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MIND THEORY AT PRESCHOOLERS: ASSOCIATION BETWEEN
AGE DIFFERENCES AND NONVERBAL INTELLIGENCE

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Abstract

The present study investigates differences between the components of theory of mind (ToM) in children at preschool ages and its relationship with nonverbal intelligence. During the preschool period, children make significant progress in understanding their own and other people's thoughts, intentions, desires, or beliefs. The study aims to examine the performance of Theory of mind, between-age and within-age differences and relations between nonverbal intelligence and components of ToM.

The participants are 111 children aged 3 to 6 years old. Different types of tasks are given to the participants: understanding of deception, understanding of emotions, and intentions. Nonverbal intelligence is assessed with the Raven's Colour Progressive Matrices test.

The results demonstrate that starting from the fourth year, the development of ToM increases considerably. The borderline in deception understanding, intension recognition and emotion comprehension is at the age of four years old. Starting from the fourth year, about a half of children understand the situation of deception but only if they take part in cheating. The associations between different components of ToM reveal that children, who understand deception better, are more likely to reach understanding with affective expressions. Nonverbal intelligence positively correlates with the components of ToM. These findings are consistent with other studies except sex differences.

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1. Introduction

“Theory of mind” (ToM) is a psychological concept that relates to the cognition of mental states, including desires, beliefs, intentions, and feelings. During the preschool period, children make significant progress in the understanding of their own and other people’s mental life (thoughts, intentions, desires, or beliefs (Flavell, 1999; Wellman, 2001). The emergence of children's theory of mind in the preschool period is an essential step in the social-cognitive development of children (Harris, 2006).

Understanding and predicting another person's behaviour by understanding their mental states is important for social, affective, and communicative relationships with others (ex. Bekhbakhania, et al., 2012). The links between understanding ToM elements and communication skills are found among the children of different age groups. The main findings are about the difference in skills at understanding the mental phenomenon of communication partner which depends on the context of communication tasks (Sergienko & Ulanova, 2016).

The development of ToM starts in infancy when children understand intentional actions. Later at the age of 3, they begin to understand the principle of “seeing leads to knowing” and can distinguish their beliefs from those of others (Pratt & Bryant, 1990). During the period from 4 to 5 years, children begin to acquire false beliefs (Wellman, Cross, & Watson, 2001). Empirically, hundreds of studies have consistently shown that children younger than four years old systematically fail to solve the “false belief” tasks, whereas children older than four years systematically pass. These converging results have standardly been interpreted as indicating a profound conceptual change or even revolution around the age of 4 (Perner, 1991). The fourth and fifth years are considered as a milestone in development because they indicate that children understand that someone can have a belief that differs from reality (Carpendale & Lewis, 2010). This ability enables children to understand that the same actual state of affairs is interpreted differently by different people. Around the age of 6 years old, children begin to realize that knowledge and beliefs may originate through cognitive activities such as interpretation. ToM advances to include the ability to consider more complex psychological states, such as double bluffs, and second-order false beliefs (making inferences about someone’s false attribution of belief). Although there is some evidence to suggest that ToM abilities continue to develop in the middle childhood and early adolescence (Hughes & Devine, 2015). To date, only little is known about the impact of early theory-of-mind abilities on academic achievement in the early school years (Hughes & Devine, 2015).

Delays in the development of ToM skills have also been found. There are considerable individual differences in ToM skills among typically developing children (Pons & Harris, 2005) and children with various clinical disturbances including children with hearing loss (Fujino, Fukushima & Fujiyoshi, 2017), and children with autism spectrum disorder (ASD) (Zhang, Shao & Zhang, 2016).

Cross-cultural differences in the development of ToM have been identified in many studies. The sociocultural influences on the development of ToM are specified not only through behavioural performance but also through neural processes (Zhang, Shao & Zhang, 2016).

Sex or gender differences have been analyzed in the past studies. As the main result, it is found that girls outperform boys in some tasks on emotion understanding and reasoning (Lagattuta, Elrod & Kramer, 2016).

To sum up, ToM may be viewed as a mental ability to infer the thoughts, intentions, emotions, and feelings of other people, and predict their future behaviour, accordingly.

2. Problem Statement

Some of the studies showed that the performance of theory of mind considerably changed through the age period from 3 to 6 years (Wellman, Cross & Watson, 2001) and could be related with other cognitive functions (Sergienko, 2014), but rarely tested on the Russian children sample. There was some evidence (Marcovitch et al., 2015) of age differences in the components of ToM; at the same time, associations between them and correlations with nonverbal intelligence should be clarified. Also, the replication of the previous facts in the Russian children sample could lead to the opinion of the cultural independence on the development of ToM.

3. Research Questions

Are the facts of the development of Theory of mind obtained on the Russian children sample the same as found in the other studies?

Are there any differences between- and within-age in the task performance of Theory of mind and, is the borderline in task performance of ToM the fourth year?

Are there any associations between different components of ToM, or they develop independently?

4. Purpose of the Study

The primary goal of the present study is to assess the performance of Theory of mind during the age period of 3 to 6 using a variety of tasks (deception understanding, the principle of “seeing leads to knowing”, and intention and emotion recognition).

The second goal of the study is to examine between-age and within-age differences, the associations between different components of ToM, and reveal sex differences.

The third goal of this study is to investigate the relations between non-verbal intelligence and components of ToM.

5. Research Methods

5.1. Subjects

One hundred and eleven children (51 girls, 61 boys) from two kindergartens at the age of 41 months to 72 months ($M=55$, $SD=14,4$) participated in this study. Four children were tested but excluded from the analysis because they were uncooperative. The parents were previously informed and gave their written consent to the experimental participation. A female experimenter examined the children either in a quiet room of their daycare. The sample was divided into three age subgroups:

- 1) 3-4 years old (from 41 to 51 months) — 36 children;
- 2) 4-5 years old (from 59 to 63) — 60 children;
- 3) 5-6 years old (from 67 to 72 months) — 15 children.

5.2. Procedure

The research included methods for the development estimate of ToM with different types of tasks: understanding of deception, understanding of emotions, and intentions. All the tasks were proposed by Sergienko E.A. and tested in various studies on typical and atypical children samples (Sergienko, 2006).

5.2.1. The deception task

Each child was tested in two trials of Deception task in the active and passive conditions. Passive conditions. Two personages (P1, P2) and the protagonist (PR) was showed to the child. Each of the personages had a colour label, and the protagonist had an object (candy). The story was that the protagonist left the object and went away. One of the personages (P1) took the object but left colour label of another (P2) personage. When the protagonist returned, the control question from the experimenter was: "What does he/she think, who stole the object?" The active conditions. It was the same scene but before one of the personages leaving, the label child was asked the question: "Which label should he/she leave to deceive the protagonist?" Before the main task, each child was tested in the training-task. The training task checked the general understanding of the story and the link between the personages and colour labels. The advantage of this task was that child did not need to demonstrate good verbal abilities. Each right answer was assessed as 1, wrong as 0, the maximum of scores was 2 (100%).

5.2.2. The mental world understanding task

This task was used to test the understanding of the principle "seeing leads to knowing". Four pictures with two persons on it and a box were shown to a child. The difference between the pictures was that only one person saw the object in the box. The experimenter asked a child: "Who can see the object in the box?" Each right answer was assessed as 1, wrong as 0, the maximum of scores was 4 (100%).

5.2.3. The intentions task

The following task was used to test the intentions based on the eye direction. Five pictures with a face looking at different corners of the list, each with an object were presented. The question is: "What object does he/she want?". Each right answer was assessed as 1, wrong as 0, the maximum of scores was 5 (100%).

5.2.4. The emotions recognition

We used five basic emotions (joy, wonder, sadness, fear, anger and pain) that were randomly shown (each emotion on the single picture) to a child. The question was: "What does this person feel?" Each right answer was assessed as 1, wrong as 0, the maximum of scores was 5 (100%).

5.2.5. The Raven's Colour Progressive Matrices test (RCPM)

The Raven's Colour Progressive Matrices test (RCPM) comprised 36 items divided into three sets of 12 each (A, Ab and B), in which the items were ordered by the increasing difficulty. Each item was presented as a coloured pattern with a missing portion and six options to choose to fill in the missing element. Some items called upon the ability to complete a continuing pattern whereas others required the

perception of the parts of the whole pattern as one on the basis of spatial relations. Finally, some of them required an analogical reasoning. The 36 items were all administered in the order prescribed in the manual with no time. Testing sessions were conducted in quiet rooms situated near the participants' classrooms.

Statistical methods were the Chi-square and Spearman Rank-order correlation analysis

6. Findings

6.1. Emotion recognition in the three ages groups

Analyzing the difference in emotion recognition between age groups, significant differences were found between children aged 3-4 years old, and 4-5 and 5-6 years old ($\chi^2=20,04$; $p=0,03$).

As shown in Table 1, the difference in the recognition of separate emotion was significant for "joy" and "pain", and not for "sadness", "anger" and "wonder" recognition.

Table 01. Percentage of the right answer in the emotion recognition task of three ages groups of the children.

Emotions (%)	3-4 years old	4-5 years old	5-6 years old	Between group differences	
				χ^2	<i>p</i>
Joy	67	92	100	13,97	0,001
Pain	61	93	100	20,55	0,001
Anger	83	88	100	2,84	0,24
Sadness	83	92	100	3,66	0,16
Wonder	42	43	60	1,59	0,45

6.2. Deception task solving by the children aged 3 to 6 years old

Significant differences were found between the active condition task and passive condition of the deception tasks in aggregate score ($\chi^2= 8,57$; $p=0,01$). Table 2 revealed between age differences. At the age of 3-4, no differences in the active or passive task condition were found, but at the age of four and older, there were significant differences in the task solving. The differences in sex were found only at the age of five. The boys understood deception in the active condition better than the girls ($\chi^2= 5,63$; $p=0,05$).

Table 02. Percentage of the right answer in the deception task of three ages groups of the children.

Sample	Deception task (active condition) %	Deception task (passive condition) %	χ^2	<i>p</i>
3-4 yeas old	39	37	0,24	0,24
4-5 yeas old	62	35	8,54	0,01
5-6 yeas old	80	27	8,57	0,01

6.3. Mental world understanding task

We did not find significant differences in the *Mental world understanding task* solving but about a quarter of the children did not understand this task. No sex differences were found, as well.

6.4. Intentions task

There is a significant age difference in the Intension task solving ($\chi^2=25,4$, $p=0,001$). A quarter of the children aged 3 to 5 years old did not understand the task but the older children solved the task with no more than two mistakes.

6.5. Correlations between the components of ToM and nonverbal intelligence

The correlations between the different tasks were depicted in Table 3. There were positive correlations between the Deception task (the active condition), the Emotions recognitions and Intensions task (ER: $r = 0.37$; IT: $r = 0.20$). The Mental world task had positive correlations with the Emotions recognitions and Intensions task (ER: $r = 0.16$; IT: $r = 0.29$), and the Emotions recognitions and Intensions task also positively ($r = 0.32$) correlate (see Table 3).

Table 03. Significant correlations between the different tasks of ToM.

ToM components tasks	1	2	3	4	5
1. Deception task (active condition)	1,00				
2. Deception task (passive condition)		1,00			
3. Mental world understanding task			1,00		
4. Intensions task	0,20		0,19	1,00	
5. Emotions recognition	0,37		0,29	0,32	1,00

On the sample of 5-60-year-old ($N=60$) children, we examined the Spearman Rank-order correlations between nonverbal Intelligence and solving the tasks of TOM, Table 04. Positive correlations between non-verbal intelligence were found with all the tasks of Theory of Mind in the whole sample of the 5-6-year-old children. Positive correlation between nonverbal intelligence and the understanding of the active condition in the Deception task remained the same at the age of 5 and 6 in a separate analysis. The correlation between Emotion recognition and nonverbal intelligence was also found at the age of 5 and 6. At the age of 5 years, positive correlations between nonverbal intelligence and active condition in the Deception task were observed.

Table 04. Significant correlations between different task of ToM and nonverbal intelligence at the age of 5-6 years.

ToM components tasks	All subsample (5-6 years old, $N=60$)	5 years old ($N=45$)	6 years old ($N=15$)
	Non-verbal intelligence (RCPM)		
1. Deception task (active condition)	0.26	0.27	0.26
2. Deception task (passive condition)	0.30	0.26	
3. Mental world understanding task	0.26		
4. Intensions task	0.27		
5. Emotions recognition	0.34	0.35	0.33

7. Conclusion

Observing the difference in emotion recognition between age groups and consistent with previous research (Harris, et al., 1989; Wellman, Cross & Watson, 2001; Sergienko & Ulanova, 2016), we would like to conclude that starting from the age of five years old, children recognize all the emotions clearly than at the previous ages, and at six-year-old children recognize all the presented emotion. Three-year-old children identify negative emotions (“anger” and “sadness”) better than positive (“joy”). “Wonder” is the hardest emotion for understanding until the age of five years. The borderline in emotion comprehension is four years because all the presented emotions are recognized by the same percentage of kids. This fact leads to the conclusion that children understand better positive than negative emotions.

The understanding of deception as a complex mental and behavioural scheme depends on the active or passive condition. Starting from the fourth year, about a half of children understand the situation of deception but only if they take part in the fraud. One may conclude that to cheat is easier than to recognize cheating. Thus, from the age of three to six years, children become more experienced in the active cheating. They have difficulties in deception recognition as they observe this situation. These facts support the ideas of the development of Theory of Mind.

Our results show that intention detection continuously develops from the age of three to six years with the borderline at four years; most of the kids start to understand any kind of intentions.

However, no sex differences are found except the better understanding of deception by boys.

The associations between different components of ToM (the emotion recognition links with the understanding of deception, intentions and the principle “seeing leads to knowing”) let us conclude that children, who better understand different cognitive phenomena, are more likely to reach understanding with affective expressions. These results are consistent with the study of the mental basis of children’s communication.

In addition, we have found that children with a higher non-verbal intelligence are better at understanding emotions as well as deception. Our findings provide the indirect support for the idea (Sergienko, 2006, 2014) that ToM possibly depends on affective states as well as general domain abilities.

In sum, the present study replicates the finding that ToM develops at preschool ages, and its development has the period when the understanding of different mental and physical principles is increasing considerably. The current study corroborates previous findings that the relations between emotions recognition, deception, intentions and the principle “seeing leads to knowing” form the complex “Theory of mind.” Generally, ToM appears to be a cognitive skill coupled with other cognitive and affective processes.

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