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



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### 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 as well as relations among ToM, mental state talk (inclusion of mental state words in the recall of narrative and informational texts), and narrative and informational text comprehension. Results from children in Grade 4 ( $N = 132$ ;  $M_{\text{age}} = 10.39$  years) revealed that a greater number of mental state talk instances appeared in children's recall of narrative texts than in their recall of 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,

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and both ToM and mental state talk play greater roles in comprehension of narrative texts than in comprehension of informational texts.

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## Introduction

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 (Wellman, Cross, & Watson, 2001). ToM is essential for social and communicative interactions, including discourse comprehension of both oral language and written texts. In fact, a growing number of studies indicate that ToM skill is related to children's listening comprehension (Kim, 2015, 2016, 2017, 2020a, 2020b; Pelletier, 2006; Pelletier & Beatty, 2015) and reading comprehension (Atkinson, Slade, Powell, & Levy, 2017; Florit, De Carli, Giunti, & Mason, 2020; Guajardo & Cartwright, 2016; Kim, 2015, 2017, 2020a).

In the current study, we extended 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 Grade 4 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 article 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; LaRusso 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, Bernstein, Gerrard, & Atance, 2017).

### *ToM 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 that 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 & Beatty, 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 et al., 2017; Guajardo & Cartwright, 2016; Kim, 2017, 2020a), Italian (Florit et al., 2020), and Korean (Kim, 2020c). The current study used the DIET model as a theoretical framework and built on this model to further consider the role of text features.

### *Text features, ToM, and mental state talk*

Texts vary in multiple aspects such as primary goals, language demands (e.g., vocabulary, syntactic complexities), topic knowledge demands, and organizational structures (Kim, 2020a; McNamara, Kintsch, Songer, & Kintsch, 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, Singer, & Trabasso, 1994; McNamara, 2004; Trabasso & Magliano, 1996).

If genres differ by their goals and content, the relative role of language and cognitive skills in discourse comprehension also likely varies (Kim, 2020a). In the current study, we examined two such constructs: ToM and mental state talk. Mental state talk refers to “the set of words used . . . to attribute thoughts, feelings, emotions, and desires to people” (Pinto, Tarchi, Gamannossi, & Bigozzi, 2016, p. 21). Prior work showed that the use of mental state talk is related to children’s ToM skill (e.g., Devine & Hughes, 2019; Ruffman, Slade, & Crowe, 2002; Symons, Peterson, Slaughter, Roche, & Doyle, 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, Taumoepeau, & Perkins, 2012). Similarly, during a joint book reading activity, both parental comments about the mental states of the story characters (e.g., thoughts, feelings, 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-olds 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., Hughes, Lecce, & Wilson, 2007; Pinto et al., 2016; Symons et al., 2005) based on the idea that language is foundational for its development (Astington & Baird, 2005).

In the current 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 children’s recall of texts captures the 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 in informational texts (Dore, Amendum, Golinkoff, & Hirsh-Pasek, 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 authors’ goals and attitudes (Graesser et al., 1994). Thus, ToM likely plays a greater role in discourse comprehension of narrative texts than in discourse comprehension of 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 . . . , whereas 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 the dorsomedial prefrontal cortex and posterior cingulate cortex) are activated for informational texts as well as for narrative texts (Jacoby & Fedorenko, 2020; Moss & Schunn, 2015).

Beyond differential amounts of mental state talk by genre, the amounts of mental state talk are 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 the 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.

### *The current 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 children in Grade 4 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 number of studies have 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, 2020a; Kim & Phillips, 2014; Lepola, Lynch, Laakkonen, Silvén, & Niemi, 2012; Tompkins, Guo, & Justice, 2013).

To our knowledge no prior work has examined the research questions in the current 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 in their recall of 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 in 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 current 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 where 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 obtained from 132 children in Grade 4 (50% boys; mean age = 10.39 years,  $SD = 0.56$ ) from 28 classes in five schools in the southeastern 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 or 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 as having a learning disability. Most children were monolingual, with only 1 child being 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 administered individually 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 taken from a normed measure for children aged 5 to 12 years, 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 that 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. After that, 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 action 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). The 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* (hereafter *Wool*; 220 words; QRI Level 3), *Plant structures for survival* (hereafter *Plants*; 278 words; QRI Level 4), and *The octopus* (hereafter *Octopus*; 254 words; QRI Level 5). All these texts were 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 were 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) guidelines (Miller & Iglesias, 2006). 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, Fernyhough, Russell, & Clark-Carter, 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., seeing, hearing), physical states (e.g., being tired), or behavioral manifestations of emotions (e.g., smiling, being 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 children used a synonym or a simple rephrasing of the language from the text without adding additional meaning. The second type was instances in which children'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 .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 Version 3.2 (Graesser et al., 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*, and *know*), 5 times in the Shipwreck story (*decide*, *bet*, *feel*, *think*, and *surprised*), 13 times in the Dragon story (*decide*, *believe* [2 times], *think* [3 times], *excited*, *scared*, *know*, *think*, *fear*, *terror*, and *sure*), 3 times in the Wool text (*know* [2 times] and *think*), 0 times in the Plants text, and 6 times in the Octopus text (*think* [2 times], *frightened* [2 times], *shy*, and *excited*).

#### ToM skill (false belief task)

Appropriate to children's developmental level (Mahy et al., 2017), ToM skill was measured by three second-order false belief scenarios that 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, a visit to a farm, and going out for a birthday celebration (Kim, 2017), 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 years, 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 was discontinued after 6 consecutive incorrect items. Cronbach's alpha was estimated to be .65.

#### Grammatical knowledge

A standardized and normed task for ages 3 to 21 years, the Grammaticality Judgment 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 the sentence was grammatically incorrect, the child was asked to correct the sentence. Test administration was discontinued after 5 consecutive incorrect items. Cronbach's alpha was .95.

#### Working memory

Working memory was measured by a listening span task (Kim, 2015, 2016; Daneman & Merikle, 1996) in which the child was aurally presented with a short sentence involving common knowledge familiar to children (e.g., *Birds can fly*) and was asked to identify whether the sentence was true (yes/no). After hearing and responding on the veracity of two or three sentences, children were asked to identify the last words in the sentences in correct order. Similar listening span tasks have been used successfully in prior studies with children in elementary grades. There were 4 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 identifying the correct last words in incorrect order, and 0 points for identifying incorrect last words. The total possible maximum score was 26. Cronbach's alpha was estimated to be .74.

#### Attentional control

The first 9 items of the Strengths and Weaknesses of ADHD Symptoms and Normal Behavior Scale (SWAN; Swanson et al., 2012; see Arnett et al., 2013, for validity evidence) were completed by children's teachers. SWAN is a behavioral checklist for children aged 6 to 17 years 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 9 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 lasting 30 to 40 min, in the following order: working memory and vocabulary in Session 1, TNL and grammatical knowledge 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 as well as 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 (Muthén & Muthén, 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 Fig. 1).

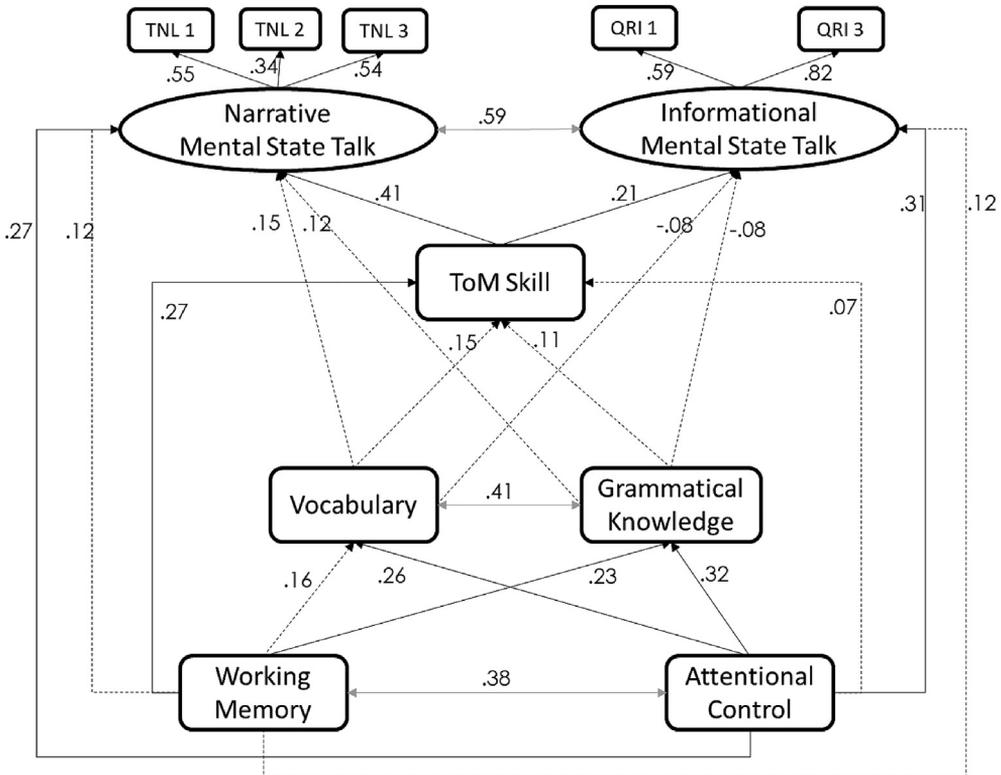
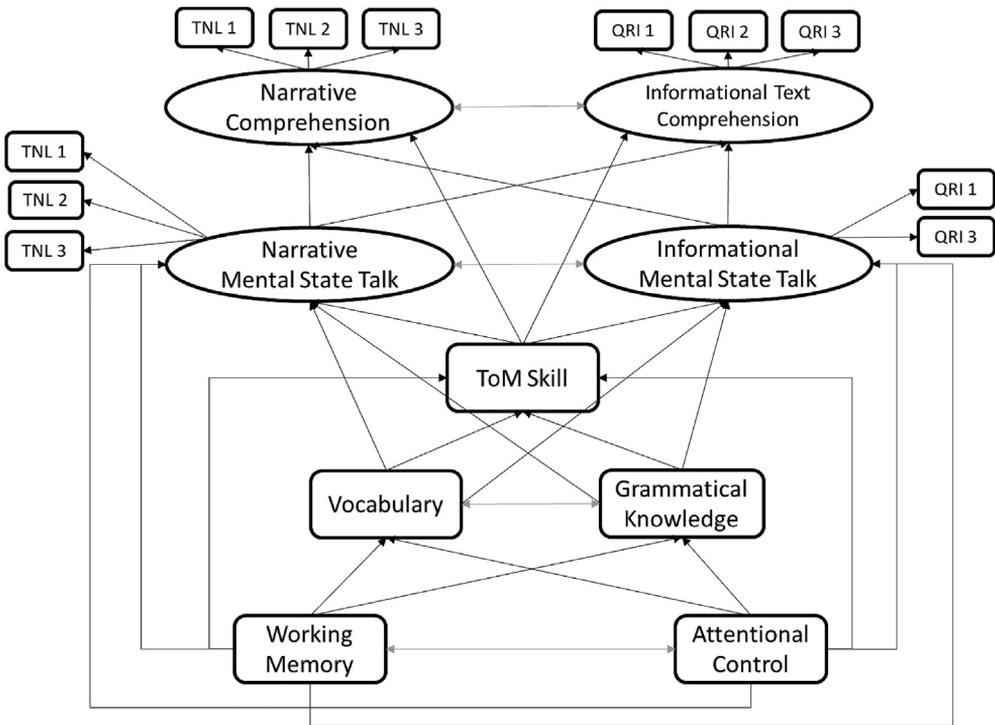


Fig. 1. Standardized coefficients for the relations of language and cognitive skills to mental state talk in narrative and informational text recalls. In fitting the model, QRI 2 (Plants text) was not included due to a floor effect and consequent lack of loading. ToM, theory of mind; TNL, Test of Narrative Language; QRI, Qualitative Reading Inventory; TNL 1, McDonald's; TNL 2, Shipwreck; TNL 3, Dragon; QRI 1, Wool; QRI 3, Octopus.

The language and cognitive skills were assessed by single measures for each construct, and therefore observed variables were used. Predictive relations were examined in the structural equation model shown in Fig. 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 the DIET model (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 the structural equation model shown in Fig. 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 values equal to or less than .05 indicate an excellent model fit, and CFI values greater than .90 are considered to be acceptable (Kline, 2011).



**Fig. 2.** Structural equation model showing the relations of language and domain-general cognitive skills, ToM skill to mental state talk in narrative and informational text recalls, and ToM skill 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.

**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, grammatical knowledge, 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 rela-

**Table 1**  
Descriptive statistics.

Variable	M	SD	Min	Max	Skewness	Kurtosis
<i>Narrative mental state talk</i>						
TNL McDonald’s ToM inferences	2.41	1.84	0	7	0.42	−0.81
TNL McDonald’s text-based ToM references	3.03	1.85	0	6	−0.05	−0.93
<b>TNL McDonald’s mental state talk</b>	5.44	2.96	0	11	−0.19	−0.87
TNL Shipwreck ToM inferences	0.61	0.85	0	5	1.84	5.16
TNL Shipwreck text-based ToM references	0.83	0.85	0	3	0.79	−0.08
<b>TNL Shipwreck mental state talk</b>	1.44	1.28	0	6	0.83	0.51
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	0.48	−0.41
<b>TNL Dragon mental state talk</b>	3.43	2.34	0	10	0.49	−0.38
ToM inferences across TNL texts	4.12	2.37	0	13	0.49	0.47
Text-based ToM references across TNL texts	6.19	3.37	0	15	0.22	−0.45
ToM information across TNL texts	10.31	4.74	0	21	−0.08	−0.56
<i>Informational text mental state talk</i>						
QRI Wool ToM inferences	0.06	0.24	0	1	3.73	12.06
QRI Wool text-based ToM references	0.51	0.67	0	4	1.59	4.47
<b>QRI Wool mental state talk</b>	0.57	0.71	0	4	1.37	2.97
QRI Plants ToM inferences	0.03	0.17	0	1	5.54	29.17
QRI Plants text-based ToM references	0	0	0	0	NA	NA
<b>QRI Plants mental state talk</b>	0.03	0.17	0	1	5.54	29.17
QRI Octopus ToM inferences	0.58	0.89	0	5	2.04	5.46
QRI Octopus text-based ToM references	1.19	1.23	0	5	0.73	−0.30
<b>QRI Octopus mental state talk</b>	1.77	1.67	0	7	0.86	0.24
ToM inferences across QRI texts	0.67	0.98	0	5	1.89	4.26
Text-based ToM references across QRI texts	1.70	1.57	0	7	0.75	0.12
ToM information across QRI texts	2.37	2.12	0	10	0.93	0.69
<i>Language and cognitive skills</i>						
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	0.18	−0.13
<i>Narrative comprehension</i>						
TNL comprehension	30.45	4.25	14	39	−0.98	1.81
TNL comprehension SS+	9.86	3.27	1	18	−0.06	−0.32
<i>Information text comprehension</i>						
QRI comprehension	6.52	3.03	0	14	0.14	−0.57

Note. Unless otherwise noted, values are raw scores. Bolded variables were used to create latent variables in structural equation modeling analysis. Plus sign (+) indicates that the mean standard score (SS) is 10 with a standard deviation of 3. Mental state talk is the sum of theory of mind (ToM) inferences and text-based ToM references included in children’s recall. The SS for the Test of Narrative Language (TNL) comprehension (narrative texts) has a mean of 10 and a standard deviation of 3. QRI, Qualitative Reading Inventory (informational texts); CASL, Comprehensive Assessment of Spoken Language; WJ, Woodcock-Johnson (third edition).

tion with narrative (TNL) comprehension ( $r = .62$ ) and a had 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 ( $.12 \leq r_s \leq .30$  in narrative texts;  $-.08 \leq r_s \leq .49$  in informational texts). Mental state talk in narrative recall was weakly to moderately related to both narrative (TNL) comprehension ( $.29 \leq r_s \leq .50$ ) and informational (QRI) comprehension ( $.22 \leq r_s \leq .32$ ). Mental state talk in informational text recall was weakly related to narrative comprehension and informational comprehension ( $.08 \leq r_s \leq .19$ ). Working memory, attentional control, vocabulary, and grammatical knowledge were weakly to moderately related to mental state talk in narrative recall and informational text recall ( $-.01 \leq r_s \leq .38$ ).

*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 0.61 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 (0.83 in the Shipwreck story to 3.03 in the McDonald's story), which were also statistically significant ( $ps < .001$ ). 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 0.03 (4 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 ( $ps < .001$ ).

**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

Note. All coefficients are statistically significant at the .05 level except those marked by a plus sign (+). Mental state talk is the sum of theory of mind (ToM) inferences and text-based ToM references included in children's recall. TNL, Test of Narrative Language (narrative texts); QRI, Qualitative Reading Inventory (informational texts).

**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 analysis. Prior to fitting the structural equation model in Fig. 1, latent variables were created for mental state talk in narrative recall and mental state talk in informational text recall (without the Plants text). All loadings were appropriate (see Fig. 1). Bivariate correlations between mental state talk in narrative recall and informational text recall, as well as between language and cognitive skills, were examined, and model fit was excellent,  $\chi^2(73) = 69.01, p = .61, CFI = 1.00, RMSEA = .00$ , confidence interval (CI) [.00-.05], 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 ( $.45 \leq rs \leq .61$ ), whereas mental state talk in informational text recall was weakly to moderately related ( $.07 \leq rs \leq .35$ ).

When the structural equation model in Fig. 1 was fitted, the model fit was excellent,  $\chi^2(19) = 14.59, p = .75, CFI = 1.00, RMSEA = .00, CI [.00-.06], SRMR = .03$ . Standardized parameter estimates are reported in Fig. 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 to mental state talk in informational recall ( $.21, p < .05$ ). To test whether the relation of ToM skill was 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 was more strongly related to the mental state talk in narrative recall than in informational text recall.

When it came 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 in 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,

**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

Note. All coefficients are statistically significant at the .05 level except those marked with a plus sign (+). The coefficient marked with an asterisk (\*) is not admissible (Heywood case). Mental state talk is the sum of theory of mind (ToM) inferences and text-based ToM references included in children's recall.

vocabulary, grammatical knowledge, and ToM skill) explained 58% of total variance in mental state talk of narrative recall and 18% of total variance 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 so as to result in a Heywood case (i.e., correlation stronger than 1). Conversely, mental state talk in informational text recall was weakly related to informational text comprehension ( $r = .28$ ,  $p < .001$ ). Given the Heywood case, we were unable to fit the structural equation model in Fig. 2.

## Discussion

In the current 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 differentially 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, with children including 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 did not provide a solution at the end of the story. This unresolved ending left 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 given that 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 did 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 emotion-related mental state vocabulary in the Octopus text versus the Wool text. The mental state words in the Wool text were primarily cognition related (*know* [2 times] and *think* [1 time]), whereas the Octopus text included emotion-related words such as *frightened* (2 times) and *excited* (1 time) in addition to *think* (2 times). Studies have shown that emotion words have an impact on encoding information (Jung, Wrانke, 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 to be 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 relations of ToM skill to mental state talk in recall of narrative and informational texts*

Another important finding in the current 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 interpretive 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, Zelazo, & Palfai, 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 to show 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, and 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., 2002; 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, 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 the relation 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 might not be as indicative of their level of comprehension because mental states are usually less central to the comprehension of such texts compared with 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. Although 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 current findings, together with the results of previous studies (e.g., Atkinson 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 United States) and international assessments (e.g., 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 children 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 ( $g = .75$ ), indicating that ToM can be improved when taught explicitly (Hofmann et al., 2016). The finding that ToM was linked more strongly to narrative comprehension than to 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 current 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 current 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, Floyd, & McNamara, 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 current 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 & Beatty, 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 current 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 (Fig. 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 have shown 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 the results reported in Fig. 1. Nonetheless, future studies with a larger sample are needed to replicate the current study. Future replications are also warranted for the structural relations in Fig. 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 current 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 children 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 was weakly related to comprehension of informational texts. In light of these results, further investigations are needed to explore text

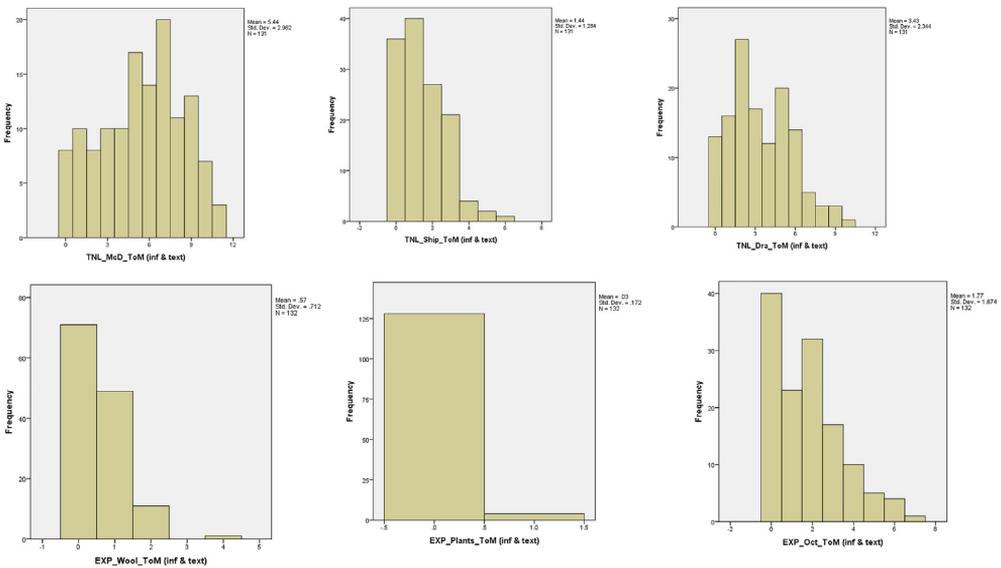
features and individual characteristics that are associated with the inclusion of mental state talk in children’s mental representations of texts and their relations to discourse comprehension. Systematic efforts are also needed to shed light on the effects of explicit teaching of ToM skill on children’s discourse comprehension across genres.

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**Appendix A**

See Fig. A1



**Fig. A1.** Distribution of mental state talk (sum of theory of mind inferences and text-based theory of mind references) in children’s recall of the Test of Narrative Language texts (top panel in the order of McDonald’s, Shipwreck, and Dragon stories) and the informational texts (bottom panel in the order of Wool, Plants, and Octopus texts). *Note.* In structural equation modeling, 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). ToM, theory of mind; TNL, Test of Narrative Language; EXP, informational texts.

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