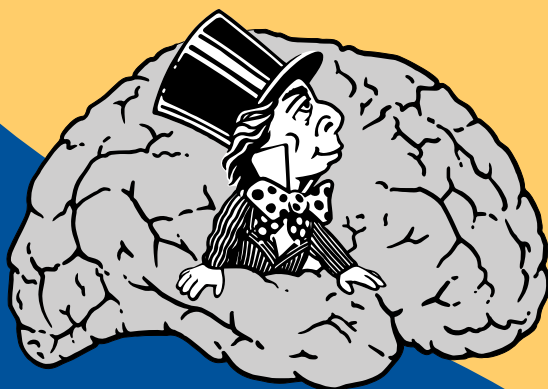


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MENTAL-ATTENTIONAL CAPACITY AND COGNITIVELY GIFTED CHILDREN IN RUSSIA

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Abstract. The analysis of cognitive competence can predict the level of a child's development and, thus, can play an important role in their future academic progress. Although the majority of children show comparable cognitive performance for their age, some children significantly outperform their peers of the same age. Based on the Theory of Constructive Operators (TCO), children's mental attentional capacity (i.e., the number of items that a child can simultaneously manipulate in their mind) normally increases from about 3 units when they enter school to about 7 units when they finish. In this study, we use parametric visual-spatial measures of mental-attentional capacity to examine whether we can identify cognitively gifted children. In contrast to intelligence tests, which are still a popular measure of giftedness, mental-attentional capacity measures do not depend on context knowledge and have already been used in Canada, South America, Europe, and Australia (Arsalidou & Im-Bolter, 2017), supporting the theoretical prediction of mental-attentional capacity development suggested by the TCO (Pascual-Leone, 1970). We report data on more than 750 children in Moscow schools to evaluate whether Russian children follow similar stage-wise increases in mental-attentional capacity and to estimate the percentage of cognitively gifted children identified by these measures. Our data show agreement between the performance of Russian children and the theoretical prediction, which supports the culture-fairness of the tasks. The percentage of gifted children varied from 0.22% to 9.44%, depending on a measure. The task that showed results closer to the theoretical expectation also reflected the percentage of cognitively gifted children similar to what was reported based on studies in the United States (0.7% to 9.9%; Lupart, & Pyryt, 1996).

Keywords: mental-attentional capacity, cognitive giftedness, cognitive development, parametric measures, gifted children

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Background

Although traditional intelligence tests have been widely used since the 19th century, there is now a shift to non-verbal measures of core functions as predictors of cognitive giftedness (Clynes, 2016), which are more culture-fair and do not depend on context knowledge. In order to identify cognitively gifted children, in the current study, we use parametric measures of mental attention that are cre-

ated within the framework of the Theory of Constructive Operators (TCO; Pascual-Leone, 1970; Pascual-Leone & Goodman, 1979). The main construct in this theory is mental attention which is involved in everyday life cognitive activities such as reading and counting as well as higher-order activities like problem-solving and planning (Howard et al., 2013) and which allows us to simultaneously manipulate several objects in mind (Pascual-Leone & Raymond, 1994). The Theory of Constructive Operators suggests that the capacity of mental attention increases by 1 item every 2 years starting from the age of 3, so children aged 7–8 are expected to process 3 items at the same time, at 9–10 years – 4 items, at 11–12 years – 5 items, and, finally, 7 items at 15–16 years (Pascual-Leone, 1970). To assess mental-attentional capacity, specific measures were developed within the TCO. These tasks are parametric (provide multiple levels of difficulty), measure the same construct within all the levels and thus, can be used with both children and adults which is crucial in developmental psychology (Arsalidou, Im-Bolter, 2017). These measures assess the capacity of a child's mental attention and provide their Mental score (the number of items that a child can simultaneously manipulate) that is an integer between 1 and 7 (maximum).

Early identification of giftedness gives an opportunity to invest in a gifted child's potential and adapt to their specific needs. Research with the use of mental-attentional capacity measures and the Wechsler Intelligence Scale for Children – Third Edition showed that gifted children identified with this intelligence test perform about 1 unit higher than their same age mainstream peers (Johnson et al., 2003). Based on this finding, in the current study, we selected a strict criterion of cognitively gifted performance of 2 units above the theoretical prediction for a specific age group. In other words, if a child is 8 years old and their Mental score is 2 or more units higher than the theory predicts (e.g., 5, 6, or 7), then we consider them cognitively gifted.

The main aim of our project is twofold: First, to study for the first time cognitive performance using mental attentional capacity measures in Russian children and second, to study individual differences in early cognitive development and to evaluate the percentage of cognitively gifted children in Russia using parametric visual-spatial measures of mental-attentional capacity.

We hypothesized that Russian children would follow similar stages of mental-attentional capacity development as proposed by the TCO (Pascual-Leone, 1970) and that the percentage of cognitively gifted children would be around 0.7–9.9% based on the study conducted in North America (Lupart, Pyryt, 1996).

Method

More than 750 children (*Table 1*) from grade 1–4 (age 6–12) from public schools in Moscow took part in the study. Testing was conducted in school classrooms during the weekdays in small groups with 5 children at a time using a computer with Presentation software (version 20.1; Neurobehavioral Systems Inc.). After each session that lasted around 45 minutes, children received a small gift.

The Ethics Committee of the HSE approved the study and the materials used. To participate in the study, parents of children were asked to provide a signed informed consent.

Table 1. Means and standard deviations for age and gender distribution per grade

Grade	Age		N	Females	Males
	Mean	SD			
1	7.61	0.39	81	34	47
2	8.60	0.39	279	141	138
3	9.58	0.37	228	113	115
4	10.61	0.63	192	84	108

The testing program included the tasks that were administrated in the form of cognitive games for children with different levels of complexity. The following tasks were administered on different days.

1. The Colour Matching tasks (CMT; Arsalidou et al., 2010) are two computerized tasks with 6 levels of difficulty which have common rules but differ in context: in a facilitative version the picture of balloons is used (CMT-balloons) and in a misleading version children look at the picture of a clown (CMT-clown). Pictures with different colours are presented one by one and children are asked to check whether the colours on the picture are the same as on the previous pictures irrespective of location. They also needed to ignore blue and green colour, size, and shape in both tasks and the face of the clown in the CMT-clown. To answer whether the colours are the same or different, a child needs to press a corresponding button.
2. The Number Matching Task (NMT) follows the same presentation and the same rules as in CMTs, but instead of colours, children need to compare numbers. In the facilitative version, numbers are presented in the form of a square (NMT-squares) and in the misleading one the numbers form a big “4” (NMT-fours).

These games are designed to measure the functions of mental attention, namely the retention of mental attention and manipulation. Mental attention retention characterizes the memorization of colours and numbers, their manipulation – comparing the colours ignoring their location, and inhibition is ignoring irrelevant information.

Results and Discussion

The graph (*Fig. 1*) shows the means and standard deviations of Russian children organized per grade to catch the transitions in mental-attentional capacity development. The horizontal line in the graph represents the theoretical prediction: taking into account that the development is a continuous process, grade 1 (age 6–8) and grade 3 (age 8–10) must be the points of transition, while grade 2 (age 7–9) and grade 4 (age 9–11) represent the maximum within the age groups with respect to the TCO prediction.

The results of both CMT measures (CMT-Balloons and CMT-Clown) are consistent with the theoretical prediction: grade 1 – $M_{\text{balloons}} = 2.50$ (1.08) / $M_{\text{clown}} = 2.76$ (0.98), grade 2 – $M_{\text{balloons}} = 2.85$ (1.56) / $M_{\text{clown}} = 3.05$ (1.15), grade 3 – $M_{\text{balloons}} = 3.58$

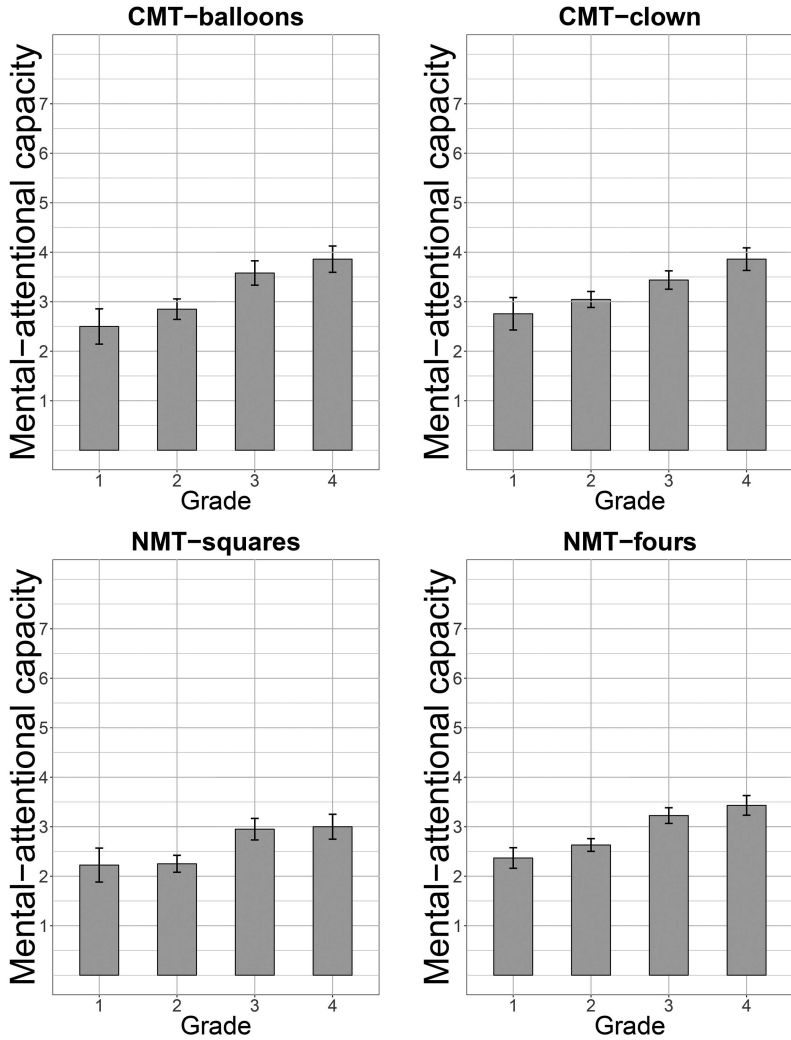


Figure 1. Representation of mean mental-attentional capacity in Russian children for all the tasks. The horizontal line represents the theoretical prediction of mental-attentional capacity.

(1.68)/ $M_{\text{clown}} = 3.44$ (1.19), and grade 4 – $M_{\text{balloons}} = 3.86$ (1.61)/ $M_{\text{clown}} = 3.86$ (1.35). This goes in line with the means of the CMTs obtained in previous studies in other countries (e.g., Arsalidou et al., 2010).

The NMT tasks (NMT-Squares and NMT-Fours) also demonstrated a stage-wise pattern of mental-attentional capacity development; however, the scores are 0.5 – 1.5 units above the theoretical prediction.

The percentages of gifted children (*Table 2*) demonstrated by the CMT tasks (together and separately) are comparable to the hypothesized percentage based on the study in the USA (0.7 – 9.9 %). The NMT tasks are stricter measures showing a very low percentage of cognitively gifted children (0.22 % to 1.08 %).

Table 2. Percentage of gifted children based on the theoretical prediction with the criterion of 2 units above.

Balloons	Clowns	CMT tasks ¹	Squares	Fours ²	NMT tasks
9.44 %	5.16 %	3.96 %	0.42 %	1.08 %	0.22 %

Note: ¹ – percentage calculated based on both CMT tasks together; ² – percentage calculated based on both NMT tasks

Conclusion

In the current study, we used measures of mental-attentional capacity in the Russian population for the first time. According to the means of the data collected, the CMT tasks demonstrated the same stagewise pattern of mental-attentional capacity development as predicted by the Theory of Constructive Operators (Pascual-Leone, 1970) and supported by the previous studies (Arsalidou et al., 2010) which proves our first hypothesis of compatibility of the developmental stages of Russian children with the predicted ones.

Our other hypothesis was that the number of children identified with the mental-attentional capacity measures would lie between 0.7 % and 9.9 % according to the research in North America (Lupart & Pyryt, 1996). The percentage shown by the CMTs (3.96 – 9.44 %) is consistent with the hypothesized one; however, the NMT measures were stricter and identified only 0.42 – 1.08 % of gifted children. Our next step will be to compare Mental scores and academic achievements of children identified as gifted based on the CMTs with gifted children based on the NMTs and with the group of mainstream children.

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ОБЪЕМ МЕНТАЛЬНОГО ВНИМАНИЯ И КОГНИТИВНО ОДАРЕННЫЕ ДЕТИ В РОССИИ

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Аннотация. Анализ когнитивных компетенций может предсказать уровень развития ребенка и таким образом сыграть важную роль в его дальнейших академических успехах. Хотя большинство детей имеют сопоставимые с их возрастом показатели когнитивных способностей, некоторые дети значительно превосходят своих сверстников. В соответствии с Теорией когнитивных операторов (ТКО), в норме объем ментального внимания у детей увеличивается с 3 объектов в начале обучения в школе до 7 при окончании школы. В данном исследовании мы используем параметрические визуально-пространственные методы измерения объема ментального внимания для изучения возможности выявления когнитивно одаренных детей. В отличие от тестов на интеллект, которые являются распространенным методом выявления одаренности, методы измерения объема ментального внимания не зависят от школьных знаний и уже использовались в Канаде, Южной Америке, Европе и Австралии (Arsalidou, Im-Bolter, 2017), подтверждая теоретическое предсказание развития объема ментального внимания, предложенного ТКО (Pascual-Leone, 1970). Мы собрали данные около 750 детей из московских школ для проверки того, следуют ли российские дети этапам развития объема ментального внимания, и для оценки процента когнитивно одаренных детей, выявленных с помощью предложенных методов. Наши данные показали согласованность между показателями российских детей и теоретическим предсказанием, что подтверждает культурную независимость используемых нами методов. Процент одаренных детей варьировал от 0.22 % до 9.44 %, в зависимости от метода. Процент когнитивно одаренных детей, подсчитанный по тем заданиям, результаты которых оказались ближе к теоретическому предсказанию, был близок к проценту, полученному в аналогичных исследованиях в США (0.7 – 9.9 %; Lupart, Pyryt, 1996).

Ключевые слова: объем ментального внимания, когнитивная одаренность, когнитивное развитие, параметрические методы, одаренные дети

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