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The assessment of meta-cognition in different contexts: individualized vs. peer assisted learning

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Abstract This study investigated the effectiveness of assessing young children's meta-cognition in different contexts (i.e., individual learning (IL), peer assisted learning (PAL) and self-reports). Additionally, the contributions of declarative and procedural meta-cognition in IL and PAL, TOM and language ability on children's cognitive performance (recalling a series of pictures) were examined. Sixty-four 4–5-year-old children ($M=5.14$; $SD=0.72$), randomly selected from two Israeli kindergartens, participated in the study. Children were first asked in an individualized setting to recall a series of nine pictures; they were then asked (self-report) to tell the interviewer how they tried to recall the pictures. Finally, they were asked to assist a peer in recalling the pictures in a PAL situation. All the children's verbal and non-verbal behaviors were coded and analyzed. In addition, the children's language ability and Theory of Mind (TOM) were assessed. The findings indicated significant differences between children's declarative (self-report) and procedural meta-cognitive behavior in IL and PAL. Procedural meta-cognition in PAL and TOM predicted cognitive performance even when procedural meta-cognition in IL, declarative meta-cognition and language ability were controlled for. The findings are discussed in light of recent research on meta-cognition in young children.

Keywords Peer Assisted Learning (PAL) · Meta-cognition ·
Theory of Mind (TOM) Cognitive development

Young children's meta-cognition

The most common definition of meta-cognition is "cognition about cognition" or "thinking about thinking" (e.g., Veenman et al. 2006). Flavell, who coined the term meta-cognition, defined it as "any knowledge or cognitive activity that takes as its cognitive object, or that

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regulates, any aspect of any cognitive activity" (Flavell et al. 1993, p. 150). Nelson (1996) as well as Nelson and Narens (1990) further distinguished between the "object" level of cognition and the meta-cognitive level. The former refers to the level on which cognitive activity takes place. The "meta" level governs the object level. The relationship between the two levels of cognition is conceived as a reciprocal flow between monitoring and control. During learning, the monitoring function provides the information used by the control function to guide and regulate cognition. Meta-cognition thus regulates cognitive activity by enabling students to be aware of how they think and by guiding them in the strategies they are to employ in order to solve a problem during learning. Schraw and Dennison (1994) distinguished between two components of meta-cognition: knowledge about cognition and regulation of cognition. The first refers to declarative, procedural and conditional knowledge, whereas the second includes planning, information management, monitoring, debugging and evaluation during learning. Lockl and Schneider (2007), who focus on young children's meta-memory, suggested a model comprised of three main components: knowledge about the mental world (Theory of Mind or TOM), declarative meta-memory (knowing that) and procedural meta-memory (knowing how, also referred to in the literature as meta-strategic knowledge).

To date, inconsistent findings have been obtained regarding the age at which young children can activate meta-cognitive behaviors (e.g., Lockl and Schneider 2006; Veenman et al. 2006; Whitebread et al. 2005). Several studies have indicated that meta-cognitive skills (e.g., procedural knowledge required for regulation and control over learning) emerge at the ages of 8–10 and develop thereafter (Veenman et al. 2006) whereas others have reported that children as young as 3 demonstrate meta-cognitive behaviors, including elementary forms of orientation, planning and reflection (e.g., Whitebread et al. 2005). One explanation for these inconsistencies in the findings rests on the methodologies used to assess meta-cognition in the different studies.

The most common methodology for assessing meta-cognition is based on paper-and-pencil questionnaires. Because questionnaires cannot be used with young children lacking reading and writing skills, researchers have suggested an interview methodology in which the interviewer asks the child to "think aloud" during cognitive performance or immediately thereafter (Schneider and Pressley 1997). Yet, it has been found that methodologies relying on verbal reports underestimate young children's meta-cognitive capabilities (Kreutzer et al. 1975; Winne and Perry 2000). To overcome this difficulty, recent studies (e.g., Whitebread et al. 2005) have turned to observing children's behaviors in naturalistic settings (Whitebread et al. 2005). Veenman (2005) has suggested that "off-line" methods, which are applied outside a task context, should be distinguished from "on-line" methods, used to collect data during task performance. On-line methods, due to their focus on observed behaviors, are better predictors of learning outcomes (external predictive validity) than are off-line methods. Evidence suggests that what learners say they do or intend to do is not what they do in practice (Veenman 2005, 2007).

One on-line context having considerable potential for assessing meta-cognitive behaviors in young children is Peer Assisted Learning (PAL). PAL appears to have at least three advantages over self-reports in individualized settings. First and foremost, PAL is a natural setting for children (Crook 1998) whereas face-to-face interaction with an interviewer who is a stranger quite often biases the young interviewee's responses. Second, PAL provides ample opportunities for interaction. In this situation, children can activate procedural meta-cognitive behaviors by suggesting planning and control activities to one another, proposing strategies appropriate for solving the problem and reflecting on the solutions (Whitebread et al. 2007). Procedural meta-cognitive behaviors in PAL thus reflect what children actually think about the problem and the learning process (Shamir and Lazerovitz 2007), which is preferable to relying on what children recall or think they did in the learning situation. Finally, PAL is particularly appropriate for young children because it does not distract the child from the task, as might occur in the presence of an unfamiliar observer.

Despite these investigations, the literature about young children's meta-cognition is in its infancy, with no hard data yet collected regarding the effect of context on the assessment of such behaviors. Furthermore, we currently know little about the relationship between cognitive performance and the meta-cognitive behaviors assessed in different contexts when confounding or intervening factors such as language ability and Theory of Mind are controlled. The present study addresses these issues by focusing on young children's (4–5 year olds) meta-cognitive behaviors as observed in three contexts: PAL, individualized learning and self-reporting.

Peer assisted learning

Peer Assisted Learning (PAL), also called collaborative learning, is a commonly used method that has been implemented for almost three decades on various levels of schooling. The method has been applied in different ways, all of which involve children studying collaboratively or assisting their classmates and other children (e.g., Topping and Ehly 1998). PAL's effect on cognitive and academic performance has been extensively explored, with research confirming its effectiveness for promoting learning in various academic subjects (e.g., Fuchs et al. 1998; Griffin and Griffin 1997; Kramarski and Mevarech 2003; Mevarech 1991, 1999; Mevarech and Kramarski 1997; Shamir et al. 2006; Slavin 1978, Topping and Ehly 1998; Utay and Utay 1997) and cognitive task completion (King 1997; O'Donnell and King 1999; Shamir and Lazerovitz 2007; Shamir et al. 2007; Tudge 1996).

PAL's potential for enhancing cognitive performance is rooted in Vygotsky's (1978) approach, which suggested that cognitive development results from the interplay between spontaneous development and social adaptation, experienced in interactions between the child and a more competent person, whether a significant adult or a peer. Karpov and Haywood (1998) have claimed that by regulating a peer's cognition, the child reconstructs his/her own thinking process.

PAL takes advantage of natural situations, those where children can share their ideas and competencies, participate in mutual thinking, resolve cognitive conflicts and express their expanding cognitive competencies (e.g., Crook 1998; Light and Mevarech 1992; Shamir et al. 2007). Moreover, peer tutoring has been found to be an effective method for evaluating school children's meta-cognitive development (Shamir and Lazerovitz 2007) because during PAL, children raise to consciousness the thoughts that they have just begun to grasp intuitively (Crook 1998). However, the literature regarding the way young (pre-school) children function in PAL settings is limited, with many questions still open. For example, to what extent can young children describe the meta-cognitive behaviors that they activate in PAL situations and how are these behaviors related to cognitive performance? The present study addresses these questions.

Given that meta-cognition is a significant contributor to later cognitive development (Cornoldi et al. 1991; Schneider 2005; Schneider and Sodian 1988; Veenman et al. 2006), it is important to examine how young children activate these behaviors in different situations, particularly in IL and PAL environments, two settings that are commonly implemented in kindergartens and the early grades (Crook 1998; Shamir et al. 2008; Whitebread et al. 2007). Moreover, although young children often play collaboratively (Crook 1998) and probably activate some meta-cognitive behaviors in these situations, too (Whitebread et al. 2007), it is not clear how the different components of meta-cognition contribute to cognitive performance when other relevant factors such as language ability and TOM are controlled for.

TOM and meta-cognition in young children

TOM refers to young children's interpersonal understanding of mental states, that is, children's initial understandings of the beliefs, desires and intentions held by themselves and others (Flavell 2004, p. 274). Flavell (2000) has argued that meta-cognition is "problem-centered" and can thus be considered an "applied theory of mind." Lockl and Schneider (2007) have noted that TOM is related to young children's later meta-cognitive and cognitive performance. Flavell (2004) has further claimed that although there is much in common between meta-cognition and TOM, three main features differentiate the two concepts. The first relates to the fact that meta-cognition, as a field of research, focuses primarily on the contributions of meta-cognitive knowledge and meta-cognitive monitoring of cognitive performance whereas theory of mind studies address the origins of such knowledge and operations. The second difference between the two research paradigms is the age group studied: TOM researchers primarily study the cognitive processes of infants and young children because they are interested in the origins of knowledge about mental states whereas meta-cognitive researchers examine mainly older children and adolescents who have reached a more advanced stage of cognitive development. The third factor distinguishing meta-cognition from theory of mind is that research on meta-cognition focuses on the idiosyncratic development of an individual child's own mind while theory of mind scholars focus on children's understanding of other children's minds. We may assume, therefore, that TOM competencies, which relate to a child's ability to comprehend others' mental states (Flavell 2004), may have a more crucial role in PAL than in IL settings. One may consequently argue that TOM and meta-cognition, when assessed in PAL settings, are confounded with and thus predict cognitive performance in an intertwined way.

In a longitudinal study extending over three years, Lockl and Schneider (2007) found that children's performance on TOM tasks improved with time. Moreover, TOM competencies at Time 1 (when the children were 3 years old) and Time 2 (when they were 4 years old) made significant contributions—on verbal and non-verbal abilities independently—to the prediction of meta-memory at Time 3 (when the children were 5 years old). In the current study, children's language ability was tested to examine it's relation to all the other relevant variables. This promising research direction nonetheless has focused solely on IL situations so far (Lockl and Schneider 2006, 2007). We considered it interesting to see how meta-cognition in PAL, IL and self-report situations contributes to cognitive performance in areas other than TOM and verbal ability.

We therefore hypothesized that TOM and meta-cognition, when assessed in PAL settings, are confounded with and thus predict cognitive performance. In addition, we assumed that if young children's cognitive performance was related primarily to language ability, we would expect no significant relationships to be found between cognitive performance (in this case, the memory task) and the children's understanding of other children's thinking and/or task completion behaviors in PAL situations.

Based on this hypothesis, the main purpose of the current study was to examine the effectiveness of assessing young children's meta-cognitive behaviors in different contexts. Three research questions were addressed: (a) To what extent can young children (4–5 years old) employ declarative and procedural meta-cognitive processes when performing a memory task? (b) What are the differential effects of the context in which children are assessed (individual learning (IL), peer assisted learning (PAL), and self-reports) on children's meta-cognition? (c) What are the contributions of declarative and procedural meta-cognition in IL and PAL, TOM, and language ability on children's cognitive performance (recalling a series of pictures)?

Method

Participants

Participants were 64 Israeli children aged 4–5 (M=5.14; SD=0.72), attending two Israeli public kindergartens. About half of the children were girls (51.5%). The children came from middle SES families as defined by Israel's Ministry of Education. The two kindergartens were located in the same neighborhood, belonged to the Israeli state education system (public kindergartens), used the same curriculum and were supervised by the same supervisor. None of the children had learning disabilities.

For the purposes of the present study, the children were randomly assigned into dyads: One half of the children (N=32) served as tutors, the other half as tutees. This study focused only on the children who served as "tutors", i.e., assisting the tutees in performing the memory task (see below). We assumed that the experienced tutor (who had just performed this recall task individually) would express a range of meta-cognitive behaviors while trying to guide a non-experienced tutee, who was about to perform the task for the first time. Data were thus collected on the cognitive, meta-cognitive and TOM behaviors of 32 children.

Measures

Three types of tasks were used in the present study: a memory task, a language ability test and Theory of Mind (TOM) tasks. The children's procedural and declarative behaviors were also observed. Declarative meta-cognition was defined as the number of behaviors that children reported using in IL, information requested immediately after they recalled the pictures. Procedural meta-cognition was defined as the number of meta-cognitive behaviors that the children employed in IL or PAL.

Memory task The children were given, separately, a package of nine cards. On each card, a different picture was printed, as follows: three different animals, three different pieces of furniture and three different articles of clothing. The children were asked to recall the pictures printed on the cards. Children could do whatever they wished in their attempt to complete the task. After a few moments, the interviewer collected the cards and asked the children to recall the pictures printed on the cards. Cognitive performance was captured in the number of items (the pictures) that the children recalled. Each correct recall was scored 1; total scores thus ranged from 0 to 9.

Language ability Language ability was assessed by the antonyms subtest of the Kaufman Intelligence Inventory (Kaufman and Kaufman 1983). The Kaufman Assessment Battery for Children (KABC) is a standardized test that can be administered to assess the intelligence of subjects ranging in age from 2 years 6 months through adulthood. The antonyms subtest was used because its reliability is relative high (0.83=α) when compared to the other parts of the battery relevant for preschoolers. The subtest is composed of 18 common Hebrew words. The children were asked to state the antonym of each word given. Prior to testing, they practiced one example item and were given corrective feedback and explanations. The KABC in general and the antonyms subtest in particular are commonly used in Israel's kindergartens for research purposes. Scoring: each correct answer was scored 1; total scores ranged from 0 to 18.

Theory of Mind (TOM) To assess TOM competencies, each child was administered two false-belief content tasks (a false-belief transfer task and an appearance-reality task) and two second-order belief tasks. This battery was selected on the basis of a recent study (Lockl and Schneider 2006) that had demonstrated its ability to reflect developmental trends in TOM among young children (aged 4–5).

The false-belief contents tasks were based on studies by Gopnik and Astington (1988) and Wimmer and Hartl (1991). In these two tasks, different boxes and contents were used (a Smarties box containing a pen, a soap-bubble box containing candies). The interviewer asked the children to indicate what was inside a box. She then opened the box and showed that it had unexpected contents, e.g., a pen in a candy box. The children were then asked the following two test questions: "What did you think was inside the box before it was opened?" and "What would another child, who had not looked inside the box, think was in it?" The same procedure was applied with the second box, the soap-bubble box containing candies. Scoring: Each correct response was scored 1; total scores for these tests ranged from 0 to 4.

The false-belief transfer task was designed by Wimmer and Perner (1983). It involves children listening to the following story, which is also enacted with dolls: Mother buys chocolate for a cake. David helps her put away the items and puts the chocolate into the blue cupboard; he then leaves for the playground. While David is gone, Mother takes the chocolate out of the blue cupboard, grates a bit into the dough, puts the remainder into the green cupboard and then leaves the kitchen. David comes home and wants to eat some chocolate. The children were asked the following two test questions: "Does David know where the chocolate is?" and "Where will David look for the chocolate?" Scoring: A score of 1 was given for each correct answer, scores thus ranged from 0–2.

The standard appearance–reality task was based on a study conducted by Flavell et al. (1983). In this task, children are shown a candle that looks like an apple. First, children are encouraged to touch the object while the interviewer explains that it is a candle with a wick that can be lighted. They are then asked: "What does the object look like?" and "What is the object really?" Both questions concern the relationship between appearance and reality. Scoring: each correct response received 1 point; hence, scores on this part ranged from 0–2.

The two second-order false belief tasks were taken from Sullivan et al. (1994). The first task consisted of a story about a boy whose mother wants to surprise him with a puppy for his birthday. So, she tells him that he will get some toy. Without his mother noticing, the boy discovers the true birthday present. Later, his grandmother phones his mother and asks whether the boy knows what he will get for his birthday. Children are then asked test question 1: "What does Mom say to Grandma?" (Correct answer: "No, he doesn't know"). Grandma then wants to know what the child thinks he will get, inspiring test question 2: "What does Mom say to Grandma?" (Correct answer: "He thinks he will get some toy").

The second task referred to a story about a brother deliberately misinforming his sister about the location of a new ball because he wants to keep it for himself. Without the brother noticing, the sister sees him take the ball, which was under his bed. Later, a friend comes to visit the brother and they decide to play with the new ball. The friend asks the brother whether his sister knows where the ball is (test question 1) and where the ball is actually hidden (test question 2). Scoring: A score of 1 is given for each correct answer; thus, scores for these two second-order false belief tasks ranged from 0–4.

For the purpose of the present study a TOM total score was calculated by adding all the TOM subtests scores.

Assessment of meta-cognitive behaviors Meta-cognitive behaviors were assessed through interviews (self-reports subsequent to task performance) and on-line observations during the IL situation as well as the PAL interaction. A graduate student majoring in Education performed all the observations and interviews. The coding was based on a grounded analysis of the data, gathered through direct observation of behaviors reflecting meta-cognition as described in the literature (e.g., Schneider and Pressley 1997; Schneider and Sodian 1988).

Declarative meta-cognitive behaviors Immediately after a child performed the task, the interviewer asked: "Please tell me what you did in order to recall the task." The interviewer wrote down all the behaviors that the children declared they had initiated in their attempts to recall the series of pictures (see appendix).

Scoring The subjects' performance was scored with respect to whether or not it reflected declarative meta-cognitive behavior. Each meta-cognitive behavior received a score of 1 (if it was observed) or 0 (if it was not observed); the total score was calculated by adding up all the meta-cognitive behaviors the subject declared that he/she had performed. For example, one child told the interviewer: "I looked at the pictures and then put them in three's; thought it is easy to remember." This declarative meta-cognitive behavior received a score of 2: "Looking"=1, and "Put them in three's"=1; total score=2. On the other hand, the following response received a score of 0: "I didn't do anything, I just remembered."

Procedural meta-cognitive behaviors in IL and PAL situations The interviewer observed the children performing the task in both situations and wrote down all the children's behaviors (see appendix). Then, she scored all the meta-cognitive behaviors as explained above. Thus, a score of 1 was given if such behaviors were observed; a score of zero was given if no such behaviors were observed. The same coding system was used in all three situations: IL, PAL and self-reporting. For example, if the child told the tutee in the PAL situation: "You should first organize the pictures in three's", or if the child in the IL situation put three cards together and stated: "These are clothing", a score of 1 was given in each case. However, if a child declared: "I don't know, I just remembered," this statement was considered absent of meta-cognitive behavior and scored zero. It is important to note that non-verbal behaviors were likewise coded. For example, a score of 1 was given if the child in the IL situation organized the cards in three's without saying anything to the interviewer, or if the child did the same in PAL without saying anything to the tutee.

In order to validate the process, two raters (including the interviewer) analyzed the protocols of five participants. Only after 90% agreement was reached, did one rater score the children's behaviors.

Procedure

Data collection was conducted during two sessions separated by a maximum interval of 10 days. Each participant was tested individually in a quiet room in the kindergarten; the sessions lasted 15–25 min. In the first session, the interviewer administered the TOM and the language ability tests. In the second session, which consisted of three phases, the interviewer first administered the memory task to each child (IL situation), as previously described. She observed the child's attempts to memorize the nine cards and wrote down all meta-cognitive behaviors, verbal and non-verbal. In the second phase, initiated immediately after completion of the first phase, the interviewer asked the child to the question: "How did you remember the cards?" (declarative meta-cognition). Finally, in the third phase, a PAL situation was created. The interviewer asked another child to enter the room and then instructed the two children to work together, with the first child, who had just completed the memory task, serving as a tutor and the other child as a tutee. She told the tutor: "You remembered the cards very nicely. Please tell your friend what to do in order to recall the cards; please help him/her". The interviewer observed the children in the PAL situation and again wrote down all the tutors' procedural meta-cognitive behaviors, verbal and non-verbal. Appendix 1 provides examples of these meta-cognitive behaviors as observed in the individualized (IL), peer assisted (PAL) as well as self-report situations.

Results

Young children's declarative and procedural meta-cognition

The first research question focused on the extent to which young children (4–5 years old) employ procedural and declarative meta-cognitive behaviors when attempting to perform a memory task. As previously indicated, cognitive performance was measured by the number of pictures the children recalled (achieved scores ranged from 2 to 9). Declarative meta-cognitive was defined as the number of behaviors the children reported using in IL (self-reports were obtained immediately after completing the task). Procedural meta-cognition was defined as the number of meta-cognitive behaviors the children employed in IL or PAL. Table 1 presents the description of the sample: mean scores, standard deviations and range scores of cognitive performance, declarative meta-cognition, procedural meta-cognition in IL and PAL, language ability, and TOM.

Table 1 shows that the preschoolers in the sample did activate declarative meta-cognition when asked to describe how they tried to recall the series of nine pictures (self-reports) on the one hand, and procedural meta-cognition in IL and PAL on the other hand. The children generally recalled about seven out of nine pictures. They reported using about three different behaviors when attempting to complete the task. Table 1 further shows that the sample's language ability and TOM were moderate.

Table 1 Mean and standard deviations of cognitive and meta-cognitive variables

Variable	Mean	Standard deviation	Range
Cognitive performance	6.97	2.01	0–9
Theory of mind (TOM)	15.60	6.53	0–24
Language ability	6.70	4.10	0–14
Declarative meta-cognition (self-report)	2.72	1.44	0–5
Procedural meta-cognition in IL	6.19	2.13	0–11
Procedural meta-cognition in PAL	5.44	1.72	0–9

The differential effects of context on children's meta-cognition

The second research question focused on the differential effects of the contexts (IL, PAL, and self-reports) in which the children's meta-cognitive behaviors were assessed. Table 1 shows large differences between the children's declarative meta-cognition (self-reports) and their procedural meta-cognition in both IL and PAL (mean scores=2.72, 6.19 and 5.44, SD=1.44, 2.13, 1.72, respectively). *T*-tests for dependent samples indicated significant differences between declarative meta-cognition and procedural meta-cognition in IL ($t(31)=9.17$, $p<0.0001$) and between declarative meta-cognition and procedural meta-cognition in PAL ($t(31)=8.04$, $p<0.0001$). These findings indicate that young children have a rich repertoire of behaviors that they can use reflectively when asked to recall a series of pictures.

In addition, as can be seen from Table 1, the children employed fewer procedural meta-cognitive behaviors in the PAL than in the IL context (mean scores=5.44 and 6.19, SD=1.72 and 2.13, respectively). A t-test for dependent samples indicated that these differences were statistically significant ($t(31)=2.026$, $p<0.05$). The data indicated, therefore, that context does make a difference when assessing children's meta-cognitive behavior. Children's declarative meta-cognitive behaviors (self-reports) were significantly fewer than were their procedural meta-cognitive behaviors in IL and PAL; significant differences between the children's procedural meta-cognition behaviors in IL and PAL were also found.

Relationships between cognitive performance and meta-cognition, TOM, and language ability

The third research question focused on the contribution of meta-cognition (declarative, procedural in IL, and procedural in PAL), TOM, and language ability on children's cognitive performance (recalling a series of pictures). To address this issue, we employed a hierarchal regression analysis with cognitive performance as the dependent variable and declarative meta-cognition, procedural meta-cognition in IL, procedural meta-cognition in PAL, language ability and TOM as the predictors. The hierarchical regression analysis included two steps. In the first step, we entered the three kinds of meta-cognitive behaviors: declarative meta-cognition, procedural meta-cognition in IL, and procedural meta-cognition in PAL. In the second step, we entered children's individual characteristics: language ability and TOM. Because the focus of the study refers to the assessment of young children's meta-cognition in different contexts, it is more appropriate to calculate how much of the variance in cognitive performance is explained by the activation of meta-cognitive processes in different contexts (e.g., the variables entered in the first step) and only then to examine the additional contribution of the children's characteristics. The regression analysis was preceded by a correlation analysis. Table 2 summarizes the correlations between these variables, whereas Table 3 summarizes the results of the regression analysis.

Table 2 Intercorrelations of cognitive performance and meta-cognitive variables

Variable	1	2	3	4	5	6
1. Cognitive Performance	–	0.58**	0.42*	0.60**	0.47**	0.45**
2. TOM		–	0.10	0.38*	0.64**	0.46**
3. Procedural meta-cognition in IL			–	0.42*	0.21	0.33
4. Procedural meta-cognition in PAL				–	0.50**	0.27
5. Language ability					–	0.54**
6. Declarative meta-cognition						–

*$p<0.05$; **$p<0.01$

Table 3 Summary of the hierarchical regression analysis of variables predicting cognitive performance from procedural and declarative meta-cognition, language ability and TOM

Predictors	β	T
Step 1: meta-cognitive behaviours		
Procedural meta	0.17	1.14
Procedural meta	0.40	2.33*
Declarative meta	0.18	1.07
Step 2: children's characteristics		
Language ability	0.07	0.38
TOM	0.34	2.02*

R^2 =0.47 for Step 1 and 0.55 for Step 2; ΔR^2 =0.47 for Step 1 and 0.08 for Step 2; *p<0.05

According to Table 2, significant correlations were found between cognitive performance and all the other variables. The correlations ranged from 0.42 to 0.60, with the highest correlations obtained between cognitive performance and procedural meta-cognition in PAL (0.60). Table 2 further shows a correlation of 0.60 between TOM and language ability, a correlation of 0.55 between declarative meta-cognition and language ability, and a correlation of 0.51 between procedural meta-cognition in PAL and language ability. The correlation between procedural meta-cognition in IL and language ability was not statistically significant.

The regression analysis indicates that the model as a whole was statistically significant ($F(2,29)=8.13$, $p<0.0001$), explaining 55% of the variance in cognitive performance. The first step explained 47% and the second added 8%, more, both statistically significant, $p<0.05$). Yet, the regression analysis indicated that not all variables made significant contributions to cognitive performance. The best predictor of cognitive performance was procedural meta-cognition in PAL ($\beta=0.40$, $t=2.33$, $p<0.02$), followed by TOM ($\beta=0.33$, $t=2.023$, $p<0.05$). The contributions of the other variables (procedural meta-cognition in IL, declarative meta-cognition and language ability) were not statistically significant. Thus, although the overall model was significant, only two variables made significant contributions to the children's cognition performance: Procedural meta-cognition in PAL and TOM.

Discussion

Despite the fact that the sphere of meta-cognition has been studied extensively, the findings regarding young children are inconsistent (e.g., Lockl and Schneider 2007; Veenman et al. 2006; Whitebread et al. 2005). One explanation proposed for the inconsistencies observed so far rests on the methodologies used in the assessment process. The current study addressed this issue by posing the question of whether simply asking children at this age about how they think is sufficient. Significant differences were found not only between off-line (self-reports) and on-line (meta-cognition in PAL and IL) behaviors but also between the responses obtained in the two on-line contexts. In addition, the study showed that only two variables, procedural meta-cognition in PAL and TOM, predicted cognitive performance even when procedural meta-cognition in IL, declarative meta-cognition and language ability were controlled for. These findings raised at least two questions: Why were significant differences found between declarative and procedural meta-cognition—or why is simply asking a child about how she/he thinks insufficient for this age group? And why did procedural meta-cognition in PAL predict cognitive performance better than did procedural meta-cognition and declarative meta-cognition in IL?

Differences between young children's declarative and procedural meta-cognition

The findings of the present study indicate that preschoolers aged 4–5 are already capable of exhibiting a wide range of procedural and declarative meta-cognitive behaviors when asked to recall a series of nine pictures. These findings are in line with other recent research employing naturalistic observations indicating early meta-cognitive competencies (Whitebread et al. 2005) as well as the preliminary appearance of meta-memory knowledge among 4–5 year olds (Lockl and Schneider 2007). Yet, early research using a self-report methodology showed a deficit in young children's meta-cognitive development (Flavell et al. 1966; Kreutzer et al. 1975). Differences were also found in the current study between the children's declarative and procedural meta-cognition in the IL as well as PAL contexts, findings that conform to the distinction proposed between on-line and off-line assessment (Veenman 2005; Veenman et al. 2006). That is, whereas off-line assessment is conducted before or after performing the task, on-line assessment examines performance during task completion and thus predicts learning performance.

We propose at least four explanations for these findings. First, it is possible that young children (4–5 years old) are unaware of all the meta-cognitive behaviors that they perform and are therefore unable to describe them. Second, although the children were asked to report everything they did in order to recall the pictures, they may have reported only those strategies that they believed were effective. Third, young children may find it difficult to describe their meta-cognitive behaviors because the very description process is highly dependent on verbal skills (Schneider and Sodian 1988). Finally, it is possible that children may find it difficult to report their actions to elders and strangers (the interviewer in this case) in contrast to peers in the more natural and therefore more comfortable PAL setting. This hypothesis merits future exploration by means of interviews and stimulated-recall techniques. One basic conclusion from the findings appears to be that multiple assessment tools are needed in order to document meta-cognitive development in this age group.

Young children's meta-cognition in PAL

One unique aspect of the present study is its use of PAL as a potential context for examining meta-cognition development among young children based on the finding that the level of the children's procedural meta-cognition in PAL was much higher than the level of their declarative meta-cognition (self-reports). As noted previously, self-reports are not natural means for expressing one's own meta-cognitive competencies, especially among young children. In contrast, PAL has been found to be a more appropriate context for testing meta-cognitive behavior among older school children (Shamir and Lazerovitz 2007). We therefore propose that because PAL is a more natural and thus more comfortable setting for young children, interaction develops more easily. Children finding themselves in this situation can therefore activate procedural meta-cognitive behaviors by suggesting planning and controlling activities to one another. As noted by Crook (1998), PAL settings provide children with opportunities to raise to consciousness the thoughts that they have just begun to grasp intuitively (Crook 1998). Indeed, young children (aged 3–5) who were observed in naturalistic settings while working in a group without adult support showed more evidence of meta-cognitive regulation (i.e., combined planning, monitoring, control and evaluation) than did children working in supervised groups (Whitebread et al. 2007). Whitebread et al.

(2007) subsequently argued that adults are more likely to accept regulatory roles when working with children. We thus suggest that in PAL settings like that in which the current study was conducted, young tutors will show more evidence of procedural meta-cognition than in self-report contexts because they are free to fulfill the regulatory role themselves. This suggestion requires further, comparative research, involving the effect of different contexts (including PAL and IL) on the same and different groups.

The relationship between TOM, language ability, procedural meta-cognition in IL, procedural meta-cognition in PAL, declarative meta-cognition and cognitive performance

Given the fact that the research findings reported here show differences in the meta-cognitive behaviors observed in each of the three settings, it appeared relevant to investigate the supporting (if any) role of developmental competencies such as Theory of Mind (TOM) and verbal abilities for young children's cognitive and meta-cognitive performance in PAL as opposed to IL.

The study's findings regarding the relationship between children's TOM and meta-cognitive performance accord with those obtained by Lockl and Schneider (2007), who claim that children demonstrating advanced TOM acquire knowledge about memory-related processes more readily. In addition, the current study's findings confirm previous results (Astington and Jenkins 1999; Lockl and Schneider 2006) indicating the positive relationship between language ability, meta-memory and memory but go further. This they do by showing that TOM and procedural meta-cognition as observed in PAL were better predictors of children's cognitive performance (memory) than were language ability and descriptive meta-cognition as observed in IL settings. We should, however, be careful of over-generalizing these results due to the fact that language ability was assessed in the present study by one limited measure (antonyms). Further research is obviously needed to examine the effects of context while controlling for different language ability measures.

As to the contribution of TOM to children's cognitive performance, the literature indicates that after the age of 4, children may begin to understand important facets of the mental state of knowing as well as the mind as a processor of information (Flavell 1999; Flavell et al. 1993; Perner 1991). These previous findings may explain the contribution of TOM competencies to the children's cognitive performance as revealed in the current study. They also support the results of the longitudinal study conducted by Lockl and Schneider (2006), who found that TOM competencies at younger ages made significant contributions to the prediction of meta-memory at older ages independently of the children's verbal and non-verbal abilities. Moreover, we propose that these same TOM competencies, which may be related to children's ability to comprehend others' mental states (Flavell 2004), fulfill a more crucial role in PAL than in IL settings.

To conclude, the current study shows that simply asking children about how they think is insufficient for research purposes. Observation of preschoolers' procedural meta-cognitive behaviors revealed that their self-reports were inaccurate. A range of measures is indeed needed to appropriately assess young children's meta-cognitive competencies (Veenman 2005). We therefore suggest using numerous on-line measures in IL and PAL environments, two settings that are commonly implemented in kindergartens and the lower grades (Crook 1998; Shamir et al. 2008; Whitebread et al. 2007).

The current findings have important theoretical and practical implications. One of the major conclusions of the present study is that each assessment context studied (i.e., IL and PAL) produced reliable but selective evidence of young children's meta-cognition as well as cognitive performance. This conclusion supports the call for construction of new models for the study of meta-cognitive development among young children (Veenman et al. 2006).

One practical implication of the current study is that in order to enhance the development of preschoolers' meta-cognition, educators should provide children with opportunities to learn in various settings, including PAL. Additional research, conducted with larger samples and a range of cognitive tasks may contribute to extending the finding's salience.

Appendix

Examples of Children's Declarative Meta-cognition in IL, PAL and TOM

Example 1: *Children's Declarative Meta-cognition (Self-reports)*
Question: "What did you do in order to remember?

I said the picture lots of times. (Repetition).

I put them together frog and cat (in two's) and tried to remember.

I thought about it hard; I used my head to see what I remember.

I don't know I just remembered.

Example 2: *Children's Procedural meta-cognition (IL)*

The child organizes the cards on the table and looks at them, saying: "I have to see all of them, to remember."

The child says again and again the name of each picture ("a table, a table, a table…") (rehearsal/repetition).

The child organizes the cards into two's and says "a table and a chair" (verbal behavior).

The child organizes the cards in two's and points to the (non-verbal behavior).

The child organizes the cards in three's and says "a cat, a frog, a turtle" (verbal behavior).

The child puts the cards on opposite sides (in two's or three's) and checks if he remembers (non-verbal behavior).

The child looks at one of the three cards he put on one sides and checks if he remembers the rest, saying: "Ah, this is the third one… (verbal behavior).

The child checks the cards and says: "This I remembered this I didn't" (verbal behavior).

Example 3: *Procedural meta-cognition (PAL)*

"Look, look at the pictures; you have to remember the pictures."

"No, start first with the animals."

"You can put them together, frog and cat, in two's."

"Put them together—trousers, shirt and jacket—in three's."

"Put it like this (a cat and a turtle) and see if you remember."

"Try to remember; you should say the names of the animals aloud again and again, many times."

The tutor points to three pictures and says: "One, two, three."

"Check if you remember, look and see if you remember a cat."

"Put the cards in opposite side and see if you remember the clothing."

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