



Reciprocal association between theory of mind and reading comprehension of narrative (but not expository) text in middle childhood: A latent change score approach

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ABSTRACT

This study presents a longitudinal evidence of co-occurring developmental changes in theory of mind (ToM) and reading comprehension in a group of 159 children (ages 8–10; $M = 9.96$, $SD = 0.93$; 92 girls). We tracked participants over one year using identical measures of ToM, narrative reading comprehension (NRC), and expository reading comprehension (ERC) at two time points. Applying a Latent Change Score (LCS) model, we found that individual differences in ToM and NRC not only influenced each other's growth over time but were also significantly correlated at both initial measurement and in their change scores. However, only initial ToM was associated with gains in ERC during the one-year interval, but not vice versa. These findings suggest a reciprocal causal relationship between socio-cognitive and academic development and highlight the importance of integrating both domains in educational interventions.

Educational relevance statement: Our findings demonstrate that Theory of Mind (ToM) and narrative reading comprehension (NRC) are reciprocally related over time, suggesting that strengthening one domain can accelerate growth in the other. Importantly, children with stronger initial abilities in either ToM or NRC experienced greater gains in the other domain, indicating the risk or widening achievement gaps without early support. Moreover, ToM predicted later gains in expository reading comprehension (ERC), underscoring its role in supporting comprehension of increasingly complex academic texts. These results suggest that integrating ToM and reading comprehension training within educational practice can enhance cognitive and academic development in tandem. Such integration may be particularly impactful for students at risk of early learning difficulties, offering a promising direction for targeted, developmentally informed interventions.

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1. Introduction

Reading comprehension during the primary school years is closely linked to children's theory of mind (ToM), the ability to infer others' mental states and predict their behaviors (Wellman, 2014). Imagine a child reading *The Boy Who Cried Wolf*. She might wonder why the villagers did not come to help the boy when he cried "wolf" the third time.

To answer this, the young reader must recognize that the boy had previously *deceived* the villagers, leading them to stop *believing* him. In this case, understanding the characters' thoughts and following the narrative go hand in hand.

However, the developmental nature of the association between ToM and reading comprehension remains elusive. It is possible that children with more advanced ToM skills are better able to form mental models of

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the text and draw inferences critical for comprehension, thereby enhancing their understanding of written stories (Dore et al., 2018). Conversely, reading provides social content and practice. Children who read frequently may develop stronger skills in interpreting beliefs and intentions, which in turn supports their ToM development (Mar, 2018; van der Kleij et al., 2025). A recent meta-analysis by Tompkins et al. (2024), based on 157 effect sizes from 5123 participants, reported a robust, moderate correlation between ToM and reading comprehension ($r = 0.33$). This association held across a wide age range (3 to 70 years, $M = 10.53$), regardless of how ToM and reading comprehension were measured, whether executive function was controlled, or whether the data were cross-sectional or longitudinal. Among the few longitudinal studies included in the meta-analysis, effect sizes did not differ based on whether ToM or reading comprehension was measured first. While this finding hints that the association between ToM and reading comprehension might be reciprocal, only four studies have measured both ToM and reading comprehension repeatedly (Kim, 2020b; Lecce et al., 2021; Osterhaus et al., 2024; Tompkins et al., 2020). Of these, only two (Lecce et al., 2021; Osterhaus et al., 2024) focused on school-aged children, yet with inconsistent findings. Due to the scarcity of longitudinal evidence, it is premature to draw conclusion on the reciprocal nature of the association between ToM and reading comprehension during middle childhood. As such, the first aim of the current study was to address this gap through a longitudinal design to examine the bidirectional associations between ToM and reading comprehension in middle childhood.

Another unsolved yet related question is whether the relation between ToM and reading comprehension differs by text genres, for example, narrative versus expository texts. Narrative texts may place greater demands on ToM due to their reliance on mental state inference (Dore et al., 2018). However, ToM also involves metarepresentational and recursive reasoning (Schidelo, 2023), which may support comprehension across all genres. Tompkins et al.'s (2024) meta-analysis distinguished between *literal* (e.g., integration of perception) and *inferential* (e.g., inference about perception) texts and found similar effect sizes between ToM and both types of comprehension. However, the only two longitudinal studies identified in this meta-analysis that examined reading comprehension and ToM bidirectionally during middle childhood (Lecce et al., 2021; Osterhaus et al., 2024) either used only a narrative reading comprehension measure (Lecce et al., 2021) or a standardized reading comprehension task that did not specify the text type (Osterhaus et al., 2024). Tompkins et al. (2024) highlighted the need for direct comparisons of text genres in future research. The second aim of the current study was to compare children's narrative reading comprehension (NRC) and expository research comprehension (ERC) in relation with ToM.

1.1. Are reading comprehension and ToM reciprocally associated?

Reading comprehension is a complex cognitive process that involves constructing and reconstructing meaning from text based on prior knowledge (Kintsch, 1998; van den Broek, 2010). It plays a vital role in children's academic success across subjects (Lecce & Devine, 2022), including science (Reed et al., 2016) and mathematics (Vilenius-Tuohimaa et al., 2008). Difficulties with reading comprehension in primary school often persist into secondary school (Ferrer et al., 2015) and are among the leading causes of school dropout (Snow & Biancarosa, 2003). During adulthood, reading comprehension continues to impact career success—more so than general intelligence or family socioeconomic status (Ritchie & Bates, 2013). While earlier reading comprehension research emphasized decoding and semantic processing, recent studies have highlighted the important role of ToM in children's reading comprehension (Dore et al., 2018).

Bruner (1987) proposed that narratives unfold across two landscapes: the *landscape of action*, which includes the explicit events and behaviors in the plot, and the *landscape of consciousness*, which reflects the internal mental states of characters—the implicit plot that drives the

story forward. ToM serves to integrate these two landscapes, enabling readers to connect characters' actions with their thoughts and motivations. Dore et al. (2018) argued that understanding narrative texts requires monitoring characters' mental states, positioning ToM as a missing piece in reading comprehension research—particularly for explaining individual differences in older children once their reading skills become automated. Dore and colleagues also observed a temporal alignment between ToM and reading comprehension. For instance, 3-year-olds could track characters' perspectives through following their movement, reflecting early visual perspective-taking. By ages 4–5, children begin tracking thoughts, linked to their false belief understanding. By age 7, they demonstrate ability to track characters' complex mental states and emotions, such as interpreting goals, which maps on to their advanced ToM and understanding of mixed emotions and non-literal meanings. Readers who could represent characters' mental and emotional states are better able to make inferences—even when those states are not explicitly described—leading to a deeper reading comprehension.

While there is strong evidence supporting the concurrent association between ToM and reading comprehension in children (e.g., Boerma et al., 2017; DeNigris et al., 2022; Kloos et al., 2022; Kim, 2020a), longitudinal findings on whether earlier ToM predicts later reading comprehension are less consistent. For instance, Atkinson et al. (2017) reported that ToM at age 4, measured via false belief tasks, predicted reading comprehension at age 6, after accounting for non-verbal ability, decoding, and language skills. However, other studies found no such predictive link between early ToM and later reading comprehension (Ebert, 2020; Guajardo & Cartwright, 2016; Kloos et al., 2022; Lockl et al., 2017). It is possible that as texts become more complex, the relations between ToM and reading comprehension also become more nuanced (Dore et al., 2018).

Meanwhile, reading comprehension fosters a deeper understanding of the connection between mental states and social behavior, potentially leading to more advanced ToM (Mar, 2018). Reading supports ToM development in two key ways: through simulation and the acquisition of mental state knowledge. Reader are invited to “step in the shoes” of the protagonists, simulate their thoughts and empathize with their emotions—processes that mirror real-life social interactions. This simulated experience offers opportunities to practice social cognition in a context similar to everyday life (Mar, 2018; Oatley, 2016). Neuroimaging studies support this view, showing that reading fiction activates brain regions associated with ToM (Tamir et al., 2016). Meanwhile, stories, novels, and fables provide concrete insights into human psychology and social dynamics. For example, *The Boy Who Cried Wolf* our imagined young reader was reading has long been used to teach children about trust, honesty, deception, and the consequences of lying.

Evidence regarding the extent to which earlier reading habit (but not comprehension per se) predicts later ToM remains circumstantial. Studies have shown that avid adult readers of fiction (Fekete et al., 2023; Kidd & Castano, 2013; Mumper & Gerrig, 2017), as well as children frequently exposed to books, shared reading, and audiovisual media (Lenhart & Richter, 2024), tend to perform better on ToM tasks. A systematic review by Secora and Maples (2024) found that storybook-based interventions aimed at improving ToM in young children were largely effective. Interventions implemented within educational settings, particularly those led by teachers (e.g., Wang & Shao, 2025), produced the highest proportion of significant ToM outcomes.

Very few longitudinal studies have repeatedly measured the same constructs to examine the potential reciprocal association between ToM and reading comprehension. The limited existing evidence is mixed. Tompkins et al. (2020) assessed preschool children's false belief understanding and their narrative skills—including story comprehension, picture sequencing, mental state inferences, total inferences, and goal-directed narration—at two time points six months apart. They found a bidirectional association between false belief understanding and total inferences, encompassing both mental state and non-mental state

inferences. Once child age and vocabulary were controlled, the bidirectional associations disappeared. Interestingly, false belief understanding and all narrative skills—except for picture sequencing—loaded onto a single factor at both time points, indicating that ToM and narrative skills co-develop during early childhood.

Focusing on school aged children, [Lecce et al. \(2021, Study 2\)](#) conducted a short-term longitudinal study with 60 Italian children aged 9, measuring both ToM and reading comprehension at two time points six months apart. They found a cross-lagged bidirectional association between ToM and reading comprehension. Specifically, earlier ToM accounted for an additional 10 % of the variance in later reading comprehension, above and beyond verbal ability, family socioeconomic status, and earlier reading comprehension. Conversely, earlier reading comprehension explained an additional 15 % of the variance in later ToM, again accounting for covariates and earlier ToM. However, a recent study by [Osterhaus et al. \(2024\)](#) failed to replicate this bidirectional association with a German sample of 9-year-old children. In their study, earlier social reasoning (a ToM measure) predicted later reading comprehension, controlling for general intelligence, but earlier reading comprehension did not predict later social reasoning.

The discrepancies between these two studies may be related to differences in measurement. [Lecce et al. \(2021\)](#) used a narrative reading comprehension task that did not involve social interactions. In contrast, [Osterhaus et al. \(2024\)](#) employed a standardized reading comprehension task ([Lenhard & Schneider, 2006](#)) without specifying the text type. The task assesses the ability to identify specific information, understand anaphoric relations, and make inferences, with examples like “*Whales live in the ocean. In order to breathe, they swim to the water surface. There, they take a deep breath and are then able to stay under water for a long time*” ([Stutz et al., 2016](#)), suggesting that the texts are largely expository in nature. In addition, ToM was assessed differently in the two studies. [Lecce et al. \(2021\)](#) administered the Strange Stories task, which focused specifically on social reasoning in interactive scenarios. In contrast, [Osterhaus et al. \(2024\)](#) employed a 15-item AToM battery ([Osterhaus et al., 2016](#)), which measured three distinct components of advanced ToM: social reasoning, recognition of social norm transgressions, and ambiguity comprehension. This battery included a broad range of tasks, including higher-order false belief tasks, the Strange Stories, the Reading the Mind in the Eyes Test (RMET), the ambiguous figure task, and the Faux Pas task. Notably, only the social reasoning component was significantly associated with reading comprehension, which aligns with the focus of [Lecce et al.'s \(2021\)](#) measure. To address the possibility that differences in measurement tasks contribute to the inconsistent findings across studies, our study explicitly compares narrative and expository texts, focusing on social cognition through the use of the Strange Stories task.

In summary, while ToM and reading comprehension are closely related, evidence for longitudinal associations during school years remains scarce and inconsistent. To better understand the direction of the relationship between ToM and reading comprehension, more longitudinal studies—particularly those that assess the same constructs repeatedly over time—are necessary. Next, we review how the associations between ToM and reading comprehension differ across text genres.

1.2. Are the associations between ToM and reading comprehension universal across genres?

As school-aged children begin to encounter various text genres, one prominent type is expository text. Expository text differs from narrative text in its goals, content, and structure, and consequently, the cognitive skills required to process each type also differ ([Kim et al., 2021](#)). Narrative texts typically focus on the progression of events over time, engaging readers in mental simulation and perspective-taking ([Mar & Oatley, 2008](#)). In contrast, expository texts often present abstract concepts without a storyline. Readers of expository text are not tasked to

mentally engage in events, but rather to discern relationships among concepts, which are typically organized in logical, causal, or sequential structures ([van den Broek, 2010](#)). In terms of content, narrative texts are typically written stories, such as novels or short stories ([Medina & Pilonieta, 2006](#)), while expository texts are designed to inform or explain specific topics, often taking the form of these, textbooks, or manuals ([Weaver & Kintsch, 1991](#)).

[Dore et al. \(2018\)](#) argued that children's developing ToM should be more strongly associated with narrative text comprehension than that with expository text comprehension, as expository texts do not necessarily require mental state reasoning. Empirical evidence supports this view. For instance, [Tong et al. \(2020\)](#) found that ToM was associated with both literal (i.e., explicit, factual information) and non-literal (i.e., inference, evaluation, and mentalization) reading comprehension in autistic children. Importantly, ToM partially explained the differences in reading comprehension between autistic children and typically developing children, specifically in non-literal texts, but not in literal texts, suggesting that ToM plays a more important role in understanding questions that require inference and mentalization than those based on factual information. In another study, [Kim et al. \(2021\)](#) examined fourth graders' mental state talk when recalling narrative versus expository texts. They found that ToM uniquely predicted the frequency of mental state talk in children's retrieval of both types of text, even after controlling for language ability and executive function. While children did use mental state talk in their recall of expository texts, it occurred much less frequently compared to their recall of narrative texts.

Nevertheless, ToM might still play a role in expository text reading comprehension for several reasons. Firstly, some expository texts, such as biographies or those involving anthropomorphized entities, reference people and require social reasoning ([Tompkins et al., 2024](#)). Secondly, ToM involves causal inferences about how events trigger (mental state) responses, which is relevant in expository text comprehension as well ([Kim et al., 2021](#)). Thirdly, domain-general thinking skills associated with ToM, such as metarepresentation, recursive thinking, mental time travel, metamemory, and episodic memory ([Schidelko, 2023](#)), can aid in integrating information that is multifaceted, layered, and across longer temporal span, which is crucial for understanding expository texts ([Jacoby & Fedorenko, 2020](#)). Neurological evidence supports this, showing that brain regions responsible for ToM are activated when reading expository text ([Jacoby & Fedorenko, 2020](#); [Moss & Schunn, 2015](#)). Although expository texts lack explicit mental states, they still engage ToM-associated brain regions involved in processing text contingencies, as expository text comprehension requires understanding relations among concepts and causal structures ([McNamara, 2004](#)).

Initial evidence supports the idea that ToM contributes to expository text comprehension. For instance, [Florit et al. \(2020\)](#) identified ToM as a unique predictor of expository multiple-text comprehension. A recent study by [Wang et al. \(2024\)](#) examined how ToM influences reading comprehension longitudinally in primary school children, directly comparing narrative and expository texts. Their findings revealed that ToM did not predict overall reading comprehension in Grade 2 students. However, ToM predicted narrative comprehension in both Grades 4 and 6, and expository comprehension only in Grade 6, after controlling for an array of associated variables such as reading frequency, decoding, vocabulary, nonverbal intelligence, listening comprehension, and executive function. These results underscore the growing significance of ToM in reading comprehension as children advance through primary school, particularly in their ability to understand more complex texts.

1.3. Present study

The present study addresses the gaps in the current literature on the associations between ToM and reading comprehension as children progress in primary school and start reading more complex texts ([Tompkins et al., 2024](#)). The study is innovative in two ways. Firstly, it assesses 8- to 10-year old children's reading comprehension and ToM

development at two time points, enabling longitudinal modelling of the associations between the constructs (cf. Lecce et al., 2021; Osterhaus et al., 2024). Importantly, it directly compares how narrative and expository texts may be differentially associated with ToM. Secondly, we are interested in understanding how individual differences and gains in ToM and reading comprehension over time influence each other. Individual differences in ToM during middle childhood are stable and predict school outcomes (Devine et al., 2016; Wang et al., 2016). However, there is limited evidence on how individual differences in ToM and reading comprehension track over the course of development, even less on how these changes might influence each other. To address this gap, we adopt a latent change score model (LCS) in the current study. LCS modelling (Kievit et al., 2018) accounts for both between-person growth factors and within-person change scores (Klopck & Wickrama, 2020), offering a more flexible longitudinal analytical framework than, for example, the cross-lagged model (Lucas, 2023). While cross-lagged models can capture changes in different abilities over time, they cannot assess the rate of growth or decline in variables. In LCS, the latent components represent the “true” changes between adjacent time points (Davies et al., 2021; McArdle, 2009). This approach allows for a more nuanced examination of how changes in one construct are associated with changes in another, potentially leading to more robust causal inferences. It was hypothesized that the association between ToM and reading comprehension would be reciprocal for narrative text. Specifically, initial levels of ToM would predict the rate of growth in NRC over time, and vice versa. Changes in ToM would be associated with changes in NRC. Additionally, it was hypothesized that initial levels of ToM would predict the rate of growth in ERC too.

The study's design and hypotheses were preregistered after data collection but before analyses were conducted. The reported analytical approach deviated from the preregistration by adopting the LCS model, chosen for its flexibility in accounting for how the rate of change in ToM relates to the rate of change in reading comprehension. Data was public in Mendeley. Materials and analysis code for this study can be obtained by emailing the corresponding author.

2. Method

2.1. Participants

A priori power analysis was conducted using G*Power version 3.1.9.7 (Faul et al., 2007) to determine the required sample size. The results indicated that a sample size of 119 was needed to achieve 95 % power for detecting a small effect size of 0.15 (Cohen, 1988) at a significance level of $\alpha = 0.05$. To account for potential attrition, a total of 186 children from Grades 3, 4, and 5 in a primary school from Zhejiang Province serving primarily middle-class families were recruited. Zhejiang Province enjoys a high level of social and economic development and education attainment, with a per capita disposable income of 63,830 Yuan and a primary school enrolment rate of 99.99 % in 2023—both ranking among the highest in the country (Zhejiang Province Bureau of Statistics, 2024). All participants were native Chinese speakers without diagnosed cognitive or language developmental delays. Due to school transfers and other reasons, 11 participants did not participate in Time 2 (T2), which took place one year after T1 assessments, resulting in an attrition rate of 5.91 %. There were no significant differences between the dropouts and the remaining sample in ToM, Narrative Reading Comprehension (NRC), Expository Reading Comprehension (ERC), or gender ($ps > 0.05$) at T1, indicating random missing. Additionally, 16 outliers were removed from the analysis based on box plot and Mahalanobis distance ($\alpha = 0.05, p = 6, \chi^2_{p,1-\alpha} = 12.59$). Values exceeding the interquartile range in the box plot or large Mahalanobis distance from the center of the distribution indicate outliers (Cousineau & Chartier, 2010; Williamson et al., 1989). The final sample consisted of 159 primary school students (92 girls, $M_{\text{age}} = 9.96$,

$SD = 0.93$). Table 1 presents the demographic characteristics of the participants.

2.2. Procedure

The current study was conducted in accordance with the Declaration of Helsinki, and all procedures involving human participants were reviewed and approved by the ethics committee of a local university (ethics approval reference number: 2023–060-01). Informed consents were obtained from parents and classroom teachers, and assents were obtained from all child participants. Participants were informed that their participation was voluntary, and there would be no negative consequences for refusing to participate or withdrawing at any time. The tasks were administered in a group setting by psychology graduate students in children's classrooms, with each session lasting approximately for 40 min. Participants received comprehensive explanations to ensure they understood the measurement items and procedures. No issues were reported regarding the children's comprehension of the procedures or measurement items.

2.3. Measures

2.3.1. Theory of mind

ToM was measured using an abbreviated version of the Strange Stories task (White et al., 2009), which has been widely used in large-scale studies of individual differences in ToM during middle childhood, demonstrating good internal consistency, test-retest reliability, and convergent validity (Devine & Hughes, 2016). A cross-cultural study (Wang et al., 2022) confirmed the Strange Stories task is a reliable measure of ToM in a Chinese sample. Four stories from the Strange Stories task were selected in this study: double bluff, misunderstanding, white lie, and persuasion. After reading each story, children were asked to make inferences about the characters' psychological states and write down their responses. There was no time limit for this task. Responses were scored on a 3-point scale following White et al. (2009): 0 for incorrect answers, 1 for answers that only state the facts without referring to mental states, and 2 for correct answers. The total score ranged from 0 to 8. Two independent coders scored the responses, and the coefficients of inter-rater reliability were 0.96 at T1 and 0.81 at T2, indicating acceptable consistency. Any discrepancies in the ratings were reviewed and resolved through discussions between the two coders.

2.3.2. Reading comprehension

A reading comprehension task purposefully designed for this study was developed by two psychology researchers and a primary school Chinese teacher collaboratively, according to the national Chinese curriculum standards. The narrative texts focus on social interactions and emotional mental states, such as excitement, but do not involve social reasoning. The expository texts do not involve social interactions. Both text types contain figures of speech, such as metaphors and analogies. Two versions of each test were developed, a basic version and an advanced version. Grade 3 children took the basic version, which included 13 items based on a narrative text, *A Favorite Photo*, and 11 items based on an expository text, *The Beautiful Flower Garden*. Grade 4 and 5 children took the advanced version, which included 21 items based on a narrative text, *A Favorite Book*, and 14 items based on an expository text, *Fleas Can Jump High*. In a multiple-choice format, each

Table 1
Demographic descriptions of the participants.

Grade (T1)	Total	Male	Female	Age ($M \pm SD$)
Three	56	22	34	9.02 \pm 0.56
Four	44	19	25	9.96 \pm 0.48
Five	59	26	33	10.85 \pm 0.47
Total	159	67	92	9.96 \pm 0.93

item consisted of a text-related question and four answer choices. These questions assess eight aspects of reading comprehension in both narrative and expository texts: (1) understanding of words and phrases; (2) understanding of context and coherence-based inference; (3) understanding of text structure; (4) understanding of the author's intent and literary techniques; (5) grasp of key information; (6) inference of implicit information; (7) organization and construction of overall information; and (8) evaluation and appreciation. Each correct answer was awarded 1 point. Children took the same version of the reading comprehension tests at both T1 and T2. To account for item difficulty, the scores for the basic and the advanced versions were standardized, respectively. Higher standardized scores indicated better comprehension.

2.4. Analytic plan

Data analyses were conducted using SPSS 26.0, Mplus8.3, and R 4.4.1. Descriptive statistics and bivariate correlations among all variables were explored. Next, a LCS model analysis was employed to investigate the longitudinal associations between ToM and reading comprehension of different genres. Full Information Maximum Likelihood (FIML) estimation was used to handle missing data, and Robust Maximum Likelihood (MLR) estimation was applied to estimate model parameters. Model fit was evaluated using established criteria: Comparative Fit Index (CFI > 0.90), Root Mean Square Error of Approximation (RMSEA <0.08), and Standardized Root Mean Square Residual (SRMR <0.08) (Hu & Bentler, 1999). The regression weights for the variables at T2 (X_T2) on T1 (X_T1) and X_T2 on the change from T1 to T2 (X_T1-T2) were fixed at 1, which allowed the latent factor to capture the change between T1 and T2 (Kievit et al., 2018). Changes were examined using fixed intercepts and variances, with the intercept of X_T2 and the variance of X_T2 constrained to 0 (Klopack & Wickrama, 2020). Additionally, we examined both the self-feedback effect, which is the impact of the initial level of each variable on the subsequent rate of change within the same construct, and the cross-domain coupling effect, which is the effect of the initial level of one construct on the subsequent rate of change in another construct. In this study, the coupling effects refer to how T1 ToM predicts the rate of change in reading comprehension, as well as how reading comprehension predicts the rate of change in ToM over time. Finally, we estimated the correlation between the changes in variables, which reflects the degree to which changes in ToM and reading comprehension co-occur, after accounting for the coupling pathways.

3. Results

3.1. Descriptive and correlation analysis

The results of descriptive statistics and paired samples *t*-tests in each grade are shown in Table 2. For Grade 3, paired samples *t*-tests showed that ToM ($t(55) = -7.95, p < 0.001, d = 1.06, 95\% \text{ CI} [-1.521, -0.908]$), ERC ($t(55) = -2.99, p < 0.01, d = 0.40, 95\% \text{ CI} [-1.074, -0.211]$), and NRC ($t(55) = -5.23, p < 0.001, d = 0.70, 95\% \text{ CI} [-2.026, -0.903]$) all increased significantly over time. For Grade 4, paired samples *t*-tests showed that ToM ($t(43) = -6.53, p < 0.001, d = 0.99, 95\% \text{ CI} [-1.681, -0.887]$) and NRC ($t(43) = -3.80, p < 0.001, d = 0.57, 95\% \text{ CI} [-2.192, -0.672]$) increased significantly over time. However, ERC ($t(43) = -1.57, p > 0.05, d = 0.24, 95\% \text{ CI} [-1.297, 0.160]$) did not show a significant change. For Grade 5, paired samples *t*-tests showed that ToM ($t(58) = -8.44, p < 0.001, d = 1.10, 95\% \text{ CI} [-1.573, -0.970]$), ERC ($t(58) = -4.08, p < 0.001, d = 0.53, 95\% \text{ CI} [-1.491, -0.509]$), and NRC ($t(58) = -2.92, p < 0.01, d = 0.38, 95\% \text{ CI} [-1.630, -0.303]$) all increased significantly over time.

Correlation analysis of the measured variables at T1 and T2 is shown in Table 3. All variables showed repeated measure stability, with correlation coefficients ranging from 0.34 to 0.35. At T1, ToM was

Table 2
Descriptive analysis (*M* ± *SD*) and paired samples *t*-test.*

Variable (maximum)	T1 (<i>M</i> ± <i>SD</i>)	T2 (<i>M</i> ± <i>SD</i>)	<i>t</i>	<i>d</i>
ToM _{total} (8)	4.11 ± 0.94	5.37 ± 1.10	-13.32***	1.06
ToM _{grade3} (8)	4.24 ± 0.90	5.46 ± 1.10	-7.95***	1.06
ToM _{grade4} (8)	4.05 ± 1.10	5.33 ± 1.20	-6.53***	0.99
ToM _{grade5} (8)	4.03 ± 0.86	5.31 ± 1.04	-8.44***	1.10
rERC _{grade3} (11)	6.98 ± 1.45	7.63 ± 1.48	-2.99**	0.40
rERC _{grade4} (14)	6.84 ± 1.73	7.41 ± 1.66	-1.57	0.24
rERC _{grade5} (14)	5.37 ± 1.67	6.37 ± 1.80	-4.08***	0.53
rNRC _{grade3} (13)	8.25 ± 1.74	9.71 ± 1.70	-5.23***	0.70
rNRC _{grade4} (21)	8.75 ± 2.26	10.18 ± 2.08	-3.80***	0.57
rNRC _{grade5} (21)	9.92 ± 2.19	10.88 ± 2.41	-2.92**	0.38

Note. The subscript indicates the corresponding grade. ToM = Theory of mind, rERC = Raw score of expository reading comprehension, rNRC = Raw score of narrative reading comprehension. T1 = Time 1, T2 = Time 2.

* *p* < 0.05.

** *p* < 0.01.

*** *p* < 0.001.

Table 3
Correlation analysis of all variables.

Variables	1	2	3	4	5	6
1. T1 ToM	-					
2. T2 ToM	0.34**	-				
3. T1 ERC	0.17*	0.05	-			
4. T2 ERC	0.31**	0.17*	0.35**	-		
5. T1 NRC	0.55**	0.39**	0.18*	0.29**	-	
6. T2 NRC	0.37**	0.41**	0.11	0.16*	0.35**	-

Note. N = 159. * *p* < 0.05, ***p* < 0.01, ****p* < 0.001. ToM = Theory of mind, ERC = Standardized score of expository reading comprehension, NRC = Standardized score of narrative reading comprehension. T1 = Time 1, T2 = Time 2.

significantly and positively correlated with ERC ($r = 0.17, p < 0.05, 95\% \text{ CI} [0.026, 0.314]$) and NRC ($r = 0.55, p < 0.05, 95\% \text{ CI} [0.426, 0.662]$), with the correlation with NRC being much stronger than that with ERC ($z = 3.95, p < 0.001$). Similarly, T2 ToM was significantly and positively correlated with both concurrent ERC ($r = 0.17, p < 0.05, 95\% \text{ CI} [0.024, 0.300]$) and NRC ($r = 0.41, p < 0.05, 95\% \text{ CI} [0.259, 0.546]$), with the latter being stronger ($z = 2.33, p < 0.05$). At both time points, ERC and NRC were significantly and positively correlated with each other with small effect sizes (T1: $r = 0.18, p < 0.05, 95\% \text{ CI} [0.021, 0.321]$; T2: $r = 0.16, p < 0.05, 95\% \text{ CI} [0.004, 0.317]$).

3.2. Bivariate LCS models with ToM and reading comprehensions

The results of the LCS model for the associations between ToM and NRC are shown in Fig. 1. The data yielded a saturated model.

Self-feedback effects: Prior levels of ToM significantly and negatively predicted subsequent changes in ToM ($\beta = -0.63, p < 0.05, 95\% \text{ CI} [-0.994, -0.598]$). Similarly, prior levels of NRC significantly and negatively predicted subsequent changes in NRC ($\beta = -0.70, p < 0.05, 95\% \text{ CI} [-0.964, -0.628]$). These self-feedback effects suggest that children with lower initial levels of ToM or NRC experienced greater gains over the one-year period, compared to children with higher initial levels of these constructs.

Cross-domain coupling effects: Prior levels of ToM significantly and positively predicted changes in NRC over time ($\gamma = 0.22, p < 0.05, 95\% \text{ CI} [0.089, 0.448]$), indicating that children with higher initial levels of ToM showed greater gains in NRC during the one-year interval. Similarly, prior levels of NRC significantly and positively predicted subsequent changes in ToM ($\gamma = 0.27, p < 0.05, 95\% \text{ CI} [0.156, 0.486]$), suggesting that children with higher initial levels of NRC experienced greater gains in ToM over time. ToM at T1 was significantly related to NRC at T1 ($r = 0.55, p < 0.01, 95\% \text{ CI} [0.347, 0.688]$). In addition,

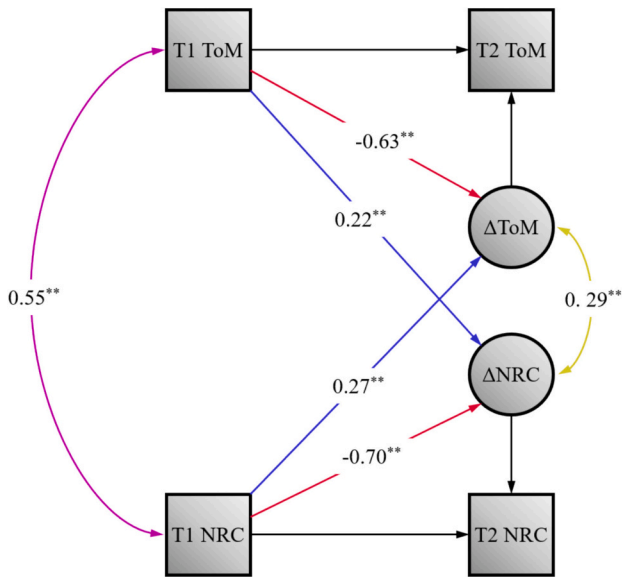


Fig. 1. Latent change scores model of theory of mind and narrative reading comprehension. ToM = Theory of mind, NRC = Narrative reading comprehension. T1 = Time 1, T2 = Time 2. All path coefficients of solid lines are standardized, except for unlabelled paths that are constrained to 1. Nonsignificant paths were represented by dotted lines. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

changes in ToM were also significantly related to changes in NRC ($r = 0.29, p < 0.05, 95\% \text{ CI } [0.099, 0.437]$).

The results of the LCS model for the associations between ToM and ERC are shown in Fig. 2. The data yielded a saturated model.

Self-feedback effects: Both initial ToM ($\beta = -0.48, p < 0.05, 95\% \text{ CI } [-0.794, -0.422]$) and initial ERC ($\beta = -0.61, p < 0.05, 95\% \text{ CI } [-0.831, -0.557]$) negatively predicted subsequent changes in the same constructs. This indicates that, compared to individuals with higher initial levels of ToM or ERC, those with lower initial levels gained more

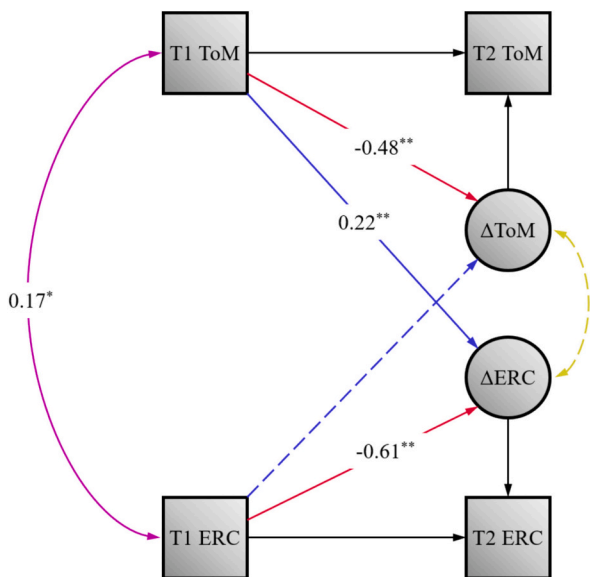


Fig. 2. Latent change scores model of theory of mind and expository reading comprehension. ToM = Theory of mind, ERC = Expository reading comprehension. T1 = Time 1, T2 = Time 2. All path coefficients of solid lines are standardized, except for unlabelled paths that are constrained to 1. Nonsignificant paths were represented by dotted lines. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

in these constructs during the one-year period.

Cross-domain coupling effects: Unlike that between ToM and NRC, only prior levels of ToM positively predicted subsequent changes in ERC ($\gamma = 0.22, p < 0.05, 95\% \text{ CI } [0.093, 0.443]$), but not the reverse ($\gamma = -0.003, p > 0.05, 95\% \text{ CI } [-0.161, 0.154]$). This suggests that ToM at T1 facilitated the rate of growth in ERC, but initial ERC did not have a significant effect on the rate of growth in ToM. Additionally, ToM at T1 was significantly related to ERC at T1 ($r = 0.17, p < 0.05, 95\% \text{ CI } [0.024, 0.296]$). However, changes in ToM were not significantly related to changes in ERC ($r = 0.08, p > 0.05, 95\% \text{ CI } [-0.062, 0.202]$).

Fig. 3 and Fig. 4 illustrate the growth patterns of ToM and reading comprehension (both narrative and expository) over the one-year time interval, respectively. The trajectories reflect how individual differences in initial levels of ToM and reading comprehension influenced subsequent growth, highlighting the dynamic interplay between these constructs over time.

4. Discussion

The present research aimed to answer two questions: whether reading comprehension and theory of mind (ToM) are reciprocally associated in middle childhood; and whether these associations are universal across narrative and expository texts. Our study makes two notable contributions. Firstly, we found that ToM was significantly and positively correlated with both narrative reading comprehension (NRC) and expository reading comprehension (ERC) concurrently in school aged children, with a stronger association observed with NRC than with ERC. Confirming our hypothesis, we found a reciprocal association between ToM and NRC, consistent with the findings of Lecce et al. (2021). Drawing on from the innovative latent change score (LCS) modelling results, the findings revealed that children with higher initial levels of ToM showed greater gains in NRC during the one-year interval, and those with higher initial levels of NRC also showed greater gains in ToM over time. In addition, changes in ToM over time were significantly associated with changes in NRC. Secondly, we distinguished the differences between NRC and ERC in relation with ToM. Initial ToM was significantly associated with the rate of growth in ERC, but initial ERC was not associated with the rate of growth in ToM. Furthermore, changes in ToM were not significantly associated with changes in ERC.

4.1. ToM and (narrative) reading comprehension are reciprocally associated

Building on Tompkins et al.'s (2024) meta-analysis, which demonstrated a robust moderate correlation between ToM and reading comprehension, our study provides the much needed longitudinal evidence of co-occurring changes in ToM and reading comprehension during middle childhood. Prior cross-lagged studies on their bidirectional associations (Lecce et al., 2021; Osterhaus et al., 2024) have

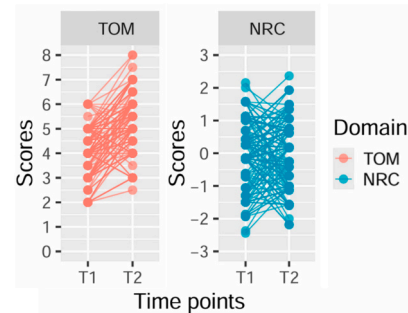


Fig. 3. Individuals' trajectories of theory of mind and narrative reading comprehension from Time 1 to Time 2. ToM = Theory of mind, NRC = Narrative reading comprehension. T1 = Time 1, T2 = Time 2.

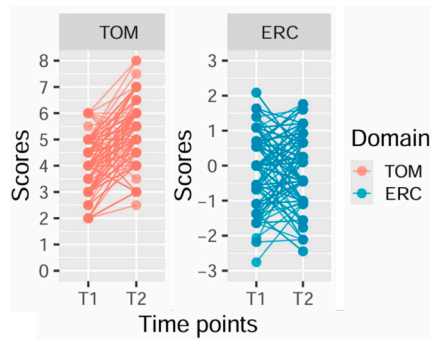


Fig. 4. Individuals' trajectories of theory of mind and expository reading comprehension from Time 1 to Time 2. ToM = Theory of mind, ERC = Expository reading comprehension. T1 = Time 1, T2 = Time 2.

yielded inconsistent findings. Moreover, how individual differences in ToM and reading comprehension track over time and impact each other remains largely unexplored (van der Kleij et al., 2025). Understanding both initial individual differences and growth trajectories in these constructs is essential for clarifying their reciprocal influence. Participants in this study completed identical ToM and reading comprehension measures at two time points one year apart. This design enabled us to apply the innovative LCS model (Davies et al., 2021; Kievit et al., 2018; McArdle, 2009) to assess how the individual differences in baseline levels and the subsequent changes in each construct influenced one another over time. We found that the individual differences in ToM and NRC influenced each other's change over time. In addition, not only were ToM and NRC concurrently correlated at Time 1, confirming Tompkins et al.'s (2024) finding, the latent change scores of ToM and NRC were also correlated. The findings indicate a reciprocal association between children's ToM and NRC in middle childhood.

Our findings provided important insights on the dynamic nature of the link between children's developing social cognition and their reading comprehension during middle childhood. Panero et al. (2016) argued that the relationship between ToM and fiction reading may follow a spiral trajectory: individuals who enjoy reading fiction develop more advanced ToM, which in turn increases their motivation to engage with fiction reading. This spiral development is likely to be age-related. Storybook-based interventions in early childhood have been shown to enhance ToM outcomes (Secora & Maples, 2024), while early ToM abilities have been linked to later reading comprehension (Atkinson et al., 2017). Middle childhood marks the ongoing development in both ToM (Devine et al., 2016; Wang et al., 2016) and reading comprehension (Dore et al., 2018). Once reading becomes automated in early school years, both ToM and NRC appear to mutually influence each other's growth, as demonstrated in the current findings. This finding is consistent with Wang et al. (2024), who reported that ToM influenced reading comprehension primarily during the middle to later stages of primary school years. We further demonstrated that children with higher initial levels of ToM exhibited greater gains in NRC over time, and those with higher initial NRC showed greater improvements in ToM. Furthermore, greater gains in ToM were associated with greater gains in NRC, suggesting a self-reinforcing pattern of development that accelerates over time.

4.2. ToM facilitates ERC too, but not vice versa

Our findings also shed light the specificity of the link between ToM development in middle childhood and different types of reading comprehension. Understanding narrative and expository texts relies on somewhat different cognitive processes (Wu et al., 2020), and our results indicate that the associations between ToM and reading comprehension is not universal across genres. While ToM and NRC demonstrated a reciprocal relationship, the pattern differed for ERC. Specifically, initial

levels of ToM predicted growth in ERC, but the reverse was not true. This finding partially supports Jacoby and Fedorenko's (2020) claim that even in the absence of explicit mental state content, ToM may still play a role in processing expository texts. Understanding expository texts often requires constructing conceptual representations and making causal inferences (McNamara, 2004). In this context, ToM can be understood as a causal reasoning ability—the capacity to infer how events or concepts trigger responses, including mental states (Frye et al., 1995). Furthermore, ToM entails metarepresentational and recursive thinking, which support the integration of multifaceted, layered, and temporally extended information (Schidelko, 2023), as well as enhancing meta-linguistic comprehension (Yuill, 2009), both of which are crucial for understanding expository texts. However, while reading expository texts may support the development of domain-general skills by requiring readers to understand abstract concepts, discern nested logical structures, integrate diverse epistemic stances, and follow hierarchical structures of ideas (e.g., causes and effects, evidence and claims), their contribution to ToM development is likely limited. Unlike narratives, expository texts typically lack emotional content and interpersonal dynamics, which are essential for fostering social cognition.

Tompkins et al.'s (2024) meta-analysis reported that the association between ToM and inferential text understanding was comparable in magnitude to its association with narrative text comprehension. In our study, the concurrent association between ToM and ERC was significant at Time 1, although notably weaker than the association between ToM and NRC. Our finding further demonstrated that individual differences in children's initial ToM levels predicted subsequent growth in ERC during middle childhood. This aligns with Wang et al. (2024), who observed that the influence of ToM on expository text processing becomes more pronounced as children advance through the primary grades. It is plausible that as the cognitive demands of expository text processing increase with age, ToM plays an increasingly important role in supporting comprehension of such texts.

4.3. Educational implications

While previous studies have underscored the role of ToM in supporting children's reading comprehension (e.g., Wang et al., 2024), our findings offer a unique perspective by emphasizing the importance of integrating ToM and reading comprehension in educational intervention programs. The observed reciprocal association between children's developing ToM and reading comprehension suggests an accelerating developmental trajectory—children who begin with stronger skills in either domain are more likely to make greater gains in the other, setting them on a path of compounding developmental advantage. Conversely, children with lower initial levels of ToM or reading comprehension may experience widening achievement gaps over time.

Encouragingly, our findings also show that enhancing one domain can promote growth in the other: strengthening children's ToM supports improvements in reading comprehension, and vice versa. These insights advocate for a shift in instructional practice toward an ecosystem framework—one that integrates social cognition and academic learning. Such a model can inform targeted early educational interventions for students at risk of academic difficulties, potentially mitigating long-term disparities that emerge from early struggles.

4.4. Limitations and directions for future research

The current study has several limitations that warrant consideration. Firstly, potential confounding variables such as language ability and executive functions were not measured. Tompkins et al. (2020) demonstrated that controlling for language ability reduced the association between false belief understanding and narrative comprehension in young children. Notably, early childhood is a developmental period during which language ability plays a central role in scaffolding both ToM and narrative comprehension (Ebert, 2020). In contrast, studies

conducted during middle childhood (Lecce et al., 2021; Osterhaus et al., 2024) controlled for family socioeconomic status, verbal ability, or intelligence, yet none of these variables significantly affected the association between ToM and reading comprehension. Furthermore, Tompkins et al.'s (2024) meta-analysis of studies across the lifespan found that the association between ToM and reading comprehension remains robust, regardless of whether cognitive variables such as executive function and language ability are controlled for. While we have reasonable confidence in these findings, future research with more comprehensive control of confounding variables would further validate the current results. In addition, family background was not measured or controlled in the current study. Future research is warranted to examine how contextual factors influence individual differences in the association between ToM and reading comprehension.

Secondly, ToM was assessed using the Strange Stories task, a widely used measure of advanced ToM in middle childhood and beyond. However, this task is highly linguistically demanding, requiring children to process complex language structures and infer implicit meanings within short narratives. As a result, performance on this task may not solely reflect children's mental state understanding but may also be influenced by their language proficiency and reading comprehension skills, potentially confounding the interpretation of results. Although our carefully designed reading comprehension tasks were constructed to avoid any explicit social reasoning content, the linguistic overlap between the Strange Stories task and reading comprehension remains a methodological concern. To address this limitation, future research should adopt a broader range of ToM assessments in middle childhood, including tasks with reduced language demands. One such example is the Reading the Mind in the Eyes Test (RMET) (Osterhaus et al., 2016), which assesses the ability to infer mental states based solely on visual cues rather than linguistic input. Incorporating such measures can help disentangle ToM abilities from language-related skills and provide a more accurate understanding of the relationship between ToM and reading comprehension during middle childhood.

Additionally, while our study focused on a one-year developmental window, it is plausible that ToM becomes increasingly important in supporting expository text comprehension as cognitive demands grow with age. Thus, future studies should adopt longer longitudinal designs that span more developmental stages. Incorporating additional measurement time points would also allow for a more precise examination of the reciprocal and potentially spiral nature of the relationship between ToM and reading comprehension.

Finally, findings from Tompkins et al.'s (2024) meta-analysis indicate that the strength of the ToM–reading comprehension association varies across linguistic and cultural contexts. Specifically, larger effect sizes were reported in studies using Asian languages compared to those using European languages (e.g., German or Dutch). This variation may reflect differences in assessment tools, as many European studies employed standardized tests, while Asian studies often used purpose-designed tasks. It remains unclear whether these differences are due to task type or underlying linguistic and cultural factors. Cross-cultural research using standardized, equivalent measures across languages is essential to disentangle these effects and advance a more generalizable understanding of ToM–reading relationships.

4.5. Conclusion

While our findings should be interpreted with caution due to the absence of cognitive control variables and contextual background information, this study provides the much needed longitudinal evidence of the co-occurring changes in ToM and reading comprehension during middle childhood. Our findings demonstrate that not only are ToM and NRC concurrently associated, but their developmental trajectories also influence one another over time in a mutually reinforcing pattern. Importantly, we show that children with higher initial levels of ToM or NRC tend to gain more in the other domain, highlighting the potential

for widening developmental gaps. In contrast, the relationship between ToM and ERC was unidirectional—initial ToM predicted gains in ERC, but not vice versa—underscoring the genre-specific nature of these associations. These findings underscore the value of integrating social cognition and academic interventions, especially for children at risk of falling behind, and point to the need for future research to explore these mechanisms across longer developmental periods and diverse linguistic and cultural contexts.

CRediT authorship contribution statement

Qiyang Gao: Writing – original draft, Supervision, Project administration, Funding acquisition, Conceptualization. **Tianyu Xu:** Writing – original draft, Formal analysis. **Peiyao Chen:** Writing – original draft, Data curation. **Ruru Zhang:** Data curation. **Zhenlin Wang:** Writing – review & editing, Writing – original draft, Conceptualization.

Declaration of Generative AI and AI-assisted technologies in the writing process

During the preparation of this work the authors used ChatGPT in order to proofreading. After using this tool/service, the authors reviewed and edited the content as needed and takes full responsibility for the content of the publication.

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Declaration of competing interest

The authors declare no conflicts of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.lindif.2025.102823>.

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