The origins of children's metamemory: The role of theory of mind.

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Abstract

The relation between preschoolers' theory of mind (ToM) and declarative metamemory (DM) was investigated in two studies. The first study focused on 4-year-old children's (N = 106) cognitive and affective ToM and their DM. The data showed a significant association between cognitive (but not affective) ToM and DM, independent of verbal ability, non-verbal ability, and working memory. The second study involved 83 children tested at 4 years 6 months of age (and 6 months later) for cognitive ToM and DM. Here, results showed that early cognitive ToM, in particular false-belief understanding, predicts later DM independent of early verbal ability. These data support a view considering cognitive ToM as a precursor of children's DM.

Keywords: theory of mind, DM, cognitive theory of mind, affective theory of mind

The Origins of Children's DM: The Role of Theory of Mind

DM (DM) refers to an individual's knowledge and beliefs about the functioning of their own memory (Flavell & Wellman, 1977; Schneider, 1999). It refers to conscious, explicit knowledge about factors that affect memory performance, and includes not only knowing that a range of variables affect memory, but also knowing why they do it. DM comprises knowledge about memory tasks, memory relevant variables and potential applicable memory strategies, as well as beliefs about the capacities, functioning, and limitations of the memory system. It is assessed using off-line tasks, such as questionnaires.

Overall, existing studies show substantial improvements in DM between kindergarten and early school years (e.g., Cavanaugh & Borkowski, 1980; Fritz, Howie, & Kleitman, 2010; Sodian, Schneider, & Perlmutter, 1986), with preschool children showing a basic understanding of metamemory-relevant variables (Kreutzer, Leonard, & Flavell, 1975; Lockl & Schnedier, 2007; Wellman, 1977). Given the effects of metamemory on children's learning (Schneider, 2008), it is striking that very few studies have investigated the origins of children's knowledge about memory. An approach that seems fruitful in addressing this issue is one that links children's emerging DM to individual differences in theory of mind (ToM).

ToM is defined as the ability to attribute mental states such as beliefs, emotions and intentions, to self and others in order to predict, influence and manipulate social behavior (Wellman, Phillips, & Rodriguez, 2000). After many years of research in this area, we now know that children acquire important milestones during preschool years (Wellman, Cross, & Watson, 2001), following a predictable developmental trajectory (Pons & Harris, 2000; Wellman & Liu, 2004). Crucially, research has shown the existence of strong individual differences between children of the same age (Cutting & Dunn, 1999), with important consequences for children's social and cognitive development (Hughes, 2011; Lecce, Caputi, & Pagnin, 2014).

In studying the connections between ToM and DM, great emphasis has been placed on the theoretical model developed by Deanna Kuhn (2000), which positions the acquisition of ToM understanding in the larger context of metacognitive development. According to this framework, ToM appears early, and is viewed as a basic metaknowing concerning the content of the mind and the nature of mental states. Metacognition is considered a subsequent (and more mature) ability encompassing knowledge about cognitive processes, and the links between these cognitive processes and cognitive performance. In addition, it involves procedural knowledge; that is, the application of metamemory during memory performance. Kuhn's model is extremely pertinent for the purpose of the present study as it claims that ToM serves as a base for the development of metacognition. Indeed, Kuhn posits that having a concept of mental states, such as beliefs, is a necessary initial step for thinking about the strategies to solve a cognitive task.

Despite being an innovative approach, very few studies have empirically tested this model. To date, the most comprehensive research on the relation between ToM and DM has been conducted by Lockl and Schneider (2007), who focused on children's false- belief understanding (i.e., the understanding that beliefs are separate and distinct from the reality , Perner, 1991). Lockl and Schneider (2007) followed a sample of German preschoolers for three years; from age 3 (Time 1), age 4 (Time 2), and finally, age 5 (Time 3). Participants were tested for verbal ability (at Time 1, Time 2, and Time 3), false-belief understanding (at Time 1, Time 2, and Time 3) and DM (at Time 3). Findings showed strong relations between false-belief understanding and DM, with false-belief understanding at Time 1 and Time 2 predicting DM significantly at Time 3, independently of verbal ability.

The results of Lockl and Schneider's study are original and have contributed considerably to increasing interest in this area of research. However, they leave a number of questions open. First, on the basis of Lockl and Schneider's work, we do not know whether the relation between ToM and DM is specific for cognitive ToM (such as false-belief understanding) or, rather, generalized to other domains of ToM, such as emotion understanding. Second, given that Lockl and Schneider (2007) measured DM only at Time 3, they were unable to test the relation between early DM and later ToM. Thus, the question of whether the relation between ToM and DM is uni- or bidirectional remains open for investigation. Answering these questions is relevant both theoretically and empirically (see the final discussion for more comments on this issue).

In the present paper, we conducted two separate studies to answer these questions. Both focused on 4- to 5-year olds, as in this developmental period, individual differences in ToM are shown clearly (Wellman et al., 2001) and DM begins to emerge (Wellman, 1977). Study 1 was designed to examine the specificity of the relationship between ToM and DM, by comparing cognitive vs. affective ToM and by taking into consideration a number of control variables. Study 2 expanded on the findings of Study 1, by using a longitudinal design in order to examine the direction of the relation between ToM and DM.

The specificity of the relationship between ToM and DM

As mentioned above, ToM is a complex developmental phenomenon that encompasses a wide range of mental states (see Astington, 2001; Wellman, 2012). One important distinction is that between the cognitive and affective ToM. Cognitive ToM concerns children's ability to understand cognitive states, and requires an appreciation of the differences between the speaker’s knowledge/belief and that of the listener. During the preschool years, children acquire a critical ability in this domain; false-belief understanding. As we might expect, this acquisition marks children's understanding that one acts based on one’s beliefs, even when these can differ from reality (Wellman et al., 2001). Affective ToM concerns children's ability to infer emotions and feelings, and it requires empathic appreciation of the listener’s emotional state. At preschool age, children become able to name different emotional expressions (e.g., happy, sad, angry and neutral), and come to understand that external events cause emotions (Pons & Harris, 2000). Recent studies on typically-developing children encourage consideration of cognitive and affective ToM separately from one another, as they do not correlate significantly when language and family socio-economic status are taken into account (Cutting & Dunn, 1999; Hughes, Lecce, & Wilson, 2007), and may show different consequences (Dunn, 1995). Similar conclusions can be drawn from neuropsychological studies on populations with typical development (Kalbe et al., 2010) and psychiatric disorders (Shamay-Tsoory, Aharon-Peretz, & Levkovitz, 2007).

To date, only one study has compared children's cognitive and affective ToM in relation to metacognition. This research, conducted by Lecce and colleagues (Lecce, Zocchi, Pagnin, Palladino, & Taumoepeau, 2010), involved a sample of Italian primary school children. It focused on children's metaknowledge about reading comprehension, and showed that, whereas cognitive ToM (indexed by cognitive mental state language and the Strange Stories task) was significantly associated with metaknowledge about reading, affective ToM (indexed by emotion mental state language and the Test of Emotion Comprehension) was not. Importantly, the relation between cognitive ToM and metacomprehension was independent of expressive and receptive language, and of reading comprehension skills.

Although Lecce et al.'s (2010) work focused on children older than those considered in the present study, and on metacognition applied to a reading comprehension task, we expected to find similar results with respect to DM. There are three main reasons for expecting DM to be closer related to cognitive than affective ToM. First, children's DM presupposes a familiarity with cognitive (such as "remembering" and "forgetting") rather than affective (such as "happy" or "sad") mental state terms (Wellman & Johnson, 1979), which seem to be more closely related to positive dimensions of social behavior, such as prosocial behavior (Denham, 1986; Iannotti, 1985). Second, a central step in children's awareness of their own memory functioning is the understanding that knowledge states depend on informative experience (see Welch-Ross, 2000). Importantly, this recognition, as argued by Lockl & Schneider (2007), is also a crucial component for passing the false-belief task which forms a critical component of cognitive ToM. For example, in order to understand that the presence of noise, or the number of items to remember, affects the memorization process, children need to understand the links between experience and knowledge state, and that knowledge of an event depends strictly on the experience concerning that event. In line with this view, Bright-Paul and colleagues (2008) have shown that children's understanding of the origins of knowledge is linked significantly with false-belief understanding in preschoolers. Finally, in examining the links between cognitive ToM and DM, it is important to consider that awareness of the processes underlying acquisition of new knowledge (e.g., acquiring new memories) becomes possible only when children address the concept of representational change, typically assessed through false-belief tasks (Gopnik & Astington, 1988). Overall, then, these considerations, together with existing findings, lead us to expect DM to be more closely related to cognitive than affective ToM. However, it is important to note that affective ToM is itself a component of ToM, and that it is possible that commonalities between the two types of ToM might play a role in the development of DM. To examine this issue, we designed Study 1.

The direction of the relationship between ToM and DM

The second main goal of the present study was to investigate the direction of the relationship between ToM and DM. As cited above, Kuhn's theoretical model (2000) and data from Lockl and Schneider (2007) suggest that ToM, and in particular false-belief understanding, is a precursor of metacognition, and that the acquisition of mental state reasoning is a necessary initial step in the development of metacognition. However, existing data did not test this prediction fully, as they did not measure both false-belief understanding and DM at two time points. More stringent tests are needed in order to demonstrate a clear direction between ToM and DM.

New studies are especially needed to understand the developmental process from theory of mind to metacognition better, and in particular, to metamemory. Despite the fact that existing research and theoretical models lead us to expect that individual differences in children's ToM may prepare the way for their later DM, we still know very little about the nature of conceptual changes. One possibility is that there is a general continuity between ToM, as the sum of the various sub-components (see Wellman & Liu, 2004), and metamemory; if so, we should find an association between children's progression in ToM understanding (as a global index) and later DM. Alternatively, it is possible that some components of ToM would more closely linked to later DM than others. Here, we acknowledge that individual differences in children's ToM in general may prepare the way for their later DM. It is, indeed, evident that unless children are aware of the existence of mental states and of their subjective nature, they cannot think about how these mental states work in a memory task. This position is emphasized by Bartsch & Estes (1996), according to whom, ToM understanding provides a foundation for thinking about mental states and their relation to cognitive tasks. Given this, we argue that ToM is a complex ability, made up of different components and concepts that develop at different ages (Wellman & Liu, 2004) and these sub-components are likely to have differential impact on later metamemory. More precisely, we expect early false-belief understanding, more than other basic aspects of ToM understanding, such as perspective taking and comprehension of ignorance, to predict later DM. There are at least three main reasons (in addition to the ones outlined above) for such a prediction. Firstly, as noted by Flavell and colleagues (Flavell, Green, & Flavell, 1998; 2000) early mastery in false-belief understanding helps the development of metacognition, because it brings mental activity to the attention of the child. Passing a false-belief task is, indeed, the first clear evidence of an understanding that mental representations do not necessarily correspond to reality and, thus, can themselves become objects of consideration. This discovery prompts children to reflect on their cognitive activity, paving the way for the development of explicit metacognition that would be impossible in the absence of this ‘mindreading’ (Kuhn, 2000; Efklides, 2008). Secondly, children’s DM requires an acquaintance with terms indicating cognitive activities, and the ability to infer and to reflect on cognitions. Importantly, individual differences in children's use and understanding of mental state terms are associated with false-belief understanding (Grazzani & Ornaghi, 2012; Hughes & Dunn, 1998), and mark full understanding of specific mnemonic conceptions (Wellman & Johnson, 1979). Here, it is important to note that a basic understanding of memory-related verbs seems to follow a mastery of the classic false-belief task. More precisely, Lyon and Flavell (1994) have shown that only at about four years of age, when most children pass 1^{st} order FB tasks, that they understand it is possible to remember or forget something only if they have previously known it. Thirdly, mastery of 1^{st}-order-FB tasks requires an understanding of the concepts of knowledge and beliefs, and this understanding is also involved in some aspects of metamemory. Indeed, as Lockl and Schneider (2007) have argued, a crucial component for passing 1^{st}-order-FB tasks is the understanding that beliefs derive from experiences in the world. These acknowledgements are likely to play a role in children's knowledge of memory processes, and, more precisely, in their awareness of the variables that affect memory performance. Overall, these considerations fit the view of considering false-belief understanding, rather than earlier ToM acquisitions, as a crucial precursor for helping children to understand the link between mental representation and memory. To test this hypothesis in Study 2 we compared the association between early pre- vs. false-belief understanding with later DM.

Study 1

Study 1 addressed our first goal, the specificity of the relationship between ToM and DM in two ways. First, it compared cognitive and emotion understanding to investigate whether the association between ToM and DM is specific for some, and not others, categories of mental states. Second, it examined if the relation between ToM and DM was independent of children's verbal ability, non-verbal ability, and working memory. This is a crucial issues as, previous studies have showed that declarative knowledge and cognitive understanding are facilitated by verbal and non-verbal abilities (Lockl & Schneider, 2007; Schneider, Korkel, & Weinert, 1987; Milligan, Astington, & Dack, 2007), as well as working memory (Demetriou, 2009; Gordon & Olson, 1998). Therefore, we considered these as control variables.

1.2 Method

1.2.1 Participants

A total of 106 preschoolers (*M* = 4.5 years; *SD* = 6.5 months), 46 boys and 60 girls, took part in this study. Children were recruited from four kindergartens in the North of Italy and were all Caucasian. Family backgrounds ranged from lower to middle class. Criteria for inclusion were: informed consent from parents, Italian as native language, and no developmental delay.

1.2.2 Measures

Verbal Ability. This was assessed via the TROG (Test of Receptive Grammar, Bishop, 1982; Italian adaptation: Cendron, Lonciari, & Sartori, 1995, personal communication), which evaluates semantic and syntactic skills. Children were required to match a picture to a word (or a sentence), choosing between 4 alternatives. One point was given for each correct item (range 0- 80, α = .83).

Non-verbal Ability. This was assessed via the Coloured Progressive Matrices (Raven, Court, & Raven, 1986). Scores on the three series of matrices (A, B, AB) were summed (range 0 – 36, α = 74).

Working Memory. This ability was assessed using the Dual-request-word-recall task (Lanfranchi, Cornoldi, & Vianello, 2004). Children were read 8 lists of 2 to 5 two-syllable words and were asked to repeat the first word of the list, while simultaneously tapping on the table every time the word *ball* was presented. One point was assigned for each list correctly responded to (range 0 - 8, α = .81).

Cognitive Theory of Mind. This was assessed via the Theory of Mind Test (TMT; Pons & Harris, 2002), which examines cognitive (and not emotion understanding). It evaluates the following ten components of cognitive understanding (Flavell, 2004): (I) level 1 of perspective taking, (II) level 2 of perspective taking, (III) comprehension of intentionality, (IV) comprehension of ignorance, (V) comprehension of false belief, (VI) comprehension of the distinction between appearance and reality, (VII) comprehension of lies, (VIII) comprehension of jokes, (IX) comprehension of second order false belief, and (X) comprehension of double-bluff. While showing a cartoon scenario, the experimenter read an accompanying story about the depicted character(s) or the content of the picture. After hearing each story, children were asked to attribute a cognition to the main character, by pointing to one of two alternative outcomes depicted below the scenario. Each component was evaluated via two items, and children were given 1 point for each category in which they passed both items (range 0 - 10, α = .69).

Affective Theory of Mind. This was measured through the Test of Emotion Comprehension (TEC; Albanese & Molina, 2008; Pons & Harris, 2000). The TEC gives an overall score of emotion understanding, by evaluating nine components with a hierarchical organization: (I) Emotion understanding based on facial expression; (II) Understanding of external causes of emotion; (III) Emotion understanding based on desires; (IV) Emotion understanding based on beliefs; (V) Understanding of the influence of a reminder on the present emotional state; (VI) Understanding of the capacity to control a felt emotion; (VII) Understanding of the capacity to hide an emotion; (VIII) Understanding of mixed emotions; (IX) Understanding of moral emotions. The task consisted of a picture book with a simple scenario on each page. While showing each picture scenario, the experimenter read the accompanying story with a neutral tone of voice. After hearing each story, children were asked to attribute an emotion to the main character (whose face was blank) by pointing to one of four alternative emotional outcomes depicted below the scenario. Two items per component were administered, and children were given 1 point for each category in which they passed both items (range 0 – 9, α = .74).

DM. This aspect was evaluated via two measures: the DM-vignette (Cornoldi & Orlando, 1988) and the DM-story task (Cornoldi, Gobbo, & Mazzoni, 1991).

The DM-vignette task (Cornoldi & Orlando, 1988) is based on items originally developed by Kreutzer (Kreutzer et al., 1975) and Wellman (1977). It evaluates children's knowledge of the following four memory-relevant variables: I) presence or absence of noise, II) number of items to remember, III) random vs. categorized order of the items to remember, and IV) memory strategies (e.g., drawing). Children were shown four pairs of illustrated vignettes, identical except for the memory variable tested in that specific item. The following is a description of the scenarios depicted for each of the pair of vignette: (I) Noise: a vignette of a child in a room with a lot of noise (e.g., a radio playing and barking dog) versus a child in a quiet room; (II) Number of items: a vignette of a child with a lot of objects to remember versus a vignette of a child with few objects to remember; (III) Classification: a vignette of a child with a list of objects to remember placed randomly versus a vignette of a child with a list of objects to remember ordered by category (e.g., vehicles, toys, etc.); (IV) Drawing: a vignette of a child trying to remember by looking at the objects versus a vignette of a child drawing pictures of the objects that need to be remembered.

For each pair of vignettes, the experimenter briefly described the drawings before asking children a test question (e.g., “which girl will remember all the items?”). One point was given for each vignette (range 0 – 4, α = .74).

The DM-story task (Cornoldi et al., 1991) examined children’s knowledge about memory strategies, using a narrative format. It was chosen as narratives offer children an important opportunity to organize social experience (Bruner, 1986) and reflect on mental states (Dyer, Shatz, & Wellman, 2000). The story was entitled “The Captive Princess” and was divided in two sections, each followed by a group of questions. It comprised a story of a prince, who has to meet a wise man in order to discover how to undo a spell and free a princess. Children are told that, once the antidote for the spell has been revealed (i.e., a sequence of actions), the prince has to make a very long journey to return to the castle where the princess has been imprisoned. The first section of the story ends with the prince in front of the castle and is followed by 3 questions. The first two questions assess children’s knowledge of forgetting and were: 1) “Will the prince remember what to do to free his princess?”, and 2) “(In fact,) the prince did not remember, so why does he not remember ?”. The third question evaluates children’s knowledge of retrieval and was: “What can the prince do in order to remember the antidote?”. When the children have answered these questions, the second section of the story starts. Children are told that the prince decides to go back to the wise man. Once there, the wise man repeats to the prince what he has to do in order to break the spell; and the prince comes back again to the castle. At this point of the story, children are asked the final question (“What can the prince do in order to be sure to recall what to do?”) assessing their knowledge of memory maintenance strategies. In this last question, children are encouraged to give as many answers as possible.

Children’s answers were coded according to the criteria presented by the authors (Cornoldi et al., 1991), including an evaluation of the maturity of children’s knowledge of memory strategies (for more details, see Cornoldi et al., 1991). More precisely, children’s knowledge of forgetting (first two questions) was evaluated on a 0 (e.g., “don't know" response or “Yes the prince will remember” without any justification) to 7 (e.g., “The prince will not remember because he did not think about the instructions and got distracted by the trip") scale. This scale assesses children 's knowledge that: a) information decays from memory, b) information is sensitive to time delay between coding and retrieval as well as on how such time is used to strategically rehearse memory information. Children’s knowledge of retrieval was evaluated on a 0 (e.g., "don't know") to 5 (e.g., "he can think carefully about those three things in his head") point scale. This scale assesses children 's knowledge of the necessity of doing something before information decays from memory and of the role of mental activity in contrasting decay. Children’s knowledge of storage was evaluated, coding the maturity of each strategy mentioned on a 1 (e.g., magic retrieval) to 3 (e.g., rehearse information in memory, so that they can be fixed in the head) point scale, and then summing these. Scores on this scalereflect the efficacy of metamemory strategies to contrast decay. Although the Alpha was modest (= .55), the three scales were all significantly associated with cognitive ToM ($r \geq .29$, $p = .003$). Therefore, as suggested by the authors of this task, we computed an overall score of children's knowledge of memory strategies by summing raw scores of each answer.

1.2.3 Procedure

All tasks were administered individually in the children's kindergarten. At each time point, children participated in 3 testing sessions of approximately 20/30 minutes each. During the first session, children were administered the verbal-ability, non-verbal-ability, and the working-memory task; in the second session, they completed the DM-story task and the affective ToM tasks. In the last session, they undertook the DM-vignette and the cognitive ToM tasks.

1.3 Results

First, we present descriptive statistics for each study measure and data reduction strategies for constructing DM-knowledge indexes. Next, we report findings concerning associations between control and key variables, and associations between cognitive and affective ToM. Finally, we consider links between children's ToM and DM.

Table 1 provides a summary of the descriptive statistics for metamemory tasks. Results showed that children had difficulties in identifying categorization as an efficient memory strategy but that they understand that remembering fewer items is easier than remembering many. With reference to the metamemory-story task, results on percentage of success showed that their knowledge of forgetting was better than their knowledge of retrieval, $t(105) = 2.55$, $p = .012$, and of storage, $t(105) = 3.35$, $p = .001$.

Table 1.

Descriptive statistics for items in declarative metamemory tasks

Task		*M* (*SD*)	Actual Range
Vignette task	Noise	.64 (.48)	0-1
	Number	.70 (.46)	0-1
	Category	.49 (.50)	0-1
	Drawing	.54 (.50)	0-1
Story Task	Knowledge of Forgetting	2.64 (1.19)	0-6
	Knowledge of Retrieval	1.59 (.88)	0-4
	Knowledge of Storage	1.16 (.95)	0-4

Descriptive statistics for all study tasks are shown in Table 2.

Table 2

Means and (Standard Deviations) of scores for Study 1 Key Variables.

Variable	Task	*M* (*SD*)	Actual Range
Verbal Ability	TROG	55.42 (16.40)	0-78
Non Verbal Ability	Raven Matrices	17.24 (3.95)	0-27
Working Memory	Dual-request-word-recall task	4.1 (1.81)	0-8
Cognitive ToM	TMT	6.64 (1.5)	0-10
Affective ToM	TEC	5.16 (1.53)	0-8
Declarative Metamemory	Vignette task	2.37 (1.08)	0-4
	Story Task	5.40 (2.05)	0-10

TROG: Test for Reception of Grammar; TMT: Theory of Mind Test; TEC: test of Emotion Comprehension

Inspection of correlations showed that individual differences in the DM-vignette and DM-story task were significantly associated with one another, $r(106) = .48$, $p < .001$; therefore, we created an aggregate index of DM by summing z scores on each task.

Table 3 shows the pattern of correlations between the study variables. As expected, individual differences in cognitive ToM, affective ToM, and DM were all significantly associated with individual differences in control variables: verbal abilities, non-verbal abilities, and working memory. The only exception was a lack of association between working memory and affective ToM. Given these results, children's scores in verbal and non-verbal abilities and in working memory were treated as control variables in the following analyses. Table 3 also shows that children's cognitive and affective ToM were significantly associated. Nevertheless, when we computed partial correlation analyses, controlling for verbal ability, non-verbal ability and working memory, the value of this correlation fell below the significance level, *r*(101) = .09, *p* = .34. This finding supports our decision to consider them separately.

Table 3. *Correlations Between Study 1 Variables*

	NVA	WM	C_ToM	A_ToM	DM
Verbal Ability (VA)	.51***	.41***	.54***	.57***	.58***
Non Verbal Ability (NVA)	-	.17	.33**	.38***	.41***
Working Memory (WM)		-	.28**	.05	.21*
Cognitive ToM (C_ToM)			-	.36***	.51***
Affective ToM (A_ToM)				-	.37***
Declarative Metamemory (DM)					-

* *p* < .05; ** *p* < .01; *** *p* < .001;

The main goal of Study 1 was to examine whether children’s cognitive and affective ToM were related to DM differently. Our results showed that individual differences in DM were significantly correlated with both cognitive and affective ToM. However, when we controlled for verbal, non-verbal abilities and working memory, the relationship between DM and cognitive ToM, *r*(101) = .29; *p* = .003, remained significant but not that between DM and affective ToM, *r*(101) = .08; *p* = . 34. Crucially, the difference between these two indices of partial correlations was marginally significant, *Z* = 1.615, *p* = .05, one tailed.

1.4 Discussion

The main aim of Study 1 was to investigate the relationship between preschoolers' ToM and DM. We were particularly interested in examining whether this association was: (a) independent of verbal, non-verbal, and working memory abilities, and (b) differed, depending on whether we considered children's cognitive or affective ToM.

The most important finding of Study 1 was that the association between preschoolers' ToM and DM was significant when we controlled for verbal ability, non-verbal ability, and working memory, and was specific for cognitive, but not affective, ToM understanding. Crucially, the correlation between cognitive ToM and DM was significantly stronger than the one between affective ToM and DM. These results confirm our predictions and are also consistent with the claim that acquisition of an understanding of mental representation promotes the development of DM as proposed by Kuhn (2000). Our results also fit with empirical findings on German (Lockl & Schneider ,2007) and Cypriot children (Demetriou, 2009). In addition of confirming existing findings our study also expands them by adopting new measures of both ToM (TMT by Pons & Harris (2002) and metamemory (Story task by Cornoldi, Gobbo, & Mazzoni, 1991) and involving younger children.

Study 1 represents the first clear demonstration that the relationship between ToM and DM in preschool years does not generalize across domains of mental-state understanding, but is specific to cognitive ToM. However, although Study 1 yielded interesting findings, its correlational nature did not allow us to investigate the direction of the relationship between children's cognitive ToM and DM fully. In order to address this issue we designed a second study, outlined below.

2. Study 2

Study 2 was, designed to expand on the findings of Study 1, and to investigate the direction of the relation between ToM and DM. Given the results of Study 1, in Study 2 we only considered children's understanding of beliefs (cognitive ToM). Notably, in order to make our study more sensitive to individual differences, we also expanded the tasks to measure cognitive ToM (see the Method section for more details) in two ways. First, we administered two tasks for each component of the TMT test. Second, we included four classic 1st – order FB tasks. The addition of these tasks provides an extended, genuinely progressive developmental assessment of children's ToM competence, and allowed us to investigate which components of cognitive ToM are more closely related to DM. More precisely, in addition to considering ToM as a general index, comprising different components, we examined pre-false-belief *vs.* false-belief understanding in relation, to DM.

In order to achieve these goals, Study 2 adopted a longitudinal design in which we followed a group of children between the ages of 4 years, 6 months and 5 years. This design allowed us to compare two models: one in which early cognitive understanding predicts later DM (Model A), and one in which early DM predicts subsequent cognitive understanding (Model B). In this second study, we considered language as a control variable (as in Study 1). For reasons of testing constraints, we did not include children's non-verbal and working memory abilities. However, Study 1 showed that these play a minor role in the association between cognitive understanding and DM.

2.1 Method

2.1.1 Participants

Eighty-three children (40 girls and 43 boys), all Caucasian, took part in the study. They had a mean age of 4.6 years (*SD* = 3.55 months, range = 48 - 63 months) at Time 1 and of 5.2 years (*SD* = 3.56 months, range = 54 - 69 months) at Time 2. Participants were recruited through kindergartens in a small University town in Northern Italy. Kindergartens were located in areas with mixed socioeconomic backgrounds. Children with language or developmental difficulties were excluded from the sample.

2.1.2 Measures

Children were tested longitudinally at two time points, separated by a testing interval of approximately 6 months. At each time point, they were evaluated for verbal ability, cognitive ToM, and DM.

Verbal Ability. Language skills were assessed with the Vocabulary subtest of the WPPSI (Wechsler, 2008). The subtest consists of 38 items of increasing difficulty. For each item, children were required to indicate the picture depicting a word spoken by the experimenter, by choosing one of four alternatives (range 0 - 38, $\alpha_{\text{Time 1}}$ = .85 and $\alpha_{\text{Time 2}}$= .81).

Cognitive Theory of Mind. This was assessed via four 1st order false-belief tasks and the Theory of Mind Test used in Study 1 (TMT; Pons & Harris, 2002).

The first two 1st order tasks were presented using puppet scenarios, as previously undertaken in studies on British and Italian children (Lecce & Hughes, 2010). The first was an unexpected content task (Bartsch & Wellman, 1989), where children were shown a plain container and a prototypical container (a miniature cereal box). They were asked to guess what was inside the prototypical container. Children were then shown that the prototypical content (i.e., cereal) was actually in the plain container. A puppet was introduced and children were asked the test question (i.e., "Which box will the puppet think has cereal in it?") and the control question (i.e., What is it in this box?"). The second 1st order task was based on the standard 'Sally Ann' task (Wimmer & Perner, 1983) and was enacted using a toy kitchen. The third and fourth 1st order false-belief tasks were presented using storybooks, and were based on the first part of the 2nd order tasks developed by Sullivan and colleagues (Sullivan, Zaitchik, & Tager-Flusberg, 1994). In the first of these, a mother tells her son Peter that she has bought him a toy for his birthday, when in fact she has bought him a puppy. Children were asked a test question (i.e., "What did Peter think he was getting for his birthday?") and a reality control question (i.e., "What was his Mum giving him really?"). The second task involved a similar scenario, but with two siblings (i.e., Mary and John) and a bar of chocolate. The same set of test questions (1st order) and control reality questions were asked. In each task, children were only coded as being successful if they passed both the test and control questions (range 0 - 4, $\alpha_{\text{Time 1}}$ = .58 and $\alpha_{\text{Time 2}}$ = .68).

Theory of Mind Test (TMT; Pons & Harris, 2002). In this study, we administered 2 items for each of the following components (I) level 1 of perspective taking, (II) level 2 of perspective taking, (III) comprehension of intentionality, (IV) comprehension of ignorance, (V) comprehension of false belief, (VI) comprehension of the distinction between appearance and reality, (VII) comprehension of lies, (VIII) comprehension of jokes. One point was given for each correct answers (range 0-16; $\alpha_{Time\ 1} = .65$ and $\alpha_{Time\ 2} = .64$). For additional comments on the TMT test, see Study 1.

DM. This was assessed using the same tasks used in Study 1: the DM-vignette (Cornoldi & Orlando, 1988) and the DM-story task (Cornoldi et al., 1991).

For the DM-vignette task (Cornoldi & Orlando, 1988), in Study 2, we administered 7, rather than 4 items (i.e., pairs of vignettes). These 3 additional items evaluated children's knowledge of the following memory variables: the age of the person performing the memory task, the presence/absence of external help, and the amount of time to study the items to remember. For each item, the experimenter asked children a test question (i.e., "which girl will remember all the items?") as well as a justification question (i.e,. "Why?"). The addition of a justification question was important, as it served to check whether children who correctly answered the forced-choice question were simply guessing (Lockl & Schneider, 2007). A justification was considered as appropriate (e.g,. meriting 1 point) when the child referred in any way to the critical aspect in which the memory task conditions differed (e.g., ‘‘because the dog makes too much noise’’, ‘‘because she has more pictures’’). In contrast, a justification was coded as inappropriate when the child; (a) referred to an aspect of the picture that was memory irrelevant (e.g., "because this dog is too big"), (b) provided an irrelevant answer (e.g., ‘‘because I like girls more than boys’’, ‘‘because her jacket is nicer’’), or (c) provided no answer (range 0 - 14, $\alpha_{Time\ 1} = .67$ and $\alpha_{Time\ 2} = .76$).

The DM story task (Cornoldi et al., 1991) and its coding system were identical to that used in Study 1.

2.1.3 Procedure

All tasks were administered individually in the children's kindergarten. At each time point, children participated in 2 testing sessions of approximately 20/30 minutes each. The order of the tasks was fixed. During the first session, children were administered the vocabulary task and the false-belief tasks; in the second session, they were asked to complete the Theory of Mind Test and the DM task.

2.2 Results

We begin by reporting descriptive statistics for each measures and preliminary results concerning: (a) descriptive statistics for the metamemory tasks, (b) developmental changes, (c) stability of individual differences across time. Next, we present relations between conceptually overlapping measures and data reduction strategies for constructing aggregate measures of cognitive ToM and DM. Finally, we report analyses concerning relationships between cognitive understanding and DM (within and across time).

2.2.1 Preliminary analyses

We started by examining, in detail, the results of the metamemory tasks (see Table 4). As in Study 1, the most difficult item on the metamemory vignette task was the categorization item. The easiest vignettes were the number item, at Time 1, and the drawing item, at Time 2. Regarding the metamemory-story task, our results showed that children had a good knowledge of forgetting, but a limited knowledge of memory strategies.

Children significantly increased or improved their performance on all tasks (See Table 5) Given these developmental changes, individual differences in the following variables were also significantly stable across time: verbal ability, $r(83) = .56$, $p < .001$; 1^{st}-order false-belief, $r(83) = .31$, $p = .005$; Theory-of-Mind test, $r(83) = .67$, $p < .001$, DM-vignette task, $r(83) = .44$, $p < .001$, and DM-story task, $r(83) = .44$, $p < .001$.

Table 4

Descriptive statistics for various items of the declarative metamemory tests

In respect of associations between conceptually overlapping measures, our analyses showed

		Time 1		Time 2	
		Actual Range	M (*SD*)	Actual Range	M (*SD*)
Vignette task	Category	0-2	.51 (.55)	0-2	.46 (.57)
	Number	0-2	1.13 (.85)	0-2	1.52 (.85)
	Time	0-2	.96 (.86)	0-2	1.24 (.92)
	Noise	0-2	.72 (.83)	0-2	1.34 (.86)
	Help	0-2	.77 (.72)	0-2	.98 (.74)
	Drawing	0-2	1.02 (.84)	0-2	1.61 (.64)
	Age	0-2	1.08 (.84)	0-2	1.23 (.84)
Story task	Knowledge of Forgetting	0-6	2.53 (1.20)	0-6	3.07 (1.33)
	Knowledge of Retrieval	0-5	1.47 (1.03)	0-5	1.49 (.97)
	Knowledge of Storage	0-6	.76 (.1.31)	0-4	.95 (1.09)

that individual differences on the 1st-order false-belief tasks and ToM Test were correlated at Time 1, $r(83) = .50$, $p < .001$, and Time 2, $r(83) = .31$, $p = .063$. Therefore, we computed an overall index of cognitive ToM at Time 1 ($\alpha = .66$) and Time 2 ($\alpha = .72$) by summing z scores. Within DM, children's performance on the vignette task was significantly associated with that on the story task at Time 1, $r(83) = .26$, $p = .016$, and at Time 2, $r(83)= .55$, $p < .001$. Therefore, again here, we computed aggregate scores of children's DM at Time 1 ($\alpha = .67$) and Time 2 ($\alpha = .77$) by summing z scores. Table 6 shows the pattern of associations between the study variables. As can be seen, at Time 1 and Time 2 children's verbal ability was significantly correlated with concurrent level of cognitive ToM and DM. Therefore, we adopted verbal ability as a control variable in examining the association between cognitive ToM and DM.

Table 5. *Children's Scores on the Key Variables of Study 2*

		Time 1	Time 2			95% CI		
Variable	Task	*M (SD)* Actual Range	*M (SD)* Actual Range	*t*(81)	*p*	*LL*	*UL*	Cohen's *d*
Verbal Ability	WIPPSI	22.66 (5.63) 0-32	25.14 (4.62) 0-33	-4.96	.000	-3.47	-1.48	-0.48
Cognitive ToM	1st order FB	2.05 (.99) 0-4	2.39 (.80) 0-4	-2.83	.006	-.58	-.10	-0.38
	TMT	12.69 (2.38) 6-16	14.03 (2.09) 7-16	-6.52	.000	-1.75	-.93	-0.60
Declarative Metamemory	Vignette task	6.55 (2.57) 1-13	8.66 (2.92) 3-14	-6.46	.000	-2.76	-1.46	-0.77
	Story task	5.15 (2.80) 1-15	5.78 (2.55) 1-12	-2.54	.013	-1.12	-.14	-0.24

Table 6

Correlations between Study 2 variables, within and across time

	T1 C_ToM	T1 PRE_FB	T1 FB	T1 DM	T2 VA	T2 C_ToM	T2 PRE_FB	T2 FB	T2 DM
T1 VA	.38***	.32**	.37**	.45***	.56***	.35**	.22*	.32**	.53***
T1 C_ToM	-	.62***	.80***	.35**	.53***	.56***	.51***	.28*	.50***
T1 PRE_FB		-	.37**	.25**	.42***	.48***	.15	.51***	.27*
T1 FB			-	.34**	.48***	.51***	.15	.51***	.50***
T1 DM				-	.38***	.39***	.27*	.34**	.65***
T2 VA					-	.47***	.31**	.40***	.52***
T2 C_ToM						-	.46***	.80***	.43***
T2 PRE_FB							-	.16	.18
T2 FB								-	.43***
T2 DM									-

Note. T1 = Time 1, T2 = Time 2, VA = Verbal Ability; C_ToM = Cognitive ToM; PRE_FB = Pre false-belief understanding; FB = false-belief understanding; DM = Declarative Metamemory

* $p < .05$; ** $p < .01$; *** $p < .001$

2.2.2 Concurrent and Longitudinal Relationships Between Cognitive ToM and DM

As can be seen in Table 6, our data showed that individual differences in cognitive ToM were significantly associated with those in DM, at Time 1 and at Time 2, even when we controlled for concurrent verbal ability $r_{T1}(80) = .22$, $p = .05$, $r_{T2}(80) = .25$, $p = .02$. We were also interested in examining whether task demands affected our results. We, therefore, restricted these correlational analyses to the TMT and metamemory-vignette tasks that were more similar in procedure, language, and format and found that results did not change. More precisely, the correlation between individual differences in early TMT and later DM, $r(80) = .68$, $p = .000$, was significantly stronger than the correlation between early DM and later TMT, $r(80) = .36$, $p = .001$, $z = 2.92$ $p = .001$

The main aim of Study 2 was to examine the direction of the relation between children's cognitive ToM and their declarative metamemory. This was undertaken by comparing two opposing models: Model A, in which early cognitive ToM predicts subsequent DM, and Model B, in which the reverse is presented. In order to investigate this issue, we conducted correlations and hierarchical regression analyses.

Model A: Analyses of correlations (see Table 5) indicated that children's cognitive ToM at Time 1 was significantly associated with Time 2 DM. When we controlled for verbal ability, the association between cognitive ToM at Time 1 and DM at Time 2 remained significant, $r(79) = .37$, $p = .001$. In order to understand the effect of early cognitive ToM on later DM better, we performed a hierarchical regression analysis in which we entered: Time 1 verbal ability, and DM at Step 1, and Time 1 cognitive ToM at Step 2. This allowed us to establish whether Time 1 cognitive ToM made a significant independent contribution in predicting variance in Time 2 DM. Step 1 explained 50% of the variance in Time 2 DM, $F(2, 79) = 39.24$, $p < .001$. The addition of Time 1 cognitive ToM at Step 2 significantly improved the amount of variance explained, $\Delta R^2 = .06$, $\Delta F(1, 78) = 8.90$, $p = .004$. Notably, the effect of Time 1 cognitive ToM on Time 2 DM was still significant when Time 2 cognitive ToM was added to Step 1, $\Delta R^2 = .04$, $\Delta F(1, 77) = 5.59$, $p = .02$.

Model B: In respect of the relationship between early DM and later cognitive ToM, Table 4 showed that Time 2 cognitive ToM was significantly correlated with Time 1 DM. Importantly, the association between early DM and later cognitive ToM remained significant, even when verbal ability was controlled for, $r(79) = .28$, $p = .01$. In order to understand this relation more fully, we performed a hierarchical regression in which we entered Time 1 verbal ability, memory performance and cognitive ToM in Step 1 as control variables, and Time 1 DM in Step 2, as an independent variable. Results showed that Step 1 explained a significant 36% of the variance, $F(2, 79) = 19.90$, $p < .001$, in Time 2 cognitive ToM, with Time 1 cognitive ToM being the only significant predictor, $\beta = .50$, $p < .001$. The addition of Time 1 DM at Step 2 did not significantly improve the amount of variance explained, $\Delta R^2 = .03$, $\Delta F(1, 78) = 3.50$, $p = .08$. This suggested that early DM did not play a unique role in predicting the development of cognitive ToM.

2.2.3 Concurrent and Longitudinal Relationships Between Sub-components of Cognitive ToM and DM

In order to investigate the relationship between ToM and DM more fully, we computed two new indexes of ToM. First, we calculated a pre-false-belief index that reflected how close or far children were from false-belief understanding. In order to do this, we scored children on the following four components of the TMT, investigating those conceptual steps held to precede false belief developmentally on a regular basis (e.g., Wellman et al., 2011): (I) level 1 of perspective taking, (II) level 2 of perspective taking, (III) comprehension of intentionality, and (IV) comprehension of ignorance. Since each component had a score range of 0-2, the pre-false-belief index had a possible range of 0-8. Second, we computed a false-belief index that reflected how well children performed on 1^{st} order false-belief tasks. To obtain this index, we summed children's raw scores on the two false-belief items of the TMT and on the four 1^{st} order false-belief tasks (range 0-6). Analyses showed that, as expected, children's scores on pre-false-belief understanding (Time 1: $M = 6.91$; $SD = 1.2$;Time 2: $M = 7.36$; $SD = .91$) were significantly higher than scores on false-belief understanding (Time 1: M = 3.11 ; SD = 1.5;Time 2: M = 3.97; SD = 1.3) at both time points, $t(82) \geq 20.91$, p = .00.

Results (see Table 6) showed significant concurrent correlations between false-belief understanding and DM at both Time 1 and Time 2. Conversely, the association between pre-false-belief understanding and DM was significant only at Time 1. These associations remained significant when we controlled for concurrent verbal ability and age, $r \geq .22$; p = .05 in both cases. Building on our results showing that early cognitive ToM predicted later DM, we explored the relations between pre- false-belief and false-belief understanding at Time 1 and DM at Time 2. Results showed that both indexes significantly correlated with later DM. However, the association between Time 1 false-belief understanding and Time 2 DM was significantly stronger than the corresponding association for Time 1 pre-false-belief understanding, z = 2.07, p = .04.. In addition, when we controlled for individual differences in children's verbal ability, only the association between Time 1 false-belief understanding and Time 2 DM remained significant, r = .38, p = .001. In order to better understand the relation between early false-belief understanding and Time 2 DM we conducted two analyses. First, we run a hierarchical regression analysis that showed that Time 1 false-belief understanding made a significant contribution in predicting variance in Time 2 DM, ΔR^2 = .05, $\Delta F(1, 78)$ = 9.34, p = .003, independently of Time 1 verbal ability and Time 1 DM, R^2 = .50, $F(1, 79)$ = 9.34, p = .003. Notably, the effect of Time 1 false-belief understanding on Time 2 DM was still significant when Time 2 false-belief understanding was added to Step 1, ΔR^2 = .03, $\Delta F(1, 77)$ = 5.50, p = .02. Second, we compared Time 2 DM in children with low (i.e., those who scored less than 3 points) and high (i.e., those who scored 4 to 6) performance on false-belief-understanding. Results showed that, as expected, children who mastered false-belief tasks had a better performance in DM than those that did not, $t(61)$ = 4.09, p = .00, even when we controlled for language and memory performance, F (1, 58) = 7.872; p = .007.

2.3 Discussion

Study 2 was designed to explore the relationship between cognitive ToM and DM in preschoolers more deeply. It had a cross-lagged longitudinal design in which the key study variables were measured at two time points, separated by a time interval of 6 months.

The main finding was that children's ability to reason about cognitive states significantly predicts their later DM, independently of verbal ability and earlier DM (Model A). In contrast, early DM did not uniquely explain a significant percentage of variance in later cognitive ToM, when we controlled for verbal ability and earlier cognitive ToM (Model B). In other words, children who scored higher in the cognitive understanding tasks were more likely to have a better knowledge about variables that may influence memory performance and the existence of memory strategies six months later.

These findings support the existence of a predictive relation between ToM and DM knowledge and fits with Khun's model. Our results, confirm and complement those of Lockl and Schneider's (2007), which support consideration of cognitive ToM as a prerequisite for the development of DM, and the acquisition of cognitive mental state concepts as a necessary initial step for the development of the other components of metacognition. Children appear to take advantage of their ability to reason about cognitive mental states and social behaviors, when asked to reflect on their own cognitive activity (Perner, 2000). Therefore, their ability to infer cognitive mental states from social behaviors seems to be intuitive knowledge that opens the gateway to more mature reasoning about mental phenomena. We argue that ToM understanding provides children with the conceptual underpinnings needed to develop metacognitive knowledge. Notably, our data showed that false-belief understanding, rather than mastery of those conceptual steps that precede false beliefs, is crucial for the development of DM. We acknowledge that children scores on pre-false-belief understanding were relatively high and that further studies should compare pre- vs. false-belief understanding in relation to DM. Having said this, our results are consistent with the view that false-belief understanding is a necessary condition for the development of DM (Lecce, Bianco, Demicheli, & Cavallini, in press). Moreover, it is worth considering how prior false-belief understanding helps the acquisition of metamemory, and we argue that an important role is played by the ability to metarepresent. This is defined as the ability to represent a representation of reality, that is, to consciously represent the content of another's belief. Passing false-belief tasks is the first clear evidence that children are able to metarepresent and reason explicitly about beliefs (Perner, 1991; Wellman et al., 2001). Indeed, in order to pass a typical change-of-location false-belief task, the child not only needs to distinguish between belief and reality, but also must be able to represent the protagonist's belief – hence, *meta*-represent. Metarepresentation is also crucial for metacognitive knowledge, such as that investigated in the present study. Notably, the concept of meta-representation is particularly relevant for DM, because memories are not a copy of reality, but rather a mental representation of it. As recently argued by San Juan and Astington (2012), cognitive mental state terms (which as predicted, are a robust correlate of FB understanding) can help children to abstract and remember the content of these representations and, critically, cultivate meta-representational understanding.

Findings of the present study have both theoretical and practical implications. Theoretically, they support Khun's model (2002) and encourage us to view ToM understanding as part of a more general meta-representational ability. Such a view is also consistent with a growing body of research, showing significant relationships between ToM and other aspects of metacognitive knowledge, such as metareading (Lecce et al., 2010), metacognitive vocabulary (Antonietti, Liverta-Sempio, Marchetti, & Astington, 2006), and epistemological beliefs about learning (Lecce, Caputi, & Pagnin, 2009; in press). Empirically, results reported above speak to the cognitive consequences of ToM and, together with the data that show an association with school achievement (Blair & Razza, 2007; Lecce, Caputi, & Hughes, 2011; Lecce et al., 2014) prompt researchers to design intervention studies for preschool and school aged children (Lecce, Bianco, Devine, Hughes, & Banerjee, 2014).

Given these strengths, it should also be noted that the present study focused on children's DM knowledge, leaving aside other components of DM such as procedural DM. Therefore, an important goal for future research would also be to investigate the links between cognitive ToM and procedural DM. This issue is particularly interesting, as procedural and DM skills show differences in developmental timing, with declarative knowledge of strategies preceding procedural application of that knowledge (Bjorklund, Miller, Coyle, & Slawinski, 1997; Grammer et al., 2011; Schlagmüller & Schneider, 2002). In addition, these forms of DM skills involve different processes (Fritz et al., 2010), with DM being affected by domain-general abilities (Schneider, 1993), and procedural DM by more specific processes, such as executive abilities (Isingrini, Perrotin, & Souchay, 2008; Nelson & Narens, 1994). Another limitation of the present study is that the tasks used for assessing cognitive ToM and DM differ in structure and, partially, in cognitive demands. However, although we cannot exclude the possibility that the difference in format between tasks affected our results, we believe this aspect had a minor role. Two pieces of evidence support this argument. First, the correlation between cognitive ToM and DM remained significant, albeit considerably reduced, after controlling for verbal ability. Second, our results did not change when we restricted our analyses to the ToM and metamemory tasks that were more similar: the TMT and the vignette task. However, clearly more work is needed to examine this issue. Finally, although in this second study we were able to compare pre-false-belief and false-belief understanding with respect to their developmental relationship with DM, we were not able to conduct finer analyses on the individual components of ToM. Future research should address this issue, paying attention to the role of knowledge access that is likely to have a strong relationship with metamemory.

3. Summary and Conclusions

In this paper, we report two studies on the specificity and direction of the relation between ToM and DM. Our results indicate that (a) there is a significant relationship between children's ToM and DM, (b) this relationship is specific to cognitive (but not affective) ToM, (c) the relationship between cognitive ToM and DM is independent of children's verbal, non-verbal ability, and working memory, (d) the link between cognitive ToM and DM goes from earlier cognitive

ToM to later DM; and finally that (e) this developmental link is due to false-belief understanding rather than early pre-false-belief conceptual acquisitions. These findings are original, yet consistent with previous empirical studies and theoretical models.

Although innovative, our studies have a number of limitations that should be acknowledged. The first is that the sample size is relatively small and therefore, more work is needed before generalizing our findings. Second, despite having used more than one control variable, we did not include a comprehensive measure of children's executive functions that are likely to be related with both ToM and DM. Therefore, an important goal for future research would also be to investigate the role of planning, inhibition, and shifting in the relation between ToM and DM. Third, with only two time points, we were unable to adopt a more dynamic approach, assessing whether progression in cognitive ToM matters for the development of DM.

Despite these limitations, our findings provide a valuable foundation for future research and encourage interventions to promote children's cognitive understanding in preschool years.

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