Cognitive Development 76 (2025) 101635

Contents lists available at ScienceDirect

Cognitive Development

journal homepage: www.elsevier.com/locate/cogdev

Relationship between narrative ability and executive functions: A longitudinal study in kindergarten classrooms

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ARTICLE INFO

Keywords:
Narrative ability
Executive functions
Kindergarten
Longitudinal study

ABSTRACT

Narrative ability and executive functions develop rapidly in children during the preschool years. The aim of this study was to investigate the nature of the longitudinal relationship between these two abilities by examining two competing theoretical accounts: direct reciprocal influence and the role of shared underlying factors. The sample consisted of 280 kindergarten children who were assessed in three waves over 18 months. A dual-model approach was used, employing both a Cross-Lagged Panel Model with lag-2 effects (CL2PM) and a Random Intercept Cross-Lagged Panel Model (RI-CLPM). The CL2PM revealed a directional relationship, where higher executive functions predicted subsequent growth in narrative ability, but not the inverse. This cumulative, directional influence helps explain the robust, stable connection between the abilities observed at the between-person level in the RI-CLPM ($r = .58$, $p < .001$) - a finding consistent with the hypothesis of shared underlying factors. This robust predictive relationship was observed despite evidence from descriptive data that the two skills were otherwise differentiating. No evidence was found for a more immediate, dynamic interplay at the within-person level. The findings suggest a complex relationship characterized by a robust, stable connection, likely stemming from both shared underlying factors and a cumulative, directional influence. Further research is warranted to identify these shared factors and experimentally test this directional influence in order to inform effective interventions.

1. Introduction

Academic success depends on a number of factors including well-developed language and literacy skills (Hulme et al., 2015). A predictor for well-developed literacy skills is early narrative ability (Babayiğit et al., 2021; Suggate et al., 2018). Narrative ability helps both learning and classroom participation since it is key for reading and storytelling (M. Westerveld et al., 2022). Executive functions also play a significant role in literacy skills and academic success (Cortés Pascual et al., 2019), as it enables individuals to regulate their own behavior while considering environmental conditions such as the academic interaction and context (Blair, 2017).

Both narrative ability and executive functions can be regarded as goal-directed and higher-order abilities (Roth, 2009; Zelazo, 2015). Executive functions are important when solving problems in order to achieve a goal (Zelazo, 2015). Narratives involve relating

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https://doi.org/10.1016/j.cogdev.2025.101635
Received 5 June 2024; Received in revised form 22 September 2025; Accepted 22 September 2025
Available online 26 September 2025

stories in which a character wants to achieve a goal (Roth, 2009). Executive functions rely on hierarchical rules and include higher-order rules that enable switching between the different rules (Zelazo, 2015). On the other hand, narrative ability permits the mastery of higher order literacy tasks such as story structure or connecting events through cause-and-effect relationships (Roth, 2009).

The years before primary school are crucial for both narrative ability (Roth, 2009) and executive functions (Zelazo & Carlson, 2020). In Switzerland, where kindergarten spans ages four to six, this period provides a valuable opportunity to investigate these abilities. Developing concurrently, both narrative ability and executive functions are higher order abilities that predict academic success, hence a reciprocal relationship between these abilities may be assumed. In their meta-analysis, Scionti et al. (2023) identified an absence of longitudinal studies that explore the relationship between executive functions and narrative ability, particularly within the context of preschool-aged participants. This paper addresses this research gap by examining the reciprocal relationship between narrative ability and executive functions over time. However, beyond the need for more longitudinal research, understanding the nature of this relationship holds significant practical implications. If one ability influences the development of the other, targeted interventions on just one could enhance both. Similarly, if both rely on a common underlying factor, this could serve as a valuable starting point for interventions. A deeper understanding of the nature of their relationship could lead to more effective strategies for promoting these crucial abilities during the ages of four to six. To contribute to this understanding, this study uses an exploratory approach to investigate the relationship between narrative ability and executive functions.

1.1. Narrative ability and executive functions

In order to define narrative ability, it is first necessary to define narratives. Narratives can be oral or written. When examining kindergarten-aged children, the focus is on oral narratives. Existing definitions for narratives emphasize either the structure or function of the narrative. For example, one definition describes a narrative as a sequence of events that are connected through a goal-directed structure, where the characters' goals provide coherence both within and between narrative episodes (Berman & Slobin, 1994; McCabe & Peterson, 1991a; Stein, 1982). On the other hand, Bruner (1986) emphasizes the pragmatic function of communicating events to others. These events can be real or imagined and the narratives can be either original or retold (Engel, 1995; Hughes et al., 1997). Narratives range along a spectrum of contextualization, from a highly contextualized narratives woven into the flow of conversation, to those prompted in a school setting (Reese et al., 2011). Prompted narratives often involve a monological character (Spencer & Pierce, 2023). Consequently, oral narrative ability can be regarded as the ability to construct and communicate real or fictional events in a coherent manner (Hudson & Shapiro, 1991; Reese et al., 2011). A common approach for evaluating narrative ability is to differentiate between the macrostructure and microstructure of the narrative (Justice et al., 2010; M. F. Westerveld & Vidler, 2016). The macrostructure refers to the global characteristics of a narrative, which includes the ability to produce a well-structured, coherent narrative and also the usage of story grammar (Justice et al., 2010; Stein, 1982). Conversely, the microstructure focuses on grammatical and semantic details like word count, cohesive device usage, and grammatical complexity (Justice et al., 2010). A comprehensive understanding of narrative ability provides a foundation for exploring its relationship with other cognitive domains, such as executive functions.

Executive functions represent a group of higher order cognitive processes required for goal-directed, flexible, and adaptive actions or behaviors (Zelazo & Carlson, 2012). There is a notion that the executive functions require working memory, inhibitory control, and cognitive flexibility (Diamond, 2013). Working memory enables the temporary storage and manipulation of information (Klingberg et al., 2002). Inhibitory control refers to the ability to restrain impulses and thoughts that would otherwise interfere with the resolution of the current task (McClelland et al., 2007). Cognitive flexibility allows for the consideration of information from different perspectives and the adjustment of behavior according to the situation (Cañas et al., 2003). However, the differentiation of executive functions occurs across development, transitioning from a unitary construct to specific core domains. It is currently unclear when and how this differentiation occurs (Zelazo & Carlson, 2020). Executive functions exist on a continuum that ranges from *hot executive functions* to *cool executive functions:* The former are required in motivationally significant situations (e.g., delay of gratification) and the latter in random and decontextualized situations (e.g. in most tests of working memory, inhibitory control and cognitive flexibility (Zelazo, 2015).

1.2. Possible interplay of narrative ability and executive functions

During the developmental period in children of four to six years, narratives not only become longer but also contain multiple story elements (Allen et al., 1994; Hudson & Shapiro, 1991). The story elements need to be chronologically sequenced, increasing the cognitive demand on the child (Roth, 2009). Keeping all the story elements in mind also places demand on working memory. In order to correctly sequence the story elements, it is necessary to inhibit other story elements, hence inhibitory control is required. Around the age of six years, children engage in even more complex forms of thinking, including the capacity for relating a perspective, which enables them to consider what the listeners already know and what they need to be told (McCabe & Peterson, 1991b). They also begin to represent the internal states of the characters in their narratives (Trabasso et al., 1992). Mastering all of these aspects demands cognitive flexibility.

Executive functions may influence narrative ability and engaging in narratives may enhance and train executive functions. Investigations in the field of neuropsychology have shown that narrative ability and executive functions share similar frontal cortical areas, implying not only a reciprocal relationship, but also creating a foundation for a training effect (Coelho et al., 2012). The following section will further outline the theory of how executive functions can be trained through narratives.

An important method for facilitating the development of executive functions is reflection (Zelazo, 2015). Reflection is the process of

identifying and integrating multiple aspects of a situation to achieve a sophisticated and nuanced interpretation. The reflection process enables individuals to better evaluate a situation, leading to greater awareness of the available options. (Trope & Liberman, 2010). With practice, reflection improves information processing, enhances executive functions such as the ability to focus, and improves memory retention and behavioral self-regulation (Zelazo, 2015). Telling oral narratives is an effective means of exercising reflection, since the telling permits insight into thoughts and feelings (Motta et al., 2012). Psychological distancing, another reflection strategy, creates a distance between the individual and the ongoing environment (Sigel, 2002). Telling oral narratives supports psychological distancing as it requires empathizing with the inner states of the protagonists through perspective-taking (Dodd et al., 2011; McCabe & Peterson, 1991b). In summary, reflection plays a major role in the development of executive functions, and telling oral narratives promotes reflection, in turn supporting the development of executive functions. This suggests a reciprocal relationship between narrative ability and executive functions, where improvements in one may reinforce the other.

1.3. Potential shared underlying factors

While reflection provides one pathway linking narrative and executive functions, their interplay could also stem from shared reliance on common underlying factors. Beyond reflection itself, other constructs may also influence both narrative ability and executive functions. For example, Theory of Mind, which refers to the ability to understand and reason about other people's mental states or beliefs (Dunn et al., 1991), has been shown to be associated with both domains (Ketelaars et al., 2012; Perner & Lang, 1999). Narration requires the ability to understand the mental states of characters and how these states motivate their behavior (Pelletier & Beatty, 2015). A factor analysis with preschool children as participants even showed that Theory of Mind and narrative ability loaded onto a single factor, suggesting that these abilities may overlap during developmental period (Tompkins et al., 2020). Moreover, Foldager et al. (2024) found that these two constructs were related across genres (fictional or autobiographical stories).

The exact nature of the relationship between Theory of Mind and executive functions remains unclear (Wade et al., 2018). One perspective suggests that executive functions require Theory of Mind in order to strategically control thoughts and behavior (Perner et al., 2002; Perner & Lang, 1999).

Additionally, language development may play a central role in narrative ability and executive functions. The ability to tell a coherent narrative relies on the mastery of pragmatics, syntax, and semantics (Suggate et al., 2018). Consequently, oral narrative ability was found to be predicted by early language abilities (Gardner-Neblett & Iruka, 2015). Language development may also be a contributing factor to the development of executive functions, as it facilitates the integration of rules into inner speech. Inner speech refers to the subjective experience with language that occurs without any overt and audible articulation (Alderson-Day & Fernyhough, 2015). According to Vygotsky (1987), private speech - in which children talk to themselves while engaged in a cognitive task - represents a transitional stage in the process of internalizing their inner speech. Executive functions, which comprise a set of higher-order cognitive processes, are typically verbally mediated through private or inner speech (Emerson & Miyake, 2003). The experimental study conducted by Doebel and Zelazo (2016) support this, as it demonstrated that experience with contrastive language could be used to integrate rules in inner speech, leading to a positive impact on executive function in preschoolers.

1.4. Mental representations: the foundational construct

The previously mentioned potential underlying factors rely on mental representations (Pesch et al., 2020; Piaget, 1952; Slavova & Soschen, 2015; Vygotsky, 1967). Mental representations require a system of symbols for representing complex contents and are closely related to both narrative ability and executive functions (Gallistel, 2001). The influence of mental representations on narrative ability has been demonstrated in several ways. For instance, Wannagat et al. (2020)) found that making the main characters' goals seem more important helps listeners connect different parts of the story together. Emphasizing these goals creates points of reference, making it easier for people to build a consistent and logical mental map of the whole narrative. Additionally, recent evidence suggests that the realism of story characters affects how richly children represent social content: children who retold a story featuring human protagonists used more socio-relational language than those who heard stories with animal characters, indicating that realistic characters may elicit more robust representations of social ideas (Russell et al., 2024).

Mental representations are also essential for the development of executive functions. Kharitonova and Munakata (2011) demonstrated that children who could flexibly switch between rules in a card-sorting task used more abstract representations, while children who persisted in using a particular rule relied on more stimulus-specific representations.

Building on this theoretical groundwork that explores the roles of reflection, Theory of Mind, language development, and mental representations, the following section examines the empirical evidence regarding the direct relationship between narrative ability and executive functions.

1.5. Research on the relationship between narrative ability and executive functions

To date, several cross-sectional studies and a scant number of longitudinal studies have yielded inconsistent findings regarding the relationship between oral narrative ability and executive functions (Scionti et al., 2023).

A meta-analysis by Scionti et al. (2023), involving 30 studies that investigated the relationship between narrative ability and executive functions showed a weak association during childhood ($r = .24$), with a stronger association observed before the age of seven. For children in this younger age group, the meta-analysis found similar strengths of association between narrative ability and all domains of executive functions (working memory, inhibitory control, and cognitive flexibility). However, the association between

these two constructs appeared to be stronger when the macrostructural level of narrative ability was investigated (Scionti et al., 2023).

When investigating the direction of the relationship between narrative ability and executive functions, empirical evidence suggests that executive functions predict not only language proficiency in kindergarten-aged children (Fuhs et al., 2014; McClelland et al., 2014; Weiland et al., 2013) but also narrative ability (Ögel Balaban & Hohenberger, 2020; Veraksa et al., 2020). An intervention study by Veneziano and Bartoli (2022) identified individual variability in narrative ability improvements and demonstrated a significant positive correlation between substantial growth in children's narratives and their inhibitory control skills.

Although several studies have shown that language proficiency predicts executive functions in kindergarten-aged children (Fuhs & Day, 2011; Kuhn et al., 2016), there is limited evidence indicating that narrative ability serves as a predictor of executive functions. While research has often examined executive functions as predictors of narrative ability, the inverse relationship—narrative ability predicting executive functions—has not been extensively studied. Friend and Bates (2014) found that children's ability to structure a coherent narrative at the age of 4;5 years predicted subsequent inhibitory skills at the age of 5 years. Their findings suggest a reciprocal relationship between oral narrative ability and executive functions, since a child's ability to focus attention and suppress distractions at the age of 4;5 years predicted the ability to construct a complex and coherent narrative at the age of 5 years.

Friend and Bates (2014) used a traditional Cross-Lagged Panel Model (CLPM) to examine the reciprocal influences of executive functions and narrative ability over two measurement waves (Little, 2013). However, the traditional CLPM only controls for the stability of the constructs through autoregressive relationships (i.e., controlling for the previous measurement of the construct) and assumes no trait-like individual differences. Trait-like individual differences refer to stable characteristics or traits that differentiate one person from another and remain relatively constant across different time points. While often exemplified by factors like gender and IQ, stable characteristics can also refer to consistent environmental factors during the time of investigation (e.g., home literacy, parenting style). Furthermore, it is debatable whether the stable variance captured in a statistical model represents a psychological trait or should be considered as a statistical "task factor" that could be explained by such unmeasured individual differences. Not accounting for trait-like individual differences can cause an overestimation of reciprocal effects through a third factor. This is known as the "omitted variable problem" (Allison, 2009). To address this limitation of the CLPM, a Random Intercept Cross-Lagged Panel Model (RI-CLPM) was developed, which addresses the omitted variable problem by separation of the within person and the between person levels and by adding a random intercept. The random intercept removes between-person variance, ensuring that the lagged relationships in the RI-CLPM reflect within-person dynamics (Hamaker et al., 2015). Within-person effects refer to changes and fluctuations in an individual's behavior over time, while between-person effects pertain to the aforementioned trait-like differences. Therefore, the RI-CLPM allows the estimation of reciprocal effects at the within-person level, reflecting dynamic processes where changes in narrative ability within a child predict subsequent changes in their executive functions (or vice versa), without these estimates being confounded by stable between-person differences. An association between narrative ability and executive functions at the between-person level may suggest stable environmental factors or the influence of common underlying third factors.

However, this approach of separating variance is part of a broader methodological debate. An alternative perspective argues that in order to understand long-term development, the stable differences between individuals are a crucial part of the causal process and should be retained in the model. This approach suggests enhancing the traditional CLPM by including effects from more distant points in time. The Cross-Lagged Panel Model with lag-2 effects (CL2PM) achieves this by offering stronger statistical control for confounding variables and delayed effects, thus providing a clearer view of overall developmental trajectories (Lüdtke & Robitzsch, 2021).

Given that these two advanced models both offer valid but distinct insights, the present study employs both to provide a more comprehensive analysis. This dual-model approach follows the recommendation of Lüdtke and Robitzsch (2022) to juxtapose the different models. This means the results from both the CL2PM and the RI-CLPM will be presented side-by-side to allow for a direct comparison of their findings. This comprehensive analysis is crucial because each model provides different potential targets for intervention. The CL2PM tests for systematic change, where a significant finding would suggest that an intervention targeting one ability could alter a child's overall developmental trajectory in the other compared to their peers. The RI-CLPM, in contrast, provides two distinct pieces of information: its within-person effects can show whether an intervention causing a short-term increase in one ability could trigger a corresponding increase in the other, while its between-person association can point to the existence of a shared underlying factor, suggesting that an intervention targeting this common cause could be a valuable way to support both abilities simultaneously.

2. Aim of the study

The aim of this study is to investigate the nature of the relationship between narrative ability and executive functions during the kindergarten years. This study seeks to explore two key theoretical accounts for this relationship. The first posits direct reciprocal influences, and while theoretical arguments support influences in both directions, one might hypothesize that executive functions influence narrative ability earlier during kindergarten, with narrative ability providing a training opportunity for executive functions later on. The second account focuses on the stable, parallel development of both abilities, which could be explained by the influence of shared underlying factors or other stable between-person differences. By employing two complementary statistical models (CL2PM and RI-CLPM), the data can be examined from these different analytical perspectives to provide a more nuanced understanding that has practical implications for early childhood intervention.

Building on this theoretical framework, this study was designed to address three key research goals. The first goal was to investigate whether narrative ability and executive functions influence each other's growth over time within the context of the overall development of the children. The second goal was to determine the nature and strength of the stable, underlying connection between the two abilities. The final goal was to ascertain if, after accounting for this stable connection, temporary increases in one ability still

predict subsequent increases in the other.

3. Method

3.1. Participants and procedure

From 2018–2021, the intervention study EmTiK (the German language acronym for Erwerbsunterstützung Mündlicher Textfähigkeiten, i.e. Promotion of Oral Text Abilities) was conducted in Swiss kindergartens. In most cantons of Switzerland, kindergarten is mandatory for children ages four to six, with children attending for two years. In the first year, they typically attend only in the mornings, whereas in the second year, they also spend two afternoons there. The data obtained from the EmTiK project were used for this longitudinal study. The EmTiK project received approval from the school authorities, and school principals were informed about the study. Parents were asked to give written consent for their child's participation and were asked to fill out a short questionnaire. The first author and other trained research assistants visited the kindergartens for testing. Children with diagnosed intellectual disabilities were excluded from the project. However, children from diverse language backgrounds or those receiving therapy, such as speech therapy or psychomotor therapy, were included. Potential ethical concerns related to the project were discussed with the ethics commission of eastern Switzerland and none were found.

The first wave (T0) took place in the fall, approximately three months after the child had started kindergarten. The second wave (T1) commenced 13 months later, approximately in the middle of the second year of kindergarten. The third wave (T2) took place another five months later, at the end of the second year of kindergarten. Narrative ability and executive functions were tested at each wave. The testing procedure took approximately 20 min per child.

The EmTiK project dataset comprised test data from 280 kindergarten children who were from 65 different Swiss kindergartens in the cantons of Zurich and Thurgau. The selection process is outlined as follows: firstly, teachers were randomly selected from the complete list of kindergarten teachers in the respective cantons and were then invited to participate in the project. The aim was to recruit 80 teachers; however, the acceptance rate was very low (5.4 %). After three random draws from the list of kindergarten teachers, with each draw comprising around 400 teachers, teacher recruitment was halted to avoid violating the principle of randomization. Once the teachers had been selected, four to five children from each teacher were randomly selected to form the sample set. Table 1 shows the sample composition of the children at each wave. It should be noted that 74 % of the children completed all tests in all three waves.

In terms of social background, 51 % of the children spoke only the official school language at home, and 30 % of the children spoke the official school language plus an additional language at home. Only 19 % of the children did not speak the school language at home. In 35 % of the cases, at least one parent held a university degree and in 9 % of the cases, neither parent had a degree.

A number of t-tests were performed to verify the sample set. To check for systematic sample dropout, a *t*-test was conducted to examine whether the children who participated in all tests had different test scores at T0 compared to those with incomplete participation. The results indicate that there were no significant differences in the level of narrative ability at T0 ($t = .53$, $df = 106.20$, $p = .60$) and executive functions at T0 ($t = -.79$, $df = 124.73$, $p = .43$).

The data used in this study originated from the EmTiK intervention study, which aimed to improve teachers' scaffolding practices during everyday conversations by providing them with videobased coaching, professional development inputs, and online lessons. Child-level data, including narrative ability, were collected as part of this larger project. T-tests were also performed to verify whether the children in the intervention group had differing scores in narrative ability and executive functions at each wave compared to those in the control group. Furthermore, the grand means of the three waves were computed for both variables and *t*-test were performed to examine differences in the grand means between the control and the intervention group (T0 narrative ability: $t = .73$, $df = 265.96$, $p = .46$; T0 executive functions: $t = .42$, $df = .273.39$, $p = .68$; T1 narrative ability $t = .76$, $df = 224.03$, $p = .45$), T1 executive functions ($t = -.33$, $df = 221.58$, $p = .74$); T2 narrative ability ($t = .95$, $df = 227.61$, $p = .34$); T2 executive functions: $t = -.31$, $df = .222.85$, $p = .76$). Further, there was no significant difference neither between the grand means for executive functions ($t = -.43$, $df = 285.01$, $p = .67$) nor between those of narrative ability ($t = -1.34$, $df = 283.91$, $p = .18$). Given these findings, the intervention was not taken into account in the following analyses to reduce model complexity.

3.2. Measures

Narrative Ability. In this study, narrative ability was assessed using the MuTex instrument (the German acronym for Mündliche

Table 1
Sample composition during the three waves.

	T0 (Beginning of the first year of kindergarten)	T1 (Beginning of the second year of kindergarten)	T2 (Towards the end of kindergarten)
Participants (n)	280	234	232
Age	*M*= 4;10 (*SD*=5)	*M*= 6;1 (*SD*=4)	*M*= 6;5 (*SD*=4)
Gender (%)	46 % female	45 % female	47 % female
Group allocation (%)	47 % control group	47 % control group	48 % control group

Note. Mean age (*M*) is reported in years;months. Standard deviation (*SD*) is reported in total months.

Textfähigkeiten, i.e., Oral Text Abilities), developed as part of the EmTiK project and cross-sectionally validated (Isler et al., 2018). This task requires the child to watch an approximately 3-minute-long silent cartoon and then immediately narrate the content, thus engaging both memory for the viewed events and narrative production ability. MuTex is particularly well-suited for measuring narrative ability in linguistically diverse kindergarten settings because this visual stimulus and subsequent narration minimizes dependency on understanding the official school language, unlike tasks requiring comprehension of a verbally told story. Thus, potential disadvantages for children from diverse language backgrounds are mitigated in contrast to children who primarily speak the official school language at home.

The measuring instrument, MuTex, contained semantic aspects of microstructure and all aspects of macrostructure, but also included further interactional aspects. With MuTex, the child's narrative was rated based on four dimensions: soloistic production, representation of distant content, textual organization and genre-specific features. Soloistic production, which refers to the child's ability to assume the role of a narrator and produce the narrative independently, was assessed by considering both the length of the produced narrative and the number of turns used. A longer narrative with fewer turns (indicating less support from the test leader) resulted in a higher score, indicating greater independence for the child. Representation of distant content, which refers to the child's ability to use language in a decontextualized manner, was assessed by counting the number of characters, objects, and events from the cartoon that the child described. Textual organization, which refers to the use of linking words and sentences, and the chronological order of the propositions, was assessed and finally, genre-specific features, the fulfillment of narrative tasks and the use of particular narrative markers, were analyzed. When rating, points were awarded for each of the four dimensions on a scale of 1–5. A detailed description of the rating process and a longitudinal validation of MuTex using the data from this study can be found in Schönberger et al., n.d et al. (under review). A total score was computed by summing the respective dimensions, resulting in a value between 4 and 20. Descriptive statistics for each of the four dimensions at all three waves are provided in Table 2. Twenty percent of all the ratings were double rated. An excellent interrater reliability at each wave, ranging from.92 to.95, was achieved. Furthermore, the reliabilities, as measured by McDonald's Omega, ranged from.77 to.82, indicating adequate to good values. Partial scalar measurement invariance was achieved with two out of the four indicators being invariant with the following model fit indices: $\chi^2 = 74.91/76.95/79.48$; $df = 39/41/43$; $CFI = .97/.97/.97$; $RMSEA = .06/.05/.05$; $SRMR = .04/.04/.03$) (Author et al., under review).

Executive Functions. The focus of this paper is on cool executive functions. The executive functions were measured using the app-based Minnesota Executive Function Scale ("MEFS"; Carlson & Zelazo, 2014). MEFS is widely recognized as a comprehensive assessment tool for testing executive functions during the preschool years, since it assesses all domains of executive functions including working memory, inhibitory control, and cognitive flexibility. It can be used for children aged two years and above. MEFS involves sorting virtual cards into two boxes based on an increasingly complex set of rules. This app has a good test-retest reliability ($r_{tt} = .86$) as cited in the MEFS test manual. In addition, MEFS has been shown to capture age-related trends in executive functions and is highly correlated with the Dimensional Change Card Sort Test (DCCS), another commonly used research measure of executive functions (Carlson, 2017). The app's total score is calculated using an algorithm that takes into account both accuracy and response time. The score can have values from 0 to 100. A score near 100 indicates that the test person was both accurate and fast (Reflection Sciences, 2018). This total score was used as a manifest variable representing executive functions in our analyses. The decision to was based on the nature of the MEFS, which provides a single, validated composite score reflecting overall proficiency, and was further supported by meta-analytic findings indicating that different executive functions domains show similar strengths of association with narrative ability before age 7 (Scionti et al., 2023).

3.3. Statistical analysis

Narrative ability was modeled as a latent variable consisting of four indicators using the effect coding method (Little, 2013). To test for measurement invariance of narrative ability, a confirmatory factor analysis was computed for the three time points (Putnick & Bornstein, 2016). Configural, metric and scalar measurement invariance across all three waves were assessed by sequentially constraining the model structure, factor loadings and item intercepts to be longitudinally equal (Meredith, 1993). The interrater reliability analyses for the narrative ability instrument were conducted by calculating intraclass correlations (ICC) estimates and their 95 % confidence intervals using the R package psych (Revelle, 2021), which is based on a single-rating, absolute-agreement, two-way mixed-effects model.

Executive functions on the other hand, were captured by a manifest variable. The total score was used for both constructs when conducting the statistical analyses.

Initially, a Cross-Lagged Panel Model that included autoregressive lag-2 effects was fitted to the data. The structural portion of the

Table 2
Descriptive statistics for MuTex sub-scores across three waves.

Variable	T0 M (SD)	T1 M (SD)	T2 M (SD)
Soloistic Production	2.27 (1.04)	3.04 (1.03)	3.47 (1.02)
Representation of Distant Content	1.91 (0.90)	2.71 (1.19)	3.20 (1.20)
Textual Organisation	2.63 (1.22)	3.38 (0.99)	3.69 (0.97)
Genre-Specific Patterns	2.18 (1.23)	3.05 (1.40)	3.43 (1.30)
Total Score	8.99 (3.57)	12.18 (3.55)	13.79 (3.42)

model was specified as follows. Each variable at a given wave (e.g., narrative ability at T2) was predicted by its own value at both the immediately preceding wave (narrative ability at T1) and two waves prior (narrative ability at T0). The cross-lagged paths, however, were only specified from the immediately preceding wave; for example, narrative ability at T2 was predicted by executive functions at T1, but not from T0. Finally, the concurrent associations between the variables were modeled by permitting a covariance in their residuals at each wave. This structure was chosen because including additional autoregressive lag effects allows for a stronger control for confounding variables and accounts for potentially delayed effects not captured by simpler models (Lüdtke & Robitzsch, 2021).

Subsequently, a Random Intercept Cross-Lagged Panel Model (RI-CLPM) was computed to examine the reciprocal effects between narrative ability and executive functions while separating within-person dynamics from stable between-person differences. (Hamaker et al., 2015). The RI-CLPM permits the evaluation of within-person variation and accounts for time-invariant components by separating the between-person and within-person components. The model used random intercepts as time-invariant components. These accounted for each child's time-invariant deviation from the grand means, thus representing the stable differences between children (depicted as "RI_NA" and "RI_EF" in Fig. 1). The random intercepts were specified by defining a latent variable and using the repeated measures as its indicators. All the factor loadings of the latent variable were set to 1. The four indicators of narrative ability were assigned four random intercepts to capture the trait-like aspect of each indicator. The model also included within-person components, which were specified by a latent variable for each measurement with a constrained measurement error of 0. Additionally, three within-unit components were specified to capture the state-like aspect for narrative ability at each wave of the test (Mulder & Hamaker, 2021). Due to the presence of partial scalar measurement invariance for narrative ability, the factor loadings and intercepts were constrained to be invariant for two out of the four indicators (Schönberger et al., under review). The components related to within-person variability encompassed both autoregressive effects and cross-lagged effects. The autoregressive effects represented the persistence or stability of within-person deviations over time (i.e., how much an individual's deviation from their own average level or trajectory at one time point predicted their deviation at the next), while the cross-lagged effects captured the spillover of influences from one construct to another. To evaluate the model fit, the following model fit indices as recommended by (Hu & Bentler, 1999) were used: the comparative fit index (CFI) had a recommended threshold of $\geq$ 0.95, and the root mean square error of approximation (RMSEA) had a recommended threshold of $\leq$ 0.05 and a satisfactory range of 0.05–0.08. The full information maximum likelihood (FIML) procedure was employed to address missing data and the lavaan package (Rosseel, 2012) in the R Software Version 4.1.2 (R Core Team, 2021) was used to conduct all analyses.

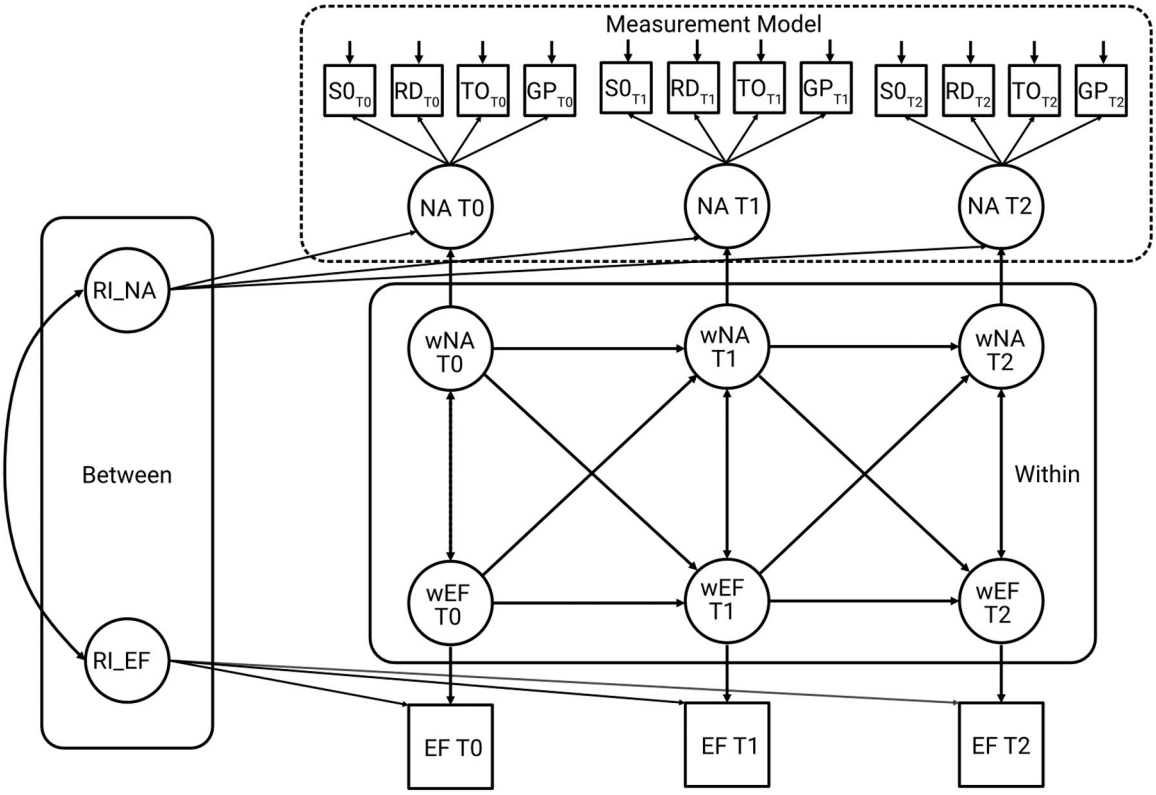

Fig. 1. *Random Intercept Cross-Lagged Model with Narrative Ability and Executive Functions Note.* RI_EF=random intercept of executive functions. RI_NA=random intercept of narrative ability. wEF=within component for executive functions. wNA=within component of narrative ability. GP=genre-specific patterns. RD=representation of distant content. SO=soloistic production. TO=textual organization.

4. Results

The bivariate correlations of all variables and their descriptive data are shown in Table 3. Narrative ability and executive functions had positive associations over the three time points (range of $r = .27$–$.35$, all $p < .01$). In addition, there were moderate significant correlations among narrative ability at each time point and among executive functions at each time point (range of r in narrative ability =.44–.48, all $p < .01$; range of r in executive functions =.52–.61, all $p < .01$). The mean values for executive functions and narrative ability exhibit an increase across the three time points.

Prior to the main longitudinal analyses, preliminary bivariate associations were examined between key demographic variables (age at T0 and gender) and overall mean performance across the three waves for narrative ability and executive functions. Age at T0 showed a small significant positive correlation with mean narrative ability ($r = .13$, $p < .05$) but a non-significant correlation with mean executive functions ($r = .07$, $p > .05$). Gender was not significantly correlated with either mean narrative ability ($r = .05$, $p > .05$) or mean executive functions ($r = .06$, $p > .05$).

4.1. CL2PM of narrative ability and executive functions

The CL2PM was fitted to the data and showed an acceptable model fit: χ^2 (74) = 145.63, $p < .001$, CFI = .947, RMSEA = .059, SRMR = .068. The standardized path coefficients for all autoregressive and cross-lagged paths are presented in Fig. 2. The model revealed significant cross-lagged paths from executive functions to subsequent narrative ability, both from T0 to T1 (β =.22, $p < .001$) and from T1 to T2 (β =.23, $p < .001$). In contrast, the cross-lagged paths from narrative ability to subsequent executive functions were not statistically significant. In addition, the model showed positive concurrent associations between narrative ability and executive functions at the first two waves.

4.2. RI-CLPM of narrative ability and executive functions

The results of the RI-CLPM of narrative ability and executive functions revealed that the model fitted the data well: χ2 (71) = 134.12, $p < .001$, CFI = .953, RMSEA = .056, SRMR = .062. The coefficients of the RI-CLPM are presented in Fig. 3. The random intercepts of narrative ability and executive functions were significantly associated ($r = .58$, $p < .001$), indicating a positive association between narrative ability and executive functions at the between-person level. At the within-person level only the autoregressive path from the executive functions from the second to the third wave (β =.23, $p = .032$) was significant. Neither the concurrent correlations between narrative ability and executive functions across the time points, nor the other autoregressive paths were found to be significant. Furthermore, there was no significant cross-lagged path between narrative ability and executive functions.

In summary, the results from the two models provide a nuanced view of the relationship between narrative ability and executive functions. The CL2PM suggests a directional influence of executive functions on the subsequent overall development of narrative ability. The RI-CLPM complements this by showing a robust, stable association between the two abilities at the between-person level, but shows no evidence of short-term, dynamic influences at the within-person level.

5. Discussion and conclusion

This study employed a dual-model approach to investigate the longitudinal relationship between narrative ability and executive functions over 18 months in kindergarten. The analysis examined both the overall systematic change between the two abilities and the more specific dynamics at the between-person and within-person levels.

First, the results pointed to a one-way influence on children's overall development. Stronger executive functions were found to predict subsequent growth in narrative ability. However, the reverse was not true; the data did not support the idea that narrative ability enhance executive functions within this timeframe. This was complemented by concurrent residual correlations that diminished

Table 3
Means, standard deviations, and correlations.

Variable	*M*	*SD*	1	2	3	4	5
1. Executive Functions T0	45.40	11.81					
2. Executive Functions T1	65.11	13.87	.52***				
3. Executive Functions T2	69.65	11.93	.56***	.61***			
4. Narrative Ability T0	8.99	3.57	.35**	.27***	.33***		
5. Narrative Ability T1	12.18	3.55	.32***	.33***	.32***	.46***	
6. Narrative Ability T2	13.79	3.42	.29***	.28***	.34***	.44***	.48***

Note. ** indicates $p < .01$.

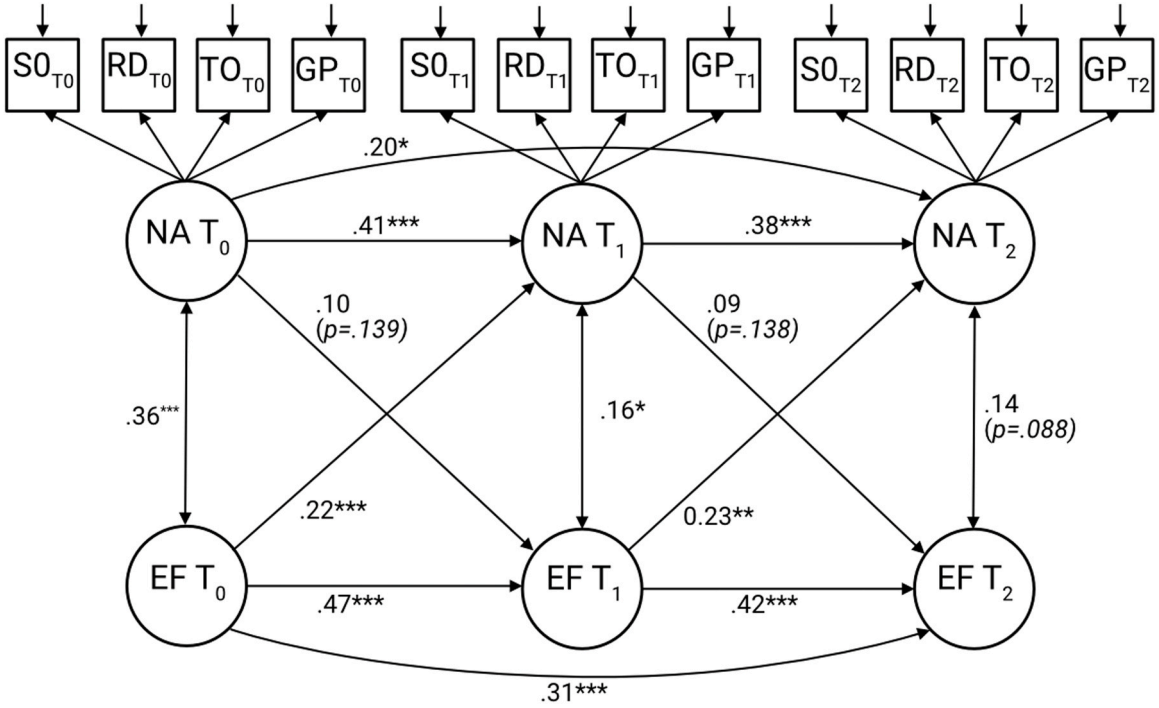

Fig. 2. Results of the Cross-Lagged 2 Panel Model with Narrative Ability and Executive Functions Note. The time points represent the approximate ages (T0 ≈ 5 years; T1 ≈ 6 years; T2 ≈ 6.5 years). EF=executive functions. NA=narrative ability. GP=genre-specific patterns. RD=representation of distant content. SO=soloistic production. TO=textual organization.

over time and were no longer significant at the final wave. Second, the analysis confirmed a robust and stable underlying link between the two abilities. Children who consistently demonstrated higher narrative ability also tended to have higher executive functions. This finding is consistent with the hypothesis of a shared underlying factor that influences both domains.

Finally, after accounting for this stable connection, there was no evidence of a reciprocal relationship between temporary, individual fluctuations in these abilities. In fact, the only significant short-term path was the stability of executive functions between the second and third waves. Nevertheless, the notable concurrent correlation coefficients for the first two measurements (r = .15, r = .11) suggest an association within the respective measurement occasions.

A synthesis of these findings suggests a complex interplay between the two abilities. The robust, stable association points to the influence of shared underlying factors, while the pattern of longitudinal effects suggests that any direct influence of executive functions on narrative ability is likely a slow, cumulative process rather than a series of dynamic influences within an individual.

This study identified a positive correlation between narrative ability and executive functions, which is consistent with previous research (Scionti et al., 2023). However, some results were inconsistent with previous research. Friend and Bates (2014), for instance, used a traditional CLPM and found a reciprocal relationship between narrative ability and executive functions. In contrast, the present study's CL2PM—a more robust model with three waves and additional lag-2 effects—found a directional relationship, where executive functions predicted subsequent narrative ability, but the inverse was not found. Furthermore, when the effects were disentangled using the RI-CLPM, no significant cross-lagged paths whatsoever were found at the within-person level. One potential reason for these differing results lies in the modelling approaches. The findings from our CL2PM suggest the relationship may be directional rather than fully reciprocal when more comprehensive controls are included. The RI-CLPM results further specify that this directional influence appears to be a feature of children's overall developmental trajectories, as there was no evidence of a dynamic interplay between temporary fluctuations within an individual. What is consistent across the studies is the evidence for a robust, stable association between the abilities, which in the present study was captured by the significant correlation at the between-person level.

The absence of a predictive path from narrative ability to later executive functions in this study warrants further discussion. One possibility is that the relationship is truly asymmetrical during this developmental period. Executive functions, as foundational cognitive processes, may be a prerequisite for developing complex narrative ability, while the reverse is not necessarily true for children aged four to six. This may be because the "training effect" of storytelling on executive functions might emerge later in childhood, once narrative production becomes more self-directed and complex, requiring more sophisticated planning and self-monitoring. Finally, the nature of the executive function measure is an important consideration. This study focused on "cool" executive functions, which are assessed in abstract, decontextualized situations. However, the process of storytelling, which involves perspective-taking and is verbally mediated through inner speech, might primarily train "hot" executive functions used in more social and emotional contexts. This is a domain of executive functioning that the current study did not assess.

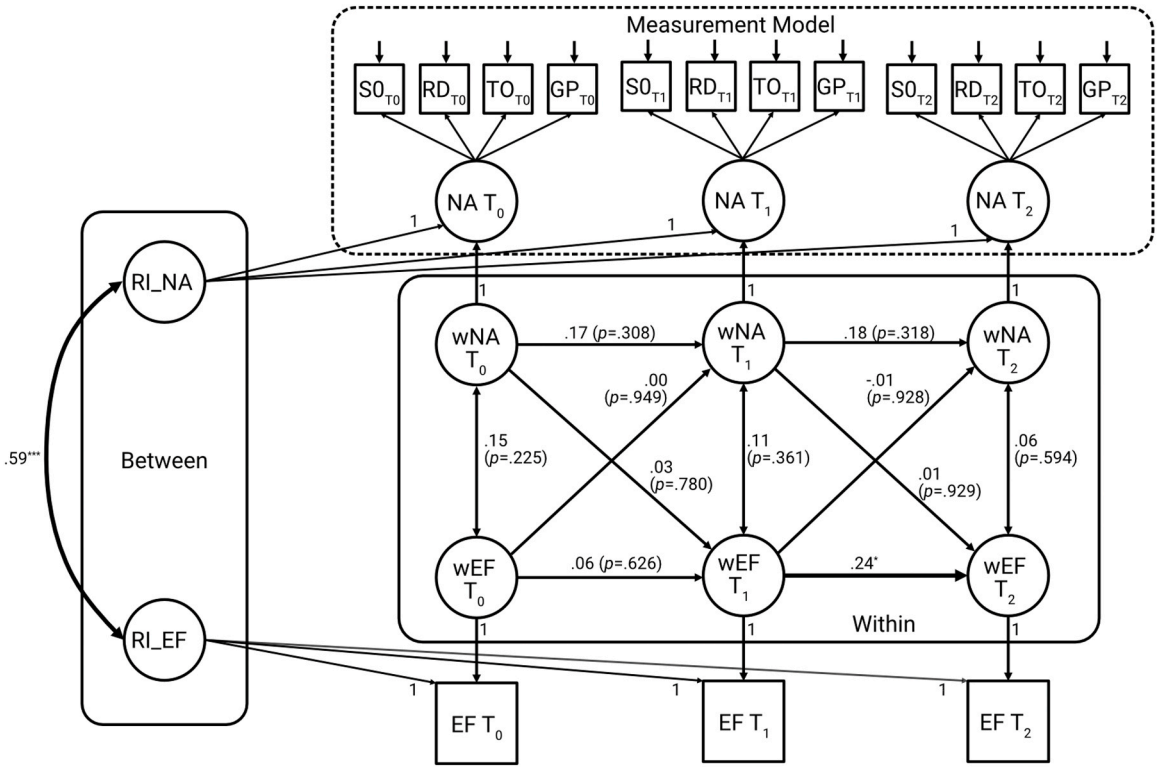

Fig. 3. Results of the Random Intercept Cross-Lagged Model with Narrative Ability and Executive Functions Note. The time points represent the approximate ages (T0 ≈ 5 years; T1 ≈ 6 years; T2 ≈ 6.5 years). RI_EF=random intercept of executive functions. RI_NA=random intercept of narrative ability. wEF=within component for executive functions. wNA=within component of narrative ability. GP=genre-specific patterns. RD=representation of distant content. SO=soloistic production. TO=textual organization.

The concurrent residual correlations in the CL2PM model show a diminishing trend. This pattern is best understood by first considering the statistical properties of the model itself. The model applies increasing control at each successive wave by including additional autoregressive and cross-lagged predictors. This, in turn, reduces the amount of unexplained variance available for correlation between the residuals. This statistical process must be considered when evaluating the developmental implications. In addition, the descriptive data (see Table 3) suggest that narrative ability and executive functions develop at different paces, following distinct trajectories. Executive functions exhibited rapid growth during the first two waves followed by consolidation, whereas narrative ability developed at a more sustained rate. This developmental differentiation could also be a contributing factor to the diminishing concurrent correlation. A plausible driver for this differentiation is the increasing integration of more advanced Theory of Mind abilities, as narratives evolve to require the management of character perspectives and motivations (Pelletier & Beatty, 2015). This could involve, for instance, interpreting complex narrative elements such as uncertainty and deception. While research by Hentschel et al. (2023) illustrates a more developed version of this interpretive ability in older children, it is plausible that the emergence of its foundational abilities in the younger sample of this study contributes to the observed differentiation.

The remarkably high correlation coefficient ($r = .58$, $p < .001$) at the between-person level in this study is notable. In their meta-analysis, Scionti et al. (2023) reported only moderate effect sizes ($r = .30$–$.50$) during preschool years. It is important to note that the between-person level of the RI-CLPM does not control for other potential impact factors, whereas the studies in the meta-analysis employed various covariates. Nevertheless, a significant positive correlation between narrative ability and executive functions at the between-person level is apparent. This high between-person correlation likely stems from multiple processes. While it could reflect influences that occurred before our measurement window or the presence of common underlying third factors, the results from the CL2PM model provides direct longitudinal support for a key contributing mechanism: a cumulative process where stronger executive function abilities consistently foster growth in narrative ability over time. It is therefore plausible that this ongoing, directional influence is a significant driver of the robust, stable individual differences captured by the between-person association.

It is crucial to interpret this between-person association with caution, as this statistical "between-subject factor" may not represent an inherent psychological trait (e.g., temperament) but rather a task factor reflecting the stable correlation between the two measures. This stable variance, in turn, could be explained by unmeasured individual differences, such as socioeconomic status or home literacy environment, which were not included in the model.

As previously stated, the cross-lagged paths at the within-level in the RI-CLPM showed no significance, suggesting the absence of a reciprocal relationship. Most of the autoregressive paths of the model also showed no significance. The RI-CLPM often results in

autoregressive parameters that are closer to zero and has larger standard errors than the traditional CLPM (Hamaker et al., 2015). Therefore, significant autoregressive parameters in a CLPM may not be significant in a RI-CLPM. Mulder and Hamaker (2021) recognized that the autoregressive parameters represent different phenomena in these two models. In the traditional CLPM, the autoregressive parameters capture the stability of the rank-order of participants between tests and are therefore related to test-retest reliability. However, in the RI-CLPM, this trait-like information is captured by the random intercepts at the between level. The autoregressive within-parameters account for additional moment-to-moment stability of the within-unit fluctuations over time. That is, they indicate how much an individual's deviation from their own expected level at one time point predicts their deviation from their own expected level in the next wave (Hamaker et al., 2015). Significant positive autoregressive paths would suggest that if a child performed higher than their own average in wave 1, they would likely still perform higher than their average in wave 2. The mostly non-significant autoregressive paths imply that a child being higher or lower than their own typical level provided little information about whether they would be higher or lower than their typical level in the next wave. These deviations from individual developmental trajectories appeared relatively temporary, perhaps reverting quickly towards the child's stable mean level or being influenced more strongly by immediate situational factors than by their state at the previous measurement wave. Therefore, while stable differences between children were accounted for by the random intercepts, there was limited evidence for predictable carry-over in the within-child variations around those stable levels from one wave to the next. In conclusion, the autoregressive parameters should not be seen as reliability measures in the RI-CLPM, since reliability and stability do not align for state-like concepts (Hertzog & Nesselroade, 1987).

It is essential to consider the limitations that may have influenced the results of this study. Previous research investigating the relationship between narrative ability and executive functions often utilized tests that assessed only one of the core components of executive functions (Drijbooms et al., 2017; Ögel Balaban & Hohenberger, 2020; Veneziano & Bartoli, 2022). However, in this study, the comprehensive screening measurement instrument MEFS was utilized to assess all domains of executive functions simultaneously. Developmental studies suggest that executive functions skills emerge through differentiation over the course of childhood. However, little is known about how and when this differentiation takes place (Zelazo & Carlson, 2020). A potential limitation of this study is that the simultaneous measurement of executive function domains may not accurately capture a potential link between a specific executive function and narrative ability. However, a meta-analysis found similar strengths of association between narrative ability and all domains of executive functions (Scionti et al., 2023).

Another limitation of measurement instruments used in this study is the partial measurement invariance of MuTex, the instrument used for assessing narrative ability. According to Mulder and Hamaker (2021), longitudinal invariance is crucial for calculating a RI-CLPM and making meaningful comparisons between the constructs measured at different waves. Furthermore, in this study, the intervals between the waves were unequal (T0, T1 - ~13 months later, T2 - ~5 months later), which did not allow for the constraint of lagged parameters or means. This lack of constraints resulted in a more complex model with a higher number of estimated parameters. In addition, a minimum of three waves are required to conduct a RI-CLPM provided that the means are not constrained. Therefore, having more waves would improve the accuracy of the results (Hamaker et al., 2015). Furthermore, the shorter second interval, which coincided with a slowing rate of gain for executive functions, may have reduced the variance available for analysis, potentially affecting the statistical significance of effects within that timeframe. Nevertheless, the only significant autoregressive path for executive functions occurred over this shorter interval during this period of slowing growth rate. This could reflect shorter-term persistence (only detectable over 5 months, but not 13 months) or perhaps a consolidation of executive function abilities late in kindergarten.

Narrative ability and executive functions develop significantly in children aged between 3 and 6. The average age at T0 was around 4;10 and around 6;5 months at T2. However, younger children aged 3–4 and children aged 7 were not included in this study, thus preventing examination of potential reciprocal relationships. Age has been shown to significantly influence the associations between narrative ability and executive functions, with the associations peaking at the age of 7 and then decreasing (Scionti et al., 2023). Although within-person effects were not observed in the study, these effects may nevertheless have been present. It is possible that within-person effects might have briefly appeared between measurement intervals and not during the performed measurements. Additionally, detecting the within-person effects requires careful consideration of statistical power. While formal power analysis for complex RI-CLPM models is challenging, results from previous studies indicate that associations between narrative ability and executive functions in this kindergarten age range are typically small to moderate ($r = .27$ –.32). Detecting such effects, especially potentially smaller within-effects generally require substantial power. Our sample size was determined by the recruitment outcomes of the parent EmTiK study. This sample size was sufficient for the robust between-person correlation, but may have limited our ability to detect potentially smaller within-person effects. This power consideration warrants caution in interpreting the null findings regarding within-person dynamics.

In conclusion, this study provides a nuanced account of the relationship between narrative ability and executive functions in kindergarten. The findings suggest a robust, stable connection between the two abilities, likely stemming from both shared underlying factors and a directional, cumulative process where a child's overall executive functions consistently predict the long-term growth of their narrative ability. However, there was no evidence of a more immediate, dynamic interplay where temporary fluctuations in one ability predicted changes in the other. Therefore, further investigation is necessary to clarify whether a general underlying factor, such as the capacity to build and use mental representational models, could explain both the stable association and the observed cumulative, directional influence, and to replicate these findings across different age groups and with larger samples.

CRediT authorship contribution statement

Claudia Hefti: Resources, Project administration, Investigation, Funding acquisition. **Dieter Isler:** Writing – review & editing,

Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition. **Judith Schönberger:** Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Fabio Sticca:** Writing – review & editing, Validation, Software, Methodology, Formal analysis, Data curation, Conceptualization.

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

During the preparation of this work, the first author used ChatGPT to check the accuracy of the grammar. After using this tool, the first author reviewed and edited the content as needed and takes full responsibility for the content of the publication.

Declaration of Competing Interest

None.

Acknowledgments

The study has been financed by the Swiss National Science Foundation (SNSF).

Data availability

Data will be made available on request.

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