

# Gender Differences in Dysorthography Manifestations in Younger Schoolchildren when Learning the Russian (Native) Language: a Neuropsychological Analysis

Aleksandr Bizyuk

*Department of General and Clinical  
Psychology  
Federal State Budgetary Educational  
Institution of Higher Education St.  
Petersburg First Medical Pavlov-  
University  
St.Petersburg, Russia*

Viktor Sorokin

*Department of Special Psychology  
St. Petersburg State University  
St.Petersburg, Russia*

Ekaterina Kats

*Department of Pedagogic  
Private Educational Institution of  
Higher Education Institute of Special  
Pedagogy and Psychology  
St.Petersburg, Russia*

Roman Demianchuk

*Department of Psychology of  
Education and Pedagogy  
St. Petersburg State University  
St.Petersburg, Russia*

Tatiana Kolosova

*Department of Special Psychology  
St. Petersburg State University  
St.Petersburg, Russia*

Anton Shchukin

*Department of Developmental  
Psychology  
St. Petersburg State University  
St.Petersburg, Russia*

**Abstract**—To identify differences in neuropsychological mechanisms of spelling competence development in boys and girls, a correlation analysis of the data obtained using a complex of neuropsychological tests and the data of evaluating the written language of schoolchildren was carried out. The study group consisted of 150 children. The results of the study allow for the conclusion that the success in mastering Russian spelling in groups of boys and girls may be caused by different factors. In both groups, the correlation between the level of spelling competence and success in performance of the Kohs Block Design Test was revealed. In addition, in the group of girls, correlations were found between the success in mastering spelling skills and the state of mechanical verbal memory, as well as the development of thinking (finding the odd one out). In the group of boys, correlations were found between the number of spelling errors and signs of dynamic praxis development, copying rhythmic structures, arithmetic skills, and thinking (arranging pictures in a right sequence to make a story, listing objects belonging to the same category).

**Keywords**—*spelling competence, dysorthography, neuropsychology, gender differences, younger schoolchildren*

## I. INTRODUCTION

Both domestic and foreign studies aimed at analysis of the brain processing of written language show that it has a complex systemic nature with different levels of involvement of a whole range of cerebral morphofunctional systems, a certain logic of their development as a process, as well as the associative relations with the components of mental activity that provide a kind of background for writing as a special kind of activity [4]. At the same time, despite lots of cognitive models of writing which are mainly built on abstract but, perhaps, correct reasoning, specific

data on certain brain systems being involved when writing are clearly lacking. A particularly problematic aspect of writing is the development of literacy and its delay in a child who, by a certain age, continues to make various mistakes due to underdeveloped morphological, conventional, grammatical, syllabic-morphemic, and lexico-semantic skills of writing. In this case, the errors are not directly related to deficiency of a child's (or sometimes an adult's) mnestic activity, because even formal mastering of spelling rules does not guarantee that they will be used when needed [1; 2; 3; 5; 6].

Although the description of external signs of unformed spelling skills accompanying general psychological signs (a kind of psychological "comorbidity" with weak processes of proactive attention, weak willpower, impulsiveness, and lowered self-esteem) as well as external prerequisites (problems with somatic health, maladaptation at school, etc.) provides sufficient detail, the description of the actual brain support of this function still remains at the level of "individual brain systems". Another explanation of the weakness of spelling skills is pointing at failure "to get a feel for the language", which, as pedagogical practice proves, does play an important role, especially in children who can master literate writing spontaneously almost without any conscious reference to language rules and laws and sometimes without having to learn them at all; that is, they may skip the stage of comparing their results with the models of orthographic and orthographematic transformation defined by the rules.

Gender differences in the development and genesis of mental activity are as obvious as little they have been studied. One of the applied aspects of this fundamental

problem refers to the issues of education and upbringing of children taking into account their gender that is manifested specifically in mental and speech development. It is well known and accepted that girls are ahead of boys in speech development. [7; 8; 10, 14, 15, 16]. At the same time, the incidence of speech pathology and particularly writing disorders is higher in boys [7; 15]. This suggests a hypothesis about the differences in the mechanisms of writing disorders manifested in children of different genders. That is why we have conducted a study aimed at identifying relations between the results of neuropsychological tests and the number of spelling errors in writings of children of different genders.

## II. METHOD AND MATERIAL

The methodic framework of the study was a complex of neuropsychological and pathopsychological tests making it possible to assess the functional state of various parts of the cerebral cortex. Research methods included a test on the reciprocal coordination of movements; dynamic praxis test; the graphic test of copying a line of ornaments; playing rhythms according to verbal instructions; choice-point behaviour test; finger position praxis test; Hed's test; presentation of verbal stimulus material with whisper speech; copying rhythms according to an auditory sample; test for assessment of sounds of different subjects; the odd-one-out method (verbal variant); the Kohs Block Design Test; solving arithmetical problems (subtest from the Wechsler battery); listing objects belonging to the same category; remembering 10 words according to the method of A. R. Luria; the odd-one-out method (concept variant); understanding figurative sense; arranging pictures in a right sequence to make a story; test for recognizing figures that are impossible to describe verbally; test for the left-side ignoring. The study of writing disorders in younger schoolchildren was conducted using specially selected texts for writing from dictation and for copying [11].

150 schoolchildren of 3 years (9-10 years old) attending secondary schools of St. Petersburg took part in our study. The study group included 78 girls and 72 boys.

## III. RESULTS AND DISCUSSION

The correlation analysis resulted in the following statistically significant patterns for the whole probation group.

The strongest correlation was recorded between the number of spelling errors and the results of an arithmetic test ( $r = -0.42$ ;  $p < 0.01$ ). Intellectual activities of this kind require a combination of understanding of quasi-spatial relations presented in the text of the problem itself, ability to compute correctly, and critical approach to the results obtained (verification of the calculation result with the original data). It is noteworthy that the indicator of the arithmetic test itself correlates with the performance of the Kohs Block Design Test, which requires good spatial thinking, effective spatial gnosis, and effective constructive gnosis that also depend on the parietal-occipital cortex

activity. Therefore, it is not surprising to reveal that the indicator of reasonable activity is not only indirectly but also directly related to the number of spelling errors ( $r = -0.31$ ;  $p < 0.01$ ).

Performance of "Listing of objects belonging to the same category" which, to a great extent, relies on the processes of analysis, synthesis and generalization, is aimed at establishing genus-species relations in its essence, as well as on mnemonic processes that ensure the retrieval of necessary categories from the long-term memory; it also correlates with the number of spelling errors ( $r = -0.34$ ;  $p < 0.01$ ), which indicates the operational affinity of brain mechanisms that provide the solution to these problems.

Another correlation with spelling errors was found in the index of the metaphor test ( $r = -0.28$ ;  $p < 0.05$ ). It appears that it is expedient to interpret this correlation in view of the metaphor's figurative form that makes the comparison hidden in a metaphor apprehensible. Such a phenomenon is only possible if the phrase that contains a metaphor is "grasped" completely, figuratively and with gestalt, which is typical for the right hemisphere with its strategy of simultaneity.

Statistically significant was also the correlation between spelling errors and the test result of "finding the odd one out among the four options" (verbal version) ( $r = -0.31$ ;  $p < 0.01$ ). This fact, as well as the brain mechanisms behind the recoding of metaphors and proverbs from their literal meaning, which is typical of undeveloped thinking, into the figurative meaning, which requires interaction of cortex of two hemispheres, indicates the involvement in assimilating the orthograms by not only the expected left hemisphere with its parietal-occipital and temporal cortex but also the symmetrical zones of the right hemisphere that, among other things, "specialize" in intuition that relates to literacy as "feel for the language" mentioned in some language therapy literature.

The use of correlation analysis made it possible in principle to determine the differences in the structure of statistical relationships of the studied values in groups of children of different genders. In boys, 6 correlations of neuropsychological factors with the number of spelling errors were revealed while there were only 3 correlations in the group of girls. According to our results, boys on average make 40% more spelling errors as compared to the girls, which, taking into account the results of the correlation analysis, suggests that there is a variety of reasons causing dysorthography in boys. The smaller number of correlations in girls, given an earlier maturation of the speech function, may indicate a more invariant specialization of cortical systems responsible for written language.

Analysis of the obtained correlation graphs in boys and girls revealed different roles of the studied indicators in determining spelling competence. The only method, the effectiveness of which was important in both groups was the Kohs Block Design Test. Analysis of the work with the stimulus materials of that method allowed us to identify

several psychological mechanisms. First, it is a distinct influence of the optical-spatial factor, which is mostly associated with the maturity of the parietal-occipital cortical zones. These cerebral zones are also used in constructive activity that requires additional involvement of analysis and synthesis mechanisms involved in the teaching of writing. It is known that the spelling of unstressed endings is based on a certain maturity of grammatical competences, the ability to identify the syntactic function of a word in the sentence structure. It is widely believed that complex mental activities are triggered by the posterior associative zone of the cerebral cortex that also evaluates such a semantic factor as grammatical meaning. It seems that the incomplete development of the cerebral cortical zones is the reason for both low success in the Kohs Block Design Test and spelling errors when dealing with unstressed word endings in Russian.

An indication of the special role of analysis and synthesis in the development of spelling skills in girls is a high statistical relation between the score in the odd-one-out test (verbalized version) and writing literacy. However, the influence of the level of lexicon development on the success of their spelling competence development is also possible [13]. A similar trend is also observed in boys but the difference is that, for them, the key factor in determining spelling competence are concretization operations as shown in the test of listing subjects of the same category.

The results of the group of boys showed a correlation between spelling and arithmetic skills. Here, the correlation between the element and the class (the part and the whole) is less significant but the evaluation of the semantics of a task and the logic program for its solution play a notably larger role. This shows that functional insufficiency in this group of participants is observed in the angular gyrus of the left hemisphere and the prefrontal and premotor cortex of the frontal lobes involved in complex forms of activity and behaviour. The results are consistent with the data that women may outperform men in relation to speed of arithmetic operations [9].

Analysis of the data obtained in the group of girls revealed a significant relation between the number of spelling errors and success in mechanical memorization of verbal stimuli (A. R. Luria method). There is an opinion that the role of auditory and language memory is quite high in mastering the Russian spelling [12]. Probably girls tend to use memorization strategies in mastering the spelling, whereas boys do not show such a trend.

Correlation analysis in the group of boys also showed the relationship between the number of spelling errors and the effectiveness of the fist-edge of the hand-palm test, which has a connection with the premotor zones of the frontal cortex that determine the development of motor and intellectual functions over time. This correlation might be possibly explained by the negative impact of incomplete development of forecasting the sequence of graphic items on how one would spell a word.

A statistically significant correlation between the success in spelling skills development and rhythm copying according to the sample was found in the group of boys. Underdevelopment of the sense of rhythm causes the deficiency in the word syllabic analysis, in particular in the selection of the stressed syllable. Difficulties in determining the stressed place make it impossible to find the test word properly when writing words with unstressed vowels. These functions are largely determined by the maturity of the non-nuclear zones of the temporal cortex. At the same time, the performance of this test is to a certain extent influenced by the rhythm performance by the proband, which is regulated by the premotor zone of the cortex. These cortex areas have already been found to be involved in the dynamic praxis test in the group of boys, which emphasizes its role in the spelling skills.

Let us highlight one more significant relation that is typical for the group of boys. It reflects the dependence of spelling literacy on the results of the "sequential pictures" test. This test includes perceptive and logical components, the adequate relation of which ensures the correct solution of proposed tasks. The diagnostic meaning of this test mainly reflects the functional maturity of the two cortical zones, which are formed very late in the process of age development – it is the anterior and posterior associative zones of the cerebral cortex.

The above indicates that there are significant differences in determining spelling skills in boys and girls both in the number of factors taking part in such determining and in their mental load.

#### IV. CONCLUSIONS

In the group of girls, the dependence of the level of spelling competence on the maturity of the optical-spatial factor, analytical-synthetic activity, and verbal memory was revealed. It is important to stress that these factors determine the development of a number of specific language functions, namely understanding of the grammatical meaning of the word and structuring of the lexicon.

The group of boys is characterized by more diverse correlations of spelling competence with the level of maturity of mental processes. At the same time, the analysis of the psychological content of loads that significantly correlated with the success of mastering spelling in boys reveals two trends. First of all, the ability to simultaneously assess various relationships (quantitative, spatial, etc.) is obviously important as evidenced by correlation between the number of spelling errors and the successful performance of the Kohs Block Design Test, arithmetic subtest, and sequential pictures test. The second trend suggests that mastering of spelling skills is influenced by the level of development of forecasting and control of various activities in the group of boys (fist-palm-edge of the hand test, copying rhythmic structures, as well as solving arithmetic problems or arranging story-related pictures in the right sequence).

#### ACKNOWLEDGEMENT

This study has been financially supported by the Russian Foundation for Basic Research as part of the research project No. 17-06-00803-OFH.

#### REFERENCES

- [1] Azova, O. A. The system of language therapy aimed at correction of dysorthography in younger schoolchildren. – Author's abstract of the thesis for a Candidate Degree in Pedagogic Sciences. – Moscow, 2006. – 26 p.
- [2] Dmitrova, E. D., Vigel, T. G. Dysorthography in middle school and high school students: Diagnosis and correction // Practical psychology and language therapy. – 2005. – No. 1. – p. 34-38.
- [3] Yeletskaya, O. V., Loginova, E. A., Shchukina, D. A. Scientific and theoretical bases of language therapy for the correction of dysorthography in fifth-graders // Scientific-methodical electronic journal "Concept". – 2015. – No. S23. – P. 36-40. URL: <http://e-koncept.ru/2015/75285.htm>
- [4] Mikadze, Yu. V., Skvortsov, A. A., Kozintseva, E. G., Zaykova A.V., Ivanova M. V. Psychological structure of written language in the modern foreign neuropsychology // Neurology, neuropsychiatry, psychosomatics. – 2012. – No. 2. – P. 21-30.
- [5] Prishchepova, I. V. The nature of spelling errors in writings by students with dysorthography and their peers with normal language development // Theory and practice of social development. – 2014. – No. 12. – P. 64-67.
- [6] Sharipova, N. Yu. Typology of dysorthography manifestations in secondary school students // Problems of modern education. – 2013. – No. 2. – P. 152-159.
- [7] Bendas, T. V. Gender psychology. – St. Petersburg: Piter. – 2006. – 431 p.
- [8] Dobrova, G. R. Variability of speech development in children. Moscow: Publishing House YaSK: Languages of the Slavic culture. – 2018. – 264 p.
- [9] Druzhinin, V. N. Psychology and psychodiagnostics of general abilities. – St. Petersburg: Piter. – 2007. – 368 p.
- [10] Eliseeva, M. B., Vershinina E. A. MacArthur Questionnaire as a diagnostics tool for the lexical development in children from 8 to 36 months old// Special education. – 2017. – No. 3. – p. 66–81.
- [11] Inshakova, O. B., Nazarova A. A. Methods of identification of dysorthography in younger schoolchildren. Moscow: V. Sekachev. – 2013. – 72 p.
- [12] Kornev, A. N. Reading and writing disorders in children: The study guide – St. Petersburg: MiM. – 1997. – 286 p.
- [13] Stepanova, T. A. Written language of younger schoolchildren as related to gender differences. Abstract of a thesis for a candidate degree in philology. – Cherepovets. – 2007. – 19 p.
- [14] Tikhomirova, T. N., Modyaev, A.D., Leonova, N. M., Malykh, S. B. Success factors in learning at a standard primary school: Gender differences // Psychological journal. – 2015. – No. 5. – Vol. 36. – P. 43–54.
- [15] Ushakova, R. Yu. Gender features of speech in preschool children. Abstract of a thesis for a candidate degree in psychology. – Irkutsk. – 2006. – 22 p.
- [16] Khromova, S. K., Loginova, E. S. Development of spoken language in 7-8 year-olds and its relation to indicators of intelligence development// New studies. – 2013. – No. 4(37). – P. 89–101.