Title

Theory of mind, mental state talk, and discourse comprehension: Theory of mind process is more important for narrative comprehension than for informational text comprehension

Authors

Kim, Young-Suk Grace
Dore, Rebecca
Cho, Minkyung
et al.

Publication Date

2021-09-01

DOI

10.1016/j.jecp.2021.105181

HHS Public Access

Author manuscript

J Exp Child Psychol. Author manuscript; available in PMC 2022 September 01.

Published in final edited form as:

J Exp Child Psychol. 2021 September ; 209: 105181. doi:10.1016/j.jecp.2021.105181.

Theory of Mind, Mental State Talk, and Discourse Comprehension: Theory of Mind Process is More Important for Narrative Comprehension than for Informational Text Comprehension

Young-Suk Grace Kim,
University of California, Irvine

Rebecca Dore,
Ohio State University

Minkyung Cho,
University of California, Irvine

Roberta Golinkoff,
University of Delaware

Stephen Amendum
University of Delaware

Abstract

We investigated the relations among theory of mind (ToM), mental state talk, and discourse comprehension. Specifically, we examined the frequency of mental state talk in children's oral recall of narrative texts and informational texts, and relations between ToM, mental state talk (coding inclusion of mental state words in the recall of narrative and informational texts), and narrative and informational text comprehension. Results from Grade 4 children (N = 132; M_{age} = 10.39) revealed that a greater number of mental state talk instances appeared in children's recall of narrative texts than informational texts, but the mean number also differed across texts within a genre. ToM skill predicted the extent of mental state talk in narrative texts and informational texts, and the relation was stronger for narrative texts than for informational texts, after accounting for vocabulary, grammatical knowledge, working memory, and attentional control. Mental state talk in narrative texts was extremely strongly related to narrative comprehension whereas mental state talk in informational texts was weakly related to informational text comprehension. Results suggest that ToM skill relates to mental state talk in the recall of texts, and both ToM and mental state talk play greater roles in comprehension of narrative texts than informational texts.

Theory of Mind (ToM) is a broad term that refers to an understanding of one's and others' mental states such as beliefs, thoughts, desires, and emotions in order to understand, predict, and judge utterances and behavior (Brownell & Martino, 1998; Wellman, Cross, & Watson, 2001). ToM is essential for social and communicative interactions, including discourse

Corresponding Author Professor, School of Education, University of California at Irvine, youngsk7@uci.edu, Phone: (949) 824-2348.

comprehension of both oral language and written texts. In fact, a growing number of studies indicates that ToM skill is related to children's listening comprehension (Kim, 2015, 2016, 2017, 2020a, 2020b; Pelletier, 2006; Pelletier & Beaty, 2015) and reading comprehension (Atkinson, Slade, Powell, & Levy, 2017; Florit, De Carli, Giunti, & Mason, 2020; Guajardo & Cartwright, 2016; Kim, 2015, 2017, 2020a).

In the present study, we extend prior work on the relation of ToM to discourse comprehension by investigating whether the relation varies by genre—narrative versus informational (expository) texts, which differ in goals, content, and structure (see below). To this end, we examined whether the extent of mental state talk in fourth grade children's text recall varies by genre (narrative vs. informational texts). In general, narrative texts are about social or interpersonal relationships and everyday problem solving (Langer, 1986), whereas informational texts are about concepts and ideas and logical relations among them (Goldman & Murray, 1992). We then examined whether ToM skill as measured by false belief tasks is differentially related to mental state talk in narrative recall versus informational text recall, and whether mental state talk is differentially related to comprehension of narrative versus informational texts, after controlling for working memory, attentional control, vocabulary, and grammatical knowledge. Note that in this paper, we use the term ToM skill to refer to ToM that is measured by second-order false belief tasks. ToM is a multifaceted construct (e.g., emotions, desires, intentions, beliefs) that is measured and operationalized by a variety of tasks (e.g., false beliefs, vignettes, audio-recording, film clips, hypothetical social dilemmas; Beaudoin, Leblanc, Gagner, & Beauchamp, 2020; Devine & Hughes, 2016; Florit et al., 2020; Kim et al., 2018; RaLusso et al., 2016). Second-order false belief tasks are appropriate for the age group targeted in this study and measure whether children can infer a story character's mistaken belief about another character's knowledge (Mahy et al., 2017).

Theory of Mind and Discourse Comprehension

Successful discourse comprehension is characterized as establishing a coherent mental representation of the situation described by the text called the situation model (Kintsch, 1988; McNamara & Magliano, 2009; van Dijk & Kintsch, 1983). Establishing the situation model involves construction and integration processes. The construction process involves construction of initial propositions based on surface linguistic information. Initial local propositions, however, are prone to inaccuracies, which need to be corrected and integrated across texts and with background knowledge to establish global coherence through the integration process. ToM is posited to play an important role in establishing global coherence during the integration process according to the direct and indirect effects model of text comprehension, referred to here as the DIET model (Kim, 2016, 2020b). That is, ToM acts as an interpretive mechanism in making connections among various perspectives, thoughts, and emotions represented in texts, and hence it plays a critical role in establishing an accurate and rich situation model (Kim, 2016, 2020b). Evidence in support of the DIET model is that ToM was related to listening comprehension for English-speaking children (Kim, 2017, 2020a, 2020b; Pelletier, 2006; Pelletier & Beaty, 2015) and Korean-speaking children (Kim, 2015, 2016). Furthermore, ToM was also related to reading comprehension for primary and upper elementary grade children in English (Atkinson, Slade, Powell, & Levy, 2017; Guajardo & Cartwright, 2016; Kim, 2017, 2020a), Italian (Florit, De Carli,

Giunti, & Mason, 2020), and Korean (Kim, 2020c). The current study uses the DIET model as a theoretical framework and builds upon this model to further consider the role of text features.

Text Features, Theory of Mind, and Mental State Talk

Texts vary in multiple aspects such as primary goals, language demands (e.g., vocabulary and syntactic complexities), topic knowledge demands, and organizational structures (Kim, 2020a; McNamara et al., 1996; Wolfe & Mienko, 2007). Broadly, these aspects differ by narrative versus informational genres. Because narrative texts typically involve social relationships and informational texts typically center on concepts and logic, successful comprehension of narrative texts tends to involve processes related to creating a coherent representation in thematic and causal structure involving events and characters, whereas comprehension of informational texts tends to involve creating a representation of the text content, including connections and causal structure of ideas (Graesser, León, & Otero, 2002; Graesser et al., 1994; McNamara, 2004; Trabasso & Magliano, 1996).

If genres differ by their goals and content, the relative role of language and cognitive skills to discourse comprehension also likely varies (Kim, 2020a). In the present study, we examined two such constructs: ToM and mental state talk. Mental state talk refers to "[t]he set of words used … to attribute thoughts, feelings, emotions, and desires to people" (Pinto et al., 2016, p. 21). Prior work showed the use of mental state talk is related to children's ToM skill (e.g., Devine & Hughes, 2019; Ruffman, Slade, & Crowe, 2002; Symons et al., 2005; Tompkins, 2015). For example, the following uses of language on the part of parents to their children related to preschool-aged children's ToM skill: mental state words (e.g., *think, know, imagine, remember* (Tompkins, 2015) and mental state words and utterances (e.g., *want, feel, She knows that's going to happen*; Ruffman et al., 2012). Similarly, during a joint book reading activity, both parental comments about the mental states of the story characters (e.g., thoughts, feelings, and desires) and the extent to which children included mental state words in the description of pictures was related to 5- to 7-year-olds' ToM skill (Symons et al., 2005). The extent to which 8- to 10-year-old children included mental state words in a written description of a friend related to their performance on false belief tasks (Grazzani & Ornaghi, 2012). In addition, training on mental state words improved preschool-aged children's false belief understanding (Ornaghi, Brockmeier, & Gavazzi, 2011). Prior work used mental state talk as an indicator of children's ToM (e.g., Pinto et al., 2016; Symons et al., 2005; Hughes, Lecce, & Wilson, 2007) based on the idea that language is foundational for its development (Astington & Baird, 2005).

In the present study, we measured children's mental state talk in the recall of narrative texts and informational texts to capture whether ToM is used as an interpretive mechanism in text comprehension—mental state talk in the child's recall of texts captures ToM process involved in the comprehension of the given texts. Although ToM is posited to be important to discourse comprehension of both narrative and informational texts, the contribution of ToM to discourse comprehension is expected to be greater for narrative texts than for informational texts because understanding thoughts, beliefs, emotions, and intentions plays a more prominent role in narrative texts than informational texts (Dore et

al., 2018; Kim, 2016, 2020b). Studies have shown that communicative exchanges and social experiences that involve varying points of view promote children's development of ToM (Carpendale & Lewis, 2006; Harris, 2005; Wellman, 2017), and narrative texts typically render greater opportunities to engage in such exchanges. For example, one of the critical aspects of understanding narrative texts is making inferences about the characters' goals, the characters' beliefs and emotions, and the author's goals and attitudes (Graesser, Singer, & Trabasso, 1994). Thus, ToM likely plays a greater role in discourse comprehension of narrative texts than informational texts.

To our knowledge, no prior work has evaluated whether narrative and informational texts differ in this way. This, however, is not to say that mental state talk would be completely absent in mental representations of informational texts (Kim, 2016, 2017, 2020a). For example, informational texts may present information using ToM words in a way that evokes readers' thoughts about others' mental states (e.g., statements such as "Some people may think that … while others consider …"). Therefore, one might include mental state talk about relations among concepts and ideas in mental representations of informational texts. Indeed, studies have shown that brain regions for ToM (medial frontal regions such as DMpfc, PCC) are activated for informational texts as well as narrative texts (Jacoby & Fedorenko, 2018; Moss & Schunn, 2015).

Beyond differential amount of mental state talk by genre, the amount of mental state talk is also likely to vary among texts *within* a genre. Texts within a genre vary in the multiple dimensions (e.g., language, content) and therefore are likely to vary in the extent to which they induce mental state talk. For example, if narrative texts are more conducive to the inclusion of mental state talk (see above), then the degree of narrativity—the extent to which stories include characters, places, and events—may also lead to more mental state talk. Narrative texts also would vary in the extent to which understanding relationships and generating inferences about characters' mental states are key to understanding the story. Similarly, informational texts vary in the way content is presented. Some texts within informational genre may present ideas and concepts at an abstract level without referring to individuals, whereas others may include substantial references to individuals (e.g., persuasive texts; a text about how a bill becomes a law; Dore et al., 2018). These types of practices may lead to the inclusion of more mental state talk in children's mental representations. In addition, the number of mental state words included in texts such as *think*, *decide*, and *believe* may influence the inclusion of mental state talk in one's mental representation of the text. Language plays an important role in mental representation (Astington & Baird, 2005; De Villiers, 2007), and thus the presence of mental state words likely evokes recall of the text using those words *and* may also evoke or trigger ToM inferences, encouraging individuals to make inferences on mental states not explicitly stated in the text.

Present Study

The primary goal of this study was to investigate the relation of ToM skill and mental state talk to discourse comprehension with a specific attention to differential patterns by text genre. The following research questions guided the study:

1. To what extent do Grade 4 children include mental state talk in their recall? Does the inclusion of mental state talk vary by narrative versus informational texts? Does the inclusion of mental state talk vary by texts within a genre?
2. Does children's ToM skill differentially relate to mental state talk in their recall of narrative versus informational texts after controlling for working memory, attentional control, vocabulary, and grammatical knowledge?
3. Does mental state talk differentially relate to comprehension of narrative texts versus informational texts after controlling for working memory, attentional control, vocabulary, and grammatical knowledge?

We included working memory, attentional control, vocabulary, and grammatical knowledge as predictors of ToM, mental state talk, and narrative comprehension and informational text comprehension based on prior evidence. Language is essential in representing mental states (Astington & Baird, 2005; De Villiers, 2007), and by now a large body of studies has shown a robust relation of oral language such as vocabulary and syntactic knowledge to ToM skill (see Milligan, Astington, & Dack, 2007, for a meta-analysis). Evidence is also clear that domain-general cognitions or executive functions such as working memory and inhibitory and attentional control play an important role in ToM (e.g., Arslan, Hohenberger, & Verbrugge, 2017; Carlson & Moses, 2001; Carlson, Moses, & Breton, 2002; Davis & Pratt, 1995; Kim, 2015, 2016; Kim & Phillips, 2014; Reed, Pien, & Rothbart, 1984; see Devine & Hughes, 2014, for a meta-analysis). In addition, vocabulary, grammatical knowledge, working memory, and attentional control are related to discourse comprehension (Alonzo et al., 2016; Daneman & Merikle, 1996; Florit, Roch, & Levorato, 2011, 2014; Kendeou, Bohn-Gettler, White, & van den Broek, 2008; Kim, 2015, 2016, 2017; Kim & Phillips, 2014; Lepola, Lynch, Laakkonen, Silvén, & Niemi, 2012; Tompkins, Guo, & Justice, 2013).

To our knowledge no prior work examined the research questions in the present study. However, based on previous hypotheses noted above (Dore et al., 2018; Kim, 2016, 2020b), we posited that children would include mental state talk more frequently in their recall of narrative texts than informational texts, and that even within a genre, there would be variation in the inclusion of mental state talk. We also posited that ToM skill would be more strongly related to mental state talk in narrative recall than informational text recall. Lastly, we posited that the relation of mental state talk in narrative recall to narrative comprehension would be stronger than the relation of mental state talk in informational text recall to informational text comprehension.

Note that we differentiated two types of mental state talk in this study: (a) *text-based ToM references,* which are children's recall of ToM words and ideas as explicitly stated in the text, and (b) *ToM inferences,* which are children's inferences of ToM content not explicitly stated in the text. These distinctions were made for the present study because mental state talk was evaluated in the context of text recall. Because many of the texts children heard included mental state words, we differentiated children's recall of the *explicit* ToM references in the text (i.e., text-based ToM references) from the use of mental state talk based on their *inferences* about the text (i.e., ToM inferences). This distinction has

typically not been relevant in previous studies in which mental state talk was captured in parent-child or peer interactions (Hughes et al., 2007; Ruffman et al., 2012) or children's descriptions of illustrations or writing (Symons et al., 2005). Our original intent was to examine text-based ToM references and ToM inferences separately in relation to ToM skill and discourse comprehension. However, in the data analysis we examined mental state talk as a whole including both text-based ToM references and ToM inferences due to less-than-ideal distributional properties of the ToM inferences (low occurrence; see below for details).

Method

Participants

Data were from 132 children in Grade 4 (50% boys; mean age = 10.39, *SD* = .56) from 28 classes in five schools in the southeastern part of the United States. These children were part of a larger longitudinal study, and results related to their literacy skills were reported earlier (Kim, 2020d). According to school district records, the sample was composed of approximately 58% Whites, 32% African Americans, 5% Hispanics, 2% Asian Americans, and 3% mixed race. Approximately 67% of the participating children were eligible for the free and reduced lunch program (a proxy for low socioeconomic status), and approximately 20% of the children received speech services, 3% received language services, and 2% were identified with a learning disability. Most children were monolingual with only one child classified as an English learner. All children were included in the analysis. The study was approved by the Institutional Review Board of the Florida State University and caregivers provided informed consent prior to children's participation.

Measures

The following skills were measured: narrative comprehension, informational text comprehension, mental state talk in recall of narrative and informational texts, ToM skill, vocabulary, grammatical knowledge, working memory, and attentional control. The measure of attentional control was completed by children's teachers. All other tasks were individually administered to children in oral language contexts. Unless otherwise noted, children's responses were scored dichotomously (1 = correct; 0 = incorrect) for each item, and all items in each task were administered to children.

Narrative comprehension.—Three narrative texts were from a normed measure for children of age 5 to 12, the Test of Narrative Language (TNL; Gillam & Pearson, 2004). The first story (Task 1; 155 words), *McDonald's*, was about a family visiting a McDonald's restaurant (no illustrations); the second story (Task 3; 197 words), *Shipwreck*, was about a child who worked on a school project making a ship, which was ruined on the way to school (presented with a series of five illustrations); and the final story (Task 5; 390 words), *Dragon*, was about a boy and a girl encountering a dragon and a treasure chest (presented with one illustration). The assessor read each narrative story aloud to the child and then asked the child to recall the story. Then, the child was asked short open-ended comprehension questions about the story. This was repeated for the three stories (for a total of 30 comprehension questions across the stories). Comprehension questions included both recall of information or literal comprehension questions (e.g., What was the girl's name?

What was the problem in the story?) and inferential questions on various aspects such as the next course of actions required (e.g., What should they do?) or a character's emotion (Why did she feel that way?). Following the TNL manual, the majority of items were scored using a dichotomous scale of 0 or 1, but some items were scored using a trichotomous scale of 0, 1, or 2 for a total possible maximum score of 40. Cronbach's alpha was .70.

Informational text comprehension.—The informational comprehension was composed of three informational passages (descriptive passages) from the Qualitative Reading Inventory-5 (QRI-5; Leslie & Caldwell, 2011). QRI-5 is an informal reading inventory, and the three passages in this study were for Grades 3, 4, and 5. Given that there is no normed listening comprehension task of informational texts, QRI-5 passages were used for listening comprehension. Titles of the passages were *Wool: From sheep to you* (*Wool* hereafter; 220 words; QRI Level 3), *Plant structures for survival* (*Plants* hereafter; 278 words; QRI Level 4), and *The octopus* (*Octopus* hereafter; 254 words; QRI Level 5). These texts were all descriptive in nature. The *Wool* text was about the process that wool undergoes from sheep to yarn (no accompanying illustrations); the *Plants* text was about plants' structures and their roles in growth and survival (presented with two illustrations); and the *Octopus* text was about how the octopus protects itself from predators (no accompanying illustrations). The assessor read each text aloud to the child and then asked the child to recall the text. As in the narrative texts, comprehension questions included literal comprehension questions (e.g., What is the first step in the making of wool? What is the favorite food of the octopus?) and inferential questions using information provided in the text (e.g., Why might the shy octopus attack another creature? Why don't pine trees lose water through their leaves?). There was a total of 24 short open-ended comprehension questions (8 questions per text). Cronbach's alpha was .70.

Mental state talk in recall of narrative and informational texts.—Children's inclusion of mental state talk was measured from their recall of three narrative texts and three informational texts, as described above. Children's recall was digitally recorded (wav. file) and transcribed verbatim following the Systematic Analysis of Language Transcription (SALT; Miller & Iglesias, 2006) guidelines. Procedures of assessment, recall recording, and transcription were identical for narrative texts and informational texts. We coded children's recall transcriptions for mental state talk, partially adapted from Meins and Fernyhough (2010); see also Meins et al. (1998). This included any statements that refer to mental states, including intentions, desires, emotions, thoughts, interests, imagination, intellect, knowledge, memories, and metacognition. Mental state talk does not include perception (e.g., see, hear), physical states (e.g., tired), or behavioral manifestations of emotions (e.g., smiling or cheerful). Under the umbrella of mental state talk, we coded two types. The first type was ToM content children recalled that was stated explicitly in the text (text-based ToM reference). This category also included instances in which the child used a synonym or a simple rephrasing of the language from the text without adding additional meaning. The second type was instances in which the child's recall included both ToM content and an inference that went beyond what was explicitly stated in the text to derive meaning about the content (ToM inference; e.g., People like living in the city because they are closer to their

jobs; The children wanted something to eat). Inter-rater agreement was 0.93 for 67 coded files.

Text characteristics.—To capture characteristics of these texts, we evaluated their narrativity—the extent to which texts include characters, places, and events—using Coh-Metrix Text Easability Assessor 3.2 version (Graesser, McNamara, Cai, Conley, & Pennebaker, 2014; Graesser, McNamara, Louwerse, & Cai, 2004). Not surprisingly, narrativity values were high for the narrative texts (85% for McDonald's, 95% for Shipwreck, and 94% for Dragon), whereas values were lower in the informational texts (44% for Wool, 29% for Plants, and 31% for Octopus). We also examined the extent to which each text included mental state words such as *think*, *know*, *believe*, and *decide*, and results were as follows: mental state words were used 6 times in the McDonald's story (*want* [2 times], *decide*, *make up her mind*, *realize*, *know*); 5 times in the Shipwreck story (*decide*, *bet*, *feel*, *think*, *surprised*); 13 times in the Dragon story (*decide*, *believe* [2 times], *think* [3 times], *excited*, *scared*, *know*, *think*, *fear*, *terror*, *sure*); 3 times in the Wool text (*know* [2 times], *think*); 0 times in the Plants text; and 6 times in the Octopus text (*think* [2 times], *frightened* [2 times], *shy*, *excited*).

Theory of mind skill (False belief task).—Appropriate to the children's developmental level (Mahy et al., 2017), ToM skill was measured by three second-order false belief scenarios, which examine the ability to infer a story character's mistaken belief about another character's knowledge (e.g., Text: "…The mailman asks Maria 'What does Sam think you are buying at the bake sale?'" Question to the child: "What does Maria tell the mailman?). The scenarios involved the context of a bake sale, visit to a farm, and going out for a birthday celebration (Kim & Phillips, 2014), and they were presented with a series of illustrations, followed by questions. There were six questions in each scenario with a total of 18 items. Cronbach's alpha was estimated to be .81.

Vocabulary.—A standardized and normed task for ages 2 to 90, the Picture Vocabulary of the Woodcock Johnson-III (WJ-III; Woodcock, McGrew, & Mather, 2001) was used in which the child was asked to identify pictured objects. Test administration discontinued after six consecutive incorrect items. Cronbach's alpha was estimated to be .65.

Grammatical knowledge.—A standardized and normed task for ages 3 to 21, the Grammaticality Judgement task of the Comprehensive Assessment of Spoken Language (Carrow-Woolfolk, 1999) was used. The child was asked whether a heard sentence was grammatically correct (e.g., *The baby funny*; *Yesterday, she rided her bike*). If grammatically incorrect, the child was asked to correct the sentence. Test administration discontinued after five consecutive incorrect items. Cronbach's alpha was .95.

Working memory.—Working memory was measured by a listening span task (Daneman & Merikle, 1996; Kim, 2015, 2016) in which the child was aurally presented with a short sentence involving common knowledge familiar to children (e.g., *Birds can fly*) and asked to identify whether the sentence was true (yes/no). Similar listening span tasks have been used successfully in prior studies with children in elementary grades. After hearing and responding on the veracity of 2 or 3 sentences, children were asked to identify the last

words in the sentences in correct order. There were four practice items and 13 experimental items. Testing was discontinued after three incorrect responses. Children's yes/no responses regarding the veracity of each statement were not scored, but their responses on the last words in correct order were given a score of 0 to 2: 2 points for correctly identifying all the last words in correct order, 1 point for the correct last words in incorrect order, and 0 points for incorrect last words. The total possible maximum score was 26. Cronbach's alpha was estimated to be .74.

Attentional control.—The first nine items of the Strengths and Weaknesses of ADHD Symptoms and Normal Behavior Scale (SWAN; Swanson et al., 2006; see Arnett et al., 2013, for validity evidence) was completed by children's teachers. SWAN is a behavioral checklist for children 6 to 17 that includes 30 items that are rated on a 7-point scale ranging from 1 (*far below average*) to 7 (*far above average*). The first nine items (e.g., "Engages in tasks that require sustained mental effort") have been shown to capture attentional control (Sáez, Folsom, Al Otaiba, & Schatschneider, 2012). Higher scores represent greater attentional control skill. Cronbach's alpha was estimated to be .99.

Procedures

Rigorously trained research assistants worked with children individually in a quiet space in the school. The included assessment battery was administered in three sessions, with each session 30- to 40-minutes long, in the following order: working memory and vocabulary in session 1; TNL and Grammaticality Judgement in session 2; and QRI-5 and ToM in session 3.

Data Analysis Strategy

The first research question, inclusion of mental state talk in children's text recall and the comparison between narrative and informational texts and between texts within a genre, was examined by descriptive statistics and t-tests. The second research question about the relation of ToM skill to mental state talk in children's text recall was examined by Confirmatory Factor Analysis (CFA) and Structural Equation Modeling (SEM), using MPLUS 8 (Muthen & Muthen, 2013) and full-information maximum likelihood. Latent variables were created for mental state talk in narrative recall and informational text recall, respectively, using children's performance in each text as indicators (see Figure 1). The language and cognitive skills were assessed by single measures for each construct, and therefore, observed variables were used. Predictive relations were examined in a structural equation model shown in Figure 1, where ToM skill, vocabulary, grammatical knowledge, working memory, and attentional control predicted mental state talk in narrative recall and informational text recall. The relations among the predictors were hierarchical in line with DIET (see Kim, 2016, for a review) such that domain-general cognitions predict oral language skills, vocabulary and grammatical knowledge, all of which, in turn, predict ToM skill and mental state talk. The third research question about the relation of mental state talk to narrative comprehension and informational text comprehension was addressed by fitting a structural equation model shown in Figure 2. In this model, narrative mental state talk and informational mental state talk predicted narrative comprehension and informational

text comprehension over and above ToM skill, vocabulary, grammatical knowledge, working memory, and attentional control.

Model fits were evaluated by chi-square statistics, comparative fit index (CFI), root mean square error of approximation (RMSEA), and standardized root mean square residuals (SRMR). Typically, RMSEA values below .08, CFI values equal to or greater than .95, and SRMR equal to or less than .05 indicate an excellent model fit, and CFI values greater than .90 are considered to be acceptable (Kline, 2011).

Results

Descriptive Statistics

Table 1 shows descriptive statistics including means, standard deviations, minimum, maximum, skewness, and kurtosis. Children's mean performances on the normed tasks (i.e., vocabulary, grammaticality judgement, and TNL comprehension) were in the low average to average range (see standard scores). Subsequent analyses were conducted using raw scores.

Correlations between measures are displayed in Table 2. ToM skill was weakly to moderately related to mental state talk in narrative recall ($.26 \leq rs \leq .34$, $ps \leq .05$) and was weakly related to mental state talk in informational recall ($.12 \leq rs \leq .23$, $.009 \leq ps \leq .16$). ToM skill had a fairly strong relation with narrative (TNL) comprehension ($r = .62$) and a moderate relation with informational (QRI) comprehension ($r = .55$). Correlations between mental state talk of different texts within each genre also ranged from weak to moderate ($.12 \leq rs \leq .30$ in narrative texts; $-.08 \leq rs \leq .49$ in informational texts). Mental state talk in narrative recall was weakly to moderately related to both narrative (TNL) comprehension ($.29 \leq rs \leq .50$) and informational (QRI) comprehension ($.22 \leq rs \leq .32$). Mental state talk in informational text recall was weakly related to narrative comprehension and informational comprehension ($.08 \leq rs \leq .19$). Working memory, attentional control, vocabulary, and grammatical knowledge were weakly to moderately related to mental state talk in narrative recall and informational text recall ($-.01 \leq rs \leq .38$).

Research Question 1: Frequency of Mental State Talk in Recall of Narrative and Informational Texts

Table 1 shows descriptive statistics of mental state talk (both ToM inferences and text-based ToM references) by stories and passages. To compare means between narrative and informational texts, the scores were summed across texts within each genre. Narrative texts were higher in means of ToM inferences ($t = 16.75$, $p < .001$) and text-based ToM references ($t = 16.39$, $p < .001$). Not surprisingly, when both types of mental state talk were summed (i.e., ToM inferences plus text-based ToM references), there were large mean differences between narrative texts ($M = 10.31$, $SD = 4.74$) and informational texts ($M = 2.37$, $SD = 2.12$).

There was also large variation in mean mental state talk across texts within a genre. With regard to ToM inferences in the narrative genre, the mean ranged from .61 in the Shipwreck story to 2.41 in the McDonald's story. The differences in ToM inferences between the narrative stories were statistically significant in paired t-tests ($ps < .001$). Similarly, large

variation was found in the means of text-based ToM references across the narrative texts (.83 in the Shipwreck story to 3.03 in the McDonald's story), which were also statistically significant (*p*s < .001). A similar pattern was also found in informational texts although overall means were lower than those in narrative texts. Low occurrence was particularly the case in the Plants text where the mean ToM inference was .03 (four children made 1 ToM inference), and there were 0 text-based ToM references (note that the Plant text itself did not include any mental state words). The other two informational texts differed in ToM inferences and text-based ToM references (*p*s < .001)

Research Question 2: The Relation of ToM Skill to Mental State Talk in Recall of Narrative and Informational Texts

For analysis involving covariance (i.e., CFA and SEM), a composite score of ToM inferences and text-based ToM references (i.e., mental state talk) was used. Although it would have been interesting to investigate whether ToM inferences and text-based ToM references are differentially related with ToM skill, distributional properties for inferential statistics were not ideal to examine them separately due to overall low frequency of ToM inferences, particularly in informational texts (i.e., floor effects; see Table 1). When ToM inferences and text-based ToM references were combined, distributional properties (see Table 1 and Appendix) were acceptable. An exception was the informational Plants text, which essentially had no loading ($p = .97$), and therefore, the Plants text was removed in subsequent CFA and SEM analyses. Prior to fitting the structural equation model in Figure 1, latent variables were created for mental state talk in narrative recall and mental state talk in informational text recall (without the Plants text). Loadings were all appropriate (see Figure 1). Bivariate correlations between mental state talk in narrative recall and informational text recall, and language and cognitive skills were examined and model fit was excellent ($\chi^2(73) = 69.01$, $p = .61$; CFI = 1.00; RMSEA = .00 [.00 - .05]; and SRMR = .04). Correlations are presented in Table 3. The mental state talk in narrative recall latent variable and mental state talk in informational text recall latent variable had a fairly strong bivariate correlation ($r = .63$). Mental state talk in narrative recall was moderately to fairly strongly related with the language and cognitive skills ($.45 \leq r\text{s} \leq .61$) whereas mental state talk in informational text recall was weakly to moderately related ($.07 \leq r\text{s} \leq .35$).

When the structural equation model in Figure 1 was fitted, the model fit was excellent: $\chi^2(19) = 14.59$, $p = .75$; CFI = 1.00; RMSEA = .00 [.00 - .06]; and SRMR = .03. Standardized parameter estimates are reported in Figure 1. After accounting for working memory, attentional control, vocabulary, and grammatical knowledge, ToM skill was independently related to mental state talk in narrative recall (.41, $p < .001$) and mental state talk in informational recall (.21, $p < .05$). To test whether the relation of ToM skill is stronger with mental state talk in narrative texts than in informational texts, we fitted a model where the magnitude of the relations of ToM skill to mental state talk in narrative versus informational texts was constrained to be equal. This model yielded a poorer fitting model with $\Delta\chi^2 = 9.13$, $\Delta df = 1$, $p < .001$, indicating that ToM skill is more strongly related to the mental state talk in narrative recall than in informational text recall.

When it comes to the relations of language and domain-general cognitive skills to ToM skill and mental state talk, attentional control was independently related to mental state talk in narrative recall (.27, $p = .03$) and informational text talk (.31, $p = .006$). Working memory was independently related to ToM skill (.27, $p = .001$) over and above attentional control, vocabulary, and grammatical knowledge whereas the latter—attentional control, vocabulary, and grammatical knowledge—were not (ps > .10). The included language and cognitive predictors (working memory, attentional control, vocabulary, grammatical knowledge, and ToM skill) explained 58% of total variance in mental state talk of narrative recall and 18% in mental state talk of informational recall.

Research Question 3: The Relation of Mental State Talk to Narrative Comprehension and Informational Comprehension

Table 3 shows that mental state talk in narrative recall was extremely strongly related to narrative comprehension to result in a Heywood case (correlation stronger than 1). Conversely, mental state talk in informational text recall was weakly related informational text comprehension ($r = .28$, $p < .001$). Given the Heywood case, we were unable to fit the structural equation model in Figure 2.

Discussion

In the present study, we examined the amount of mental state talk included in the recall of narrative texts and informational texts. We also examined whether ToM skill is differently related to mental state talk by genre, and whether mental state talk is differentially related to narrative comprehension and informational text comprehension. Overall we found different patterns by text genre, and below we discuss each of these aspects.

Mental State Talk in Children's Recall of Narrative and Informational Texts

As expected, text genre, operationalized as narrative versus informational texts, mattered, as children included more mental state talk in their recall of narrative texts than in their recall of informational texts. Narrative texts typically involve people performing actions driven by goals, as well as people's emotional reactions to actions and goals, and thus, present greater opportunities for making references about thoughts, beliefs, and emotions. Beyond the narrative versus informational distinctions, our findings also revealed variation among texts within genre, further highlighting the role of text features in children's inclusion of mental state talk. Within the narrative genre, one feature that might influence the extent to which children include mental state talk in their recall is the extent of narrativity. Alternatively, the number of mental state words (e.g., *think, decide, believe*) in the source text may lead to the inclusion of more mental state talk in recall, similar to prior evidence that exposure to mental state talk was related to children's mental state talk and ToM skill (e.g., Hughes et al., 2007; Symons et al., 2005; Tompkins, 2015). Interestingly, however, the inclusion of mental state talk did not clearly correspond to the narrativity index as measured by Coh-Metrix or to the frequency of mental state words included in the source texts. Narrativity and frequency of mental state words were highest in the Dragon text, but the average mental state talk (both ToM inferences and text-based ToM references) was highest in children's recall of the McDonald's text. Therefore, additional text features are

likely at play in inducing mental state talk. For example, one apparent difference between the McDonald's story and the other two narrative stories is that the McDonald's story does not provide a solution at the end of the story. This unresolved ending leaves children with unanswered questions and thus might have triggered children to think about characters' needs and mental states.

Results also revealed that children included mental state talk in their recall of informational texts, albeit at much lower frequencies. As noted above, informational texts typically deal with information about concepts and ideas and relations among them. However, this does not imply complete absence of ToM inferences as concepts can be presented in a way that triggers ToM inferences. Similar to the narrative text genre, variation in mental state talk was found within the informational text genre. Again narrativity does not appear to be entirely driving the inclusion of mental state talk in children's recall of informational texts because narrativity was highest in the Wool text (44%), followed by the Octopus text (31%) and the Plants text (29%), whereas recall of the Octopus text had the highest mean mental state talk, followed by the Wool and Plants texts. In contrast and unlike the narrative texts, however, the number of times mental state words were used in the informational texts—the Octopus text (6 times), the Wool text (3 times), and the Plants text (0 times)—appears to be in line with the mean frequency of mental state talk. The highest frequency of text-based ToM *references* in the Octopus text is not particularly surprising given the greater frequency of mental state words in the source text. However, it is interesting that the Octopus text also had a greater frequency of ToM *inferences*. One possibility is that the greater frequency of mental state words triggered ToM inferences in the Octopus text. Another potential explanation might be the number of emotion-related mental state vocabulary in the Octopus text compared to the Wool text. The mental state words in the Wool text were primarily cognition-related (*know* [2 times] and *think* [once]), whereas the Octopus text included emotion-related words such as *frightened* (2 times) and *excited* (once) in addition to *think* (2 times). Studies have shown that emotion words have an impact on encoding information (Jung, Wranke, Hamburger, & Knauff, 2014; Um, Plass, Hayward, & Homer, 2012; Vuilleumier, 2005), and thus, it is possible that the use of emotion words in the Octopus text may have played a role in generating ToM inferences. This, however, does not appear in line with the results of the narrative texts where the Dragon text, not the McDonald's text, had the greatest number of emotion words. Future work is needed to investigate text features (structure and words, and their interactions) that influence the extent to which mental state talk (both ToM inferences and text-based ToM references) is included in children's mental representations of texts.

Differential Relation of ToM Skill to Mental State Talk in Recall of Narrative and Informational Texts

Another important finding in the present study is that ToM skill predicted the extent to which mental state talk was included in children's recall of narrative and informational texts, and this was the case even after controlling for working memory, attentional control, vocabulary, and grammatical knowledge. The relation of ToM skill to mental state talk is convergent with prior work with younger children (e.g., Hughes et al., 2007; Symons et al., 2005) showing that children's ToM skill relates to their mental state talk in naturalistic

joint interactions, but our findings go beyond this prior research to show that ToM also relates to mental state talk in children's recall of texts. Importantly, ToM skill was more strongly related to mental state talk in narrative texts than in informational texts. This is in line with our hypothesis that narrative texts render greater opportunities for mental state talk because narrative texts typically involve interpersonal relationships, and an accurate understanding of them relies on knowledge of mental states of characters and authors, and thus ToM skill is tapped as an interpretative mechanism. Although the relation was weaker, the relation of ToM skill and mental state talk in informational texts, even when controlling for other language and cognitive skills, is also notable. Although ToM skill has been primarily examined in the context of narrative texts in prior work, at its foundation, ToM skill is a causal reasoning skill—the ability to make causal inferences about how events or concepts cause or trigger responses such as mental states (Frye et al., 1995; Wellman & Liu, 2004), and therefore, would relate to children's inclusion of mental state talk even in informational texts. To our knowledge this is the first study that shows an independent relation of ToM skill to mental state talk for narrative texts versus informational texts.

It is also of note that the correlation between mental state talk in children's recall of narrative and informational texts was substantial (.63). In other words, children who included more mental state talk in their recall of narrative texts also included more mental state talk in their recall of informational texts; therefore, children's abilities to include mental state talk in their mental representations of texts from different genres are not independent.

Although not our focal research question, the relations of language and domain-general cognitive skills to ToM skill and mental state talk are noteworthy. The results suggest that attentional control is important to mental state talk over and above ToM skill and the other language and domain-general cognitive skills, perhaps because attentional control allows children to focus on and process the mental states in the text. It is also of note that working memory was independently related to ToM skill whereas vocabulary, grammatical knowledge, and attentional control were not although they were in bivariate correlations (.29-.31). Whereas the importance of working memory in ToM skill is in line with several previous studies (Arslan et al., 2017, Carlson et al., 2001; Davis & Pratt, 1995; Kim, 2016; Kim & Phillips, 2014), lack of the relations of vocabulary and grammatical knowledge is discrepant with prior work (see Milligan et al., 2007 for a meta-analysis), Importantly, the much of the prior work did not include the language and domain-general cognitive skills simultaneously, which is important given intercorrelations between these variables. Furthermore, the vast majority of prior studies were conducted with preschool children and these relations may change across development.

Relation of Mental State Talk to Comprehension of Narrative and Informational Texts

We posited that mental state talk would be more strongly related to narrative comprehension than to informational text comprehension. Although we could not fully address this question in a structural regression model because of an extremely strong relation of narrative mental state talk with narrative comprehension, these results indicate that the relation of mental state talk is stronger for narrative texts than for informational texts (see Table 3). The

extremely strong relation is interesting in that we coded only mental state talk included in the retell, not the overall quality of recall which typically takes into account the extent to which key content and elements are included (e.g., key plot, characters, setting, and problems in narrative texts; key details and ideas in informational texts; Barnes, Kim, & Phillips, 2014; Collins, Compton, Lindström, & Gilbert, 2020). These results suggest the key role of ToM process and mechanism in narrative comprehension (e.g., Bohnacker & Gargarina, 2020; Dore et al., 2018; Kim, 2015, 2016, 2020a).

In contrast, the relation of informational mental state talk to informational text comprehension was weak (.28). These results indicate that a relation exists between mental state talk in the recall of informational text and informational text comprehension, but it is certainly not as strong as that between narrative mental state talk and narrative comprehension. As stated above, we believe that this is attributable to the fact that by nature, informational texts do not typically include many opportunities for taking different perspectives, and this was supported in the overall low frequency of mental state talk. Furthermore, the extent to which mental state talk is incorporated into children's recall of informational texts may not be as indicative of their level of comprehension because mental states are usually less central to the comprehension of such texts compared to narratives. This is reflected in the comprehension questions. Comprehension questions of informational texts were mainly about concepts in the texts and inferring main ideas on the given topic whereas comprehension questions of narrative texts included an understanding of characters' feelings and thoughts. While these differences in comprehension questions may explain the stronger relation of mental state talk to text comprehension of narrative texts, note that the different nature of comprehension questions reflects differences in goals and content of narrative and informational texts.

The results of the present findings, together with previous studies (e.g., Atkins et al., 2017; Florit et al., 2020; LaRusso et al., 2016), indicate the importance of ToM skill to discourse/text comprehension across both narrative and informational texts (Kim, 2016, 2020a). Discourse comprehension not only is central in daily life, but also is an educationally meaningful outcome. Discourse comprehension of oral texts (i.e., listening comprehension) is the foundation of discourse comprehension of written texts (reading comprehension; Gough & Tunmer, 1986; Kim, 2017, 2020a), and reading comprehension is assessed in national assessments (e.g., National Assessment of Education Progress [NAEP] in the U.S.) and international assessments (e.g., the Program for International Student Assessment [PISA]). The roles of ToM skill and mental state talk in discourse comprehension suggest a need for the development of ToM skill through instruction. Children vary in their ToM skill, and those with weak ToM skill will benefit from explicit and systematic instruction on ToM to improve their discourse comprehension -- as a meta-analysis revealed; a large positive effect (g = .75; Hofmann et al., 2016) indicated that ToM can be improved when taught explicitly. The finding that ToM was linked more strongly to narrative comprehension than comprehension of informational texts suggests that although ToM training is likely to be beneficial for improving discourse comprehension broadly, examining children's abilities and challenges with different genres may be useful in providing instruction that meets their needs.

Limitations and Future Directions

Results should be interpreted with a few limitations in mind. First, the informational texts in the present study were descriptive in nature. Informational text is a broad category that includes multiple subtypes such as exposition or description, compare-contrast, cause-effect, persuasive, and argumentative texts. Therefore, our results are generalizable to informational texts with similar characteristics (i.e., description). It is reasonable to speculate that ToM skill and mental state talk would be particularly important for understanding and producing persuasive and argumentative informational texts. Future work should investigate the extent to which mental state talk is included in recall of various subgenres of informational texts (e.g., opinion, persuasive, description) and narrative texts with different features. Furthermore, the narrative texts and informational texts used in the present study differed in many aspects other than their narrative or informational nature, including the number of illustrations, total words, mental state words, and familiarity and ease of concepts. As noted earlier, narrative texts typically include more mental state words by nature and children find them easier to comprehend than informational texts (Best et al., 2008; Williams, Hall, & Lauer, 2004). To address the latter aspect to some extent, we fitted statistical models with proportion of mental state talk. However, the models had a convergence issue. Overall, future experimental work should replicate the present study with carefully developed texts where multiple aspects of texts are controlled.

Second, it is possible that the stronger relation of ToM skill to mental state talk of narrative recall than to mental state talk of informational recall is at least partially driven by a method effect because the false belief tasks used to measure ToM skill were in the context of narrative texts, in line with previous studies (Astington, Pelletier, & Homer, 2002; Pelletier & Beaty, 2015; Perner & Wimmer, 1985; see Ruffman, 2014, for a review). Future work where ToM is measured using tasks in contexts other than narrative texts would be useful to extend the present study. On a related note, mental state talk in this study was measured by free recall tasks. It is unknown whether results would differ if mental state talk were measured by prompted recall tasks.

Third, as noted above, we were not able to tease out ToM inferences and text-based ToM references in our SEM analysis (Figure 1) due to low frequencies particularly in informational texts, which result in problems with distributional properties when examined separately. Future efforts, perhaps with children at a more advanced phase of development and/or using informational texts with different features, might be able to address this issue.

Fourth, approximately 20% of the children in this study sample received speech services and 3% received services for developmental language disorder. Studies showed that children with developmental language disorder, on average, are more likely than their peers to have difficulty with text comprehension (e.g., Snowling, Hayiou-Thomas, Nash, & Hulme, 2020). However, we were not able to examine our research questions for children with and without language and speech services due to small sample sizes. Thus, it is an open question whether similar patterns are found for different populations.

Lastly, the sample in this study was small for the complexity of the models. The sample size-to-parameters ratio was 4.3:1 in this study, which is less than ideal (Kline, 2011). This low ratio was primarily due to the inclusion of the additional language and cognitive skills (i.e., vocabulary, grammatical knowledge, working memory, and attentional control) to account for their effects on ToM and mental state talk. When these were not included in the model, the sample size-to-parameters ratio increased to 14.67, which is acceptable (Kline, 2011), and importantly, the results were essentially the same as those reported in Figure 1. Nonetheless, future studies with a larger sample are needed to replicate the present study. Future replications are also warranted for the structural relations in Figure 2, which we were not able to examine due to the extremely strong relation of mental state talk of narrative recall with narrative comprehension.

Conclusions

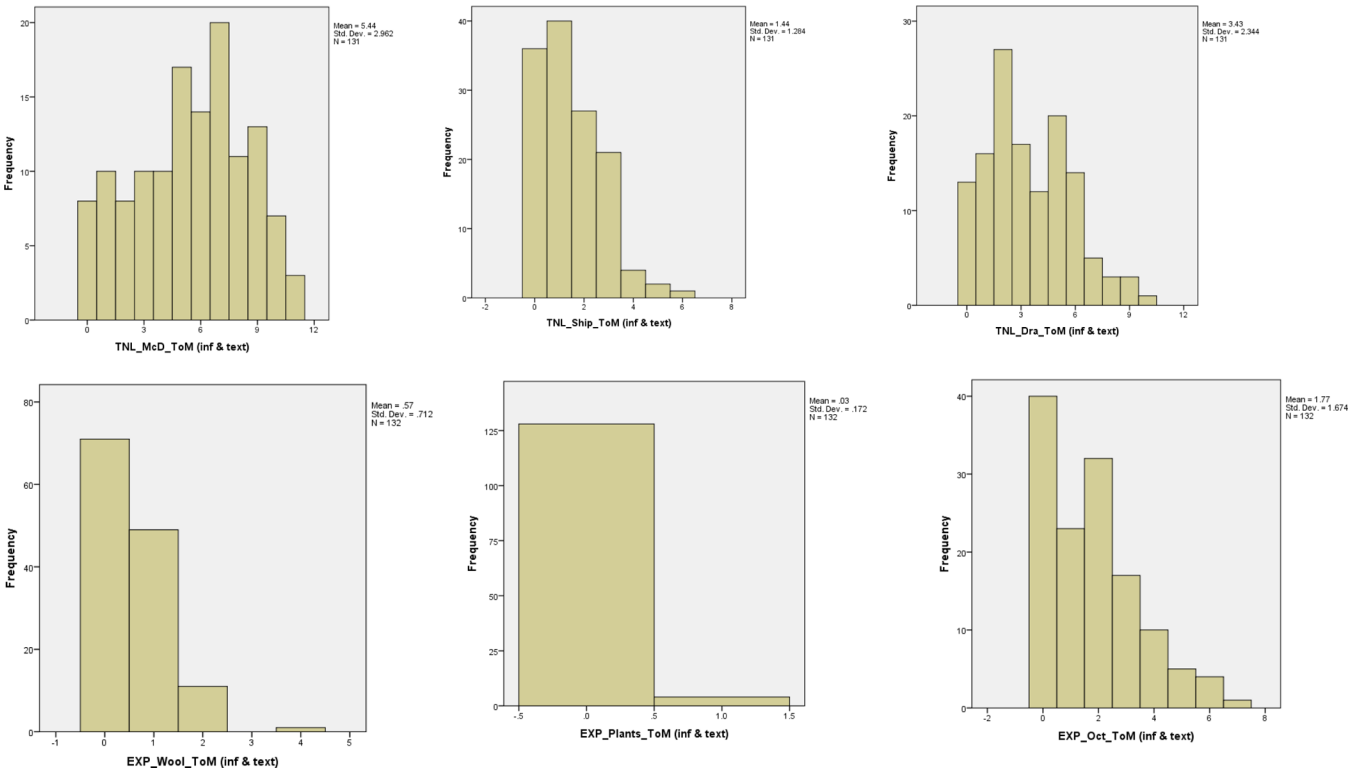
Overall, the present findings indicate that children in Grade 4 include mental state talk in their mental representations of texts, and the frequency of this information varies by genre and texts. Furthermore, children's ToM skill uniquely predicts the extent to which they include mental state talk in their recall of narrative texts and informational texts. In addition, mental state talk in recall was very strongly related to comprehension of narrative texts, but only weakly related to comprehension of informational texts. In light of these results, further investigations are needed to explore text features and individual characteristics that are associated with the inclusion of mental state talk in children's mental representations of texts, and their relations to discourse comprehension. Systematic efforts are also needed to shed light on the effects of explicit teaching of ToM skill on children's discourse comprehension across genres.

Acknowledgments

This research was supported by the grant from the Institute of Education Sciences, US Department of Education (R305A130131, R305A180055, & R305A200312), and Eunice Kennedy Schriver National Institute of Child Health and Human Development (NICHD; P50HD052120) to the first author. The content is solely the responsibility of the authors and does not necessarily represent the official views of the funding agency. The author(s) wish to thank participating schools and children.

Appendix:

Distribution of mental state talk (sum of ToM inferences and text-based ToM references) in children's recall of the Test of Narrative Language texts (TNL; top panel in the order of McDonald's, Shipwreck, and Dragon stories) and the informational texts (EXP; bottom panel in the order of Wool, Plants, and Octopus texts). In SEM, the Plants text was excluded due to a severe floor effect. The Wool and Octopus texts had some floor effects, but skewness values were in the acceptable range (Table 1).



References

Arnett AB, Pennington BF, Friend A, Willcutt EG, Byrne B, Samuelsson S, & Olson RK (2013). The SWAN captures variance at the negative and positive end of the ADHD symptom dimension. Journal of Attentional Control Disorders, 17, 152–162. DOI: 10.1177/1087054711427399

Arslan B, Hohenberger A, & Verbrugge R (2017). Syntactic recursion facilitates and working memory predicts recursive theory of mind. PLoS ONE, 12(1): e0169510. doi:10.1371/journal.pone.0169510 [PubMed: 28072823]

Astington J, Pelletier J, & Homer B (2002). Theory of mind and epistemological development: The relation between children's second-order false-belief understanding and their ability to reason about evidence. New Ideas in Psychology, 20, 131–144. doi:10.1016/S0732-118X(02)00005-3

Barnes AE, Kim YS, & Phillips BM (2014). The relations of proper character introduction to narrative quality and listening comprehension for young children from high poverty schools. Reading and Writing, 27(7), 1189–1205. doi: 10.1007/s11145-013-9481-0

Beaudoin C, Leblanc E, Gagner C, & Beauchamp MH (2020). Systematic review and inventory of theory of mind measures for young children. Frontiers in Psychology, 10, article 2905. doi: 10.3389/fpsyg.2019.02905

Best RM, Floyd RG, & McNamara D (2008). Differential competencies contributing to children's comprehension of narrative and expository texts. Reading Psychology, 29(2), 137–164. 10.1080/02702710801963951

Bohnacker U, & Gargarina N (2020). Developing narrative comprehension: Multilingual assessment instrument for narratives. John Benajmins Publishing.

Carlson SM, & Moses LJ (2001). Individual differences in inhibitory control and children's theory of mind. Child Development, 72, 1032–1053. doi:10.1111/1467-8624.00333 [PubMed: 11480933]

Carlson SM, Moses LJ, & Breton C (2002). How specific is the relation between executive function and theory of mind? Contributions of inhibitory control and working memory. Infant and Child Development, 11, 73–92. doi:10.1002/icd.298

Carpendale JIM, & Lewis C (2006). How children develop social understanding. Oxford, UK: Blackwell.

Carrow-Woolfolk E (1999). Comprehensive assessment of spoken language. Bloomington, MN: Pearson Assessment.

Collins AA, Compton DL, Lindström ER, & Gilbert JK (2020). Performance variations across reading comprehension assessments: Examining the unique contributions of text, activity, and reader. Reading and Writing, 33(3), 605–634. doi:10.1007/s11145-019-09972-5

Craik FI, Naveh-Benjamin M, Ishaik G, & Anderson ND (2000). Divided attentional control during encoding and retrieval: Differential control effects? Journal of Experimental Psychology: Learning, Memory, and Cognition, 26(6), 1744–1749. DOI: 10.1037/0278-7393.26.6.1744

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

Davis HL, & Pratt C (1995). The development of children's theory of mind: The working memory explanation. Australian Journal of Psychology, 47, 25–31. doi:10.1080/00049539508258765

Devine RT, & Hughes C (2016). Measuring theory of mind across middle childhood: Reliability and validity of the Silent Films and Strange Stories tasks. Journal of Experimental Child Psychology, 149, 23–40. 10.1016/j.jecp.2015.07.011 [PubMed: 26255713]

Diakidoy I-AN, Stylianou P, Karefillidou C, & Papageorgiou P (2005). The relationshipbetween listening and reading comprehension of different types of text at increasinggrade levels. Reading Psychology, 26(1), 55–80. DOI: 10.1080/02702710590910584

Dore RA, Amendum SJ, Golinkoff RM, & Hirsh-Pasek K (2018). Theory of mind: A hidden factor in reading comprehension? Educational Psychology Review, 30, 1067–1089.

Duke NK (2000). 3.6 minutes per day: The scarcity of informational texts in first grade. Reading Research Quarterly, 35, 202–224.

Elliot-Faust DJ, & Pressley M (1986). How to teach comparison processing to increase children's short- and long-term listening comprehension monitoring. Journal of Educational Psychology, 78, 27–33.

Florit E, De Carli P, Giunti G, & Mason L (2020). Advanced Theory of Mind uniquely contributes to children's multiple-text comprehension. Journal of Experimental Child Psychology, 189, 10.1016/j.jecp.2019.104708

Florit E, Roch M, & Levorato MC (2011). Listening text comprehension of explicit and implicit information in preschoolers: The role of verbal and inferential skills. Discourse Processes, 48, 119–138. 10.1080/0163853X.2010.494244

Florit E, Roch M, & Levorato MC (2014). Listening text comprehension in preschoolers: A longitudinal study on the role of semantic components. Reading and Writing: An Interdisciplinary Journal, 27, 793–817. 10.1007/s11145-013-9464-1

Frye D, Zelazo PD, & Palfai T (1995). Theory of mind and rule-based reasoning. Cognitive Development, 10(4), 483–527. 10.1016/0885-2014(95)90024-1

Gillam RB, & Pearson NA (2004). Test of Narrative Language. Austin, TX: Pro-Ed.

Goldman SR, & Murray JD (1992). Knowledge of connectors as cohesion devices in text: Acomparative study of native-English and English-as-a-second-language speakers. Journal of Educational Psychology, 84, 504–519.

Gough PB, & Tunmer WE (1986). Decoding, reading, and reading disability. RASE: Remedial & Special Education, 7(1), 6–10. 10.1177/074193258600700104

Graesser AC, León JA, & Otero J (2002). Introduction to the psychology of science text comprehension. In Otero J, León JA, & Graesser AC (Eds.), The psychology of science text comprehension (pp. 1–15). Mahwah, NJ: Erlbaum.

Graesser AC, McNamara DS, Cai Z, Conley M, Li H, & Pennebaker J (2014). Coh-Metrix measures text characteristics at multiple levels of language and discourse. The Elementary School Journal, 115(2), 210–229. 10.1086/678293

Graesser AC, McNamara DS, Louwerse MM, & Cai Z (2004). Coh-Metrix: Analysis of text on cohesion and language. Behavior Research Methods, Instruments, & Computers: A Journal of the Psychonomic Society, 36(2), 193–202. 10.3758/BF03195564

Grazzani I, & Ornaghi V (2012). How do use and comprehension of mental-state language relate to theory of mind in middle childhood? Cognitive Development, 27, 99–111. 10.1016/j.cogdev.2012.03.002

Harris PL (2005). Conversation, Pretense, and Theory of Mind. In Astington JW & Baird JA (Eds.), Why language matters for theory of mind (p. 70–83). Oxford University Press. 10.1093/acprof:oso/9780195159912.003.0004

Hofmann SG, Doan SN, Sprung M, Wilson A, Ebesutani C, Andrews LA, . . . Harris PL (2016). Training children's theory-of-mind: A meta-analysis of controlled studies. Cognition, 150, 200–212. 10.1016/j.cognition.2016.01.006 [PubMed: 26901235]

Hughes C, Lecce S, & Wilson C (2007). "Do you know what I want?" Preschoolers' talk about desires, thoughts and feelings in their conversations with sibs and friends. Cognition & Emotion, 21, 330–350. 10.1080/02699930600551691.

Jacoby N, & Fedorenko E (2018). Discourse-level comprehension engages medial frontal theory of mind brain regions even for expository texts. Language, Cognition and Neuroscience. DOI: 10.1080/23273798.2018.1525494

Jung N, Wranke C, Hamburger K, & Knauff M (2014). How emotions affect logical reasoning: Evidence from experiments with mood-manipulated participants, spider phobics, and people with exam anxiety. Frontiers in Psychology, 5, Article 570. 10.3389/fpsyg.2014.00570

Kendeou P, Bohn-Gettler CM, White MJ, & van den Broek P (2008). Children's inference generation across different media. Journal of Research in Reading, 31, 259–272. 10.1111/j.1467-9817.2008.00370.x

Kim HY, LaRusso MD, Hsin LB, Harbaugh AG, Selman RL, & Snow CE (2018). Social perspective-taking performance: Construct, measurement, and relations with academic performance and engagement. Journal of Applied Developmental Psychology, 57, 24–41. 10.1016/j.appdev.2018.05.005

Kim Y-SG (2015). Language and cognitive predictors of text comprehension: Evidence from multivariate analysis. Child Development, 86, 128–144. doi:10.1111/cdev.12293 [PubMed: 25174258]

Kim Y-SG (2016). Direct and mediated effects of language and cognitive skills on comprehension of oral narrative texts (listening comprehension) for children. Journal of Experimental Child Psychology, 141, 101–120. doi:10.1016/j.jecp.2015.08.003 [PubMed: 26342474]

Kim Y-SG (2017). Why the simple view of reading is not simplistic: Unpacking the simple view of reading using a direct and indirect effect model of reading (DIER). Scientific Studies of Reading, 21, 310–333. doi:10.1080/10888438.2017.1291643

Kim Y-SG (2020a). Hierarchical and dynamic relations of language and cognitive skills to reading comprehension: Testing the direct and indirect effects model of reading (DIER). Journal of Educational Psychology, 112(4), 667–684. 10.1037/edu0000407

Kim Y-SG (2020b). Theory of mind mediates the relations of language and domain-general cognitions to discourse comprehension. Journal of Experimental Child Psychology, 194, 10.1016/j.jecp.2020.104813

Kim Y-SG (2020c). Toward integrative reading science: The direct and indirect effects model of reading (DIER). Journal of Learning Disabilities, 53(6), 469–491. 10.1177/0022219420908239 [PubMed: 32125226]

Kim Y-SG (2020d). Structural relations of language, cognitive skills, and topic knowledge to written composition: A test of the direct and indirect effects model of writing (DIEW). British Journal of Educational Psychology, 90, 910–932. 10.1111/bjep.12330

Kim Y-S, & Phillips B (2014). Cognitive correlates of listening comprehension. Reading Research Quarterly, 49, 269–281. 10.1002/rrq.74

Kline RB (2011). Principles and Practice of Structural Equation Modeling (3rd ed.). New York: Guilford Press.

Kraal A, Koornneef AW, Saab N, & Van den Broek PW (2017). Processing of expository and narrative texts by low- and high-comprehending children. Reading and Writing, 31, 2017–2040. [PubMed: 30416261]

Kraal A, Van den Broek P, Koornneef A, Ganushchak L, & Saab N (2019). Differences in text processing by low- and high-comprehending beginning readers of expository and narrative texts: Evidence from eye movements. Learning & Individual Differences, 74, 101. 10.1016/j.lindif.2019.101752

Langer JA (1986). Children reading and writing: Structures and strategies. Norwood, NJ: Ablex.

Lepola J, Lynch J, Laakkonen E, Silvén M, & Niemi P (2012). The role of inference making and other language skills in the development of narrative listening comprehension in 4- to 6-year old children. Reading Research Quarterly, 47, 259–282. 10.1002/rrq.020

Leslie L, & Caldwell JS (2011). Qualitative reading inventory-5th Edition. Boston, MA: Allyn & Bacon.

McKeown MG, Beck IL, Sinatra GM, & Loxterman JA (1992). The contribution of prior knowledge and coherent text to comprehension. Reading Research Quarterly, 27, 78–93. doi:10.2307/747834

McNamara DS (2004). SERT: Self-explanation reading training. Discourse Processes, 38, 1–30. doi:10.1207/s15326950dp3801_1

Meins E, & Fernyhough C (2010). Mind-mindedness coding manual, Version 2.0.

Meins E, Fernyhough C, Russell JA, & Clark-Carter D (1998). Security of attachment as a predictor of symbolic and mentalising abilities: A longitudinal study. Social Development, 7(1), 1–24. doi:10.1111/1467-9507.00047

Miller JF, & Iglesias A (2006). Systematic analysis of language transcripts (SALT). Madison, WI: University of Wisconsin.

Milligan K, Astington JW, & Dack LA (2007). Language and theory of mind: Meta-analysis of the relation between language ability and false-belief understanding. Child Development, 78, 622–646. 10.1111/j.1467-8624.2007.01018 [PubMed: 17381794]

Moss J, & Schunn CD (2015). Comprehension through explanation as the interaction of the brain's coherence and cognitive control networks. Frontiers in Human Neuroscience, 9, Article 562. 10.3389/fnhum.2015.00562

Muthén LK, & Muthén BO (2013). Mplus 7.1. Los Angeles: Muthén and Muthén.

Ornaghi V, Brockmeier J, Gavazzi IG (2011). The role of language games in children's understanding of mental states: A training study. Journal of Cognition and Development, 12(2), 239–259. 10.1080/15248372.2011.563487

Perner J, & Wimmer H (1985). "John thinks that Mary thinks that. . ." attribution of second-order beliefs by 5- to 10-year-old children. Journal of Experimental Child Psychology, 39, 437–471.

Pinto G, Tarchi C, Gamannossi, & Bigozzi L (2016). Mental state talk in children's face-to-face and telephone narrative. Journal of Applied Developmental Psychology, 44, 21–27. 10.1016/j.appdev.2016.02.004

LaRusso M, Kim HY, Selman R, Uccelli P, Dawson T, Jones S, ... Snow C (2016). Contributions of academic language, perspective taking, and complex reasoning to deep reading comprehension. Journal of Research on Educational Effectiveness, 9, 201–222. 10.1080/19345747.2015.1116035

Mahy CEV, Bernstein DM, Gerrard LD, & Atance CM (2017). Testing the validity of a continuous false belief task in 3- to 7-year-old children. Journal of Experimental Child Psychology, 160, 50–66. 10.1016/j.jecp.2017.03.010 [PubMed: 28426950]

Reed MA, Pien DL, & Rothbart MK (1984). Inhibitory self-control in preschool children. Merrill-Palmer Quarterly, 30, 131–147.

Rollo D, & Sulla F (2016). Maternal talk in cognitive development: Relations between psychological lexicon, semantic development, empathy, and temperament. Frontiers in Psychology, i, Article 394. doi: 10.3389/fpsyg.2016.00394

Ruffman T (2014). To belief or not belief: Children's theory of mind. Developmental Review, 34, 265–2923.

Ruffman T, Slade L, & Crowe E (2002). The relation between child and mothers' mental state language and theory-of-mind understanding. Child Development, 73, 734–751. 10.1111/1467-8624.00435 [PubMed: 12038548]

Sáez L, Folsom JS, Al Otaiba S, & Schatschneider C (2012). Relations among student attentional control behaviors, teacher practices, and beginning word reading skill. Journal of Learning Disabilities, 45, 418–432. doi:10.1177/0022219411431243 [PubMed: 22207616]

Scerif G (2010). Attentional control trajectories, mechanisms and outcomes: At the interface between developing cognition and environment. Developmental Science, 13, 805–812. [PubMed: 20977552]

Slaughter V, Peterson CC, & Mackintosh E (2007). Mind what mother says: Narrative input and theory of mind in typical children and those on the autism spectrum. Child Development, 78(3), 839–858. [PubMed: 17517008]

Snowling MJ, Hayiou-Thomas ME, Nash HM, & Hulme C (2020). Dyslexia and Developmental Language Disorder: comorbid disorders with distinct effects on reading comprehension. Journal of Child Psychology and Psychiatry, 61(6), 672–680. [PubMed: 31631348]

Swanson JM, Schuck S, Mann M, Carlson C, Hartman K, Sergeant JA,… McCleary R (2006). Categorical and dimensional definitions and evaluations of symptoms of ADHD: The SNAP and SWAN Rating Scales.

Symons DK, Peterson CC, Slaughter V, Roche J, & Doyle E (2005). Theory of mind and mental state discourse during book reading and story-telling tasks. British Journal of Developmental Psychology, 23, 81–102. 10.1348/026151004X21080.

Tompkins V (2015). Mother's cognitive state talk during shared book reading and children's later false belief understanding. Cognitive Development, 36, 40–51. 10.1016/j.cogdev.2015.08.004

Tompkins V, Guo Y, & Justice LM (2013). Inference generation, story comprehension, and language in the preschool years. Reading and Writing: An Interdisciplinary Journal, 26, 403–429. doi:10.1007/s11145-012-9374-7

Trabasso T, & Magliano JP (1996). Conscious understanding during comprehension. Discourse Processes, 21, 255–287.

Uccelli P, Galloway EP, Barr CD, Meneses A, Dobbs CL (2015b). Beyond vocabulary: Exploring cross-disciplinary academic-language proficiency and its association with reading comprehension. Reading Research Quarterly, 50, 337–356. doi: 10.1002/rrq.104

Um E, Plass JL, Hayward EO, & Homer BD (2012). Emotional design in multimedia learning. Journal of Educational Psychology, 104, 485–498. doi: 10.1037/a002 6609

Vuilleumier P (2005). How brains beware: Neural mechanisms of emotional attentional control. Trends in Cognitive Sciences, 9, 585–594. doi: 10.1016/j.tics.2005.10.011 [PubMed: 16289871]

Wellman HM (2017). Learning a theory of mind. In Slaughter V & DeRosnay M (Eds.), Theory of mind development in context (pp. 1–22). London, UK: Routledge.

Wellman HM, & Liu D (2004). Scaling of theory-of-mind tasks. Child Development, 75(2), 523–451. 0009–3920/2004/7502–0020 [PubMed: 15056204]

Williams JP, Hall KM, & Lauer KD (2004). Teaching expository text structure to young at-risk learners: Building the basics of comprehension instruction. Exceptionality, 12, 129–144. doi:10.1207/s15327035ex1203_2

Wolfe MBW, & Mienko JA (2007). Learning and memory of factual content from narrative and expository text. British Journal of Educational Psychology, 77, 541–564. doi:10.1348/000709906X143902

Woodcock RW, McGrew KS, & Mather N (2001). Woodcock–Johnson III Tests of Achievement. Itasca, IL: Riverside.

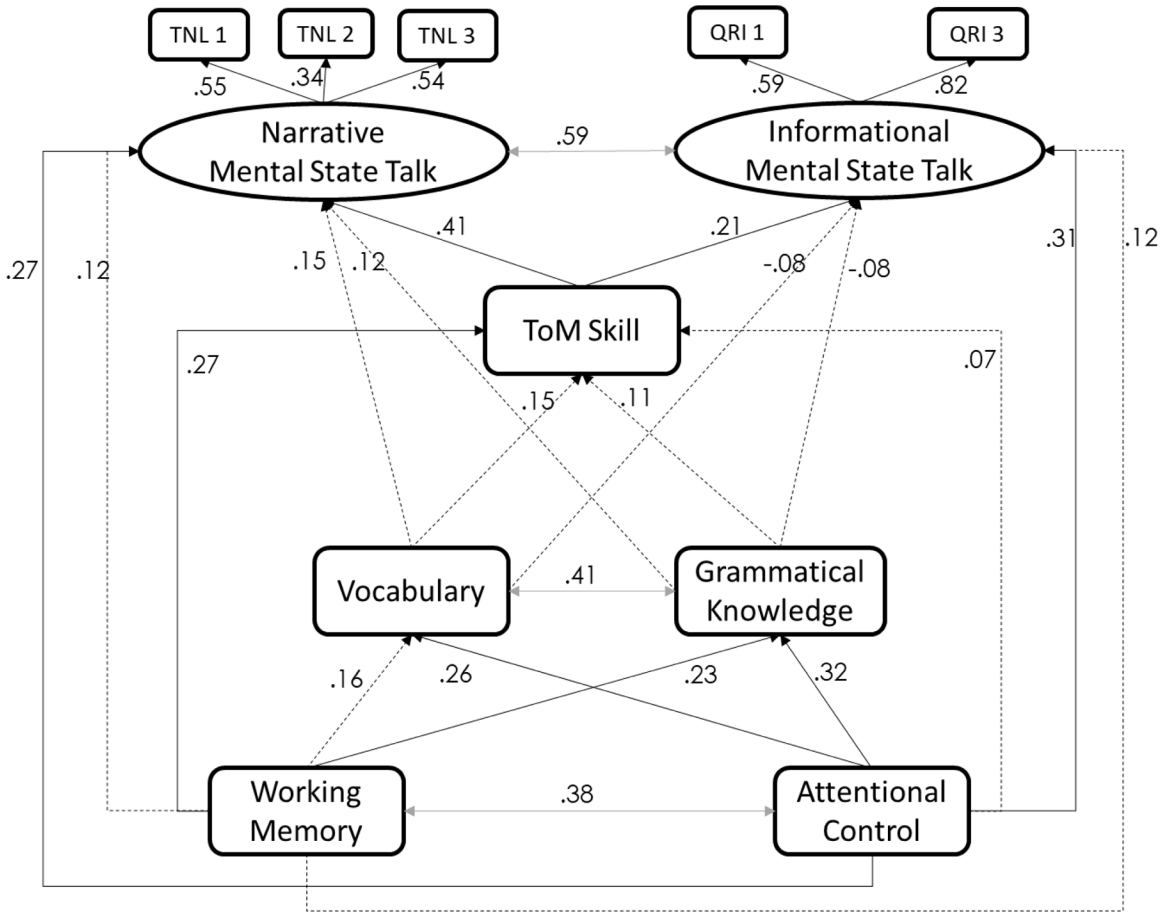


Figure 1.

Standardized coefficients for the relations of language and cognitive skills to mental state talk in narrative and informational text recalls. In fitting the model, QRI 2 (Plants text) was not included due to a floor effect and consequent lack of loading.

ToM = Theory of Mind; TNL = Test of Narrative Language; QRI = Qualitative Reading Inventory; TNL 1 = McDonald's; TNL 2 = Shipwreck; TNL 3 = Dragon; QRI 1 = Wool; QRI 3 = Octopus.

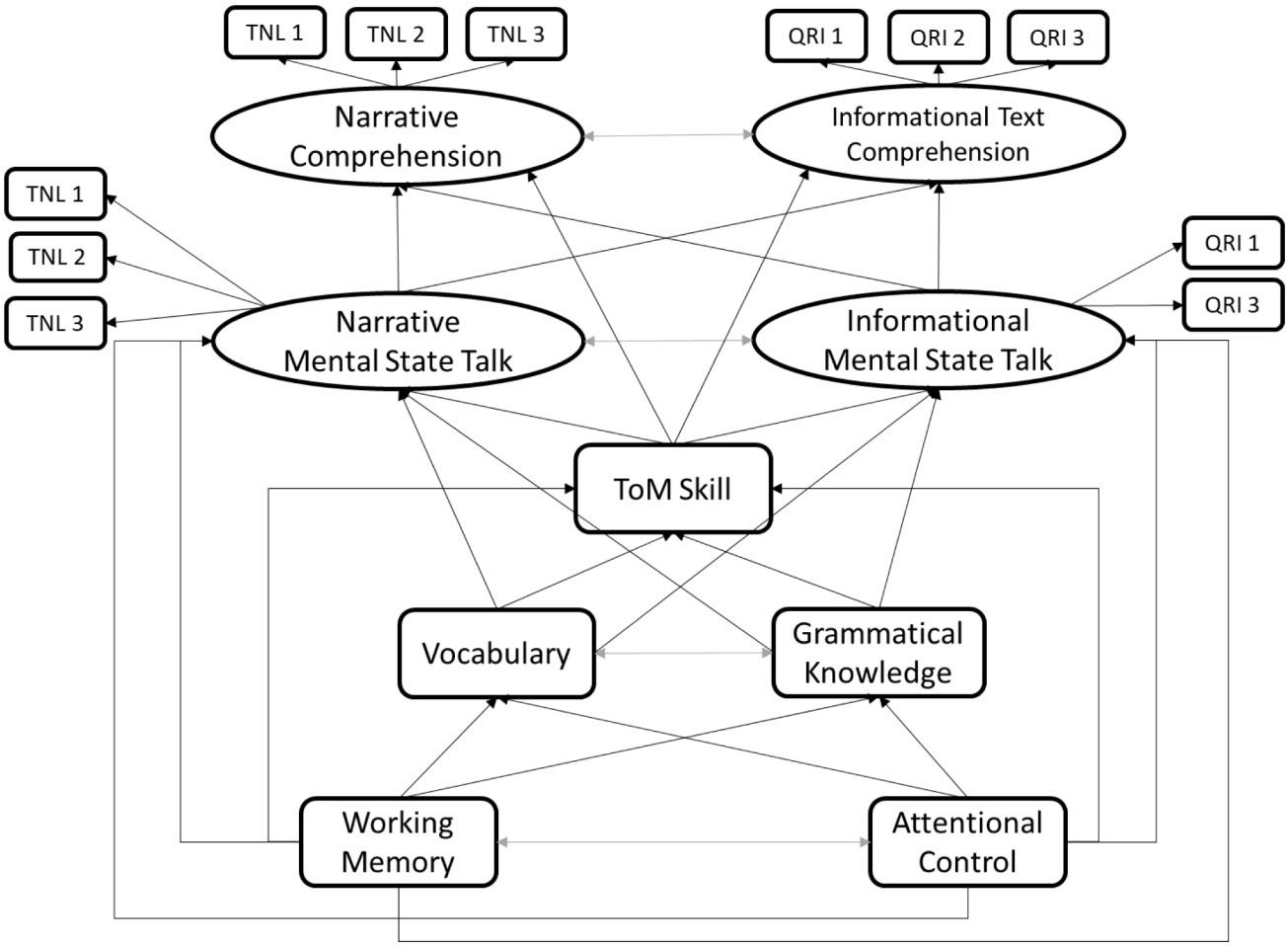


Figure 2.

Structural equation model that shows the relations of language and domain-general cognitive skills, ToM skill to mental state talk in narrative and informational text recalls, and to narrative comprehension and information text comprehension. Note that the paths from vocabulary, grammatical knowledge, working memory, and attentional control to narrative comprehension and informational text comprehension were allowed, but are not shown here due to visual complexity.

ToM = Theory of Mind; TNL = Test of Narrative Language; QRI = Qualitative Reading Inventory; TNL 1 = McDonald's; TNL 2 = Shipwreck; TNL 3 = Dragon; QRI 1 = Wool; QRI 2 = Plants; QRI 3 = Octopus.

Table 1.

Descriptive Statistics

Variable	*M*	*SD*	Min	Max	Skewness	Kurtosis
Narrative mental state talk						
TNL McDonald's ToM inferences	2.41	1.84	0	7	.42	−.81
TNL McDonald's text-based ToM references	3.03	1.85	0	6	−.05	−.93
TNL McDonald's mental state talk	5.44	2.96	0	11	−.19	−.87
TNL Shipwreck ToM inferences	.61	.85	0	5	1.84	5.16
TNL Shipwreck text-based ToM references	.83	.85	0	3	.79	−.08
TNL Shipwreck mental state talk	1.44	1.28	0	6	.83	.51
TNL Dragon ToM inferences	1.10	1.26	0	6	1.44	2.69
TNL Dragon text-based ToM references	2.33	1.76	0	7	.48	−.41
TNL Dragon mental state talk	3.43	2.34	0	10	.49	−.38
ToM inferences across TNL texts	4.12	2.37	0	13	.49	.47
Text-based ToM references across TNL texts	6.19	3.37	0	15	.22	−.45
ToM information across TNL texts	10.31	4.74	0	21	−.08	−.56
Informational text mental state talk						
QRI Wool ToM inferences	.06	.24	0	1	3.73	12.06
QRI Wool text-based ToM references	.51	.67	0	4	1.59	4.47
QRI Wool mental state talk	.57	.71	0	4	1.37	2.97
QRI Plants ToM inferences	.03	.17	0	1	5.54	29.17
QRI Plants text-based ToM references	0	0	0	0	NA	NA
QRI Plants mental state talk	.03	.17	0	1	5.54	29.17
QRI Octopus ToM inferences	.58	.89	0	5	2.04	5.46
QRI Octopus text-based ToM references	1.19	1.23	0	5	.73	−.30
QRI Octopus mental state talk	1.77	1.67	0	7	.86	.24
ToM inferences across QRI texts	.67	.98	0	5	1.89	4.26
Text-based ToM references across QRI texts	1.70	1.57	0	7	.75	.12
ToM information across QRI texts	2.37	2.12	0	10	.93	.69
Language and cognitive skills						
ToM skill	10.23	3.97	0.00	17.00	−0.30	−0.62
WJ Picture Vocabulary	23.08	2.74	16.00	30.00	0.00	−0.12
WJ Picture Vocabulary SS	95.84	9.55	69.00	120.00	−0.07	0.25
CASL Grammaticality	43.55	13.75	10.00	84.00	0.06	0.36
CASL Grammaticality SS	94.53	15.89	54.00	159.00	0.52	2.18
Working memory	11.26	4.36	0.00	26.00	0.15	0.97
Attentional control	36.41	11.90	9	63	.18	−.13
Narrative comprehension						
TNL comprehension	30.45	4.25	14	39	−.98	1.81
TNL comprehension SS[+]	9.86	3.27	1	18	−.06	−.32
Information text comprehension						

Variable	*M*	*SD*	Min	Max	Skewness	Kurtosis
QRI comprehension	6.52	3.03	0	14	.14	−.57

Notes. Unless otherwise noted, values are raw scores. Bolded variables were used to create latent variables in SEM analysis.

+ mean standard score is 10 with a SD of 3.

Mental state talk is the sum of ToM inferences and text-based ToM references included in children's recall. Standard score (SS) for TNL comprehension has a mean of 10 and SD of 3. ToM = Theory of mind; TNL = Test of Narrative Language (narrative texts); QRI = Qualitative Reading Inventory (informational texts); CASL = Comprehensive Assessment of Spoken Language; WJ = Woodcock Johnson third edition.

Table 2.

Bivariate Correlations between Variables

Variable	1	2	3	4	5	6	7	8	9	10	11	12
1. TNL 1 (McDonald's) mental state talk	--											
2. TNL 2 (Shipwreck) mental state talk	.12+											
3. TNL 3 (Dragon) mental state talk	.30	.23										
4. QRI 1 (Wool) mental state talk	.22	.14+	.21									
5. QRI 2 (Plants) mental state talk	.15+	.15+	.02+	−.08+								
6. QRI 3 (Octopus) mental state talk	.27	.22	.23	.49	.00+							
7. ToM skill	.34	.26	.30	.19	.12+	.23						
8. Vocabulary knowledge	.26	.08+	.26	.02+	.11+	.07+	.30					
9. Grammatical knowledge	.21	.14+	.32	−.01+	−.04+	.11+	.31	.50				
10. Working memory	.32	.11+	.19	.06+	.02+	.25	.37	.26	.35			
11. Attentional control	.29	.12+	.34	.15+	−.05+	.33	.29	.32	.41	.39		
12. TNL comprehension	.50	.29	.42	.08+	.11+	.18	.62	.56	.47	.42	.39	
13. QRI comprehension	.22	.22	.32	.11+	.13+	.19	.55	.50	.45	.30	.28	.53

Notes. All coefficients are statistically significant at .05 except for those marked by +. Mental state talk is the sum of ToM inferences and text-based ToM references included in children's recall. TNL = Test of Narrative Language (narrative texts); ToM = Theory of mind; QRI = Qualitative Reading Inventory (informational texts); CASL = Comprehensive Assessment of Spoken Language; WJ = Woodcock Johnson third edition.

Table 3.

Bivariate Correlations between Mental State Talk Latent Variables with Language and Domain-General Cognitive Skills

Variable	1	2	3	4
1. Narrative comprehension	--			
2. Informational text comprehension	.85	--		
3. Narrative mental state talk latent variable	1.05*	.27	--	
4. Informational mental state talk latent variable	.27	.28	.63	--
5. ToM skill	.77	.70	.61	.29
6. Vocabulary knowledge	.54	.68	.45	.07+
7. Grammatical knowledge	.58	.57	.48	.10+
8. Working memory	.53	.38	.46	.26
9. Attentional control	.48	.36	.53	.35

All coefficients are statistically significant at .05 except for those marked by +.

* is not admissible and is a Heywood case

Mental state talk is the sum of ToM inferences and text-based ToM references included in children's recall. ToM = Theory of mind; WJ = Woodcock Johnson third edition; CASL = Comprehensive Assessment of Spoken Language.