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A Study on the Relationship among Meta-Memory, Meta-cognitive Vocabulary and the Role of Theory of Mind in Persain Young Children

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Meta-cognition refers to the process of active control over one's own cognition and is essential to successful learning. It enables individuals to better manage their cognitive skills and to determine weaknesses that can be corrected by constructing new cognitive skills. Anyone who could perform a skill could think about how to perform that skill (meta-cognition). In this paper, we try to examine the relationship among meta-memory, meta-cognitive vocabulary and the role of theory of mind in Persian young children.The research sample consisted of 51 children (age range 4 to 6 years old). Children were tested at four sessions, separated by a testing interval of approximately half a year. At the first session of testing, children completed a set of theory of mind tasks. At each of the following sessions, measures of meta-cognitive vocabulary and general vocabulary as well as meta-memory were administered. Data were analyzed using ANOVA & regression analysis. Findings showed that theory of mind performance of the 4 to 6 years old children could predict meta-cognitive knowledge that was assessed about one and a half years later. Another finding was that there was reciprocal relationship between meta-cognitive vocabulary and meta-memory in that comprehension of meta-cognitive vocabulary predicted later meta-memory and, conversely, meta-memory significantly predicted later comprehension of meta-cognitive verbs. Meta-cognitive vocabulary of their own thinking processes is very important if learners are to be able to manage, organize and develop their abilities to think and learn.

Keywords: theory of mind, meta-cognitive vocabulary, meta-memory.

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Meta-cognition has been defined as any knowledge that regulates any aspect of a cognitive activity (Flavell, Miller, & Miller, 2004). At the beginning of research on Meta-cognitive development in the 1970s, many studies focused on children's meta-memory, that is, their knowledge about person, task, and strategic variables. Overall, studies in this research tradition (e.g., Kreutzer, Leonard, & Flavell, 2000; Myers & Paris, 2008; Schneider, 2005, 2009) indicated substantial improvement on most of the above mentioned variables as a function of age. For example, whereas Meta-cognitive researchers have concentrated on task-related cognitive processes such as learning strategies for improving performance on various tasks or attempts to monitor improvements, theory of mind researchers have investigated children's initial Meta-cognitive knowledge, that is, knowledge about the existence of various mental states such as desires and intentions. Thus, Meta-cognition focuses primarily on the contributions of Meta-cognitive knowledge and Meta-cognitive monitoring to cognitive achievements (e.g., memorizing), whereas theory of mind research addresses the conceptual underpinnings of such abilities. Moreover, the two research traditions focus on different age groups. Theory of mind researchers predominantly studies infants, toddlers, and preschoolers because they are mainly interested in the origins of knowledge about mental states. On the other hand, researchers interested in the development of Meta-cognition mainly test older children and adolescents. A further distinction concerns the fact that developmental research on Meta-cognition deals with what a child knows about his or her own mind rather than somebody else's. As noted by Flavell (2000), how and how often other people use their minds in similar situations is not of primary interest. In contrast, it is the understanding of the participant of some other person's mind that is usually of central concern in the theory of mind studies.

Another important precondition for the development of Meta-cognition is language acquisition, in particular, the acquisition of what Miscione, Marvin, O'Brien, and Greenburg (1978) labeled "mental verbs". Although

Kreutzer, Leonard & Flavell (2000) provided evidence that the youngest participants in their study (i.e., Kindergarten children) could properly apply mental verbs; it has been proven more difficult to determine preschoolers' knowledge of this specific vocabulary. In both studies, preschool children judged mental status mostly based on the observed object or on the basis of their prior knowledge. That is, whenever the agent in Miscione et al. (1978) performed correctly, the preschoolers used the label "knowing"; and incorrect actions were labelled "guessing". Overall, the results of both studies demonstrated that children's competent use of mental verbs was highly constrained (for confirming evidence see also Johnson & Wellman, 1980). Follow-up studies - in part inspired by these early investigations - confirmed that acquiring knowledge of mental verbs has to be conceived of as a long-term process, with children's understanding being limited compared to adults' understanding (Flavell, 2000).

Theoretical relationship between the development of Meta-cognitive vocabulary (i.e., knowledge of mental verbs) and general meta-memory development has not been systematically explored in the past and is similarly unclear as the one between theory of mind and meta-memory. Is meta-cognitive vocabulary needed for successful performance on general meta-memory tasks, leading to knowledge about various memory functions? Or is knowledge about memory (meta-memory) needed to understand mental verbs referring to memory processes (e.g., remember, forget)? Finally, does meta-cognitive vocabulary predict meta-memory after individual differences in theory of mind performance have been taken into account?

We suppose that the early theory of mind competencies as well as the acquisition of specific meta-cognitive vocabulary should affect subsequent knowledge about memory. In this context, it might be important to consider what enables the child to think about his or her own memory and to determine which variables influence memory performance. We assume that the acquisition of the concept of knowledge, that is, the understanding of children that knowledge states depend on informative experience (Welch-Ross, 2000), represents the first step in the growing understanding of memory processes and contents. As a second step, having acquired this concept of knowledge, children may begin to gain a fuller understanding of mnemonic conceptions which might become apparent in their growing understanding of mental verbs such as ‘remember’ or ‘forget’ (Wellman & Johnson, 1979). As a third step or maybe simultaneous with the second step, as children acquire a conception of their own and other’s memories, they might also get a deeper understanding of how their memory works and which variables influence memory performance, for instance, that it is harder to remember many items than to remember just a few items.

The longitudinal investigation that we will describe in more detail in the following sections is part of a more comprehensive longitudinal project that explored the interrelationships among general language development, executive functioning, working memory, theory of mind, and meta-memory from preschool to kindergarten age (Schneider, Lockl, & Fernandez, 2005). The main goal of the present analyses was to combine aspects of the research on theory of mind, meta-cognitive vocabulary and meta-memory within a longitudinal framework. Because theory-of-mind research has shown that children first become capable of attributing mental states like belief between the ages of 3 and 5 and previous studies on meta-memory development have indicated that meta-memory cannot be reliably assessed until the age of about five years (Kreutzer & Leonard & Flavell, 2000; Wellman, 1977), we focus on the age range of four to six years. In order to take into account the mediating role of individual differences in general language and nonverbal skills on the relationship between early theory-of-mind competencies and later meta-memory, we also included the assessment of language competencies and nonverbal IQ.

Method

In the part of the research reported here, children were tested with four measurement scales, separated by testing intervals of half a year.

Participants

A total of 57 children (36 boys and 21 girls) were included in the present analyses. All children attended kindergartens in the city and surroundings of Rasht (Guilan province of Iran) and there was parents' written consent regarding their children' participation in this study. At the first session of testing, children were about 4 and a half years old (M =53.4 months, SD = 2.3 months). At the second session of testing, the sample still consisted of 57 children, but four children left the study before the third session of testing. At the fourth session of testing, two more children did not participate in the testing. Accordingly, 51 children participated in the all four assessments described here. Even though most of the children participated thoroughly at all phases of data collection, some of them did not succeeded to completely participate due to sickness or going on holliday.

Procedure

Children were tested individually in a quiet room at their kindergarten. At the first session of testing, children completed a set of theory-of-mind tasks. At each of the following measurement scales, children participated in two sessions within an interval of 2 weeks. Session 1 consisted of the meta-memory interview and additionally at Session 4, an assessment of nonverbal abilities. Session 2 included a general vocabulary test taken from the HAVIWA (Schuck & Eggert, 1976) and a specific vocabulary test aiming to assess children’s knowledge of mental verbs. The order of the session was counterbalanced in such a way that half of the children started with the meta-memory interview and the other half of the children began with the vocabulary tests.

Instruments

Theory of mind for the assessment of theory of mind competencies. At session 1, children were given a false-belief content task, a false-belief transfer task and an appearance-reality task. The false-belief content task was based on studies by Gopnik and Astington (1988) and Wimmer and Hartl (1991). The experimenter asked the children to indicate what was inside a soap-bubble box. She then opened the box and showed that it had unexpected content, i.e., candies. Then, children were 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?”

Meta-memory at sessions 2, 3, and 4. Children’s declarative meta-memory knowledge was assessed through an interview from the Munich Longitudinal Study on the Genesis of Individual Competencies (LOGIC; Weinert & Schneider, 1999). Two of the items (preparation object and retrieval object) were modeled after the procedure developed by Kreutzer (1975). The remaining four items were adapted from a study by Wellman (1977). The items of the meta-memory interview were presented always in the following order:

1) Preparation: object: Children were asked what they could do in the evening in order to be sure that they would not forget to take a pretzel for lunch to the kindergarten the next morning.

2) Retrieval: object: This item required the children to imagine that they had lost their jacket, while they were at kindergarten. The children were asked what they could do in order to retrieve the jacket.

For each of the following four items, two children were described as being faced with various memory tasks in each of which the conditions for the story characters differed in one crucial aspect. To illustrate the difference in the conditions for each of the memory tasks, picture cards were used depicting the relevant study materials. The test question was: “Is it more difficult for child A to remember the pictures than child B or vice versa or is it equally difficult for both children?” “Why?”

3) Study session: Two children were described as having received the same number of items to remember, but child A had less sessions than did child B.

4) Number of items: Child A was shown to have 6 items to remember, whereas child B had only 3 items to remember.

5) Color of hair (irrelevant): Two children whose hair colors were different had to remember identical sets of pictures and were given the same length of session.

6) Random vs. categorized order: Two children were shown to have identical sets of items to remember. However, the items were presented in three conceptual categories to child A and in random order to child B.

Correct answers on the first questions and the subsequent "why" questions were summed up to give a maximum score of 12. Split- half reliability coefficient of the LOGIC measure (Weinert & Schneider, 1999) was .69

Meta-cognitive vocabulary test. At Sessions 2, 3 and 4, children's comprehension of meta-cognitive verbs was assessed with the English version of a vocabulary test developed by Astington (2000). In this task, the experimenter read the children a story that consisted of 12 episodes, each illustrated by pictures. At the end of each episode, children were required to select one of the two meta-cognitive verbs to describe the character's state of mind. For example: "…Dad comes into the room and says, 'Time for bed. If it's sunny tomorrow, we'll go to the park.' In the morning Ali gets out of bed and looks out the window. He sees it is raining. 'Oh no,' says Ali, 'Look at that! We won't be going to the park today.' Tell me: Does Ali know it's raining or does Ali remember it's raining?" The story contained the following 12 meta-cognitive verbs: know, guess, remember, forget, wonder, figure out, explain, understand, learn, teach, predict, deny. Each of the verbs appeared twice in the story, once as the correct choice and once as the incorrect choice. For half of the questions the correct choice was the first verb in the pair, and for the other half it was the second verb. Children had to answer both test questions including the related verb correctly, two additional training items were given at the beginning of the first session. The reliability coefficient of the meta-cognitive vocabulary test (Astington, 2000) was .79

General vocabulary test. To assess children's general vocabulary a subtest of the Hannover-Wechsler Intelligence Scale for Preschool Children (HAWIVA; Schuck & Eggert, 1976) was administered at each session of testing. In this subtest, children were told that the experimenter wanted to figure out how many words they already knew. The question follows: "What is a (e.g., dog, knife, umbrella, etc.)?" required a complex scoring system. Depending on the quality of the answer, 2, 1, or 0 sessions were given, and extensive guidelines were provided to facilitate the scoring procedure. As the subtest consisted of 20 items, the maximum credit was 40. The testing procedure was discontinued whenever a subject failed on four consecutive items. The reliability coefficient of General vocabulary test (HAWIVA; Schuck & Eggert, 1976) was .72

Nonverbal abilities. At the last session of testing, children's nonverbal abilities were assessed with the English version of Cattell's Culture Fair Test (CFT 1; Cattell, Weiß & Osterland, 1997). The short form of the test including the subtest classifications, similarities, and matrices was administered. According to the test manual, scores on the three subtests were summed up to obtain a measure of children's nonverbal abilities (maximum score of 36). The reliability coefficient of Cattell's Culture Fair Test(Cattell, Weiß & Osterland, 1997) was .62.

Results

Table 1
Percentage of Children with Correct Answers to the Forced-Choice Questions (Correct Answers with Correct Justifications in Parentheses) in the Meta-memory Interview at the Three Sessions of Testing

	Session Point and Age of Children					
	Session 2 5 years		Session 3 5 ½ years		Session 4 6 years	
(1) Preparation: object	16.7	(9.2)	26.2	(17.9)	47.0	(34.3)
(2) Retrieval: object	16.1	(3.4)	24.9	(10.1)	35.9	(28.7)
(3) Study session	41.4	(27.0)	66.3	(57.4)	81.4	(74.9)
(4) Number of items	46.8	(36.8)	61.5	(56.2)	76.1	(74.2)
(5) Color of hair (irrelevant)	73.1	(1.8)	78.9	(6.6)	90.5	(20.2)
(6) Random vs. categorized order	42.8	(30.6)	63.1	(50.6)	81.9	(68.1)

Table 1 shows the percentage of children who correctly answered each of the forced-choice questions in the meta-memory interview at each session of testing. The numbers in parentheses represent the percentage of children who correctly answered the forced-choice questions and, at the same session, correctly justified these answers. As apparent from Table 1, there was a substantial increase over sessions in the number of children succeeding on each of the meta-memory items. The sessions on the answers to the forced-choice questions and the justifications were summed up to create a meta-memory composite score. Internal consistencies (Cronbach's alpha) obtained for the meta-memory composite score (range 0 to 12 session) were .73, .78 and .75 at sessions 2, 3, and 4, respectively. To evaluate developmental changes in children's meta-memory, we conducted an ANOVA with children's meta-memory composite scores as a within-subjects factor. This analysis revealed a significant main effect of session, $F(2,330) = 51.2$; $p < .01$, indicating that children's meta-cognitive knowledge significantly increased over sessions.

As for the domain of meta-memory, composite scores for children's comprehension of meta-cognitive verbs were computed by summing up session on individual verbs (range 0 to 12 verbs). Internal consistencies (Cronbach's alpha) obtained for these composite scores were .64, .70 and .66 at sessions 2, 3, and 4, respectively. An ANOVA with children's composite scores as a within-subject factor revealed a significant main effect of session, $F(2,312) = 54.2$; $p < .01$, indicating developmental improvement in children's comprehension of meta-cognitive verbs. However, even at the age of 6 years old, children's performance was far from being perfect.

Table 2
Means and Standard Deviations of the Dependent Variables

	Session1 (4 ½ years)	Session2 (5years)	Session3 (5 ½ years)	Session4 (6years)
Theory of Mind (Max. 5)				
M	3.12			
(SD)	(1.48)			
Meta-memory (Max. 12)				
M		3.43	5.17	7.05
(SD)		(2.40)	(2.87)	(2.65)
Meta-cognitive vocabulary (Max. 12)				
M		5.28	6.52	7.39
(SD)		(2.49)	(2.70)	(2.52)
General vocabulary (Max. 40)				
M		15.09	18.63	20.87
(SD)		(4.73)	(5.96)	(5.91)
Nonverbal abilities (Max. 36)				
M				20.78
(SD)				(5.19)

Table 2 provides a summary of the descriptive statistics for the measures of theory of mind, general vocabulary and nonverbal abilities as well as for the meta-memory and meta-cognitive vocabulary composite scores.

To create a more robust measure of children's early theory-of-mind competencies, a composite score was computed by summing up the session on individual test questions. Children could receive a maximum score of 5 points: two points from the false-belief contents tasks, two points came from the false-belief transfer task and one point from the appearance-reality task. The internal consistency (alpha) of the theory-of-mind composite score was .60. At the age of 4 ½ years, children correctly answered about 3 out of 5 test questions.

Concerning children's general vocabulary, significant developmental trends were found, $F(2,318)= 49.8$; $p < .01$, the same result was also found for the domains of meta-memory and comprehension of meta-cognitive verbs. Children's nonverbal abilities were assessed only at the last session of testing, thus, no developmental changes could be evaluated for this variable.

Table 3
Pearson Correlations of Meta-Memory, Meta-Cognitive and General Vocabulary and Nonverbal Abilities at and Across the Three Sessions

	1	2	3	4	5	6	7	8	9	10	11
1. Theory of Mind, Session 1	--	.35	.52	.38	.36	.37	.38	.34	.32	.30	.30
2. Met -memory, Session 2		--	.56	.36	.36	.45	.41	.51	.48	.43	.31
3. Meta-memory, Session 3			--	.49	.46	.44	.40	.32	.44	.38	.42
4. Meta-memory, Session 4				--	.38	.40	.48	.24	.44	.46	.51
5.Meta-cognitive vocabulary, Session 2					--	.52	.35	.28	.34	.27	24
6.Meta-cognitive vocabulary, Session 3						--	.52	.39	.39	.36	.33
7.Meta-cognitive vocabulary, Session 4							--	.37	.39	.45	.39
8.General vocabulary, Session 2								--	.62	.55	18[a]
9. General vocabulary, Session 3									--	.61	.33
10. General vocabulary, Session 4										--	.32
11. Nonverbal abilities, Session 4											--

Note: all p’s < .01 (except for [a] p < .05)

Table 3 presents the Pearson product-moment correlations between the composite scores for theory of mind, meta-memory, Meta-cognitive vocabulary, general vocabulary, and nonverbal abilities at and across the three sessions.

The first row of the table shows that theory-of-mind competencies assessed at the age of 4 and a half years old were reliably associated with all of the other variables assessed up to one and a half years older. In particular, a relatively high correlation was found between theory of mind at session 1 and meta-memory at Session 3.

Next, the data presented here provides information about the stability of children's performance within the different domains. The term "stability", as it is used here, refers to the maintenance of individuals' relative standing within their group between measurement sessions, which is usually measured with the correlation coefficient (Appelbaum & McCall, 1983). With respect to children's meta-memory, moderate correlation were found when considering the stabilities from session 1 to session 2 and from session 2 to session 3. The same pattern of correlations emerged for the stability of children's comprehension of meta-cognitive verbs. In comparison, the stability coefficients obtained for children's general knowledge were somewhat higher.

Moreover, substantial correlations were found among children's meta-memory scores and their comprehension of meta-cognitive verbs. The pattern of correlations indicates that the relation between meta-memory and meta-cognitive vocabulary tended to increase from the age of 5 until the age of 6 years old. To examine whether some underlying factor affects the development in both domains, we also computed partial correlations between the composite scores for meta-memory and meta-cognitive vocabulary, thereby controlling for the effects of nonverbal abilities and general vocabulary. The resulting partial correlations remained significant, $r = .24$, .22, and .27 all significant at $p < .01$, at sessions 2, 3 and 4, respectively.

Table 4
Summary of Hierarchical Regression Analyses Predicting Meta-Memory from Nonverbal Abilities, General Vocabulary, Earlier Theory of Mind, and Meta-Cognitive Vocabulary

Variable	beta	t	R^2	ΔR^2
	Session 2 to Session 3[a] (N = 151)			
Step 1				
Meta-memory, Session 2	.35	4.84**	.32	.32
Step 2				
Nonverbal Abilities	.23	3.70**	.41	.09
Step 3				
General Vocabulary, Session 2	-.04	ns	.41	.00
Step 4				
Early Theory of Mind	.29	4.34**	.50	.09
Step 5				
Meta-cognitive Vocabulary, Session 2	.15	2.33*	.51	.01
	Session 2 to Session 4[b] (N = 153)			
Step 1				
Meta-memory, Session 2	.10	ns	.12	.12
Step 2				
Nonverbal Abilities	.40	5.65**	.31	.19
Step 3				
General Vocabulary, Session 2	.03	ns	.32	.01

Step 4				
Early Theory of Mind	.14	1.90(*)	.35	.03
Step 5				
Meta-cognitive Vocabulary, Session 2	.17	2.34*	.37	.02
	Session 3 to Session 4[b] (N = 153)			
Step 1				
Meta-memory, Session 3	.14	ns	.21	.21
Step 2				
Nonverbal Abilities	.34	4.63**	.34	.13
Step 3				
General Vocabulary, Session 3	.16	2.10*	.37	.03
Step 4				
Early Theory of Mind	.10	ns	.38	.01
Step 5				
Meta-cognitive Vocabulary, Session 3	.15	2.11*	.40	.02

Note. (*) $p < .10$ * $p < .05$. ** $p < .01$

[a] Dependent variable = Meta-memory, Session 3

[b] Dependent variable = Meta-memory, Session 4

To examine whether children's meta-memory scores at a later session depend on their earlier comprehension of meta-cognitive verbs, hierarchical regression analyses were computed to this scores for children's comprehension of meta-cognitive verbs were entered at the final step. The results of these regression analyses are shown in Table 4; the regression coefficients are those obtained at the final step.

While session 2 results are used to predict session 3 scores, earlier meta-memory scores, nonverbal abilities and early theory-of-mind competencies were significant predictors of later meta-memory scores. After having accounted for such potentially confounding variables, children's meta-cognitive vocabulary scores still contributed reliably to the prediction of meta-memory. Similar patterns of results were found when predicting from session 2 to session 4 and from session 3 to session 4. However, the contribution of early theory-of-mind competencies to the prediction of meta-memory decreased when meta-memory at session 4 was considered. Together, all variables accounted for about 40% to 50% of the variance in subsequent meta-memory scores.

Table 5
Summary of Hierarchical Regression Analyses Predicting Meta-Cognitive Vocabulary from Nonverbal Abilities, General Vocabulary, Earlier Theory of Mind, and Meta-Memory

Variable	beta	t	R^2	ΔR^2
Session 2 to Session 3[a] (N = 151)				
Step 1				
Meta-cognitive Vocabulary, Session 2	.34	4.63**	.27	.27
Step 2				
Nonverbal Abilities	.14	2.00*	.31	.04
Step 3				
General Vocabulary, Session 2	.15	1.91(*)	.36	.05
Step 4				
Early Theory of Mind	.09	ns	.37	.01
Step 5				
Meta-memory, Session 2	.17	2.08*	.39	.02
Session 2 to Session 4[b] (N = 153)				
Step 1				
Meta-cognitive Vocabulary, Session 2	.12	ns	.12	.12
Step 2				
Nonverbal Abilities	.23	3.17**	.22	.10
Step 3				
General Vocabulary, Session 2	.15	1.89(*)	.28	.06
Step 4				
Early Theory of Mind	.15	1.90(*)	.30	.02
Step 5				
Meta-memory, Session 2	.18	2.12*	.32	.02
Session 3 to Session 4[b] (N = 153)				
Step 1				
Meta-cognitive Vocabulary, Session 3	.33	4.42**	.26	.26
Step 2				
Nonverbal Abilities	.18	2.34*	.31	.05
Step 3				
General Vocabulary, Session 3	.14	1.86(*)	.34	.03

Step 4				
Early Theory of Mind	.16	1.97$^{(*)}$	.36	.02
Step 5				
Met memory, Session 3	.02	ns	.36	.00

Note. $^{(*)}$ $p < .10$ * $p < .05$. ** $p < .01$

[a] Dependent variable = Meta-cognitive Vocabulary, Session 3

[b] Dependent variable = Meta-cognitive Vocabulary, Session 4

Figure Captions

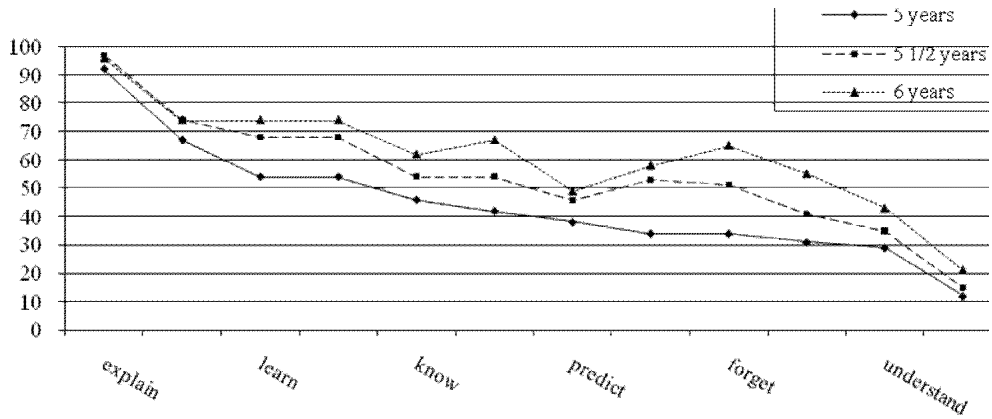

Figure 1

Percentage of Children Who Correctly Selected and Rejected Each of the Meta-cognitive Verbs

Analogous analyses were carried out to determine whether earlier meta-memory scores were predictors of children's later comprehension of meta-cognitive vocabulary (see Table 5).

When predicting from Session 2 to Session 3, earlier meta-cognitive vocabulary, nonverbal abilities and to some extent general vocabulary made reliable contributions to the prediction of meta-cognitive vocabulary. The addition of earlier meta-memory scores reliably improved the amount of variance explained after the other variables were accounted for. When predicting from Session 2 to Session 4, again, meta-memory scores reliably predicted later meta-memory scores but this was not the case for the session interval from Session 3 to Session 4. Early theory-of-mind performances tended to make valid contributions to the prediction of meta-cognitive vocabulary when the dependent variable was meta-cognitive vocabulary at Session 4. All variables accounted for 32% to 39% of the variance in subsequent meta-cognitive vocabulary.

Discussion

The main goal of this longitudinal study was to investigate whether early theory-of-mind competencies have an impact on developmental changes in meta-cognitive knowledge. Moreover, we were interested in the nature of the relationship between children’s meta-memory and their comprehension of meta-cognitive vocabulary. Therefore, theory-of-mind competencies were assessed at the first session of testing (i.e., at the age of 4), and measures of both meta-cognitive vocabulary and meta-memory were presented at subsequent session.

There were several interesting findings. First of all, we replicated previous studies showing that both meta-cognitive vocabulary and general meta-memory improve considerably over the preschool and kindergarten years (Kreutzer et al., 2000; Myers & Paris, 2008; Weinert & Schneider, 1999). In both cases, however, mean performance was far below ceiling, indicating that knowledge of mental verbs and knowledge about memory strategies is not particularly rich before children enter school. Findings also verified that item difficulty within a given domain varies considerably. For example, the data showed that knowledge about preparation and retrieval strategies as assessed by Kreutzer and colleagues was very poor at the beginning of the study and it was still restricted at the last measurement point, that is, during the last year of kindergarten. On the other hand, most of the 6-year-olds knew that task difficulty is influenced by the number of the to-be-learned items, and does also depend on the structure of an item list (categorical vs. random).

A rather new finding concerns the stability of measures over the sessions. The correlations depicted in Table 3 showed that test-retest stabilities were moderate for both the meta-cognitive vocabulary and meta-memory measures (about .50). These results indicate that individual differences in the development of meta-cognitive vocabulary and meta-cognitive knowledge have already existed at an early age. Those children who are ahead of the others with regard to these concepts at an early session point tend to be ahead of the rest of the group at a later session point, and vice versa. Findings on moderately high test-retest-stability are not in accord with the outcomes of the Munich Longitudinal Study (LOGIC; Weinert & Schneider, 1999) that reported rather low test-retest correlations for meta-memory between the ages of 4 and 6 years old. However, this difference in findings may be due to differences in retest intervals: whereas tests were repeated every six months in the present study, the test-retest interval in the LOGIC study was about two years.

The core issue of the present study concerned the origins of knowledge about memory. Thus, we wanted to answer the question whether there are precursors of an understanding of how memory works and which variables influence meta-memory development. As a main result, we found that there is a predictive relation between children's ability to attribute false belief (i.e., their theory of mind), their acquisition of meta-cognitive vocabulary, and their knowledge about variables that influence memory. Hierarchical regression analyses showed that early theory of mind made a reliable contribution to the prediction of meta-memory, and that meta-cognitive vocabulary also had a specific impact even when individual differences in nonverbal intelligence and general vocabulary were taken into account. Overall, we were able to demonstrate that children who were coming early to a theory of mind also had a better understanding of mental verbs and showed superior performance in a meta-memory interview assessed one or two years later. Thus, our data provide some evidence for the hypothesis that early theory-of-mind competencies can be considered as a precursor of subsequent meta-memory and that the acquisition of the concept of representation might be a crucial step in children's development, which at the end enables them to think about their own and other people's memories.

Moreover, our findings show that in addition to theory of mind, specific language skills, in particular, the comprehension of meta-cognitive vocabulary, reliably contributed to the prediction of knowledge about memory. However, one somewhat unexpected outcome of the hierarchical regression analyses was that prior meta-memory also predicted subsequent meta-cognitive vocabulary, even after third variables such as IQ and general vocabulary had been taken into account. Thus, the data do not support the assumption of a clear-cut cause-effect relationship between the two constructs. Instead, they point to a reciprocal association, that is, meta-memory development depends on the acquisition of meta-cognitive vocabulary and vice versa. Because some of the mental verbs were used in the test questions of the meta-memory interview ("remember", "forget"), it is likely that the comprehension of these verbs is crucial for meta-memory performance. However, it is noteworthy that the test on meta-cognitive vocabulary also included a range of terms that were not used in the meta-memory assessment. Hence, we do not think that both areas are related only because meta-memory assessment relies on the comprehension of specific verbs, but also because the acquisition of meta-cognitive terms helps children, in a deeper sense, to gain a fuller understanding of mental phenomena including memory processes. Inversely, it appears reasonable that increasing knowledge about memory can contribute to the comprehension of mental verbs.

We know from previous work on the development of meta-cognitive vocabulary (e.g., Astington, 2000; Astington & Pelletier, 1996) that this is a long-lasting process, with a complete understanding of the more difficult mental verbs not reached before adolescence. The same is true for meta-cognitive knowledge, which typically has not reached its peak before young adulthood. There is much room for most aspects of meta-memory to develop over the school years and beyond. Our data seem to indicate that developmental changes in one construct are closely related to changes in the other, and that it is really difficult to disentangle the developmental process into separate components. Given the fact that our knowledge about the long-term developmental process in the domains of meta-cognitive vocabulary and meta-cognitive knowledge is very restricted, future research should investigate the interdependencies over more extended periods of session.

Limitations

(1) Limitation of Research Scope

With the research object, it's not easy to generalize the research result to other populations.

(2) Limitation of Resources

Due to limit of research time, manpower and budget, this researche sample size is small.

Suggestions

(1) Extensive research conducted with samples and variables may include family and culture.

(2) Research on bilingual children's vocabulary by studying variables Frahafzh and meta-cognition.

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