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Dissociation of Syntax and Vocabulary Development in Junior Schoolchildren with Different Neuropsychological Profile

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This study aims to examine the features of text construction in terms of vocabulary and grammar in children with a weakness in the auditory verbal information processing (AV-group) and with a weakness in executive functions (programming and control of voluntary activity, EF-group). The participants were 71 second grade children from Moscow schools (mean age 8.8 years old, SD 0.29 years; 36 girls, 35 boys). Four groups were selected: children with good and weak development of AV and children with good and weak development of EF. The main hypothesis of the study, following A.R. Luria, was that in children with the weakness of AV, first of all, the paradigmatic mechanisms of word choice will suffer, and in children with the weakness of EF, the syntagmatic mechanisms for constructing a phrase and text. The use of non-parametric statistical analysis (Mann-Whitney test) showed the validity of the hypothesis and revealed the main errors in the narrative construction by children with both the weakness of AV and EF. The discussion of the results included consideration of the arguments in favor of a single or dual mechanism for the acquisition of vocabulary and grammar in children.

Keywords: child language, speech production, syntagmatic and paradigmatic, syntax, vocabulary, neuropsychological assessment.

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Диссоциация развития синтаксиса и лексики у младших школьников с разным нейропсихологическим профилем

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В статье рассматриваются особенности построения текстов с точки зрения лексики и грамматики у детей со слабостью функций обработки слухоречевой информации (2-ой блок, по А.Р. Лурии) и

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со слабостью функций программирования и контроля (3-ий блок). Выборку составили 71 ребенок второго класса школ г. Москвы (средний возраст — 8,8 лет, ст. откл. — 0,29 л.; 36 девочек, 35 мальчиков). Из всей совокупности детей были отобраны 4 группы: дети с хорошим и слабым развитием функций 2-го блока и дети с хорошим и слабым развитием функций 3-го блока. Основная гипотеза исследования, вслед за А.Р. Лурией, заключалась в том, что у детей со слабостью второго блока будут страдать, прежде всего, парадигматические механизмы выбора слов, а у детей со слабостью третьего блока — синтагматические механизмы построения фразы и текста. Применение непараметрического статистического анализа (критерий Манна—Уитни) показало справедливость гипотезы и выявило основные ошибки в построении текстов детьми, как со слабостью 2-го блока, так и со слабостью 3-го блока. В обсуждение результатов вошла дискуссия о едином или двойном механизме овладения лексикой и грамматикой у детей.

Ключевые слова: детская речь, порождение речи, синтагматика и парадигматика, синтаксис, лексика, нейропсихологическое обследование.

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Introduction

Neuropsychological profile of a child reflects weak and strong sides of his/her cognitive functions. In other words, it reveals an uneven development of structural and functional components of higher mental functions that can be identified in a neuropsychological assessment. In each person, some brain structures and corresponding functions are developed better than others. For instance, in those with better development of the left frontal regions and weaker development of the left dorsal regions, especially the temporal lobe, better executive functions (EF) and weaker ability for auditory verbal information processing (AV) would be revealed in the assessment [2; 7].

The aim of this work is to analyze the uneven development of language in junior schoolchildren. Our study tests the assumptions that in children with a relative weakness of the anterior parts of the left hemisphere, not only EF but also syntax of the text and sentences is impaired, and in children with a relative weakness of the posterior parts of the left hemisphere, auditory language processes and vocabulary are impaired.

These assumptions are based both on the theory and empirical neuropsychological and neurolinguistic data. Alexander Luria addressed the structure of language activity in "Traumatic Aphasia" and described two aspects of language — nominative and predicative — and analyzed their development in phylogenesis [8, p. 51]. Elaborating this idea in the "Basic Problems of Neurolinguistics" [10], he distinguished between the syntagmatic and paradigmatic mechanisms for the formation of utterance and related them to functioning of the anterior and posterior brain regions (see [10, pp. 141—146].

Our work addresses differences in development of syntax and vocabulary in typically developing children with a relative (mild) weakness of functions of the frontal or dorsal regions of the left hemisphere. Previous studies in Russian-speaking children support our assumptions, but they are sparse and do not contain a detailed analysis of language [3; 4; 6; 12; 14; 15; 30].

Method

Seventy-one second grader from Moscow schools took part in the study (mean age 8.8 years old, SD 0.29 years; 36 girls, 35 boys). None of the participants had mental development disorders. Parents (or legal representatives) of the children gave an informed consent for the use of the neuropsychological data with scientific purposes.

All children underwent a neuropsychological examination [11]. Then neuropsychological profiles were constructed for each child. These profiles reflected the development of EF and functions of serial organization, functions of auditory and visual-spatial information processing, and left-hemisphere and right-hemisphere strategies.

A rank table was created based on these profiles. For each index, each child was assigned a rank. This procedure allowed us to identify children with the highest and lowest levels of corresponding functions in the sample.

For the analysis of text construction, four groups of participants were selected based on the rank table: two groups with better/worse EF and serial organization (indices 3.1 and 3.2) and two groups with better/worse AV (index 2.2) and analytic (left-hemisphere) strategy

of information processing (L index). Each group comprised 10 participants.

The children for the "better" group were selected from the upper part of the rating list for the main index and from the three upper quarters for other indexes. In particular, the "better" EF group consisted of children with the values 1—24 for the index 3.1 (EF), and with the values 7—27 for the sum of 3.1 and 3.2 indices, i.e. for the entire third unit of the brain (according to Luria). The "worse" EF group consisted of children with the values 55-71 for the index 3.1, and with the values 54—71 for the sum of indexes.

The "better" AV group comprised children with the values 3—25 for the index 2.2., and the values 1—28 for the L index (left-hemisphere strategy). The "worse" AV group included children with the values 55—70 for the index 2.2, and with the values 48-70 for the L index (see Table 1).

During the neuropsychological assessment, children were asked to generate a narrative based on a series of pictures. They were presented with four pictures for the "Garbage" story (see Figure 1), and asked to tell what happened in these pictures. If the narrative was incomplete, additional questions were asked.

All narratives were thoroughly analysed to identify parameters of language that characterize children with worse EF and children with worse AV.

As a result, three groups of parameters were identified. The first one consisted of *general narrative* parameters, for example, the characteristics of narrative deployment and transmission of its message; *grammatical* parameters, and *lexicosemantic* parameters reflecting the child's vocabulary.

The following characteristics were included in the list of **general narrative parameters** that proved their efficiency in previous research: narrative programming, semantic completeness, semantic (conceptual) adequacy, speech rate [11], narrative structure (goal — attempt — outcome) [29], and type of narrative (distorted, incomplete, complete, according to Irina Ovchinnikova) [25]. We also took into consideration the omissions of semantic parts, logical errors, and the elements of typical

Table 1

Average rank values (top line) and range of the values (bottom line) of neuropsychological indexes for the four groups of participants

	3.1	3.1+3.2	2.2	L	2.4	R	Total rank
Better EF group	**15.7** **2.5 — 24**	**15.5** **7 — 27**	30 4-60	24.65 3 — 50	18 1 — 38.5	23 2 — 54	11.2 1 — 23
Worse EF group	**63.8** **52 — 71**	**64.7** **54 — 71**	30.6 1 — 71	35.5 6 — 71	48.5 22 — 71	45 19 — 68	61.2 36 — 71
Better AV group	31.1 8 — 59	29 12 — 50	**14.5** **3 — 25**	**14** **1 — 28**	30 6 — 58	29.4 6 — 60	22.1 8 — 39
Worse AV group	38.4 5.5 — 69	39.5 11 — 63	**64** **55 — 70**	**55.8** **16 — 70**	45.5 19 — 65	39.8 4 — 71	48.4 25 — 68

Note. 3.1 and 3.2 are the indices of EF and serial organization, respectively; 2.2 and 2.4 are the indices of AV and visual-spatial functions, respectively; L and R are the indices of the left— and right-hemisphere strategies, respectively.

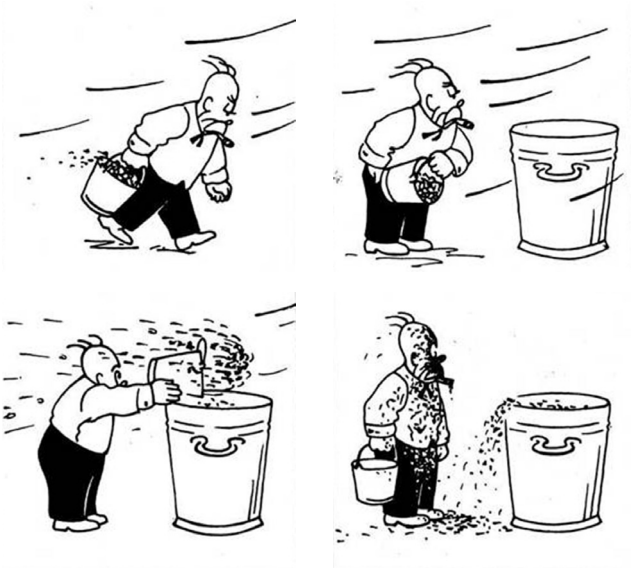

Fig. 1. Series of pictures for a narrative

genre-related style such as the presence of special introduction and ending of the narrative [18].

Finally, our analysis included the following narrative characteristics: 1) Narration mistakes (logical errors and omissions of the semantic parts); 2) Narrative length; 3) Programming of an utterance (the presence of all semantic parts and the construction of a phrase); 4) Introduction and ending; 5) Narrative type (distorted, incomplete, complete); 6) Narrative structure (goal — attempt — outcome); 7) Semantic completeness (based on a set of key words from the table 13 of the book [11, p. 40]; 8) Semantic (conceptual) adequacy [11, p. 41—42]; 9) Speech rate.

Programming, semantic completeness, and semantic (conceptual) adequacy were the most challenging parameters for the analysis. Let us compare two narratives to see how these features are used:

(Example 1) Once upon a time there was a man. He was always angry with everything. Once he decided to throw away the garbage to a garbage... to... a dump. He started throwing it in, but the wind blew, and it all flew over the man. And he was mad.

(Example 2) Well, a strong wind was blowing. And a man... Well, just a person, he went... Then he did this, he threw, and it all flew back. Because of the wind.

In the Example 1 we can see a successful deployment of the program of the narrative. The introduction is present (*Once upon a time there was a man*), and the protagonist is described (*He was always angry with everything)*. Then, the goal of his actions is explained (*Once he decided to throw away the garbage*), and the action is described (*He started throwing it in*) which met an obstacle (*but the wind blew*), and resulted in a failure (*it all flew over the man)*. Then, an emotional reaction of the protagonist is indicated (*And he was mad.*). Thus, a successful programming provides the coherence of the narrative; semantic (conceptual) parts consequently transmit the development of the plot based on the hierarchic predicative program of the narrative. The semantic completeness of this story is optimal as well as its semantic (conceptual) adequacy.

In the Example 2 we see a distorted programming of the narrative. First, the child mentioned the wind, then the man's actions, then the wind again. Important semantic parts are omitted (where the man went, why, what exactly he did, how the story ended). This is not a coherent story. Semantic completeness is minimal, but the meaning is not distorted and the semantic (conceptual) adequacy is achieved.

Let us consider other possible discrepancies between the parameters of programming, semantic completeness, and semantic (conceptual) adequacy. See the Examples 3 and 4.

(Example 3) *Once, a man went to throw away the garbage. First he... took the bucket...wanted to pour. Then... he pour (*an agrammatic error, wrong verb suffix *"sypAt"), it flew on him. The wind was flying, and everything on him... All that garbage was flying on him. The end.*

(Example 4) *A man was carrying a bucket with garbage. He brought it. He filled it. And everything went out. Or, it was dust, yes, rather, it was dust.*

The example 3 demonstrates a good beginning but a messy continuation. There is no coherent plot deployment which speaks in favour of difficulties with programming (this was evaluated with 2 points, with 0 meaning "good" and 3 meaning "bad"). Still, its semantic completeness is much better, there are much more than basic designations like *garbage* or *a bucket*, but the circumstances of the action are indicated (where does it fly? — *at him*), and certain definitions are provided (what garbage? — *all that garbage*). Therefore, 21 points were given for the semantic completeness. The Example 4 contains a sequence of actions, which confirms better programming (1 point), but the details are minimal, and the semantic completeness is very poor (6 points out of 30). Besides, the suggestion that someone was carrying a bucket of dust is not very realistic, so 2 points (with 0 — "good" and 3 — "bad") were given for the semantic adequacy.

Thus, the programming of narrative represents its coherence; semantic completeness reflects whether the event was described accurately and in detail; and semantic (conceptual) adequacy is related to the realism of the description.

Let us consider other parameters of narrative and corresponding examples.

In the Example 1, we see an introduction typical for this genre (*Once upon a time there was...*). In the Example 2, the child did not start his narration in accordance to the genre standards and actually composed the narrative as if he answered the interviewer's question "What happened here?". The answer was: "*Well, a strong wind...*" The first story contained a clear narrative structure "goal — action — outcome" (*he wanted to throw out the garbage — started throwing — everything was blown at him*). The second example contains only one of three elements, an action (*went, did*).

Our assessment of **grammatical parameters** was based on the assumption that typically developing children by this age have already acquired the core of the grammatical system of their native tongue. The syntactic structure of a sentence is supposed to gradually become more complex. In our sample, children experienced little to no difficulties with grammatical connections of verbs (case government) and concord. Therefore, to describe these features, we left only the criterion for the presence of agrammatisms, while syntax was analysed more thoroughly in terms of completeness and complexity of sentences used by children.

The structural complexity was evaluated based on the use of complex sentences, the length of a correctly composed sentence, and the number of not only correct but extended sentences. Simplification and distortion were identified based on the number of incomplete sen-

tences and omitted sentence parts (subjects, verbal predicates, objective complements, and adverbial modifiers). The "Garbage" series actually sets a difficult syntax task for a child, since he/she has to transmit the simultaneity of two actions (the wind blew when the man was pouring out the garbage). Therefore, a typical mistake would be: *The old man went to the dumpster / and/ threw. Then, a strong wind.*

The **grammatical parameters** that we analysed were: 1) Agrammatisms (for example, "I etot musor ispachkalsya dyadya" — "*And that garbage got dirty man*"); 2) Syntactic errors, e.g., omissions of necessary sentence parts such as subjects (*Flies at him*), verbal predicates (*Then, a strong wind*), objective complements, and adverbial modifiers (*And threw away*); 3) Unfinished sentences (*Too much he put there and sh-sh-sh...*); 4) Average sentence length; 5) Maximal length of a correctly composed sentence; 6) Proportion (Number) of correctly composed extended sentences in a narrative composed independently; 7) Number of complex sentences in an independent narrative (not when answering a question such as "Why?" — *Because the wind started blowing*).

Let us take a closer look at two examples.

(Example 5) *A man walked with a bucket full of earth. He wanted to throw it away. But it didn't work out, because the wind blew, and all the earth fell into his face. Just a little bit got into the tank.*

(Example 6) *He walked... He went to pour out. And then he poured out and turned black (Because of what did he turn black?) He probably carried coals.* ***He with coals … to pour out.*** *Spilled too much and sh-sh-sh ... (Too much) Oh, no,* ***it was blown out****. The wind, he walked, then he came, took out, began to pour out. And it all fell on him.* (Psychologist's words are underlined, agrammatisms are in bold).

The Example 5 demonstrates a good development of syntax. The narrative contains a variety of syntactic structures, with a complex sentence consisting of three simple sentences.

In the Example 6, on the contrary, we see agrammatisms ("*On s uglyami... vysypat'*" — He with coals... to pour out (Infinitive); "*Yego vydulo*" — It was blown out (singular form "it" instead of plural form)); unfinished sentences (*He walked*), many sentences in which their necessary members were missing (*He went to pour out* — Pour out what? Where?; *Too much spilled* — What? Where?; *And then poured out and became black* — Pour out what? Where?). In the Example 6, there is only one sentence in which there are no omissions of valences: "*And it all fell on him.*"

Lexicosemantic parameters were selected based on the features of AVdescribed in [11]. In addition, a new parameter "target nomination" was also proposed. This parameter assesses whether three key objects of the situation are named correctly, which requires the use of the low-frequency words (*garbage, bucket, dumpster*).

The basic lexicosemantic parameters included 1) Lexical errors (verbal paraphasias (*a bucket* or *a barrel* instead of *a dumpster*), word-formation errors ("*vdul*" instead of "*podul*"); word-finding difficulties (*decided to throw away the garbage to a garbage... to... a dump*); 2) Substitution of the noun with a pronoun (without antecedent); 3) Verbal-perceptual errors (*coal* or *water* instead of *garbage*); 4) Use of object attributes and action attributes (adjectives and adverbs); 5) Number of target nominations; 6) Pronominalization index (the ratio of pronouns to nouns).

Let us consider the examples from the better (the Examples 7 and 8) and the worse groups (the Examples 9 and 10).

(Example 7) *A man was going to throw away the garbage. He approached the dumpster and wanted to throw the garbage there, but a strong wind rose. And all the garbage covered him from head to toes.*

(Example 8) *Someone was carrying a bucket. Then he threw it, and got spattered* (And why was he spattered?) *Maybe there was too much water.*

(Example 9) *Here a man or an old man was transporting, well, he was carrying mushrooms, and put here. And this is what he was carrying. This is what he was going to put. This is what he had already put. He is taking out, and here he is done. (*And what happened to him then?) *He got black.* (Why?) *Because... Did he get black because of the coal? (*Where does the coal come from?) *Because the coal... You need to go far to get it. (*So, was he going for the coal?) *Well, first he was walking, then he wanted to pour out the coals, then he poured it, and then he was done pouring the coal, and then he got black accidentally. Dust was kicked up.*

The use of vocabulary in the Example 7 is normal. In the Examples 8 and 9 there are errors of lexical choice (*to put* instead of *to throw*) and verbal-perceptual errors (*mushrooms* instead of *garbage*). In the beginning of the narrative, pronouns *someone* and *this is what* are used; these pronouns without antecedents replace the required nouns. While in the Example 7 we see such adjectives as *strong*, in the Examples 8 and 9 there are no adjectives whatsoever. In the Example 9 the child did not name any of the objects from the goal nomination (garbage, bucket, dumpster).

The obtained data were processed with Statistica 12 software. First, we analysed descriptive statistics for all groups. Then the groups were compared with non-parametric Mann-Whitney test since each group consisted of 10 participants.

We compared 1) children with better and worse EF, 2) children with better and worse AV and analytic (left-hemisphere) strategy, and 3) children with low values from both groups.

Thus, we revealed typical features of children with worse EF and AV (and analytic strategy in general), and the specifics of all types of errors.

Results

In accordance with our hypothesis, the most significant differences between **children with better and worse EF** were seen in the programming of narrative. Programming is the deployment of narrative based on the internal plan of the content. It concerns the logical sequence of parts of the story, the presence of its significant parts, and the correct construction of sentences. The weakness of story programming is reflected in the omission of parts of the text ($Z = -2.72$, $p<0.01$) and in the type and structure of the created stories (respectively, $Z = 2.1$, $p<0.05$ and $Z = 3.5$, $p<0.01$). In weak children, the overall speech rate significantly slows down ($Z = 2.87$, $p<0.01$). Therefore, as a rule, these children experience significant difficulties with unfolding of narrative, they remake sentences several times trying to make them complete and express basic meaning. The difficulties of text programming are also related to more specific difficulties, namely the presence of logical errors ($Z=-2.26$, $p<0.05$) and the non-use of indicators for the beginning and ending of the story ($Z=2.1$, $p<0.05$). Semantic completeness of a narrative is also affected ($Z = 1.68$, $p = 0.09$). Moreover, we can also note a lower level of semantic (conceptual) adequacy of the story ($Z = -2.32$, $p<0.05$), but it was observed mainly in children characterized by poor EF combined with the weakness of the right-hemisphere functions.

Table 2

Quantitative outcome of the narrative analysis in four groups (group average in the top line, minimal and maximal values for the group in the bottom line)

	Better EFgroup	**Worse EF group**	**Better AV group**	**Worse AV group**
Narrative parameters				
Omitted narrative parts	0.1 0—1	1.4 1—3	0.6 0—3	1.2 0—4
Number of logical errors	0.1 0—1	0.7 0—2	0.1 0—1	1 0—2
Number of words in the independently composed narrative	26.1 15—39	20.9 10—34	24.3 12—35	22.6 9—31
Semantic completeness	19.5 15—21	16.2 6—21	21.3 12—27	11.4 6—18
Speech rate	1.65 1.17—2.5	1.15 0.7—1.7	1.46 0.9—2.3	1.01 06—1.6
Indicators of the beginning and the ending of narrative	1.9 1—3	1.1 0—3	1.4 1—2	0.8 0—2
Semantic (conceptual) adequacy*	0.1 0—1	1 0—3	0.3 0—2	1.3 0—2
Programming*	0.5 0—1	1.9 1—3	0.6 0—2	1.3 0—2
Narrative type (Narrative structure)	1.2 (2.8) 1—2 (2—3)	0.7 (1.6) 0—1 (1—2)	1 (2.7) 0—2 (2—3)	0.3 (1.8) 0—1 (1—3)
Omitted verbal predicate	0	0.3 0—2	0.1 0—1	0.1 0—1
Omitted subject	0	0.1 0—1	0.1 0—1	0.3 0—2
Omitted object complement	0.2 0—1	0.8 0—2	0.4 0—2	0.8 0—2
Omitted adverbial modifiers / attributes	0.1 0—1	**0.4** 0—2	0.3 0—1	**1** 0—2
Grammar-syntax parameters				
Agrammatisms	0	0.4 0—2	0	0
Number of incomplete sentences	0.3 0—2	1.8 0—4	0.3 0—1	1 0—3
Number of sentences	3.7 2—5	4.8 3—8	3.7 2—6	3.9 2—6
Average sentence length	7.04 5.7—8.3	**4.5**** 3.2—7	6.7 5.3—8.7	**6** 4.2—10
Maximal length of a complete extended sentence	11.9 7—16	6.7 4—10	11.4 7—16	8.3 3—16

	Better EFgroup	**Worse EF group**	**Better AV group**	**Worse AV group**
Number (and frequency) of complete extended sentences	3.4 (0.9) 2—5 (0.7-1)	2.1 (0.5) 0—4 (0—1)	3.5 (0.95) 2—6 (0.7-1)	2.4 (0.62) 1—5 (0.2-1)
Number of complex sentences	0.6 0—1	0.2 0—1	0.6 0—2	0.4 0—2
Lexicosemantic parameters				
Errors in lexical choice	0.2 0—1	**1** 0—2	0.5 0—2	**2.4** 0—6
Word-formation errors	0.1 0—1	0.5 0—1	0.1 0—1	0.6 0—1
Word finding	0.8 0—3	1.2 0—4	0.2 0—1	1.2 0—4
Verbal-perceptual errors	0.2 0—1	0.2 0—1	0.2 0—1	0.8 0—2
Number of object attributes and action attributes	1.6 0—3	1 0—4	2.7 0—4	0.8 0—4
Goal nomination	3.5 2—5	2.4 0—5	4.3 1—6	1.8 0—4
Pronominalization index	0.6 0.14—2	0.5 0—1	0.4 0. 14—0.8	1.01 0.25—2.7

* Higher values mean worse results
** Statistically significant differences between groups with worse EF and AV are in semi-bold

Let us return to the Examples 1—6 reflecting the language in children with better and worse EF. In the Example 1, the program of the narrative was deployed correctly. In the Example 2, the child was switching from one picture to another, breaking the order of the events (*First the wind, then the man was walking, then everything was flying because of the wind*). There is neither ending nor beginning of this story, it is rather an answer to a question. Important semantic (conceptual) parts of the story are missing, i.e., the goal of the protagonist and the result obtained.

At the level of a sentence, syntagmatic difficulties with the deployment of an utterance are also noticeable. Such children produced multiple unfinished sentences ($Z=-2.74856$; $p< 0.01$) which in turn reduced the average length of a sentence ($Z = 3.4$, $p < 0.01$). These participants were truly challenged by the need to compose complete extended sentences; therefore, their length and frequency of their use was much less ($Z = 2.35$, $p = 0.019$ and $Z = 3.23$, $p < 0.01$). For the same reason, the necessary sentence parts were often omitted ($Z = -2.01083$; $p<0.05$) and complex sentences were used much more seldom (at a trend level) ($Z = 1.74$, $p = 0.08$).

Let us focus on the agrammatisms. They are not seen in all in children with better EF, but in children with worse EF they are present, although it does not reach the level of significance ($Z = -1.76$, $p = 0.08$). The same is true for word-formation errors ($Z = -1.85$, $p = 0.06$).

In the Example 6, the child starts his narrative: *He walked...* Without completing this sentence, he tries to construct another sentence: *He went to pour out*. Still, this sentence is not complete either since its important parts — the direct object and adverbial modifier of place (what is to be poured and where) — are missing,. The following sentences also remain short and unfinished with their necessary parts omitted. Finally, in this case we see the most severe difficulties of sentence construction, agrammatisms: "*He with coals ... to pour out"; "It was blown out"* (about the coals).

Before we address the lexicosemantic aspect of language in children with worse EF, it is important to emphasize Luria's words about two ways of word selection: by a paradigmatic mechanism and through "syntagmatic connections" (distinguishing of a required word from spoken language constructions" [9, p. 40]). Therefore, it is no surprise that children with underdeveloped EF demonstrated more errors of lexical choice compared to the "better" EF group ($Z = -2.32$, $p < 0.05$), and lower score in goal nomination ($Z = 2.12$, $p < 0.05$). Our data confirmed Luria's assumptions, and we also believe that both the semantic incompleteness and lexical difficulties can be explained through the lack of deployment of narratives and insufficient use of syntagmatic connections.

Thus, the main difficulties in coherent speech in children with underdevelopment of EF include poor actualization of syntagmatic connections — the deployment of the text and individual sentences.

Now, let us discuss the results of children with **underdeveloped AV.** According to our hypothesis, these children mostly find themselves challenged when they have to use paradigmatic mechanisms for lexical choice in narrative production. Processing of the obtained data confirmed this assumption.

The largest difference between children with better and worse AV and analytic (left-hemisphere) strategy was found in the semantic completeness of their narratives ($Z = 3.38$; $p=0.0007$). Other differences indicated the reasons for such incompleteness. These are lexical

errors (Z = -2.81; p=0.004), word-finding difficulties (Z = 1.7; p=0.005), difficulties with finding of goal nominations (Z = 3.04; p=0.002), and word-formation errors (Z = -2.24, p=0.03). Children with poor AV lacked necessary denominations for objects and actions that were used for the assessment of semantic completeness (walks/carries/pours out, garbage/bucket, approached, dumpster/dump/trash, etc.). Usually, children tried to compensate their deficiencies replacing required words with pronouns (often without antecedents) or with pronominal adverbs (*Here a man or an old man was transporting, well, he was carrying mushrooms, and put here. And this is what he was carrying. This is what he was going to put.)* Therefore, we see the use of predominantly pronouns and their significant predominance over nouns. The Pronominalization index (pronouns/nouns relation) was significantly higher in children with weak AV (Z = -2.31, p=0.002). The poverty of the vocabulary concerns not only nouns and verbs, it is also seen in the rare use of adjectives and adverbs (Z = 2.46, p <0.01).

In addition to verbal (lexical) errors, children also make verbal-perceptual errors. Their difference is expressed at the level of a tendency (Z = -1.87, p=0.06).

At the sentence level, such children used much fewer complete extended sentences (Z = 2.75, p<0.01). The most significant differences are observed in the omissions of adverbial modifiers and attributes (Z = -2.67, p=0.007). Subjects, predicates, and objects were omitted much less, though. That is, the basis of a sentence is more preserved. It seems that the preservation of the basis of a sentence is due to stable syntagmatic connections, and the non-use of circumstances and definitions is due to the fact that these are additional, much more variable parts that are not fixed in the structure of a sentence. The same facts, in our opinion, can also explain the incomplete, unfinished sentences (Z = -2.22; p=0.05) and lesser maximal length of an extended sentence at a trend level (Z = 1.79; p = 0.07).

At the text level, problems with word selection are reflected, in addition to insufficient semantic completeness, in a decrease of the overall speech rate (Z = 2.31, p<0.05), in the non-use of indicators for the beginning and ending of the story (Z = 2.02, p<0.05), as well as in the worst type and structure of narratives (Z = 2.67, p<0.01 and Z = 2.22, p<0.05, correspondingly). The fact that logical errors were much more frequent in the narratives of children with weak AV can also partially be explained by their problems with the word selection. Let us consider the following example.

(*Here a man or an old man was transporting, well, he was carrying mushrooms, and put here.* (...) (And what happened to him then?) *He got black.* (Why?) *Because... Did he get black because of the coal?* (Where does the coal come from?) *Because the coal... You need to go far to get it.*) It is clear that the child made logical mistakes saying words that he has to explain later. A low level of semantic (conceptual) adequacy of the narrative can be related to the difficulties of word selection (Z = -2.29, p<0.05).

All above listed specifics of narratives produced by children with underdeveloped AV can be clearly seen in the Examples 8 and 9. For instance, in the Example 8, the child does not almost use any goal nominations (except the bucket) and avoids nouns at any cost: *Someone was carrying a bucket. Then he threw it, and got spattered.* Or, as in the Example 9, the child is trying his best to follow the storyline but has difficulties with choosing the right words, and therefore uses only verbs and pronominal adverbs. For instance, *and this is what he was carrying. This is what he was going to put. This is what he had already put. He is taking out, and here he is done.*

Thus, it has been confirmed that children with weak AV have difficulties associated primarily with the selection of a necessary language unit, that is, the paradigmatic mechanism.

Now, let us focus on the differences between **children with poor AV and EF.**

There are not so many statistically significant differences between the texts of children with these difficulties in our sample. The children with underdeveloped EF produce shorter sentences, while the children with poor AV make more errors in lexical choice and often omit adverbial modifiers and attributes. If we turn to differences close to statistically significant, we can note the following main trends:

1) children with poor development of EF have more agrammatisms. In the group of children with poor AV they do not exist at all (statistical data at the trend level: Z = -1.76, p = 0.07). They have a shorter average sentence length (Z = 2.16, p = 0.03) and more incomplete sentences (also at the trend level Z = -1.7, p = 0.08);

2) children with worse development of AV have lower semantic completeness (at the level of a trend: Z = -1.88, p = 0.06). They use more pronouns than nouns (pronominalization index — 1.014), while children with EF weakness use more nouns (their index is 0.47), differences in pronominalization indices at the trend level (Z = 1.7, p = 0.09). Children with worse AV also have more verbal-perceptual errors (at the level of a tendency: Z = 1.87, p = 0.06), they miss more adverbial modifiers required by the valence of the verb (Z = 2.22, p = 0.02).

Let us discuss all the results obtained in general.

Discussion

The results of the study showed that the difficulties in construction of stories in children with underdevelopment of EF are associated with the weakness of syntagmatic mechanisms, i.e., the mechanisms for constructing coherent speech and its deployment.

Alexander. Luria considered these mechanisms as a special case of the kinetic organization of movements

and speech which underlies the formation of smooth and time-organized skills and is implemented by the premotor cortex of the left hemisphere [9; 10]. Weakness of syntagmatic mechanisms is reflected in poor construction of a narrative program and its deployment into a consistent holistic and coherent text, as well as in the difficulties with the genre design of the story and in the omissions of its semantic (conceptual) parts. In addition, deployment difficulties are seen at the level of a single sentence in the terms of its abbreviation, incompleteness, and omissions of significant members of the sentence. The same difficulties cause the lack of semantic completeness, i.e., it is secondary in relation to the deficiencies of syntagmatic mechanism. As for the difficulties in the lexical choice, they are also a consequence of poor syntagmatic connections of words. It is well known from aphasiology that patients with efferent motor aphasia which occurs when the lower parts of the premotor cortex are affected, cope much better with naming than with searching for words in coherent speech. This is explained by the problems of using contextual (syntagmatic) word connections. Psychologists also mentioned the two ways of word search in the lexical memory. George Miller [24] who suggestedsix hypotheses on the organization of lexicon especially highlights two hypotheses: the lexicon as a catalogue with semantic markers and the lexicon as a part of the sentence formation mechanism (the predicate hypothesis). He writes: "...I personally believe that some combination of semantic markers and predicate hypothesis is required to describe our language abilities" [24, c. 234]. According to this researcher, "lexical memory should have at least two types of entrances: one to identify the topic of the sentence, and the second one to serve predicates." [24, p. 234]. The comparison of Miller's hypotheses and aphasiology data was made by Tatiana Akhutina [1; 6].

As for the deficits of text construction in children with poor development of AV and analytic strategy, they, on the contrary, have primary disturbances of paradigmatic mechanisms, i.e., difficulties in lexical choice. Alexander Luria regarded these mechanisms as a particular case of dysfunction of complex form of auditory analysis and synthesis caused by a damage or weakness of the external (upper and middle) parts of the temporal lobe [9; 10]. Functional deficiency of paradigmatic mechanisms manifests itself primarily in the difficulties of lexical choice which determines multiple verbal substitutions, semantic incompleteness of narratives, and problems with goal nomination. Children compensate for the difficulty of name selection by active use of pronouns.

Secondary problems caused by the same reason are lower speech rate, brief sentences, incomplete sentences, and distortion of narrative logic.

The idea developed by Luria about the relationship of sensorimotor (initial) functions and language in the phylogeny of language and morphogenesis of language structures [8] is now widespread. It is close to the nonmodular approach, which has different names (embodied or grounded cognition) [16].

However, the debate on the independent development and functioning of syntax and lexicon is not finished. Luria's perspective which is supported by the authors of this paper states that the mechanisms of syntax and lexicon are separate, and they interact in functioning. Such a view on the mechanism of language acquisition (so called dual-mechanism account of language development) does not entail the compliance with the idea of innate language knowledge promoted by Noam Chomsky [19]. The founders of the cultural-historical psychology, Lev Vygotsky, Alexander Luria and their followers, strictly insist on the social genesis of language. They rather stand by the theory suggested by Michael Tomasello and his colleagues, also known as the usage-based approach to language development [13; 21; 22; 26].

What are the arguments in favour of a single mechanism for language acquisition? One of the supporters of this idea was Elizabeth Bates [17]. As a continuation of oral discussions with Bates, Tatiana Akhutina [5] summed up three arguments of Bates which are repeated in modern works. The first and main argument is that the active use of two-word syntactic constructions occurs only with a certain amount of vocabulary. Consider the counterarguments to it. The growth of the vocabulary and, in general, the acquisition of language is based on some cognitive processes, in particular, the sharing of the intentions of adults [13; 26]. From the usage-based approach perspective, "...the child constructs language by connecting what they already know in terms of the cognitive and intention-reading developments of the first year to the language that they hear" [21, p. 348]. At first, not only individual words but also "big words" are holistically assimilated, i.e. memorized as a whole and not analysed as chains of words (for example, what's that?). Based on the statistical features of the input, children begin to identify categories of words and form the "slot-frame" patterns, where emerging categories act as slots, initially with a low level of generalization, such as THING or ACTION, but becoming more and more abstract. At first, their generalization level is very low, like A THING or AN ACTION, but with time they become more and more abstract. Elena Lieven et al. [21; 22] revealed that children create "THING" slots in the scheme "I want X, this Y". Initially, these schemes consist exclusively of nouns, then articles appear, and eventually attributes are added.

The possibility to use statistical features of input and to reveal its serial organization was supported by multiple studies (see the review [20]). For example, Gary Marcus et al. [23] found out that 7-months old babies could generalize repeating structures, such as AAB, ABB, and ABA. After getting familiar with triads of syllables of the same type (say, ba-ba-de for AAB), the

babies were presented with triads consisting of new syllables which either matched the familiar structure or a new one. The authors revealed that children clearly recognized the structure despite the use of new syllables, and drew the conclusion that the positions of syllables within the triad acted as variables. Babies discovered the relationship of those variables. Studies of this kind show the possibility of separating syntactic categories from speech heard by children.

Another important argument in favour of the dual-mechanism account of language development derives from the analysis of memory types participating in the language acquisition. As Ullman [27; 28] demonstrated, declarative memory provides the acquisition of vocabulary, while procedural memory contributes to syntax acquisition. The functioning of declarative memory is based on the temporal structures of the brain, while procedural memory is based on the functioning of a network of frontal, parietal, cerebellar, and subcortical (basal ganglia) structures.

Conclusion

Our hypothesis implied that the syntagmatic and paradigmatic mechanisms of language associated with the anterior and posterior parts of the brain will be reflected in text construction in children with a relative weakness in EF (the third brain unit, according to Luria) and in children with a relative weakness in AV (the second brain unit, the left hemisphere). We assume that differences between these groups of children will be seen in syntax and lexical choice.

The analysis of narratives created by second-grade Moscow school students allowed us to reveal several textual features that characterized children with poor EF or AV:

— Children with a weakness in AV primarily demonstrated paradigmatic difficulties, i.e., problems with word selection which were reflected in the semantic incompleteness of texts, lexical errors, and the use of pronouns instead of proper words.

— Children with a relative weakness in EF primarily demonstrated syntagmatic difficulties, i.e., problems with the construction of the text as a whole and its individual sentences, the omission of significant members of a sentence and the presence of agrammatisms.

Despite the fact that the sample consisted of typically developing children who have only a relative weakness in the development of either EF or AV, the differences in the syntagmatic or paradigmatic mechanisms of text generation can be seen. This confirms their psychological reality and shows the foresight of Luria's theoretical search.

Study limitations: the results discussed in this paper were obtained from a relatively small sample of typically developing children and need to be replicated on other samples.

In the future, we intend to study children of the same age group as well as children of other ages from 6 to 9 years. In addition, the results need to be clarified on samples of children with various developmental disorders and varying degrees of severity of these disorders.

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