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The relationship between visual recognition memory and intelligence

Ilya M. Zakharov[a]*, Ivan A. Voronin[a], Victoria I. Ismatullina[a], Sergey B. Malykh[a]

[a]*Psychological Institute of Russian Academy of Education, Developmental Behavioral Genetics Laboratory, 125009, Moscow, Russia*

Abstract

The study examines the relationship between intelligence and visual recognition processes in adolescents from Russia and Kyrgystan (n=327). We used "Raven Progressive Matrices" test to measure IQ and "Pattern Recognition memory" subtest of neuropsychological battery CANTAB to measure visual recognition. After adjusting for age effects number and latency of correct answers in "Pattern Recognition memory" test correlated with total Raven scores (r=.149, p=.05 andr=-.143, p=.05, consequently) and with series B, C (Number, r=.188 and .122, p=.05) and D (Latency, r=-.168, p=.05). Thus, individual differences in visual recognition can play a role in individual differences in intelligence.

Keywords: geheral cognitive abilities, specific cognitive abilities, intelligence, visual recognition

* Corresponding author. Tel.: +7-916-515-45-66.
E-mail address: iliazaharov@gmail.com

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1. Introduction

The relationship between the general and specific cognitive components (intelligence, measured with *g* factor, and working memory, reaction time, etc., consequently) have been under the comprehensive study for a couple of decades [1:4]. {Citation}It has been shown that altogether characteristics of specific cognitive components can explain up to 50% of variability in *g* factor [5:10].

Visual recognition processes have been shown to play an important role in a number of everyday day life outcomes [11, 12]. Given that the great deal of the intelligence tests is presented in the form of abstract visual tasks, it is surprising that,according to our knowledge, the role of short-term visual memory and recognition processes in the individual difference in intelligence scores have never been directly investigated.

In the present study we aimed to investigate the relationship between intelligence and visual recognition with one of the widely used measures of intelligence is Raven's StandardProgressive Matrices (RPM) test and Pattern Recognition Memory (PRM) test from CANTAB battery [13]. We have chosen RMP as it is generally recognized as one of the purest measure of *g* factor and non-verbal intelligence.

2.Method

2.1 Participants

327 adolescents from Russia and Kyrgyzstan (132 and 177 subjects consequently, 180 girls,age 11-17, median = 13, sd = 2.18) took part in the study. All subjects signed written consent.

2.2 Measures

Raven's Progressive Matrices (RMP) was used to asses non-verbal intelligence. RMP consists of 60 items divided by 5 series (A,B, C, D, E). In each test item, the subject is asked to identify the missing element that completes a pattern. Many patterns are presented in the form of a 6×6, 4×4, 3×3, or 2×2 matrix. PRM test was chosen as it has showed significant individual differences among clinical [14] and normal samples [15]. General intelligence scores was measured as the total number of correct answers.

Pattern Recognition Memory (PRM) is a test of visual pattern recognition memory in a 2-choice forced discrimination paradigm. The subject is presented with series of 12 visual patterns, one at a time, in the centre of the screen. These patterns are designed so that they cannot easily be given verbal labels. In the recognition phase, the subject is required to choose between a pattern they have already seen and a novel pattern. In this phase, the test patterns are presented in the reverse order to the original order of presentation. The test is repeated with a new set of 12 patterns to be remembered. There are following parameters estimated from the test results: mean correct and incorrect answers latency, number and percentage of correct and incorrect answers.

All the analysis was performed in statistical language R in the open software 'R Studio' [16, 17]. 'Hmisc', 'lawstat' and 'ppcor' packages have been used.

3.Results and discussion

We looked for 3 variables in the present analysis: latency and number of the correct answers in PRM test, and general intelligence scores measured as total number of correct answers in RPM. The latency of the correct answers was transformed to logarithm before the analysis due to the distribution issues. The Levene's test didn't show significant differences in homogeneity for subjects of different gender, place of birth or age. The Russian and Kyrgystan adolscents was combined into one group. The descriptive statistics for 3 age groups are presented in table 1.

Table 1. Means and standard deviations for different age groups

Phenotype	10-11 y.o	12-14 y.o	15-17 y.o
Correct latency (log)	7.65 (0.217)	7.53 (0.228)	7.48 (0.218)
Correct Number	21.15 (3.12)	20.70 (2.41)	21.02 (2.06)
Non-verbal intelligence	36.32 (10.13)	39.44 (9.65)	43.41 (10.53)

We performed 3 one-way ANOVA to test for age effect in the measured variables. Significant differences have been found for Raven scores and latency ($F(2,239)$=4.69, p=.001 and $F(2,324)$=12.07, p<.001, consequently), but not for the number of the correct scores.

The main interest for this article was the correlation of the PRM and RPM measures. Our initial results has shown that only latency of the correct answers has been correlated with Raven scores (r = -.187, p = .003, note that negative correlation means that subjects with higher RPM scores answered faster). However, as the ANOVA analysis has shown age difference for Raven and latency scores we decided to account for age effects with partial correlations. Table 2 presents the results of the partial correlational analysis. We also found that PRM measures correlates with separate series of RPM. Number of the correct answers with series B, C (r=.188 and .122, p=.05) and latency – with D (r=-.168, p=.05).

Table 2. Correlations between the analyzed variables

Raven's Progressive Matrices	A	B	C	D	E	Total scores
Correct latency	-0.133	-0.123	-.078	-0.168*	-0.078	-0.143*
Correct Number	0.117	0.188*	0.122*	0.116	0.063	0.149*

*Age effects for Raven and latency have been accounted for with partial correlations. *- p-value is significant at .05 level*

In agreement with the numerous studies, we found age effects in children's intelligence measured with RPM test. Age effects have also been found to be significant for the latency (but not the accuracy) of the PRM test performance. After accounting for age effects, we found significant, though moderate, correlation between general intelligence measures and visual recognition characteristics in adolescents.

We found only one paper that have discussed the role of visual recognition characteristics in individual differences in the intelligence. Lynn et al. [18] have shown that factorization of the RPM scores identify not only higher order *g* factor, but also 3 other factors: gestalt continuation analytic reasoning and visuospatial ability.
The differences in significance for separate RPM series in our data may have the same origin as the 3 separate factors structure identified by Lynn.

4. Conclusion

We showed that adolescents with better results in the accuracy and the speed of the visual recognition showed slightly higher non-verbal intelligence. Our results are in agreement with the idea that specific cognitive components can play a role in individual differences in intelligence.

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