of Research in Reading. 2008; 31:259–272.

Kim Y-S. Componential skills in early spelling development in Korean. Scientific Studies of Reading. 2010; 14:137–158.

Kim Y-S. Language and cognitive predictors of text comprehension: Evidence from multivariate analysis. Child Development. 2015; 86:128–144. [PubMed: 25174258]

Kim Y-SG. Direct and mediated effects of language and cognitive skills on comprehension or oral narrative texts (listening comprehension) for children. Journal of Experimental Child Psychology. 2016; 141:101–120. [PubMed: 26342474]

Kim Y-S, Al Otaiba S, Puranik C, Sidler JF, Greulich L, Wagner RK. Componential skills of beginning writing: An exploratory study. Learning and Individual Differences. 2011; 21:517–525. [PubMed: 22267897]

Kim Y-S, Al Otaiba S, Sidler JF, Greulich L. Language, literacy, attentional behaviors, and instructional quality predictors of written composition for first graders. Early Childhood Research Quarterly. 2013; 28:461–469. [PubMed: 24062600]

Kim Y-S, Al Otaiba S, Sidler JF, Greulich L, Puranik C. Evaluating the dimensionality of first grade written composition. Journal of Speech, Language, and Hearing Research. 2014; 57:199–211.

Kim Y-S, Al Otaiba S, Wanzek J, Gatlin B. Towards an understanding of dimension, predictors, and gender gaps in written composition. Journal of Educational Psychology. 2015; 107:79–95. [PubMed: 25937667]

Kim Y-SG, Park C, Park Y. Dimensions of discourse-level oral language skills and their relations to reading comprehension and written composition: An exploratory study. Reading and Writing: An Interdisciplinary Journal. 2015; 28:633–654.

Kim Y-S, Apel K, Al Otaiba S. The relation of linguistic awareness and vocabulary to word reading and spelling for first-grade students participating in response to instruction. Language, Speech, and Hearing Services in Schools. 2013; 44:1–11.

Kline, RB. Principles and practice of structural equation modeling. 2nd. New York: Guilford; 2005.

Lepola J, Lynch J, Laakkonen E, Silvén M, Niemi P. The role of inference making and other language skills in the development of narrative discourse-level oral language in 4- to 6-year old children. Reading Research Quarterly. 2012; 47:259–282.

Leslie, L., Caldwell, JS. Qualitative Reading Inventory. 5th. Boston, MA: Pearson; 2011.

Limpo T, Alves RA. Modeling writing development: Contribution of transcription and self-regulation to Portuguese students' text generation quality. Journal of Educational Psychology. 2013; 105:401–413.

Littleton EB. Emerging cognitive skills for writing: Sensitivity to audience presence in five through nine-year-olds' speech. Cognition and Instruction. 1998; 16:399–430.

McCutchen D. "Functional automaticity" in children's writing: A problem of metacognitive control. Written Communication. 1988; 5:306–324.

McCutchen D. A capacity theory of writing: Working memory in composition. Educational Psychology Review. 1996; 8:299–325.

McCutchen D. Knowledge, processing, and working memory: Implications for a theory of writing. Educational Psychologist. 2000; 35:13–23.

McCutchen, D. Cognitive factors in the development of children's writing. In: MacArthur, C.Graham, S., Fitzgerald, J., editors. Handbook of Writing Research. New York: The Guilford Press; 2006. p. 115-130.

McGee, LM., Richgels, DJ. Literacy's beginnings: Supporting young readers and writers. 2nd. Boston: Allyn & Bacon; 1996.

McMaster KL, Du X, Pestursdottir AL. Technical features of curriculum-based measures for beginning writers. Journal of Learning Disabilities. 2009; 42:41–60. [PubMed: 19103799]

McMaster KL, Du X, Yeo S, Deno SL, Parker D, Ellis T. Curriculum-based measures of beginning writing: Technical features of the slope. Exceptional Children. 2011; 77:185–206.

Muthén, LK., Muthén, BO. Mplus 7.1. Los Angeles: Muthén and Muthén; 2013.

Nagy W, Berninger V, Abbott R, Vaughan K, Vermeulen K. Relationship morphology and other language skills to literacy skills in at-risk second graders and at-risk fourth grade writers. Journal of Educational Psychology. 2003; 96:730–742.

Norbury CF. The relationship between theory of mind and metaphor: Evidence from children with language impairment and autistic spectrum disorder. British Journal of Developmental Psychology. 2005; 23:383–399.

Olinghouse NG. Student- and instruction-level predictors of narrative writing in third-grade students. Reading and Writing: An Interdisciplinary Journal. 2008; 21:3–26.

Olive T. Working memory in writing: Empirical evidence from the dual-task technique. European Psychologist. 2004; 9:32–42.

Puranik CS, Lombardino L, Altmann L. Assessing the microstructure of written language using a retelling paradigm. American Journal of Speech Language Pathology. 2008; 17:107–120. [PubMed: 18448599]

Roman AA, Kirby JR, Parrila RK, Wade-Woolley L, Deacon SH. Toward a comprehensive view of the skills involved in word reading in grades 4, 6, and 8. Journal of Experimental Child Psychology. 2009; 102:96–113. [PubMed: 18329037]

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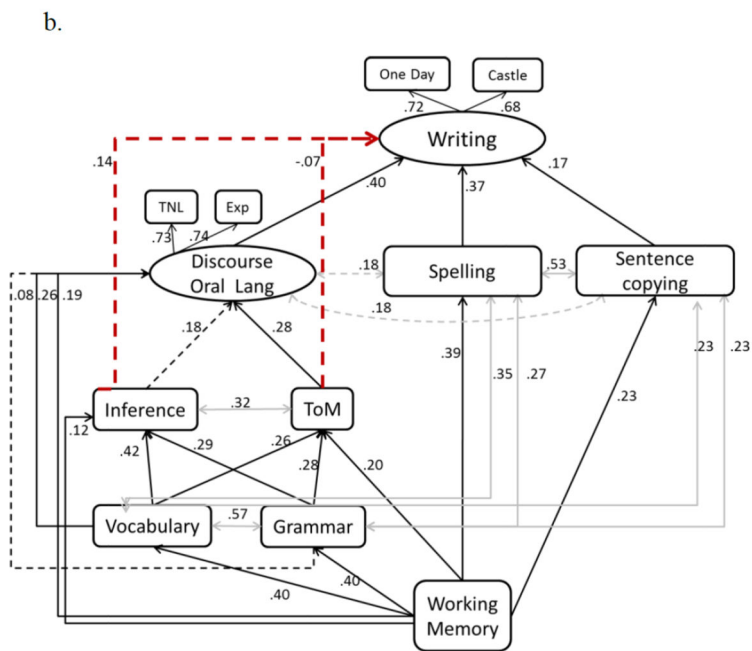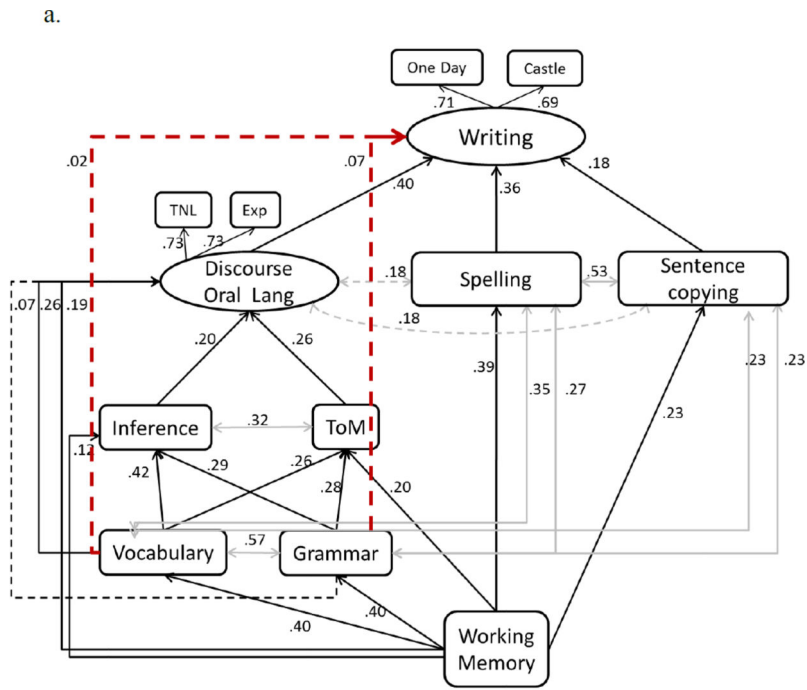
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Scott C, Windsor J. General language performance measures in spoken and written discourse produced by school-age children with and without language learning disabilities. Journal of Speech, Language, and Hearing Research. 2000; 43:324–339.

Sénéchal, M., Ouellette, G., Rodney, D. The misunderstood giant: On the predictive role of vocabulary to reading. In: Neuman, SB., Dickinson, D., editors. Handbook of Early Literacy, Volume 2. New York: Guilford Press; 2006. p. 173-182.

Shanahan, T. Relations among oral language, reading, and writing development. In: MacArthur, CA., Graham, S., editors. Handbook of writing. New York: Guilford Press; 2006. p. 171-183.

Shanahan T, Lomax RG. An analysis and comparison of theoretical models of the reading-writing relationship. Journal of Educational Psychology. 1986; 78:116–123.

Silverman, RD., Hartranft, AM. Developing vocabulary and oral language in young children. New York: The Guilford Press; 2015.

Slade L, Ruffman T. How language does (and does not) relate to theory of mind: A longitudinal study of syntax, semantics, working memory and false belief. British Journal of Developmental Psychology. 2005; 23:117–141.

Strasser K, del Rio F. The role of , theory of mind, and vocabulary depth in predicting story comprehension and recall of kindergarten children. Reading Research Quarterly. 2014; 49:169–187.

Tompkins V, Guo Y, Justice LM. Inference generation, story comprehension, and language in the preschool years. Reading and Writing: An Interdisciplinary Journal. 2013; 26:403–429.

Treiman, R. Beginning to spell. New York: Oxford University Press; 1993.

Tunmer, WE. The role of language-related factors in reading disability. In: Shankweiler, D., Liberman, IY., editors. Phonology and reading disability: Solving the reading puzzle. Ann Arbor: University of Michigan Press; 1989. p. 91-132.

van den Broek, P., Risden, K., Fletcher, CR., Thurlow, R. A "landscape" view of reading: Fluctuating patterns of activation and the construction of a stable memory representation. In: Britton, BK., Graesser, AC., editors. Models of understanding text. Hillsdale, NJ: Lawrence Erlbaum Associates, Inc; 1996. p. 165-187.

Yeong SHM, Liow SJR. Cognitive-linguistic foundations of early spelling development in bilinguals. Journal of Educational Psychology. 2011; 103:470–488.

Appendix A

Score	Description
0 (Not Scorable)	• Protocol is blank • Handwriting is illegible • Student simply rewrites prompt with nothing else
1	• Main idea is not relevant to the prompt or no topic emerges or the idea is difficult to understand. • No details are provided.
2	• At least one relevant idea is represented and many times, one simple statement captures the topic • The idea is conveyed in a very general way with few details • The writing reads as a list of activities.
3	• The writing is made up of one or more ideas with a few details. • Flow of ideas is somewhat choppy. • The writing may read as a list of activities and a few places might be repetitive.

Score	Description
4	• A sense of coherent story is emerging with relatively clear main idea and details, and the writing makes a point.
	• Reads somewhat like a cohesive story.
	• The writing is on topic but could be narrower and more focused.
5	• One clear main idea is developed and the writing reads as a cohesive story in general.
	• Topic is narrow and focused although could benefit from some additional work.
	• Supportive details are accurate and developed, and elaborated.
	• The writer uses relevant and interesting details.

Appendix B

a.

b.

c.
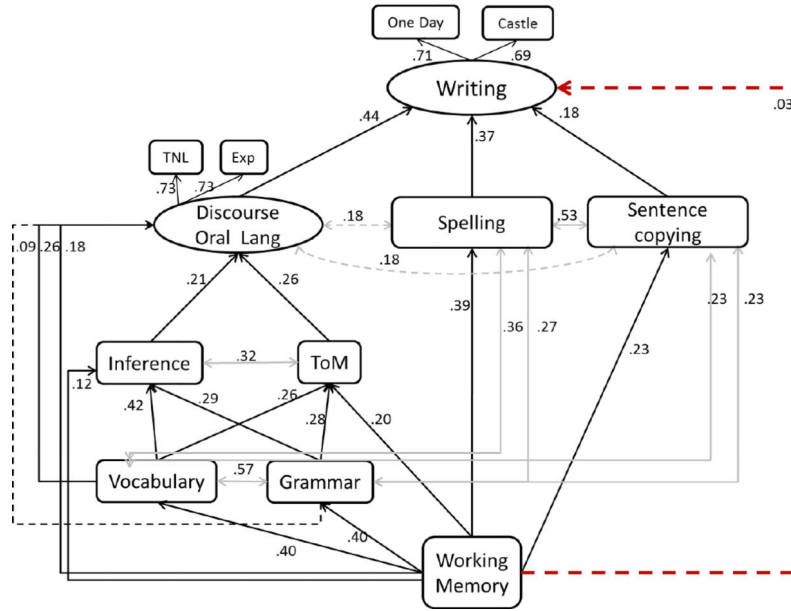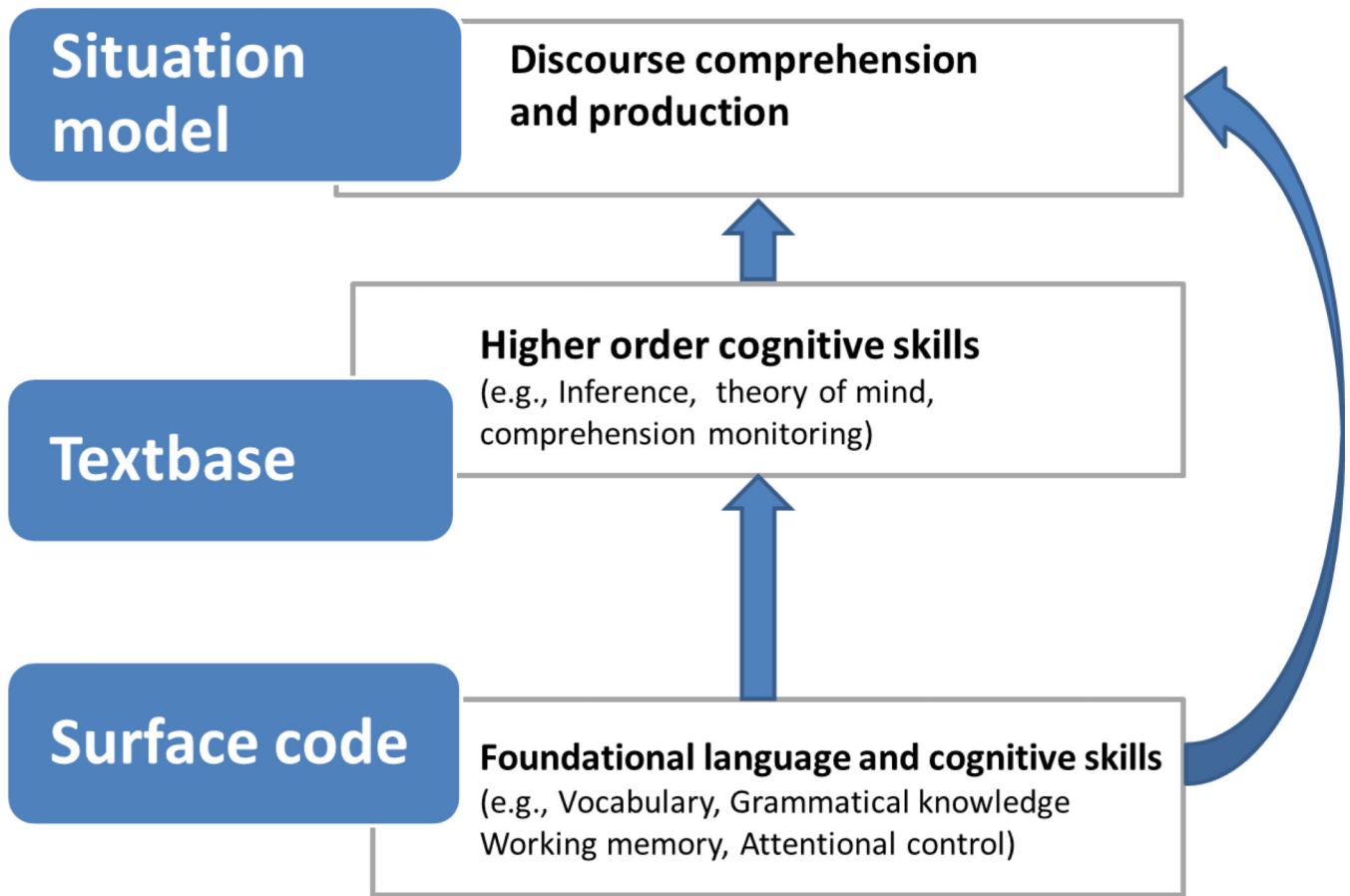
Figure 1.
Language and cognitive skills associated with three levels of text representations (modified from Kim, 2016, reprint with permission)
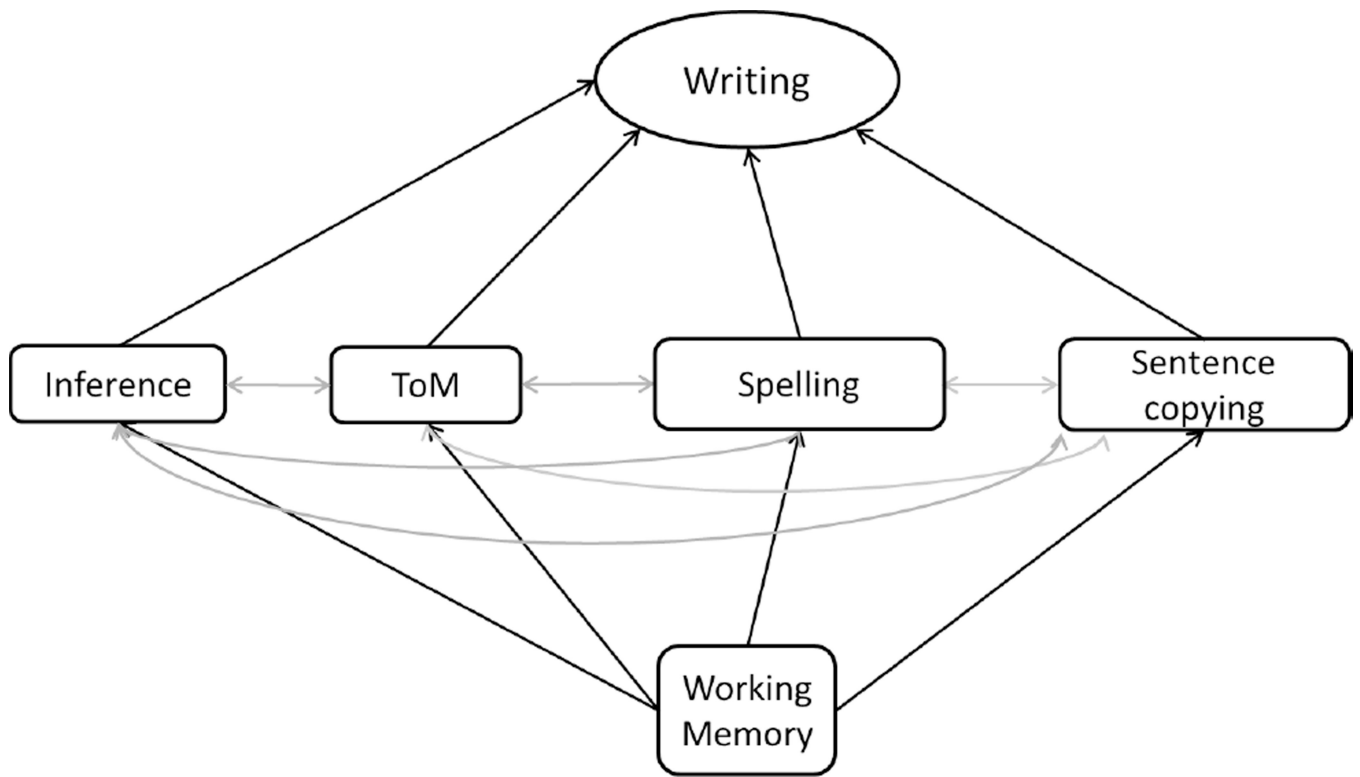
Figure 2.
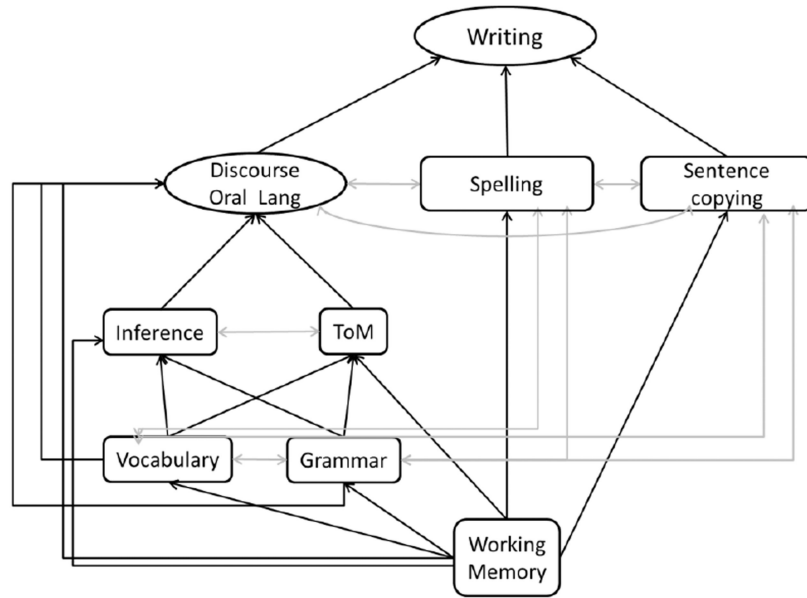The relations of inference, theory of mind (ToM), spelling, and handwriting to writing.

a.

b.

c.
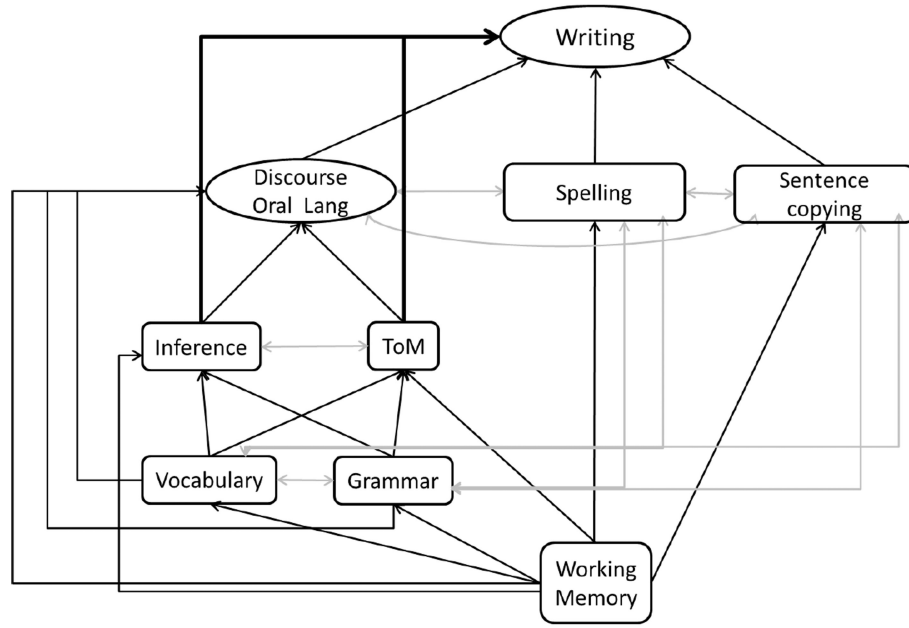
d.

Figure 3.
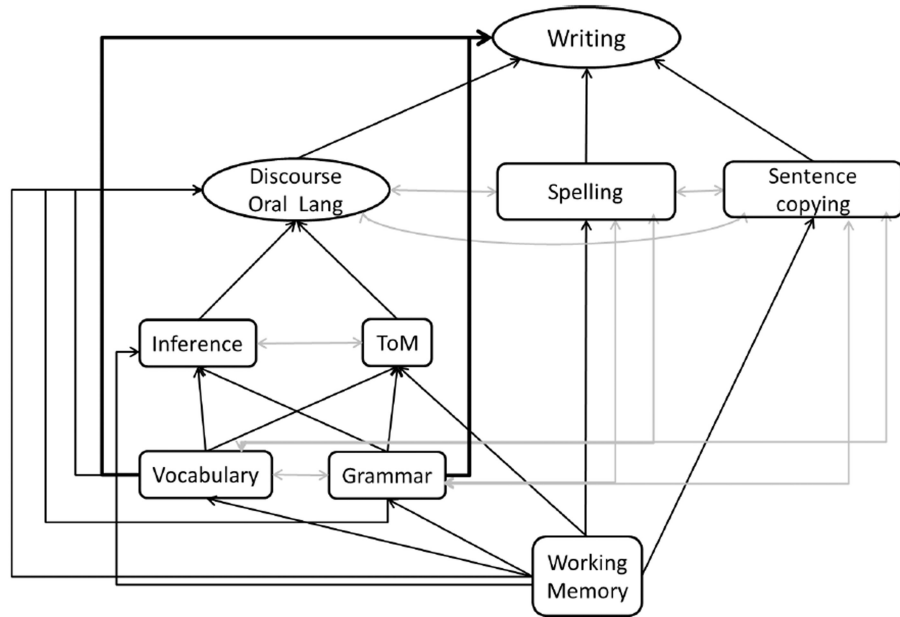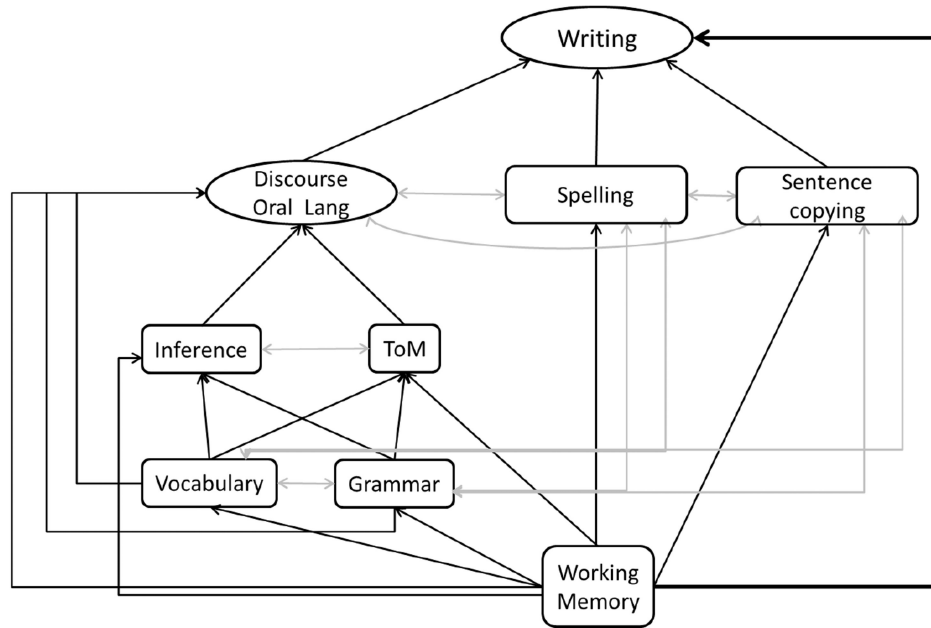Three alternative models of the direct and indirect effects of developmental writing (DIEW).
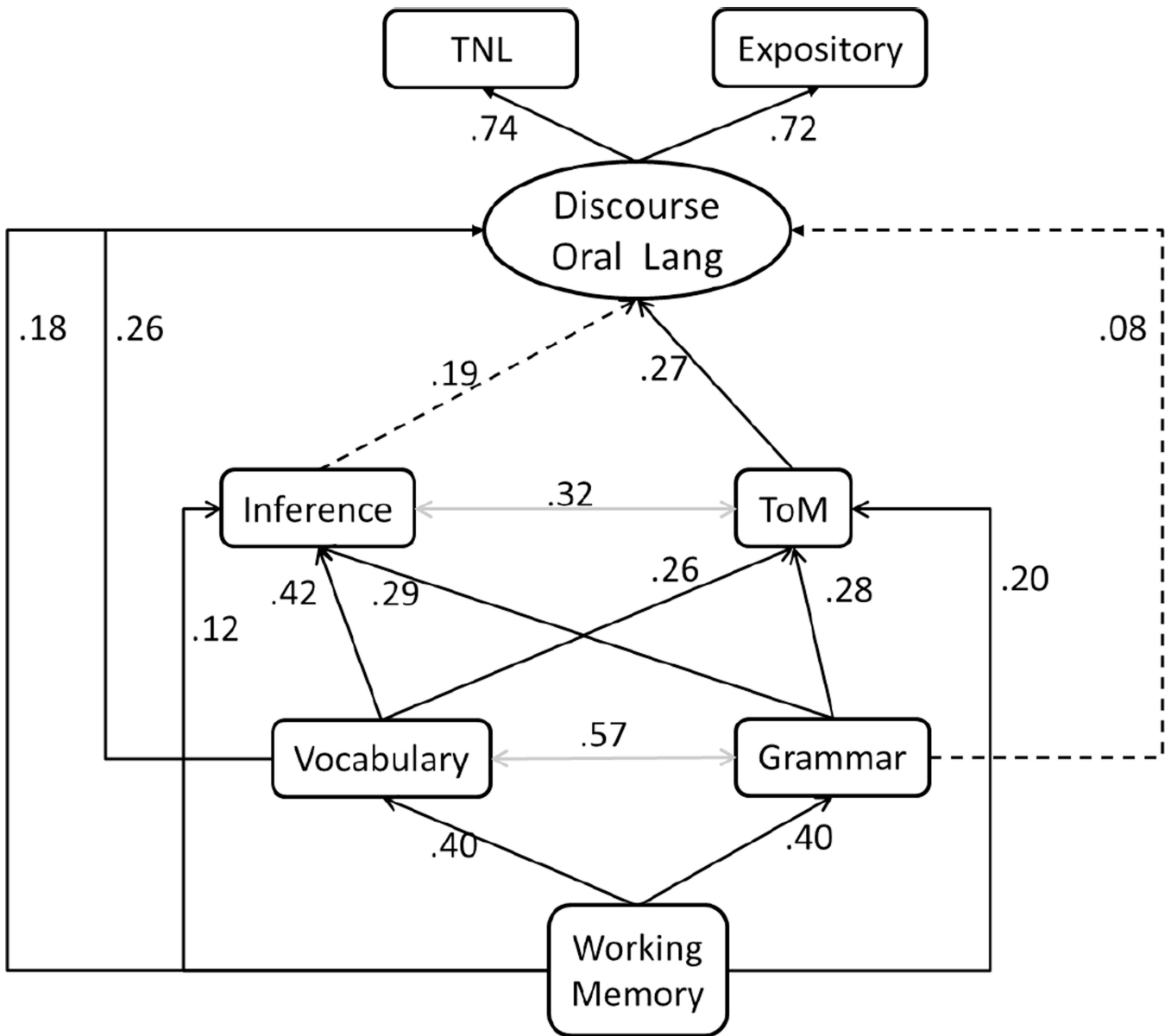ToM = Theory of Mind

Figure 4.
Standardized path coefficients of higher order cognitive skills (inference and theory of mind), foundational language skills (vocabulary, grammatical knowledge), and working memory to discourse level oral language production. Solid lines represent statistically significant relations whereas dashed lines represent non-significant relations. Gray lines represent covariances. TNL = Test of Narrative Language; Oral Language = Oral language; ToM = Theory of Mind.
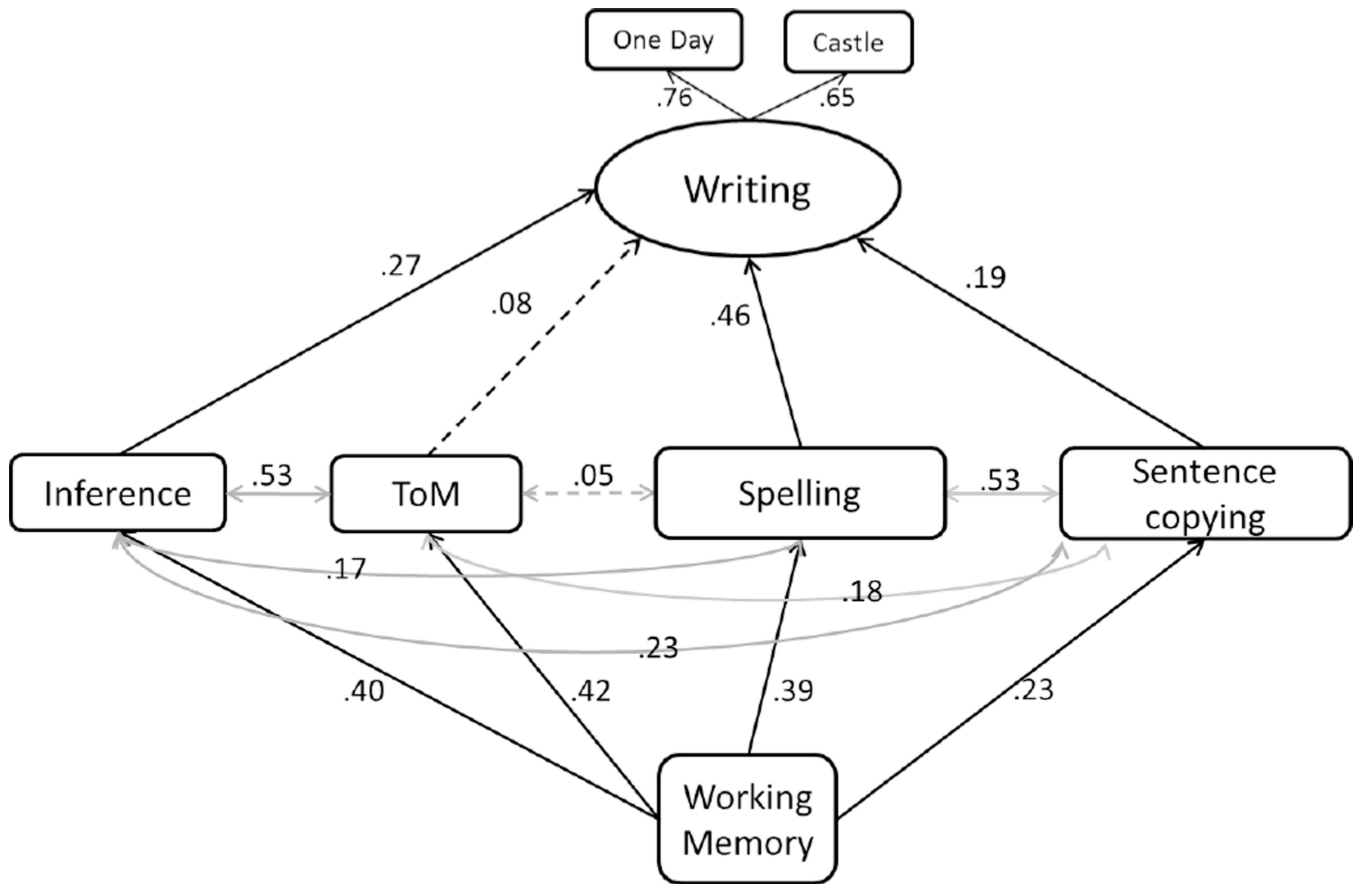
Figure 5.
Standardized path coefficients of higher order cognitive skills (inference and theory of mind) and transcription skills (spelling and handwriting) to writing. Solid lines represent statistically significant relations whereas dashed lines represent non-significant relations. Gray lines represent covariances. ToM = Theory of Mind

Figure 6.
Standardized path coefficients showing the relations of oral language and cognitive
component skills of discourse-level oral language, discourse-level oral language, spelling,
handwriting to writing. Solid lines represent statistically significant relations whereas dashed
lines represent non-significant relations. Gray lines represent covariances. TNL = Test of
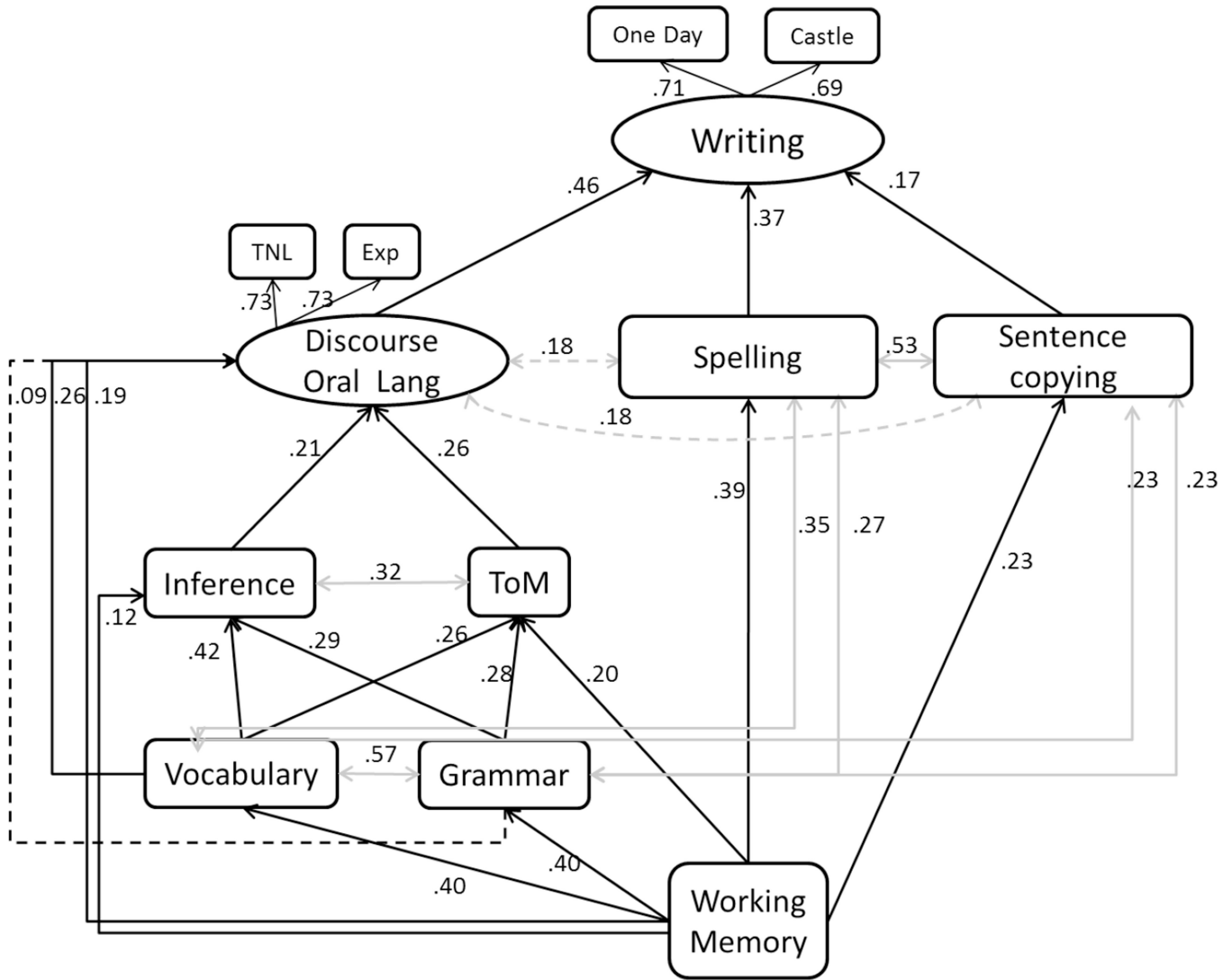Narrative Language; Oral Language = Oral language; ToM = Theory of Mind.

Table 1

Reliability and descriptive statistics

	Reliability	Mean (SD)	Min-Max	Skewness	Kurtosis
Age	NA	6.68 (.48)	6–8.11	−.25	−1.16
Working memory	.74	13.92 (5.64)	0–24	−.59	−.20
EVT	.94	94.16 (14.68)	58–149	−.15	.56
EVTSS	NA	104.26 (12.77)	72–150	−.07	.35
Grammatical knowledge	.90	26.51 (6.57)	2–36	−1.40	2.39
Inference	.89	14.09 (6.07)	0–25	−.55	−.46
Theory of mind	.79	9.21 (3.39)	2–16	.04	−.72
TNL retell	.87+	30.22 (10.16)	0–51	−.30	−.13
Expository retell	.88+	9.63 (6.11)	0–27	.53	−.4
Spelling	.90	8.86 (4.91)	0–20	.28	−.52
Sentence copy	.90*	34.21 (15.59)	3–105	1.11	2.79
Writing quality: One day	.73+	2.66 (.96)	0–5	−.39	.03
Writing quality: Castle	.82+	2.45 (.99)	0–5	.36	.18

SS = Standard score

Reliabilities are Cronbach's alpha except + (Cohen's kappa) and * (exact percent agreement).

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Table 2

Bivariate correlations between measures

	1	2	3	4	5	6	7	8	9	10
1. Working memory	1.00									
2. Vocabulary: EVT	.40	1.00								
3. Grammar	.40	.64	1.00							
4. Inference	.41	.66	.61	1.00						
5. Theory of Mind	.42	.52	.53	.61	1.00					
6. TNL retell	.34	.50	.46	.53	.48	1.00				
7. Expository retell	.42	.47	.41	.43	.47	.55	1.00			
8. Spelling	.39	.46	.39	.30	.21	.30	.37	1.00		
9. Sentence copy	.24	.31	.30	.31	.26	.32	.27	.56	1.00	
10. Writing quality: One day	.33	.35	.35	.40	.31	.25	.35	.51	.42	1.00
11. Writing quality: Castle	.30	.42	.36	.32	.24	.37	.43	.44	.37	.49

All coefficients are statistically significant at .05.

Table 3

Direct, indirect, and total effects of language and cognitive skills (standard error) on writing based on the results in Figure 4

Variable	Direct effect	Indirect effect	Total effect
Discourse-level oral language	.46 (.09)	--	.46
Spelling	.37 (.087)	--	.37
Handwriting	.17 (.094)	--	.17
Inference	--	.10 (.057)	.10
Theory of mind	--	.12 (.049)	.12
Vocabulary	--	.19 (.053)	.19
Grammatical knowledge	--	.10 (.046)	.10
Working memory	--	.43 (.062)	.43