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**STRUCTURE OF THE WPPSI-IV FOR THE RUSSIAN-SPEAKING
PRESCHOOLERS**

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Abstract

The factor structure of the Wechsler Preschool and Primary Scale of Intelligence – Fourth Edition for ages 2.5 to 4 years include the total intelligence index as a second-level factor and three first-level factors: Verbal Comprehension, Visual Spatial Index, Working Memory Index. According to the technical manual this theoretical model was confirmed by the confirmatory factor analysis. The purpose of our study was to compare factor model of WPPSI–IV received by the data of Russian-speaking children with the structure of the test. Our sample includes 97 Russian-speaking children aged 2 years and 6 months through 3 years and 11 months ($M = 42$ months, $SD = 3.8$; 51 boys and 46 girls). The results were analyzed using Pearson's correlation coefficient and confirmatory factor analyses. We decided to exclude Picture Naming from the analysis according to the fact that the scores of this subtest has no interrelations with the scores of the other subtests, except for the subtests of Verbal Comprehension Index. This allows us to propose that contribution of this subtest in FSIQ is rather low. The structure of the WPPSI–IV received on our empirical data is different from the test model. The most appropriate model is two-factor hierarchical model, including one second-order factor (g-factor) and two first-order factors (Verbal and Performance)

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Keywords: WPPSI–IV, confirmatory factor analysis, pre-schoolers, intelligence, cognitive development.



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1. Introduction

Preschool age is an important stage in the development of the child's cognitive functions. Early cognitive development diagnostics of preschool children makes it possible to obtain not only an objective assessment of the level of mental development of a particular child, but also to identify children who need remedial and developmental assistance. Diagnostics of cognitive functions in preschool children is a complex and multifaceted area of psychological knowledge. Age features of behaviour and neurocognitive development of the child, professional competence of psychologist, and finally, methodological tools used in the assessment of intelligence, can significantly influence the reliability of the results.

Wechsler Preschool and Primary Scale of Intelligence – Fourth Edition meets all the requirements for a comprehensive diagnostics of the preschoolers' cognitive development. The original WPPSI was developed in 1967. It was designed to diagnose the intelligence of children aged 4 to 6.5 years and included 11 subtests (Wechsler, 1967). The content of this test has undergone changes many times in subsequent years. In the revised versions, the diagnostic capabilities of the WPPSI were revised (the number of subtests was increased and some tasks were replaced). The development of theoretical models of cognitive abilities and the upraise of new neuropsychological concepts forced the authors of the test to reconsider the theoretical foundations on which earlier versions were based.

2. Problem Statement

Researchers usually single out the theoretical presentations on which Wechsler's tests are based (McCrimmon et al., 2015). Initially, in the first versions of Wechsler tests, the general factor – FSIQ (g), and the factors of verbal and performance IQ were distinguished. Verbal IQ was understood as the substructure of general intelligence based on existing knowledge. Performance IQ is associated with psychophysical, sensorimotor and perceptual abilities of the subject (Filimonenko & Timofeev, 2016). However, in the current version of the test, the number of factors has been increased from two to five (WAIS–IV, Wechsler, 2008; WPPSI–IV, Wechsler, 2012; WISC–V; Wechsler, 2014). This is due to the changes of ideas about the structure of intelligence. In most studies based on data obtained from factor analysis, it has been proven that intellect has a hierarchical structure, at the highest level of which the general intelligence is located, at the level below – the broad abilities, and further, even most low level – narrow abilities (Carroll, 1993; McGrew, 2009; Flanagan & Dixon, 2013).

Despite the fact that there are still discussion about the total number of broad abilities, 3 to 16 are singled out in different works (Johnson & Bouchard, 2005, Schneider & McGrew, 2012, Flanagan & Dixon, 2013), most indicate that verbal comprehension ability, visual-spatial ability, working memory, fluid intelligence and processing speed are among the broad abilities (Wechsler, 2012). Therefore, in most modern versions of the Wechsler test, there are five main factors or indexes:

- Verbal Comprehension Index – reflects the ability to access and apply acquired word knowledge.
- The Working Memory Index measures the child's ability to remember, hold in memory and perform actions in the mind with visual or auditory information.
- Fluid Reasoning Index – determines the ability to detect hidden links between visual objects and, by reasoning, to find and apply certain rules for problem solving.

- Processing Speed Index – determines the speed and accuracy of visual identification, the speed of decision making and the speed of implementation of the decision.
- The Visual-Spatial Index measures the ability to evaluate visual details, understand spatial relationships to construct geometric models (Wechsler, 2014).

An exception is the Wechsler Preschool and Primary scale of Intelligence – Fourth Edition – in a version that is designed for younger preschool children (2.5 to 4 years), in which number of major indexes is reduced to three: Index of Verbal Comprehension, Visual-Spatial Index and Index of Working Memory.

The developers of the WPPSI-IV argue that the theoretical model, which served as the basis for isolating the main indices, is confirmed by the data of the confirmatory analysis. For example, for the latest editions of the WISC-V (Wechsler, 2014) and the WPPSI-IV for children from 4 to 7.5 years old (Wechsler, 2012) – the five-factor model was recognized as most appropriate, whereas for WPPSI-IV for children from 2.5 to 3 years – a three-factor model (Wechsler, 2012). Nevertheless, there are studies in which it was shown that factor models proposed in the technical manual do not always sufficiently enough describe the empirical data (Watkins & Beaujean, 2014) especially for non-English speaking children (Lecerf & Canivez, 2017)..

3. Research Questions

The study was conducted using the Wechsler Preschool and Primary Scale of Intelligence – Fourth Edition on the Russian sample of children of preschool age. The main research interest consisted in verifying the correspondence of empirical data obtained for Russian speaking children to the theoretical construct claimed by the creators of the test..

4. Purpose of the Study

The main purpose of this study is to analysis the empirical structure of the WPPSI-IV and compare the empirical data with the theoretical construct..

5. Research Methods

5.1. Sample

Sample contains 97 Russian-speaking children aged 2 years and 6 months through 3 years and 11 months (M = 42 months, SD = 3.8; 51 boys and 46 girls).

5.2. Methods

WPPSI-IV was used as the main research method.

At ages 2:6 through 3:11 years, the WPPSI-IV subtests produce three Primary Index scores, each composed of two subtests:

1. Verbal Comprehension Index (VCI) from the Receptive Vocabulary and Information subtests;
2. Visual Spatial Index (VSI) from the Block Design and Object Assembly subtests;
3. Working Memory Index (WMI) from the Picture Memory and Zoo Locations subtests.

One supplemental subtest, Picture Naming, is provided.

The results were analyzed using Pearson’s correlation coefficient and confirmatory factor analyses. Statistical analysis was conducted using SPSS 19 and AMOS software.

6. Findings

6.1. Intercorrelations of subtest scores

The intercorrelations of the subtest scores are presented in Table 1.

Table 01. Intercorrelations of Subtests.

	RV	IN	PN	BD	OA	PM	ZL
RV	1						
IN	0.50**	1					
PN	0.37**	0.51**	1				
BD	0.40**	0.42**	0.10	1			
OA	0.26*	0.20	0.06	0.31**	1		
PM	0.30*	0.32*	0.15	0.33**	0.27*	1	
ZL	0.21	0.17	-0.12	0.35**	0.03	0.24*	1

Note. RV – Receptive Vocabulary, IN – Information, PN – Picture Naming, BD – Block Design, OA – Object Assembly, PM – Picture Memory, ZL – Zoo Locations, * – $p < 0,05$, ** – $p < 0,01$.

Verbal Comprehension subtests correlate most highly with each other than with other subtests. A similar pattern for this age band was obtained by standardization of the test (Wechsler, 2012). The Verbal Comprehension and Visual Spatial subtests share low to high correlations. Receptive Vocabulary and Information correlate more highly with Block Design, than with Object Assembly. Correlations between Verbal Comprehension subtests and Working Memory subtests vary from low to moderate level. The Verbal Comprehension subtests correlates more highly with Picture Memory than with Zoo Locations. Receptive Vocabulary significantly correlates with all subtests except one Working Memory subtest – Zoo Locations. This may indicate that Receptive Vocabulary has more highly impact in g-factor for this age band. Picture Naming significantly correlates only with two subtests included in Verbal Comprehension Index, correlations with other subtests are low. In addition, there was a negative correlation of this subtest with one of the subtests included in Working Memory, namely, with Zoo Locations.

Visual Spatial subtests correlations are moderate, besides Block Design is more highly correlated with two Verbal Comprehension subtests (Receptive Vocabulary and Information) and two Working Memory subtests (Picture Memory and Zoo Locations) than with Object Assembly. Block Design significantly correlates with all subtests except Picture Naming. This pattern can be explained by high contribution of Block Design in g-factor. The correlations between Visual Spatial subtests and Picture Memory are higher than correlations between Visual Spatial subtests and Zoo Locations. In addition to the Picture Memory Zoo Locations significantly correlates only with one subtest – Block Design. We assume that correlation between these subtests can be explained by the visual-spatial features of Zoo Locations subtest.

6.2. Confirmatory factor analysis

At the initial stage of the statistical processing of data, we used confirmatory factor analysis of all the subtests for this age group. Initial versions of all models for seven subtests showed unsatisfactory compliance with empirical data (CFI, RMSEA, BIC). To further verify the structure of the data obtained, it was decided to exclude Picture Naming subtest from the analysis. This solution is due to the fact that Picture Naming is not included in the calculation of any of the major indexes. In addition, Picture Naming is the only subtest, which requires expressive responses that can cause certain difficulties in children of this age.

For Model 1, six subtests (Receptive Vocabulary, Information, Block Design, Object Assembly, Picture Memory, Zoo Locations) load directly on the g factor.

Model 2 includes one second-order factor (g-factor) and two first-order factors. There are two Verbal Comprehension subtests (Receptive Vocabulary and Information) on the first factor and four subtests (Block Design, Object Assembly, Picture Memory and Zoo Locations) on the second factor. This model represents the two-factor model with performance and verbal factors, which for a long time was typical for Wechsler scales.

Model 3 is a three-factor model that is proposed as optimal for the 2:6–3:11 age band by Wechsler (Wechsler, 2012). Model 3 includes one second-order factor (g-factor) and three first order factors – Verbal Comprehension (Receptive Vocabulary, Information), Visual Spatial (Block Design, Object Assembly) and Working Memory (Picture Memory, Zoo Locations).

The results of confirmatory factor analysis for six subtests present in Table 2.

Table 02. Goodness-of-fit statistics for confirmatory factor analysis for six subtests.

Model	χ^2	df	AGFI	CFI	RMSEA	AIC	BIC
Independence Model	75.90	15					
Model 1	7.79	6	0.92	0.96	0.06	31.79	59.27
Model 2	5.08	8	0.94	0.99	0.04	31.08	60.85
Model 3	4.72	6	0.93	0.97	0.04	34.72	69.07

The results shown in Table 2 indicate that Model 2 (historical two-factor model) fits best for the 2:6–3:11 age band..

To select the most optimal model, we used the following criteria for model estimation: AIC, CFI and BIC. Model 2 is presented, with factor loadings, in Figure 1.

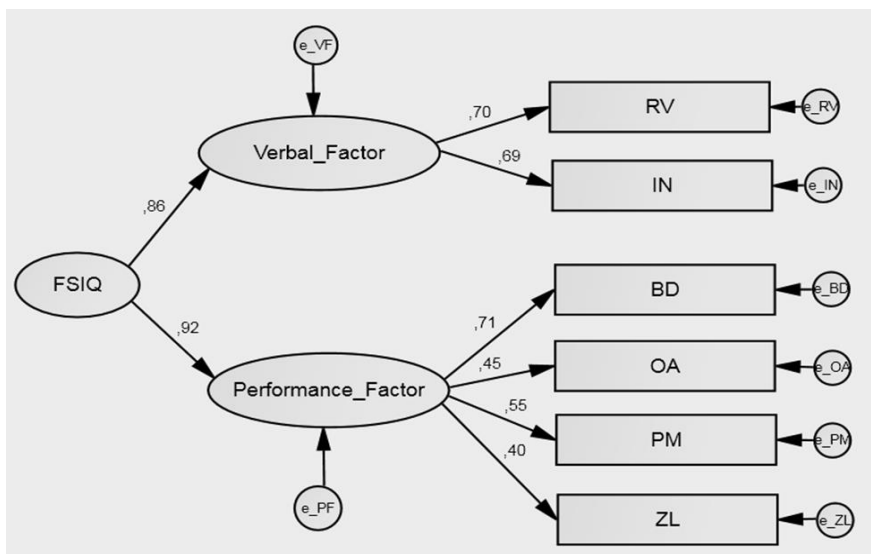


Figure 01. Two-factor hierarchical model for six subtests.

Note. RV – Receptive Vocabulary, IN – Information, PN – Picture Naming, BD – Block Design, OA – Object Assembly, PM – Picture Memory, ZL – Zoo Locations, FSIQ – Full Scale.

7. Conclusion

The study compared the empirical structure of Wechsler Preschool and Primary Scale of Intelligence – Fourth Edition for the Russian-speaking children with the theoretical model proposed by the authors. The results of the correlation analysis demonstrated the absence of interrelations between the Picture Naming and other subtests which are not included in the Verbal Comprehension index. This allows us to propose that this subtest is influenced by additional side factors and its contribution in g-factor is rather low. This is indirectly confirmed by the fact that this subtest is determined by the test developers as an additional one – it is not included in the calculation of the Full Scale score, or even in the calculation of the Verbal Comprehension index (Wechsler, 2012).

According to the technical manual, the theoretical model, which was the basis of the WPPSI-IV, is confirmed by empirical evidence. The authors indicate that the most appropriate model, which was obtained by confirmatory factor analysis for ages 2.5 to 4 years, includes the total intelligence index as a second-level factor and three first-level factors: Verbal Comprehension, Visual Spatial Index, Working Memory Index. However, the results obtained on the Russian-language sample, as well as the data of other researchers do not confirm this assumption (Watkins & Beaujean, 2014).

Confirmatory factor analysis demonstrates that the most appropriate model for the obtained empirical data is two-factor hierarchical model. The model includes one second-order factor (g-factor) and two first-order factors (Verbal and Performance). It should be noted that this model for a long time was typical for the Wechsler scale.

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