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Psychology of Personality: Real and Virtual Context

INFLUENCE OF INFORMATION PROCESSING SPEED ON COGNITIVE AND PERSONAL CHARACTERISTICS IN ADOLESCENTS

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Abstract

The study aimed to examine the relationship of the speed of information processing (SIP) to the intelligence, academic achievement, motivational and emotional characteristics in secondary school children. A total 124 students (60 boys and 64 girls) were investigated two times: in grades V (11–12 years) and VII (13–14 years). We used the following methods: the Number-Connection-Test for measure of the SIP; the Cognitive Ability Tests (verbal, mathematical, nonverbal scales and general intelligence); the Questionnaires on Anxiety and Achievement Motivation; academic achievements. The results showed a significant growth of the SIP with age from grade V to VII, and at the same time, the boys significantly exceeded their classmates-girls on the SIP both in the grades V and VII. The correlation analysis demonstrated high stability of the SIP during this period. The significant positive correlations were revealed between the SIP and mathematical and general intelligences, but the significant negative correlations between the SIP and severity of fear of failure and manifestation of school anxiety. The correlations between the SIP and verbal and nonverbal abilities as well as academic achievements did not reach the significant levels. The results of the multivariate analysis of variance (MANOVA) showed the significant positive influence of the SIP on mathematical and general intelligence but the negative influence on anxiety both in grades V and VII. The findings support the usefulness of the SIP measure for the educational practice of preparing students to perform time limited tests.

Keywords: Adolescents, anxiety Information, Intelligence, processing speed.

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1. Introduction

The development of computer and information technologies increased interest in studying the relationship between speed of information processing (SIP) and intelligence, but still many aspects remain debatable. A review of 172 researches on the relationship between SIP and cognitive performance provided numerous evidences of a significant correlation between them (Sheppard & Vernon, 2008). It is shown that both high intelligence and high SIP are associated to successful and fast learning, problem solving, making of decision. Moreover, there are many empirical data that SIP may be related to general and special (mathematics, musician, etc.) giftedness and higher academic achievement in children and adults (Duan et al., 2013; Jensen, 2006; Paz-Baruch et al., 2016). However some authors demonstrate that significant linear relationships between IQ and some SIP measures are traced only in subjects with IQ lower 160, meanwhile the significant correlations between SIP and extraordinary levels of IQ or abilities are not found (e. g., Jensen, 2006). There are some evidences that the influence of SIP on achievement is not direct, but indirect. Namely, a higher speed affects an increase in the level of intellectual abilities, which in turn affect the improvement of achievements (Rindermann & Neubauer, 2004; Tikhomirova & Malykh, 2017). In addition, the relationship between speed and cognitive variables varies depending on the methods used to measure and interpret, as well as on age and gender of the sample (Borter et al., 2018; Goldhammer, 2015; Jensen, 2006; Paz-Baruch et al., 2016).

One of the methods to measure SIP is the Number Connection Test – NCT (Zahlen-Verbindungs-Test – ZVT by Oswald, 2016). According to results of Munich longitudinal study of Giftedness, the NCT-scores in schoolchildren significantly increase between grades V and X and in higher grades remain almost unchanged (Heller, 2010). The NCT-scores significantly correlate with variables of verbal, quantitative, non-verbal, and general intelligence, but not academic achievements, except for very low correlations related to mathematics. The gender advantages are manifested in different tasks, i. e. these differences are less pronounced than age-related, and less often reach significance level. Almost equally often the researchers report about higher SIP for males or for females, both among adults and among children of different ages (Sheppard & Vernon, 2008). For example, a comparison of schoolchildren with general and mathematical giftedness using five SIP-tests revealed higher speed in girls than that in boys, but only for tests requiring the use of verbal coding (Paz-Baruch et al., 2016). The relationships between SIP and personal characteristics are notably less studied, although the available data demonstrate such relationships (Preckel et al., 2011).

To sum up the literature regarding the relationships between SIP and cognitive and personal characteristics, we can conclude, that it is inconsistent, especially with regard to the influence of SIP on these characteristics in students during early secondary school period.

2. Problem Statement

In the main, the SIP-tests are recognized in the scientific literature as relatively accurate and reliable measuring tools for speed parameters that correlate with intellectual abilities and, according to some data, with academic achievements in school age. Nevertheless, the questions on the age and gender specificity of SIP and its relationship to academic achievements and personal characteristics in students remain

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insufficiently studied. The further study of this issue remains relevant for the practice of teaching and preparing schoolchildren to perform various tests and tasks, which, as a rule, have strict time limits.

3. Research Questions

This study addressed the following questions:

3.1. Question 1

Are there any correlations between the SIP-variables and cognitive and personal characteristics of the schoolchildren at the grades V and VII?

3.2. Question 2

Does the SIP influence on cognitive and personal characteristics of the schoolchildren at the grades V and VII?

4. Purpose of the Study

The study aimed to examine the age and gender differences of the SIP in the schoolchildren, to reveal the correlations between the SIP and cognitive and personal characteristics, as well to analyze influence of the SIP on the cognitive and personal characteristics in schoolchildren during the period from grades V to VII.

5. Research Methods

5.1. Participants

A total 124 students of Moscow gymnasiums (60 boys and 64 girls) were investigated twice: in grades V (11–12 years old) and VII (13–14 years old) using the same methods. It should be noted, that generally the gymnasium students have higher intelligence, than their age peers at comprehensive schools.

5.2. Methods

The SIP was measured in each participant using the Numbers Connection Test – NCT, the paper-and-pencil test, which was administered in groups. Each participant was instructed to connect by lines the numbers, placed randomly in ascending order starting from 1. At first, the participants received two training-matrices of 20 numbers for practice and then four different test-matrices of 90 numbers one by one. The instruction stressed both speed and accuracy. The time limit was 30 seconds per matrix. The SIP-variable was the mean number of correct connections before the first error on all test-matrices. The SIP obtained was operationalized by determining the number of binary decisions per second.

Psychometric intelligence was measured using the Cognitive Abilities Tests, in according to age. The tests included the verbal (vocabulary and completion of sentences), quantitative (comparison of quantities and compiling equations), and nonverbal (figure classification and analogies) scales. The general intelligence variables were received by summing all scales. Personal characteristics were measured using the Questionnaires on Achievement Motivation (Hope for Success and Fear of Failure), School Anxiety

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(General and Test Anxiety, Instability of Thinking under Stress). Academic achievements were measured with the school marks from the final-year school report.

6. Findings

The following results were received in the study:

6.1. The relationship between SIP and cognitive and personal characteristics of schoolchildren

At the first stage, descriptive statistics were calculated for the NCT-indicators in each grade and gender. Furthermore, the comparisons of the means between the boys and girls and between the Grades V and VII were performed using the Student′s t-test to identify the intergroup differences. The results are presented in Table 01. The data obtained show that the NCT-scores in the students at Grade VII are significantly higher than that at Grade V for both boys and girls, as well as for the sample in a whole. In other words, the SIP increases highly significantly with age during period from Grades V to VII. Meanwhile gender differences in the SIP are also significant, wherein the girls lag behind their peers-boys both at Grade V and VII.

Table 01. Estimated means and standard deviations (in brackets) of the SIP in schoolchildren

Gender	Number	Grade V	Grade VII	Age Differences	T-test	p
Boys and Girls	124	1.498 (0.37)	1.985 (0.41)	0.487	16.78	.000
Boys	60	1.570 (0.39)	2.065 (0.38)	0.495	12.53	.000
Girls	64	1.430 (0.33)	1.909 (0.42)	0.480	14.02	.000
Gender Differences	124	0.140 (0.06)	0.156 (0.07)	0.016	n.s.	n.s.

The Pearson correlation analysis demonstrates high stability between the NCT-variables in the students from V to VII grades ($r = 0.725$; $p < 0.001$; $n = 124$). The significant correlations between SIP and cognitive and personal characteristics are presented in Table 02. You can see that the SIP positively correlates with quantitative and general intelligence, but negatively correlates with severity of fear of failure, general and test anxiety, as well instability of thinking under stress at grades both V and VII. There are not found any significant correlations between the SIP and such variables as verbal and nonverbal intelligence, academic achievements, and hope for success.

Table 02. Correlations between the SIP and cognitive and personal variables in schoolchildren

Cognitive and Personal Variables	SIP at V grade		SIP at VII grade
	Grade V	Grade VII	Grade VII
Quantitative Intelligence	.353***	.352***	.373***
General Intelligence	.217*	.271**	.263**
Fear of Failure	–.253*	–.238**	–.224*
Test Anxiety	–.298**	–.259*	–.312***
General Anxiety	–.211*	–.227*	n.s.
Instability of Thinking under Stress	–.185*	–.239*	–.286**

Note: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

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6.2. The influence of the SIP on the cognitive and personal characteristics of schoolchildren

To assess influence of the SIP on the cognitive and personal characteristics the multivariate analysis of variance (MANOVA) was conducted with four levels of the SIP (on the NCT-scores) at the grade V as the independent variables. According to MANOVA data obtained, the overall main effect of the SIP on the cognitive and personal characteristics was found to be significant not only at grade V but also at grade VII – see Table 03. The level of the SIP demonstrates significant positive influence on the quantitative and general intelligence, but negative influence on the manifestations of anxiety.

Table 03. Means, standard deviations (in brackets), and MANOVA results for the levels of SIP in schoolchildren at grade V

Variables	Grade	Group I	Group II	Group III	Group IV	F	p
Speed of Information Processing	V	1.07 (0.12)	1.37 (0.05)	1.58 (0.08)	2.00 (0.20)	254.0	.000
Quantitative intelligence	V	23.0 (5.8)	23.6 (6.5)	26.8 (5.8)	30.0 (7.0)	7.046	.000
General intelligence	V	95.5 (15,7)	93.0 (17,7)	101.6 (14,6)	105.3 (14,8)	3.004	.034
Test Anxiety	V	24.2 (6.8)	24.5 (4.8)	20.8 (6.1)	18.6 (7.6)	4.572	.005
Speed of Information Processing	VII	1.64 (0.30)	1.83 (0.20)	2.05 (0.31)	2.41 (0.31)	33.36	.000
Quantitative intelligence	VII	36.9 (9,4)	37.8 (12,0)	39.5 (7,0)	40.3 (6,0)	7,113	.000
General intelligence	VII	97.2 (15,0)	97.1 (20,0)	103.6 (12,3)	110.7 (10,9)	4.782	.004
Test Anxiety	VII	22.6 (7.1)	22.1 (6.4)	18.7 (5.8)	18.3 (7.1)	4.301	.007

7. Conclusion

The results of our study demonstrated a significant growth of the SIP with age in the students at the beginning of the secondary school (from V to VII grades) as we showed before for the high school students from IX to XI grades (Shcheblanova, 2019). We also revealed significant gender differences in the SIP-scores both at grade V and VII, whereas any gender differences were not observed at grades IX and XI. A review of large-scale studies on gender differences in the SIP reports that females often outperform males in speed tests, especially in requiring the reading and writing skills (Roivainen, 2011). According our data, boys outperformed girls that may be due to the age features or the nonverbal and motor character of the used tests. The study demonstrated high stability of the SIP during a period from grade V to VII, and the significant positive correlations between the SIP and the quantitative and general intelligence scores, and in the contrast the significant negative correlations between the SIP and the manifestations of anxiety. Moreover, it was shown that the SIP positively affected the quantitative and general intellectual abilities, but negatively affected the school anxiety manifestations. However, the effect of the SIP on academic performance in this study was not confirmed. In a whole, the findings support the usefulness of the SIP measures for the educational practice of preparing students to perform time limited tests.

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