**The serial mediation effect of parents' metamemory repertoire and metacognitive talk on children's associative memory**

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## Abstract

Recently, studies have revealed that parent-child interactions are one of the key drivers of children's memory development. Here, we investigated whether some specific parental behaviors and characteristics – i.e., the richness of parents' metamemory repertoire and their propensity to use metacognitive talk when interacting with their child – could mediate the well-known influence of parental education level on children's memory performance. To do so, 54 parent-child dyads with children aged between 24 and 46 months were recruited and tested at two-time points. Parents' metamemory repertoire was estimated using a questionnaire requiring to generate as many different strategies as possible to solve various memory scenarios. The frequency of parents' metacognitive comments during a standardized discussion about a past event with their child was used as a measure of metacognitive talk. An associative recognition memory task was used to assess children's memory performance. Our results revealed that the effect of parental education level on children's memory was serially mediated by children's exposure to metacognitive talk via the richness of parents' strategic memory repertoire. Specifically, parents with higher educational attainment were likely to nominate more memory strategies than parents with a lower level of education. In turn, having a rich metamemory repertoire increased the likelihood to be metacognitive when interacting with children which has a positive effect on children's memory performance. The importance of these findings for the sociocultural models of memory development is discussed.



Keywords: Metacognition; Parent-Child Interaction; Memory; Parental Education

## Introduction

The importance of parent-child interactions in early children's memory performance is widely recognized in the developmental literature (Fivush, 2011; Güler et al., 2010; Léonard et al., 2024), but all types of parent-child interactions do not appear to impact young children's memory in the same way. For instance, examining the content of parental reminiscing, Léonard et al. (2023) revealed that while metamemory references (i.e., when parents discussed memory performance and/or processes) was related to preschoolers' memory performance, it was not the case of other elements of the parents' discourse (e.g., when parents discussed the internal elements of the event or try to increase the coherence of the conversation by discussing external events), prompting questions about the potential mediating role of parental metacognitive behaviors on the well-known relation between classical indicators of home environment (i.e., socioeconomic status) and children's memory functioning.

Despite the still sparse literature in the field, available data seem to support the importance of parental metacognitive interactions for preschoolers' memory. For example, Geurten and Léonard (2023) have recently shown that parental metacognitive talk (i.e., every utterance produce by parents to help their child to monitor and regulate their own mental operations) during a shared play session was related to 2.5- to 4.5-year-old children's performance at both episodic and autobiographical memory tasks (see also Gardier et al., 2024). Along the same line, Güler et al. (2010) revealed that variations in the amount of verbal and non-verbal metacognitive information provided by mothers when participating in a collaborative sort-recall task with their 4-year-old children were concurrently and longitudinally (12 months later) related to children's own use of strategies and memory performance at a free recall test. Regardless of the various ways parents' metacognitive talk is assessed in the literature – i.e., from the frequency of mothers' mental state language when interacting with their 2-year-old children (Symons et al., 2006) to the verbalization of complex regulatory strategies when

children grow older (Güler et al., 2010) – results regarding the relation between parents' use of metacognitive talk and children's cognitive development appear quite consistent.

Interestingly, studies that have sought to identify the socioeconomic factors that could explain inter-individual differences in parental metacognitive interactions have revealed that parental education is the most strongly related factor, surpassing other indicators encompassed within socioeconomic status (Degotardi & Torr, 2007; Thompson & Foster, 2014). For example, Thompson and Foster (2014) reported that parental education level uniquely predicted the proportion of metacognitive questions used by mothers during a play session with their preschool child. In this study, mothers' occupation and the level of stress within the parent–child relationship were also included as predictors, but did not reach significance. Such findings are critical as they suggest that exposure to metacognitive talk could possibly mediate the well-established relation between parents' socioeconomic status and children's associative memory (e.g., Noble et al., 2007; Rosen et al., 2019). To date, however, no studies have directly tested this potential mediation.

Moreover, the fact that parental education level seems to uniquely predict the frequency of parents' metacognitive talk raises the question of the specific variables that are captured by educational attainment, but not by other indices of socioeconomic status, that are involved in parents' use of metacognitive talk. Here, we make the hypothesis that variations in the richness of parents' metamemory repertoire (i.e., what they know about memory functioning and strategies) could explain the education-related differences that are found in parental metacognitive interactions and, in turn, in children's memory performance. Indeed, the amount of knowledge people possess about how their mind works and can be improved is known to increase, in part, due to the cognitive demands of our educational systems (Van Overschelde, 2008). The question of whether this meta-knowledge is truly one of the missing links explaining

the relation between parental education level and metacognitive talk, however, remains to be formally documented.

For these reasons, the main goal of the present study was to test the serial mediation effect of both parents' metacognitive repertoire and parental metacognitive interactions on the relation between parental education level and preschoolers' memory performance. Such an analysis should allow us to bring light on the specific succession of mechanisms behind the effect of parental education on children's memory performance by testing whether differences in what parents know about memory strategies affect how they meta-communicate with their child and how it impacts memory at a crucial stage of its development.

To this end, we decided to examine this relation during early preschool years as it is a critical period for both memory – marked by the maturation of binding (with episodic associative memory emerging around 21 months of age, peaking at 52 months; Newcombe et al., 2014) and metacognitive processes (with explicit metacognition surpassing chance performance between ages 2.5 and 3.5; Gardier & Geurten, 2024) – and the impact of parental interaction on these processes (Fivush, 2011). Parents' metamemory repertoire was estimated using a scenarios-based questionnaire requiring to generate as many different strategies as possible when presented with a memory task. As parental metacognitive talk when discussing immediately after an event has been linked to both children's memory performance and to the amount of metacognitive talk produced by parents in other contexts (e.g., during a play session; Gardier et al., 2024), we assessed parental metacognitive interactions by analyzing parents' discourse during a standardized conversation with their child. Children's memory performance was assessed six months later using an associative recognition memory task known to be able to capture children's binding processes (Picard, et al., 2012) and metacognitive skills (Léonard et al., 2023). We expected the effect of parental education level on children's memory

development to be serially mediated by children's exposure to metacognitive talk via the richness of parents' strategic memory repertoire.

## Method

### Participants

Initially, 63 typically developing French-speaking children were recruited from January 2023 to February 2024 in the province of Liège (Belgium). Nine participants were excluded from the analyses because they chose to drop out between the two testing sessions. The final sample thus included 54 children (26 females; $M_{months}$=33.12, $SD_{months}$=6.04, *range*=24–46) and the parent with whom they interact with the most (48 females; $M_{years}$= 32.78, $SD_{years}$=5.01, *range*=20–43). Our sample was well balanced in terms of educational level assessed using the average years of education of both parents. Indeed, 15 children had parents with a low level of education ($M_{years}$=10.96, $SD_{years}$=0.70, range=10–11.5), 15 had parents with a medium level of education ($M_{years}$= 13.66, $SD_{years}$=0.71, range=12–14.5), and 24 had parents with a high education level ($M_{years}$=15.95, $SD_{years}$=0.76, range=15–18). Most of our sample was white (69%), but 22% was from Magreb and 9% from the Middle East. We ensured that these proportions remained roughly the same whether parents were from a low, medium or high educational background. A priori power analyses were computed using Monte Carlo power analysis for indirect effects (Schoemann et al., 2017). Results indicated a required sample of 53 participants to reach a predicted power of .80 for bias-corrected bootstrap mediation analyses including two serial mediators involving medium to large effect sizes (estimated on the basis of the effects reported in Geurten & Leonard, 2023) and one covariate.

### Procedure

This research was approved by a local ethics committee. Once recruited, the participants completed two sessions (about 30 minutes), 6 months apart. The first session took place in our

lab while the second session was held at home. In the first session, parental talk was assessed through a parent–child discussion of a standardized event and parents' memory strategy repertoire was assessed with a questionnaire, with both tasks administered in a counterbalanced order. Six months later, children completed a laboratory memory task adapted from Picard et al. (2012) assessing the ability to memorize new episodic associations. A 6-month delay was introduced so that even the youngest children of our sample would have been able to perform the associative memory task.

**Parental strategy repertoire.** Three scenarios loosely inspired by Geurten et al. (2015) interview of metamemory knowledge and taking the form of short memory-related situations frequently encountered in daily life were used to assess the richness of parents strategic memory repertoire. Specifically, Scenario 1 referred to a situation where participants had to generate as many relevant strategies as possible that could be useful when learning new information; Scenario 2 referred to a situation where participants had to generate strategies that could be useful to remember a past event; Scenario 3 referred to a situation where participants had to generate strategies that could be useful to avoid forgetting a future event. For each scenario, one point was granted each time a unique and novel strategy was produced. To determine whether a strategy was "novel", a classification inspired by Bjorklund at al. (2009) was applied. This classification included 9 categories of strategies encompassing the most frequently used strategies that are reported in the literature to solve memory tasks. No parents nominated strategies outside these nine categories. As there were large correlations between the 3 scenarios ($r$s>.61), the total number of strategies generated for all three scenarios ($M_{S1}$=3.78; $M_{S2}$=3.22; $M_{S3}$=2.80) was used as an estimate of the richness of parents' metamemory repertoire (Max=27). Interrater reliability was calculated on 20% of the transcripts. The mean percent of agreement was .92. Details of scenario and a description of the 9 categories of strategies are given in Table 1.

--Table 1--

Finally, additional data (n=36) were collected to ensure that our measure of strategy repertoire was not biased in favor of parents with higher education level (e.g., by referring to situations parents with more formal education were more familiar with). To do so, we recruited a new sample of participants (30 females; $M_{years}$=34.3; *SD*=6.04) including parents from low (n=12), medium (n=12) and high (n=12) education background as in the main sample. We then asked them to judge on a Visual Analog Scale (0-100%): (a) their degree of familiarity with each of the scenario of the questionnaire, (b) how important it would be for them to do well in these situations, and (c) the amount of effort they would be willing to put in such situations. The results are presented in Table S3 and revealed no differences between participants from low, medium and high education level for any of the scenarios.

**Parental metacognitive talk.** Parents' propensity to produce comments supporting children's metacognition was assessed by coding parents' talk when they discuss with their child about a specific past event. Specifically, following previous studies examining parental metacognitive talk during reminiscing (Gardier et al., 2024), all parent-child dyads first participated in a set of specific activities during which children performed several tasks with the help of their parent (i.e., coloring a banana in an unusual color; playing a card game; searching the room for a specific object during a hot-cold game). Immediately after these activities, each dyad was asked to discuss what they had just experienced as naturally as possible, without time constraints, and in the absence of the experimenter. Parent-child conversations ($M_{duration}$=206 sec.; range= 42–341) were videotaped so parental metacognitive utterances could be coded later.

Metacognitive talk included all parents' utterances aiming at supporting children's memory by helping them to monitor (e.g., by providing feedback) and regulate (e.g., by providing strategies) their internal states (the coding scheme is described in Table S1; Geurten & Léonard, 2023). From there, a global metacognitive index corresponding to the number of metacognitive

comments on the total number of utterances produced by the parent was computed. Interrater reliability was calculated on 20% of the transcripts, resulting in a mean percent of agreement of .94. Note that two parents did not produce any metacognitive comments during the discussion; excluding them from our analyses did not change our results.

**Associative memory task.** To assess children's associative memory, a version of the House test (Picard et al., 2012) modified to be used with children as young as 2.5 was administered at 6-month follow-up. This task was composed of two main phases: (a) an incidental encoding phase and (b) a forced-choice recognition phase.

*Encoding phase.* A board showing the front of a house and a timeline strip depicting the passage of time during a day were placed in front of the children. For each period of the day (i.e., morning, afternoon, and evening), six pictures were arranged in a random order below the board. The experimenter then described 9 activities performed in the house during the course of a day (3 per day period). Each activity consisted of three elements: (a) temporal context (e.g., ''on the morning''), (b) factual information (action + object; e.g., ''they poured water into,'' ''the aquarium''), and (c) spatial context (e.g., ''in the kitchen''). For each activity, children needed to pick up the pictures depicting the factual information and put them in the right area while orally providing the temporal context. Any errors were pointed out, and participants needed to rectify them after being given the information again. We moved to the next activity only when all elements of the previous activity were correctly encoded.

*Forced-choice recognition phase.* After a 10 min delay filled with non-verbal games, a forced-choice recognition test was administered. For each action and each type of information, participants were presented with three possible answers selected among the information that had previously been encoded (i.e., factual: ''Did the child pour the water into a vase, an aquarium, or a plant pot?''; spatial: ''Did this take place in the kitchen, the bedroom, or the garden?''). Note that children were not asked to recognize the temporal information as most of

them were not yet able to understand the difference between morning, afternoon, and evening. As our aim was to assess associative memory and not memory for isolated information, one point was granted only when both the factual and the spatial element of an activity were correctly recognized (maximum = 9 points).

**Children's vocabulary.** Children's level of vocabulary is known to be strongly related to both parents' level of education (Fernald et al., 2013) and their own memory (Kasperek et al., 2023). For this reason, a measure of lexical diversity was extracted from the parent-child conversations about the past and used to estimate children's level of vocabulary. Specifically, we calculated the proportion of different words produced by children during the discussion with their parent about the shared event on the total number of words they used during the conversations. We decided to use this measure because lexical diversity obtained through language samples has previously been shown to be an excellent marker of language change and maturity during the preschool years (Durán et al., 2004) in addition to being a good predictor of performance on a standardized reading vocabulary test (Wood et al., 2018). Moreover, estimating children's lexical diversity on the basis of children's production during the discussion with their parent allowed us to capture children's language when they spoke with a familiar interlocutor.

## Data analyses

The main goal of the current study was to investigate the mediating role of parents' strategy repertoire and metacognitive talk on the relation between parental education and children's memory abilities. To do so, item-by-item GLM bias-corrected bootstrap mediation analyses were carried out. All data were analyzed using the medmod R package. Effect sizes were estimated using $R^2$. All results were considered significant when the p-value was lower than .05.

# Results

Preliminary analyses first revealed no order effects on any of our variables, *ps*>.82. Second, Pearson's correlation analyses conducted to determine whether children's chronological age and vocabulary level were related to any of our variables indicated that children's age was significantly related to parental metacognitive talk, *r*=.19, and children's memory performance, *r*=.20. This factor was thus systematically controlled in all our analyses. Regarding vocabulary, once the influence of children's age was taken into account, no correlations were found with our main variables, all $r_p$<.18. Descriptive analyses for each variable are presented in Table 2 and S2.

--Table 2--

Before conducting any mediation analyses, the significance of all the paths tested in the model has to be established. To do so, GLM analyses were conducted. Confirming prior findings in the literature, we found that parental education had a significant positive impact on children's associative memory performance, *b*=.05, *z*=5.31, *p*<.001, $R^2$=.09, [path c]. Moreover, parents' level of education was related to their repertoire of memory strategies, *b*=.59, *z*=9.44, *p*<.001, $R^2$=.23, [path a]; i.e., the higher their education level, the more likely parents were to generate numerous and varied strategies when confronted with memory scenarios. Parental strategy repertoire had, in turn, a significant impact on the frequency of their metacognitive talk, *b*=.02, *z*=5.54, *p*<.001, $R^2$=.19, [path d], a pattern suggesting that parents with a richer strategy repertoire were more likely to be metacognitive when interacting with their child. Finally, both parental strategy repertoire, *b*=.04, *z*=3.65, *p*<.001, $R^2$=.04, [path b1], and metacognitive talk, *b*=.50, *z*=2.53, *p*=.01, $R^2$=.03, [path b2], were found to be related to children's associative memory performance.

**Mediation of Parental Repertoire**

Given that the various paths included in the model were all significant, we first examined the simple mediation effect of parental strategy repertoire on the relation between parental education and children's memory performance. Results indicated a significant indirect effect of parental education and memory performance through parental strategy repertoire, $b$=.02, $z$=3.89, $p$<.001, $R^2$=.13, [path a -> b1]. With this sole mediator included in the model, however, the direct effect of parental education on children's memory still remained significant, $b$=.02, $z$=2.29, $p$=.02, indicating that a significant part of the relation between parental education and children's memory performance was not explained by the richness of parents' strategy repertoire.

**Serial Mediation of Parental Repertoire and Metacognitive Talk**

To test the hypothesis that for parental strategy knowledge to influence children's memory performance, parents have to transmit this knowledge when they interact with their child, the serial mediation effect of parental strategy repertoire and metacognitive talk on the relation between parental education and children's memory performance was examined. The results revealed a significant indirect effect of parental education on memory performance through parental strategy repertoire and metacognitive talk, $b$=.01, $z$=2.44, $p$=.015, $R^2$=.16, [path a -> d -> b2]. Once the serial mediators were included, the direct effect of parental education on children's memory was no longer significant, $b$=.02, $z$=1.86, $p$=.06, [path c'], indicating a total serial mediation of parental strategy repertoire and metacognitive talk on the relation between parental education and children's memory performance (see Figure 1).

--Figure 1--

## Discussion

The aim of the present study was to examine the factors involved in the long-established relation between parental education level and children's memory performance. In view of recent

experimental data showing the importance of parental metacognitive interactions for children's memory performance (Gardier et al., 2024; Geurten & Leonard, 2023; Güler et al., 2010; Leonard et al., 2023), we postulated that parents' metamemory repertoire and the frequency of their metacognitive talk could mediate this relation.

By showing a serial mediation effect of parents' metamemory repertoire and metacognitive talk on the relation between parental education level and children's memory performance, our data seem to confirm this hypothesis. Importantly, the inclusion of both parental metamemory repertoire and metacognitive talk in the model appears to be necessary to fully explain the link between parents' education and children's memory. Specifically, our results reveal that parents with higher educational attainment are more likely to nominate memory strategies than parents with a lower level of education. As the ease with which people can access information is usually a reliable indicator of the richness of their semantic network (Duarte & Robert, 2014), this suggests that having an extensive – and thus easily accessible – metamemory repertoire increases the likelihood for a parent to be spontaneously metacognitive when interacting with their child. In turn, our data indicate that the frequency of parents' metacognitive talk is positively related to children's memory performance.

From a theoretical point of view, our findings are consistent with sociocultural models of memory development according to which social experiencing of the world – i.e., how children interact, play or reminisce with adults and peers – is one of the driving forces of memory maturation (e.g., Fivush, 2011). More specifically, our results are consistent with Gardier et al.'s (2024) assumption that by being repeatedly exposed to their parents' metacognitive comments across different contexts, children start to internalize these comments and understand that self-monitoring and regulation strategies are essential ingredients to support memory. Our findings here are important because they deepen our understanding of the inter-individual differences

that might increase the likelihood that parents implement interactional behaviors that are beneficial for their child's development.

Our data are all the more interesting that the retrieval memory condition assessed here (i.e., recognition) was probably not the best to estimate the full extent of the effect of parents' repertoire on children's memory performance. Indeed, in Geurten and Léonard (2023), the effect of parental metacognitive talk on children's memory was at its strongest when memory was assessed using a free recall task (i.e., the retrieval condition that relies the most on the implementation of strategies), suggesting that the impact of parents' metamemory repertoire on children's memory performance could have been even stronger under different retrieval conditions.

Overall, the current study raises a number of interesting issues, but also has some limitations. First, the results reported here remain correlational in nature. Future studies should be conducted to test whether parental metamemory repertoire and metacognitive talk truly impact young children's memory development in a causal manner. To do so, interventional studies manipulating one or both of these variables should be conducted. In the same vein, the use of a longitudinal design would allow examining the developmental stability of our mediation model by determining whether and how the effect of the richness of parental strategic repertoire and metacognitive talk on children's memory varied with age. Moreover, while we decided to focus our research on the effect of parental education level, the question of whether other indicators of socioeconomic status (e.g., incomes, occupations, etc.) might be better predictors of parental differences in metacognitive repertoire and talk should be formally examined. Furthermore, here, parental metamemory repertoire and metacognitive talk were only assessed for one parent. To better capture the influence of parental practices on children's memory, these measures should have been assessed for all parenting figures. This is all the more important that studies have not always been successful in finding relations between different estimates of parental

practices and children's cognitive performance (Girard et al., 2023), making it critical to identify which interactional behaviors influence children's cognitive development, and how.

Despite these limitations, however, the present findings remain important because they shed light on the relation between external factors such as parental education, metamemory knowledge and metacognitive interactions and children's memory functioning. If confirmed, our data could suggest that an improvement of parental metacognitive repertoire and talk at the very beginning of child development (e.g., through psychoeducation and supervised practice) could positively boost children's memory later in development.

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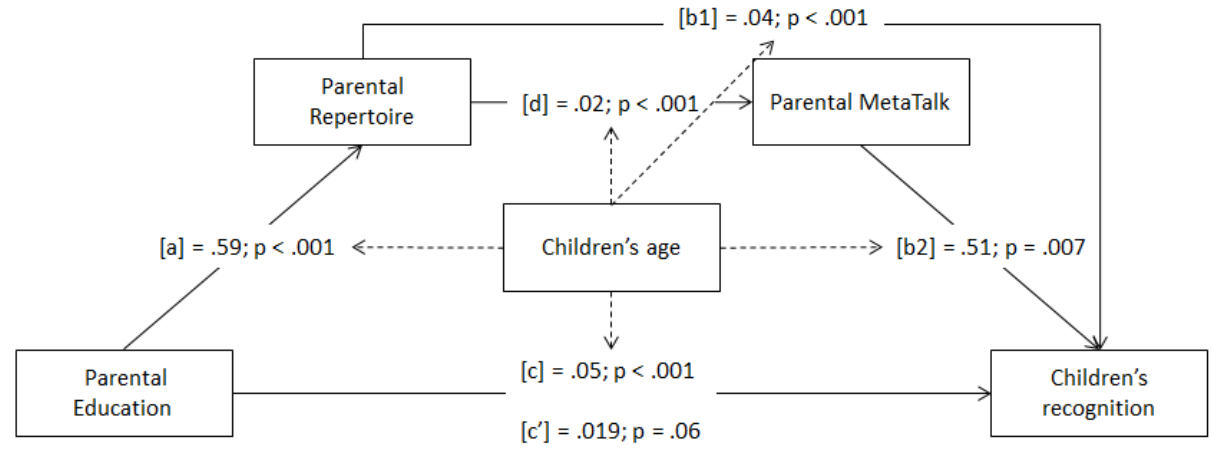
**Table 1.** Details of Scenario, Memory Strategy Categories and Examples of Responses to the Questionnaire Assessing Parental Strategy Repertoire.

| Scenario | | |
|---|---|---|
| S1 Imagine attending a professional training course ending with an exam. Before and during the exam, what strategies could you use to memorize/retrieve the course content? | S2 Imagine taking your child to an amusement park. During and after the day what strategies could you use to make sure your child remembers this day? | S3 Imagine making a medical appointment. What strategies could you use to increase your chances of not forgetting to go. |
| Strategies | Definition | Examples |
| Rehearsal | Simple or cumulative repetition of the information | "*I repeat it until I'm sure I won't forget to go.*" |
| Organization | Organizing the information into meaningful categories | "*I underline in the same color information that goes together."* |
| Elaboration | Creating new associations between to-be-remembered information | "*I make a summary or a synthesis.*" |
| Cue generation | Generating cues to support the encoding/retrieval of the information | "*I give them cues until they remember.*" |
| Allocation of study time | Adjusting the amount of time or effort allocate to remember information | "*I study the difficult parts longer.*" |
| Self-testing | Practicing the retrieval of information via an evaluation | *"I prepare with a mock exam."* |
| Reminiscing | Practicing the retrieval of past experiences | "*I often discuss it with them in the following days."* |
| Memorability-based | Using expectations about the memorability of information to guide memory decisions | "*I try to do activities that will be memorable for them."* |
| External help | Using external aid to support the encoding/retrieval of the information | "*I set a reminder on my phone.*" |

**Table 2.** Descriptive Statistics for all Parents' and Children's Outcomes.

| | Mean (SD) | Range (Min – Max) |
|---|---|---|
| Parents | | |
| Education Level | 13.9 (2.20) | 10 – 18 |
| MetaRepertoire | 9.41 (2.70) | 4 – 17 |
| MetaTalk | | |
| Rate of MetaTalk | 0.20 (0.12) | .00 – .51 |
| TotUtterances | 35.4 (17.1) | 7 – 74 |
| Children | | |
| House Rec. | 2.66 (4.05) | 0 – 9 |
| Vocabulary | 0.58 (0.34) | .00 – .67 |

*Note.* SD = Standard Deviation; MetaRepertoire = Richness of parental repertoire about memory strategies; MetaTalk = Rate of parental metacognitive talk; TotUtterances = the total number of utterances produced by the parent during the discussion about the past; House Rec. = Children's recognition performance at the House test. Note that one child did not produce any words during the conversation with their parent and another child gave no correct response at the House test. Excluding these children from our analyses, however, did not change our results.




| Relations | Total Effect | Direct effect | Indirect effect | 95% CI |
|---|---|---|---|---|
| Educ. -> Rep. -> Recog. | .05** | .02* | .02** | [.012 – .036] |
| Educ. -> Rep. -> MetaTalk -> Recog. | .05** | .019 | .03* | [.002 – .045] |

**Figure 1.** Serial Mediation Analyses. Educ. = Parental Education Level; Rep. = Parental Strategy Repertoire; MetaTalk = Parental Metacognitive Talk; Recog. = Children's recognition; CI = Confidence Interval; * $p < .05$; ** $p < .001$.