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The Relations Between Theory of Mind and Behavioral Control Among Primary School Age Children

Galina A. Vilenskaya
Institute of Psychology RAS, Moscow, Russia

Evgenya I. Lebedeva
Institute of Psychology RAS, Moscow, Russia

Abstract. Investigating links between theory of mind (ToM) and behavioral control in children advance our understanding of socialization and the development of self-regulation processes. The present study explores relations between ToM and behavioral control in children of primary school age. The Hanoi Tower task (1), Kogan task of combining attributes (2), the ABC of Mood task (3) and a series of neuropsychological tasks (4) assessed behavioral control. A visual perspective understanding task (1), false belief understanding task (2), understanding of intentions in a situation of deception (3), and reading mind in the eyes task (4) assessed ToM. Thirty children participated in the study (*M* age = 7.10 years, 20 males). We found that ToM does not correlate with behavioral control. It is likely that at primary school age, ToM and behavioral control become more differentiated and independent from each other, compared to earlier childhood ages. Moreover, the lack of interrelation between ToM and behavioral control might be a result of the dynamics of development: ToM in general is developed by the age of 6–7 years, while behavioral control continues to develop intensively at this age.

Correspondence: Galina A. Vilenskaya, vga2001@mail.ru, 13 Yaroslavskaya Street, 129366 Moscow, Russia. Evgenya I. Lebedeva, evlebedeva@yandex.ru

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Introduction

Links between theory of mind (ToM) and self-regulation are extensively investigated in psychology (Carlson & Moses, 2001; Hughes, 1998; Perner, Lang, & Kloo, 2002). Various possible interactions were found between ToM and self-regulation during development (Carlson, Moses, & Breton, 2002; Jahromi & Stifter, 2008, Benson et al., 2013). However, the mechanisms of the interactions between ToM and behavioral control are not fully understood. ToM is the ability to attribute to other people mental states different from our own and the ability to consider these states as the cause of another person's behavior (see the review by Baron-Cohen, 2000). According to most researchers, this understanding of the difference between one's own mental world and those of other people begins to develop in children after 4 years of age (see the review Sergienko et al., 2009). By the end of preschool, children more clearly appreciate complex mental states such as beliefs, desires and knowledge that allows them not only to predict and explain

the behavior of other people, but also to manipulate their own behavior, influencing representations of reality.

Behavioral control is a psychological level of self-regulation. It organizes human mental resources for goal achievement and provides an opportunity of goal-directed behavior. Three components of behavioral control can be distinguished: cognitive control, emotional control and control of action (Sergienko, Vilenskaya, & Kovaleva, 2010). It is important to note that, unlike the conceptually similar notion of executive functions, behavioral control is not limited to cognitive regulation but represents the unity of all regulatory components (Vilenskaya, 2016). Behavioral control rapidly develops during preschool and early school years.

A transition period of adaptation to a new environment or activity, such as the period of a child's adaptation to school, provides an important opportunity to trace the continuity of the development of ToM and self-organization of one's behavior during this period. Understanding the development and interaction between ToM and behavioral control and their roles in children's adaptation to school life allows researchers to increase the efficiency of schooling and socialization and to develop ways to improve and accelerate the adaptation process.

The most likely suggestion is that the interconnection between ToM and executive functions (which is closely tied to behavioral control, especially to its cognitive component) should be bidirectional. According to Kloo and Perner's research (Kloo & Perner, 2003), the process of training the understanding of false beliefs (one of the key aspects in ToM) improves the 3-to-4-year-old child's ability to complete tasks on executive functions and vice versa. Evidence from the literature is not very consistent, especially the data about school children and adolescents. For example, a predictive relationship between ToM and the executive functions (cognitive flexibility) is observed among 7 to 12-year-old children while controlling for age, vocabulary, working memory and inhibition (Bock, Gallaway, & Hund, 2015). Lagattuta, Sayfan and Blattman, in their research (2010), note that the success in completing tasks of ToM among 4 to 9-year-old children is connected to individual differences in other executive functions: verbal working memory and inhibitory control. However, in a sample of children aged 8.5 years, with and without attention deficit hyperactivity disorder (ADHD) (Charman et al., 2001), a correlation between executive functions and ToM was found in typically developing children but when age and intelligence were factored out, the two constructs were no longer significantly correlated. According to another study (Austin, Groppe, & Elsner, 2014) made on a large sample of 6 to 12-year-old children (more than 1,500 participants), longitudinal research showed that the executive functions, namely working memory and cognitive flexibility, are more likely to predict the development of ToM than vice versa.

All of these facts demonstrate that the development of ToM is impossible without the simultaneous development of the regulative function that we refer to as behavioral control (Sergienko, Vilenskaya, & Kovaleva, 2010). We focused our attention on the investigation of the mechanisms of interaction and mutual development of ToM and self-control (considering it as behavioral control, a psychological level of self-regulation). Our research was conducted in terms of the system-subject approach (Sergienko, 2011). This approach combines the propositions of the system-evolutionary and subject-activity approaches.

Our understanding of "subject" here is close to that of S. L. Rubinstein: subject is a qualitatively certain way of self-organization and self-regulation of the human (Rubinstein, 2003). The subject is always individual and is considered as a source and a cause of activity and of his own behavior. One of the main ideas is a continuity of development. All stages of human development are interrelated and interdependent.

Within this approach, ToM is considered as a cognitive function, while behavioral control is considered as a regulative function of a subject. This allows us to clarify questions about a subject's genesis, to take a step forward toward explaining the basis of socialization and to identify the formation mechanism of self-regulation. In the framework of the system-subject approach, Sergienko mentions that the search for empirical evidence of the relationship between behavioral control and ToM should be carried out through analysis that covers the development of the united system of mental organization and realization of one's own activity and interactions (Sergienko, Lebedeva, & Prusakova, 2009). Hence, our task was to find a relationship between indices of ToM and behavioral control among the primary school aged students.

In our previous research conducted among children between the ages of 3 and 6 years ($N = 44$; Vilenskaya & Lebedeva, 2014) we found several links between ToM and behavioral control during this period. There was a link between the control of actions and predictors of ToM, as well as one between emotional control and ToM. Thus, in the present study we expected to discover some links between behavioral control and ToM among older school children as well.

Method

Participants

Thirty children attending the first year of primary school participated in our study (age range 6.6–8.1 y.o., $M = 7.10$ y.o., $SD = 4.7$ y.o., 20 boys (66.7 %)). The children were recruited in two schools in Moscow.

Measures

To estimate cognitive control we used Kogan's task of combining attributes (Bleyher & Kruk, 1986) and the "Tower of Hanoi" puzzle (Bull, Espy, & Senn, 2004). Kogan's task examines a child's abilities to focus, shift and maintain attention. During this task a child is asked to sort and count cards with different geometric shapes by different colors (with a preliminary series in which the child just counts the cards). The cards are sorted first by color, then by shape, and in the final series a child must put them in a special table considering both color and shape. The experimenter records the times for each series and the number of mistakes in counting and/or sorting.

The "Tower of Hanoi" is a well-known puzzle, frequently used in psychological research on problem solving. It consists of three rods and a number of disks

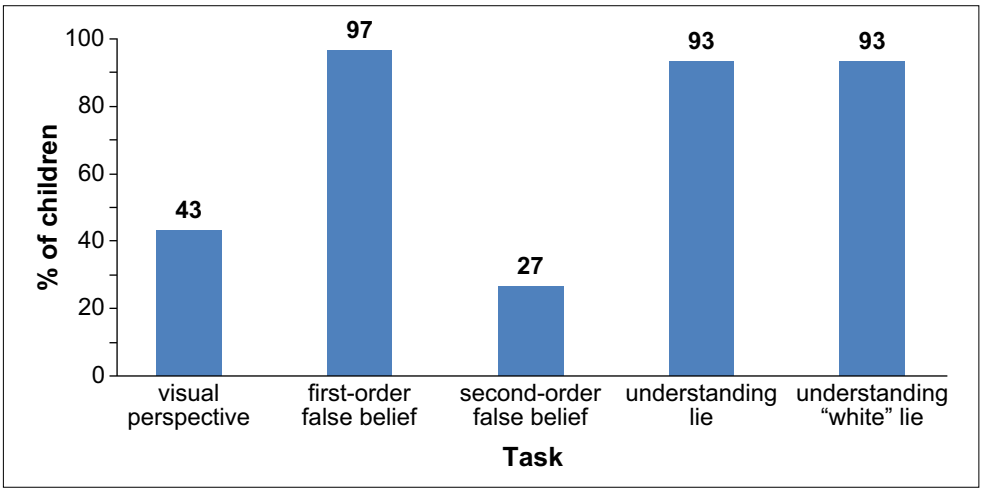

Figure 1. Results of ToM tasks performance (%), 7–8-year-old children ($N = 30$)

of different sizes, which can slide onto any rod. The puzzle starts with the disks in a neat stack on one rod, in ascending order with the smallest at the top. The objective of the puzzle is to move the entire stack to another rod, obeying the following simple rules: (1) only one disk can be moved at a time; (2) each move consists of taking the upper disk from one of the stacks and placing it on top of another stack; and (3) no disk may be placed on top of a smaller disk. We used the version with three disks, which can be solved in seven moves. We registered the time spent on solving the task and the number of moves.

To estimate emotional control, we used the "Child Anxiety Test" (Golovej & Rybalko, 2001) and the "ABC of Mood" by Belopolskaya (2006). We modified the latter for research purposes. A set of pictures with images was selected, showing people and animals (a man, a woman, a cat, a bird) with different moods (joy, anger, fear, grief, discontent, complacency). For each picture presented to the child we asked about the depicted character: "What is his\her mood?" After that we mixed the pictures and asked the children to arrange the pictures into piles so that in each pile there were images of people and animals with the same mood. Then we asked the children to name the moods of the characters in each pile. We assessed the accuracy of the named emotions (synonyms, such as angry and annoyed, counted as correct answers). We also estimated the correctness of emotion classification by how much it coincided with the classification of the author of the "ABC of Mood". In both cases, the number of errors is recorded.

The control of actions was estimated by means of three neuropsychological tasks: reciprocal hand movement, repetition of rhythmic sequence and a "Fist-Rib-Palm" task for execution of a sequence of actions (Akhutina et al., 2016). For the "Fist-Rib-Palm" task two sequences for each hand were performed. The maximum score was 6.

We evaluated the development of ToM using a task on visual perspective understanding. This task involves a picture with two characters who look at a statue from different positions and two test questions to assess the understanding that people may not see the same thing depending on their positioning (e.g., "When X looks at the statue, what does he/she see?"). We also used the first-order false belief task to assess the children's ability to infer belief in the context of an unexpected location change. The experimenter tells the child a short story, illustrating it with pictures in which one character changes the location of an item while the other character is missing. The child must predict the second character's behavior: "Where will X look for the item?" The second-order false belief task was developed from similar experimental procedures that assess the ability of children to infer one person's opinion about the belief of another person. Such tasks were borrowed from the test on understanding the mental world (Theory of Mind Task Battery) made by T. Hutchins and colleagues (Hutchins et al., 2008).

We used Happe's "Strange Stories" test for exploring the understanding of communicative intentions when a lie occurs because of altruistic versus selfish reasons (Happé, 1994). This test consists of 24 short stories, each accompanied by a picture and two test questions: the comprehension question "Was it true, what X said?" and the justification question "Why did X say that?" There are 12 story-types in the test: Lie, White Lie, Joke, Pretend, Misunderstanding, Persuade, Appearance/Reality, Figure of Speech, Sarcasm, Forget, Double Bluff, and Contrary Emotions. For our study, we used two of the stories: understanding lies and understanding "white" lies.

In addition, we used the children's version of the "Reading the Mind in the Eyes" test, made by Baron-Cohen to assess understanding of mental states by means of facial (eye) expressions (Baron-Cohen et al., 2001; Russian translation by Ekaterina A. Saprina, National Research Center of Mental Health, RAMS and Moscow City University for Psychology and Education). The choice of this test is due to its approximations to the natural situation of perception. The test consisted of 29 photographs of people's eyes (17 male and 12 female posers). There are four descriptions of mental states (emotions, intentions, beliefs, etc.) near each photo; the child must choose one of them.

All variables of ToM (except "Reading the Mind in the Eyes") were measured on a dichotomous scale: 0 = did not perform the task correctly; 1 = performed the task correctly. "Reading the Mind in the Eyes" was measured on the ordinal scale from 0 to 34.

To measure the level of intellectual development (non-verbal intelligence) as a requirement for studying ToM we used the "Raven's Progressive Matrices" test (Mukhordova & Shreiber, 2011).

For statistical analysis we used Statistica 6.0. and SPSS, with nonparametric Spearman rank order correlation. We used Fisher's angular transformation criterion to determine the differences in the success of performing certain tasks

Table 1. Descriptive Statistics of Variables

	Median	Quartile Range	Range
Age (months)	94.00	5.00	78–106
Intellect			
RavenA	9.00	2.00	0–12
RavenAB	10.00	2.00	0–12
RavenB	9.13	4.75	0–12
RavenAll	28.50	6.00	0–36
ToM			
Reading the Mind in the Eyes	16.50	4.00	0–34
Visual perspective	0	1.00	0-1
First-order false belief	1	0	0-1
Second-order false belief	0	1.00	0-1
Understanding lie	1	0	0-1
Understanding "white" lie	1	0	0-1
Behavioral Control			
Cognitive Control			
Kogan1	37.00	20.00	>0
KoganColour	48.00	14.00	>0
KoganForm	64.00	19.00	>0
KoganAll	115.00	46.00	>0
TowerTurns	11.00	10.00	>7
TowerTime	90.00	108.00	>0
Emotional Control			
Anxiety	35.00	15.00	0–100
EmotionNaming	5.00	4.00	0–24
EmotionClass	7.00	5.00	0–24
Control of Action			
Neuropsy	5.00	2.00	0–7

on ToM (φ). To calculate the relationship between certain components of ToM, we used the dichotomous correlation coefficient (φ), and for the relationship between certain components of ToM and the level of non-verbal intelligence we used a point-like biserial correlation coefficient (*rpb*). To calculate the relationship between components of behavioral control measured on ordinal scale and ToM, we used the range biserial correlation coefficient (*rrb*).

Results

The results of Raven's test correspond with actual norms from Progressive matrices (Mukhordova & Shreiber, 2011): the median score was 28.5 points, with a range of 17–35 for the overall index. All children had non-verbal intelligence within the normal range. Most of the children had an average level of anxiety as measured by the Child Anxiety Test. Other methods are usually applied for qualitative diagnostics and do not have established standards for performance. The descriptive statistics for all study variables are presented in Table 1.

The majority of 7 and 8-year-old children successfully completed the first-order false belief tasks (in which a child needs to understand the difference between his own belief and the belief of the Other). However, they were still unable to attribute to one character the false belief about the mental condition of another character (only 8 of 30 children successfully completed the second-order false belief tasks). The differences in the performance of first-order and second-order false belief tasks was significant (Fisher's angular transformation criterion $\varphi = 6.55$, $p = .001$). The results of our research on the development of ToM in primary school age children are shown in Figure 1.

While comparing the results of the completed tasks, which were focused on the development of various aspects of ToM, we discovered a connection only between the reading of mind in one's eyes and the understanding of the speaker's intentions in the case of lying. The dichotomous correlation coefficient (φ) was .43, with $p = .019$.

The children understood communicative intentions significantly better in the situation of a lie than in the second-order false belief situation (Fisher's angular transformation criterion $\varphi = 5.93$, $p \leq .01$).

Investigating the relationship between ToM and intellectual development, we found that understanding differences in visual points of view and understanding mental states by means of facial expressions are undoubtedly connected to the level of non-verbal intelligence ($rpb = .45$, $p = .013$ and $rpb = .40$, $p = .030$).

The results about the relationship between behavioral control and ToM are presented in Table 2. After checking for normality distribution, only the following variables were distributed normally: KoganAll (sorting by two features), $\chi^2(1) = 3.72$, $p = .054$, Tower of Hanoi (Turns), $\chi^2(1) = 2.82$, $p = .090$, Tower of Hanoi (Time), $\chi^2(2) = 2.67$, $p = .260$ and Neuropsychological tasks, $\chi^2(1) = 2.83$, $p = .09$.

For normally distributed variables, the range biserial correlation coefficient (*rrb*) was calculated. Because some ToM measures showed little variance (first-order false-belief task, understanding lies and "white" lies), only correlations with the visual perspective task and second-order-false-belief task were calculated.

None of the results was significant for $p < .05$.

Discussion

In this study we investigated links between ToM and behavioral control among primary school aged children. Looking at the results, we can see that behavioral control is formed at an age-appropriate level for the majority of the children. Some aspects are still developing (cognitive flexibility, emotional control), while others (mostly control of actions) are already sufficiently developed. Kogan task times increased from series1 to series4, implying that the participants had some difficulties with attention switching from one feature to another and with attention spreading. In the Tower of Hanoi task, the children performed relatively few turns but spent a lot of time on them (10 seconds per turn on

Table 2. Correlations (with *p*-Levels) between ToM and Behavioral Control Variables

	Kogan Color	Kogan Form	KoganAll	Tower Turns	Tower Time	Anxiety	Emotion-Naming	Emotion-Class	Neuropsy
Reading the Mind in the Eyes (Spearmen *r*)	.12 (.54)	.05 (.78)	−.05 (.75)	−.13 (.48)	−.1 (.60)	−.09 (.67)	−.06 (.77)	−.24 (.20)	.11 (.56)
Visual perspective (*rrb*)	—	—	.086 (.65)	.227 (.23)	.097 (.61)	—	—	—	−.279 (.24)
Second-order false-belief task (*rrb*)	—	—	−.126 (.51)	−.083 (.66)	−.078 (.68)	—	—	—	.238 (.21)

average). This may indicate that they previously solved the problem internally. In emotion classification and emotion naming, there were errors in approximately 25–30% of responses. Such a high error rate shows that their abilities to recognize and identify emotions are still developing. The performance on neuropsychological tasks is close to ceiling and consistent with the data of Akhutina et al. (2016).

The correlation between the reading of mind in one's eyes and the understanding of the speaker's intentions in the case of lying can be explained as follows. Understanding the speaker's intentions and understanding his mental states in facial expressions is in fact the realization of ToM in everyday communication, which is still developing at the age of 7–8 years (Baron-Cohen et al., 2001; Happé, 1994). Meanwhile an understanding of the first-order false beliefs is already formed at this age, and an understanding of the second-order false beliefs apparently requires, in addition to ToM, separate cognitive abilities. Previous studies have examined the possible relationship between the level of intellectual development and the development of ToM (Yirmiya, 1998). Researchers have recently discussed that it is not the level of general intelligence but the verbal mental age that predicts successful performance of ToM tasks (Blijd-Hoogewys et al., 2008). However, the results of our earlier study of the relationship between the development of ToM and the understanding of social impacts and interactions (in the example of television advertising) showed that those pre-school aged children who were more successful in understanding emotions, deception and false beliefs performed better on nonverbal subtests of WPPSI (e.g., subtest "Object Assembly" of The Wechsler Preschool and Primary Scale of Intelligence) (Lebedeva, Talanova, & Sergienko, 2012). This issue remains open. We hope that with an increase in the number of respondents, we will be able to conduct a deeper study of the relationship between ToM and nonverbal intelligence in children of primary school age.

When searching for connections between the development of behavioral control and ToM in the primary school children, we discovered that for the first-year students the ToM indices were not connected to any indices of behavioral control. The small size of our sample can limit our conclusions. However, in our previous study (Vilenskaya & Lebedeva, 2014) we found links between behavioral control and ToM in preschoolers in a sample of similar size. It is possible that in school age children the links between behavioral control and ToM are weaker and a small sample size is not enough for revealing these links. We can suppose that increasing the sample size might allow us to find some relationship between behavioral control and ToM.

An alternative explanation is that the differentiation of behavioral control and ToM functions takes place at primary school age. If in early childhood these two functions determined each other (as shown by our data from 3 to 5-year-old children in Vilenskaya & Lebedeva, 2014), then along with growing up these abilities become independent from each other, and their dynamics of development also differ. In general, ToM forms up to the age of 6–7 years (Doherty, 2008; our data support this point of view), when self-regulation (behavioral control) continues to develop intensively (Austin, Groppe, & Elsner, 2014). Such differences in dynamics can lead to the lack of interconnections between these functions.

Conclusions

In our study we found links between some measures of different aspects of ToM (mind-reading in one's eyes and understanding of lying). In primary school aged children, some aspects of ToM are sufficiently developed (understanding of the first-order false beliefs, intentions in a situation of lies) and some are still developing (understanding of the second-order false beliefs). The same is true for behavioral control: control of actions is already developed well enough, but cognitive and emotional control are still developing. A few of our results are rather intriguing and inconsistent with existing data, including the connection between some aspects of ToM and the level of non-verbal intelligence, and the absence of connections between ToM and behavioral control. Studying these questions will be an aim of future research.

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специальный выпуск

Понимание ментального мира и контроль поведения у младших школьников

Галина Альфредовна Виленская
Институт психологии РАН, Москва, Россия

Евгения Игоревна Лебедева
Институт психологии РАН, Москва, Россия

Аннотация. Исследование связей между моделью психического и контролем поведения у детей позволит продвинуться как в понимании основ социализации, так и в изучении развития саморегуляции. Данная работа посвящена поиску взаимосвязи между показателями модели психического и контроля поведения у детей младшего школьного возраста. Для оценки контроля поведения применялись методика совмещения признаков, «Ханойская башня», тест детской тревожности, «Азбука настроения» и ряд нейропсихологических проб. Модель психического оценивалась при помощи задач на понимание визуальной перспективы и на понимание неверных мнений первого и второго порядка, а также методики для изучения понимания намерений в ситуации обмана и теста «Понимание ментальных состояний человека по выражению его глаз». В исследовании участвовали 30 детей ($M = 94$ мес., 20 мальчиков). Не было обнаружено взаимосвязи между показателями модели психического и контроля поведения. Видимо, в младшем школьном возрасте функции саморегуляции и социального понимания дифференцируются, и если в раннем детстве они обуславливали одна другую, то с возрастом становятся более независимы друг от друга. Также отсутствие взаимосвязей может быть результатом различной динамики их развития: модель психического в общих чертах складывается к 6–7 годам, а контроль поведения продолжает интенсивно развиваться.

Контактная информация: Галина Альфредовна Виленская, vga2001@mail.ru; 129366, Москва, ул. Ярославская, 13. Евгения Игоревна Лебедева, evlebedeva@yandex.ru.

Ключевые слова: модель психического, контроль поведения, младший школьный возраст, когнитивный контроль, эмоциональный контроль, понимание обмана, понимание ментальных состояний по глазам

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