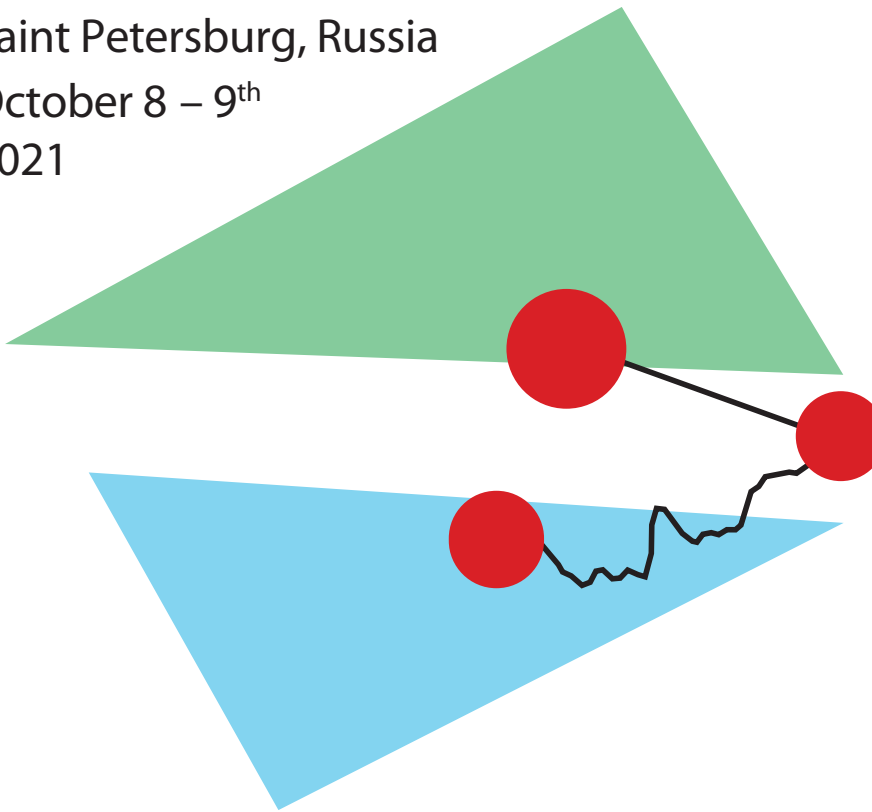
Proceedings of the 5th International Conference on

NEUROBIOLOGY OF SPEECH AND LANGUAGE

Saint Petersburg, Russia
October 8 – 9th
2021



Organised by the Laboratory of
Behavioural Neurodynamics,
Saint Petersburg State University

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Saint Petersburg State University

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October, 2021

Edited by Olga Shcherbakova

СКИФИЯ
ПРИНТ

Saint Petersburg, Russia

Neurobiology of Speech and Language. Proceedings of the 5th International Conference on Neurobiology of Speech and Language / Ed. by O. Shcherbakova.— St. Petersburg: Skifiya-print, 2021.— 78 p.

ISBN 978-5-98620-560-1

Front cover by Alexander Kirsanov

Abstracts' compilation and verification
by Varvara Averyanova, Ekaterina Blinova

Management and coordination by Ekaterina Perikova

Web page: http://cogneuro.spbu.ru

Supported by the grant of the Government of the Russian Federation
№ 14.W03.31.0010 (P.I. Y. Shtyrov)

ISBN 978-5-98620-560-1

Disclaimer: All conference materials are published in their originally submitted form, with no editing or proofreading. Programme Committee reviewed all submitted abstracts; nomination for publication was based on the abstracts' overall scientific rigour and quality, whereas spelling, grammar and punctuation remain the responsibility of the abstracts' authors. Please, note that in cases of $p < .001$ we adjusted the format in accordance with APA style.

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Prof. Teija Kujala
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Neural responses uncovering the nature of language development deficits

Language development deficits such as developmental dyslexia and developmental language disorder are prevalent and negatively influence learning and career outcomes, also causing a burden to the society. Understanding their origins is vital for developing interventions targeted to alleviate these disorders. Identifying deficits that may lead to an unfortunate path in language development in infancy is particularly important for prevention.

Recent neurophysiological studies have brought new knowledge on the perceptual deficits that may crucially contribute to these disorders. Using neurophysiological responses (event-related brain potentials, ERP) has remarkable advantages in studies on developmental language deficits. They enable us to accurately pinpoint how a specific stimulus is processed in various contexts. Moreover, they can be used even to study newborns, illuminating the development of speech from birth onwards.

According to the most prevalent theories, developmental dyslexia is primarily caused by a phonological deficit, but it is debated whether it lies in the representations of phonemes or in their accessibility. According to another hypothesis, developmental dyslexia and developmental language disorder could be based on an implicit learning deficit. ERP studies testing these hypotheses suggest poor phonological representations in infants with an inherited dyslexia risk, which appears to be less predominant in adults with dyslexia diagnosis. This result together with findings showing weak associations between phonemes and graphemes in dyslexic adults speak for poor phonological accessibility in adulthood. These findings are also compatible with the suggestion that poor phonological representations are prevalent in infants with dyslexia risk, this deficit subsiding during development. In addition, it was recently shown that whereas typical readers can implicitly extract violations of rules embedded in sound sequences, those with dyslexia display poorer ability. Moreover, the response implicating rule-extraction ability, elicited in infants without a dyslexia risk, was found to be totally absent in newborns with dyslexia risk. Overall, these results are also supported by recent neuroanatomical findings showing diminished grey matter volumes in dyslexic individuals in areas subserving phonological and implicit processing.

These neurophysiological results offer direct support to dyslexia theories suggesting phonological representation deficit in infancy, which subsides by adulthood, poor phonological accessibility becoming then more prominent. They also support the suggestion of implicit learning problems in dyslexia. A challenge for future studies is to determine the prevalence of the different types of deficits and the possibilities to ameliorate them early.

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Motivated language learning: The role of intrinsic reward and information sampling

During the last decade we have accrued important knowledge regarding the cognitive and neural mechanisms involved in the hard process of learning a new language. However, it is unknown which are the neural processes underlying the human drive to learn a language and what maintains this effortful activity. In recent studies we observed robust activations in core reward-pleasure centers when participants successfully learned the meaning of new words. These results support the view that during evolution, emerging cortical language learning mechanisms might have been glued to phylogenetically older subcortical reward centers, reinforcing motivated-language learning activities. These internal reward-related dopaminergic pathways could trigger specific value-signals, increasing the changes of the organism to actively engage in intrinsic motivated behaviors (curiosity) for improving language learning and accrue new information.

However, to a certain extent, the proper engagement of intrinsic reward-motivational circuits might depend on the proper evaluation of learning success (metacognitive processes). One crucial aspect in learning is information sampling, selecting which piece of information is more relevant to attend. This is especially important when learning occurs under uncertainty, impoverished conditions or without full access to all relevant information. Correct self-directed information sampling might prevent accruing indiscriminate information from the environment that might result in diminishing problem-solving capacities. We were the first to explore this issue using time-sensitive neuroimaging techniques and show that successful language learners were extremely sensitive to the amount of information in a learning experience. Overall, successful language learners boosted learning through optimal information sampling, probably requiring the optimal interplay between reward-motivation and self-monitoring systems, memory and attention.

Prof. Yury Shtyrov

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National Research University Higher School of Economics, Russia;
Aarhus University, Denmark

Word learning in the brain: Functional, structural and neuromodulatory evidence

The ability to use language to communicate with our conspecifics is perhaps the most important human cognitive ability, constituting the backbone of our personal, social and economic lives. Its efficient use relies on a unique human skill to quickly and efficiently learn new words, building up huge lexicons of many thousands of words throughout our lifespans. Despite its clear importance, this vital word acquisition ability is poorly understood. Conventional knowledge maintains that language learning — especially in adulthood — is slow and laborious. Furthermore, its neural bases in the brain remain unclear. Even though behavioural manifestations of learning are evident near instantly (e.g., we can start using new words immediately after hearing or reading them), the bulk of previous neuroimaging work has largely studied slow neural changes associated with months or years of practice. To overcome this gap, we used a variety of state-of-the-art neuroimaging tools, including EEG, MEG, MRI, TMS and tDCS, as well as bespoke learning paradigms to tackle rapid brain mechanisms underpinning different types of word acquisition. Our results show a network of cortical areas that take part in online word and morpheme acquisition, which exhibit immediate functional and structural plasticity. This plasticity depends on multiple factors, including phonology, semantic references, individual language experience, age, etc. Distinct cortical mechanisms become involved depending on the type of learning and semantic and morphological content of novel words. Furthermore, we show that these cortical learning systems can be modulated using neurostimulation tools to boost word acquisition outcomes, which may in the future lead to development of new applications, therapies and interventions.

SLIDE SESSION 1

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Vocabulary and phonological decoding skills affect reading in English as L2 by Russian native speakers

The study is the part of the Multilingual Eye Movements Corpus (MECO) project (Kuperman et al., under review) aimed at cross-linguistic comparison of eye-movement parameters while reading in different languages as L1 and reading in English as L2 and investigating how oculomotor reading behavior is affected by individual differences in reading-related skills.

We present a study of the reading behavior of Russian-speaking proficient L2 learners of English: 32 Russian-speaking participants proficient in English (B2 and C1 level) read 12 encyclopedic-style passages 100-150 words each and answered comprehension questions. EyeLink 1000+ desktop mount eyetracker (1000 Hz) was used to record their eye movements, mean fixation duration, mean fixation count per word, reading rate (number of words read per minute), and regression rate were

used as eye-movement measures. The participants completed a LEAP-Q questionnaire on their L2 experience and proficiency (Marian et al., 2007) and a battery of tests assessing reading-related skills: spelling recognition test (Andrews, Hersch, 2010), vocabulary size test (Nation, Beglar, 2007), word naming and pseudoword reading subtests of TOWRE test (Torgesen et al., 2012), Author Recognition Test as a measure of print exposure (Stanovich, West, 1989).

Preliminary results show that comprehension accuracy is significantly influenced by vocabulary size (beta = .06, t = 3.19, p = .004). As for reading fluency, namely regression probability, it is affected by word reading efficiency, i.e. phonological decoding skills: both sight word reading assessed by word naming subtest of TOWRE (beta = -.02, t = -2.2, p = .03) and phonemic awareness assessed by pseudoword reading subtest of TOWRE (beta = -.04, t = -2.5, p = .01).

Vocabulary size is a key predictor of text comprehension in L2 reading, as well as in L1 (see Braze et al., 2007). Phonemic decoding is involved in lexical access, so it affects word recognition and silent reading fluency (see Ashby et al., 2005), especially when L1 Russian speakers read in L2 English, which has a deeper orthography than their native language.

Supported by the Saint Petersburg State University grant no. ID 75288744.

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By trial and error: Reading aloud in first and second languages

Studying reading aloud, which combines the visual text processing and the production of spoken word, allows us to compare the interaction of different modalities when using L1 and L2. We focused on the description of eye movement patterns when errors occur in oral reading in Russian as L1 and Japanese as L2.

We chose two fragments similar in the readability from a Japanese novel and their Russian translations. The experiment consisted of two stages with an interval of 1.5–2 weeks. At each stage, the participants read aloud two texts: in Russian and in Japanese. We registered the eye movements using the EyeLink 1000+ and recorded reading aloud using Olympus voice recorder DM-720. The audio recording started when the participant began to read. The participants were 10 native Russian speakers with the level of the Japanese language proficiency not lower than N3 (JLPT).

We analyzed the eye movements on the word where the error occurred and on the next word, as the eyes are ahead of the voice during reading aloud (Laubrock, Kliegl, 2015). In Japanese, there were 102 self-repairs (SR), 85 noticed but uncorrected errors (NUE), and 26 unnoticed ones (UE). According to Kruskal–Wallis test, eye movements on the erroneous words differed in dwell time, the number of fixations, regression count ($p = .013$), but not in first-pass duration ($p = .51$). SR differed from NUE and UE in all measures ($p < .05$; $p < .005$ respectively; post hoc Dunn's test). NUE and UE differed in all measures ($p < .05$) except for regressions. We also found the difference between SR and UE in the number of regressions from the following words ($p = .011$). For Russian, we compared eye movements for 29 SR and 14 UE, as there were only 4 NUE in the data. Using Mann–Whitney U test, we found that SR are processed longer than UE: dwell time ($p = .018$); the number of fixations ($p = .006$). There were also more regressions to the erroneous word for SR ($p = .021$). The first-pass duration did not differ significantly ($p = .434$). There were more regressions from the words following SR ($p = .011$). Thus, the processing of erroneous words is similar while reading aloud in Russian as L1 and Japanese as L2. No differences in the first-pass duration (early processing) may indicate that the error in L1 and L2 is noticed during reading the next word, resulting in a regression, not longer processing of the next word.

Supported by the grant №21-18-00429 from the Russian Science Foundation.

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Written, not spoken or too much to read: How to present information more effectively?

According to the Cognitive Theory of Multimedia Learning (Mayer, 2005), the information is processed better if it is submitted by different channels (e.g., auditory and visual). In this paper, we discuss how the format of presentation influences the acquisition of the material in an online lecture.

Participants listened to four fragments of an online lecture in linguistics, each fragment being presented in one of the following formats: 1) oral text without visual support; 2) oral text and presentation with verbatim written text; 3) oral text and presentation with a summary of the content; 4) oral text and presentation with a summary of the content and illustrations. After each fragment, the participants answered to three questions about the information provided in the fragment and evaluated the fragment on three scales (clarity of presentation, presentation format, interestingness). All fragments were similar in the level of readability (SMOG; 15.36–17.09), number of words (92–98), and duration of the audio file (60–72 s). Each stimulus was listened to by 33 people.

The Kruskal — Wallis test has shown the influence of the format of presentation on the effectiveness of information acquisition ($H(3,33) = 35.72$, $p < .001$). The participants provided significantly less correct answers after the oral presentation without visual support than after all other formats of presentation ($p < .001$ for all pairs; Dunn's post hoc test). The highest scores for after the text questions were obtained for both formats with a summary of the content: the scores were significantly higher than for two other formats ($p \leq .025$). We also observed the effect of the fragment ($H(3,33)= 56.90$, $p < .001$), but it turned out not to be statistically significant for the oral text supported by a summary of the content without illustrations.

We found out that the combination of visual and auditory formats was a more effective way of presenting material than just the audio format, and the summary was more effective than the word for word. The presence of

visual information supporting the text influences the subjective assessment of the presentation format, but not the reliability of information acquisition. The results are consistent with the findings from the previous research obtained separately for the modality of the text and for the type of visual presentation of the material.

Supported by the grant №21-18-00429 from the Russian Science Foundation.

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Letter similarity effects when reading braille

Models of word recognition typically assume that the initial mapping of the sensory information onto abstract representations is noisy (Norris, Kinoshita, 2013). Consistent with this idea, visual masked priming experiments have shown that recognizing a word like NEUTRAL is more rapid when preceded by nevtral (v is similar to u) than to neztral (Marcet, Perea, 2017). However, letter similarity effects are elusive in single-presentation experiments. For instance, the pseudowords viotin and viocin (baseword: violin; t is similar to l, and c dissimilar to l) produce equivalent response times in the lexical decision task (Perea, Panadero, 2014). Here, we examine the existence of letter similarity effects in the tactile modality using braille. Unlike the visual modality, in which the processing of letters is quasi-parallel, braille requires more serial processing. As such, it may be more sensitive to letter similarity effects than the visual modality (noisier accumulation of evidence).

We conducted a lexical decision task and compared the response times (RTs) and accuracy to tactile similar vs. dissimilar pseudowords in a lexical decision task. The pseudowords were created by substituting a letter from a high-frequency word with a similar letter or a dissimilar letter (e.g., mutical

vs. mubical [base word: musical—s and t only differ in dot 5]; tactile similarity matrix, Baciero et al., 2021). The experiment was pre-registered in the OSF and employed a Bayesian sequential sampling procedure.

Bayesian linear mixed-effects models on accuracy showed responses were more accurate to the "tactile dissimilar" pseudowords than to the "tactile similar" pseudowords (97.1% vs. 89.7%, respectively; 95% Credible Interval [-2.19 — -0.73]).

When reading, there is some degree of uncertainty when mapping the input information onto abstract letter representation (e.g., noisy-channel models; e.g., Norris, Kinoshita, 2013). One reason why the effects of letter similarity with single-presentation paradigms are sizeable in braille is that tactile stimuli are processed very briefly, when the finger passes through the braille cells. Thus, the scenario in braille resembles that of briefly presented visual stimuli, where letter similarity effects have also been consistently reported. Therefore, the uncertainty associated with letter identity coding seems to be a characteristic of the general (amodal) process underlying word recognition.

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Predictors of understanding of implicit meanings of verbal texts

Understanding of implicit meanings of verbal texts is considered a complex phenomenon which is affected by both cognitive and emotional characteristics of the texts' readers (Vekker, 1976; Shcherbakova, 2009). However, recent studies on the effect of Theory of Mind, IQ and EQ on texts' understanding do not provide much support for this suggestion (Shcherbakova, Nikiforova, 2018; Golstein, Shcherbakova, 2018).

Our study was aimed at exploring a potential correlation between understanding of implicit meanings of verbal texts and cognitive (IQ, cognitive styles "field-dependence — independence" and "equivalence range", Theory of Mind) as well as emotional (EQ) characteristics of the

readers. 38 volunteers (24-53 y.o., Me = 40.5) participated in the study. First, they were tested for the aforementioned psychological characteristics; then, they read a story with a complex structure of implicit meanings (Greene, 1965); finally, they answered questions of semi-structured interviews aimed at assessing the levels of text comprehension. The interview protocols were transcribed verbatim and then assessed by two experts. Cronbach's , Pearson's r and multiple regression were used for statistical analysis.

Although we did not find any direct correlations between the psychological parameters and the levels of understanding, we observed that cognitive and emotional characteristics varied in their contribution to understanding of different elements of implicit text structure. For example, there was a correlation between IQ and reconstructing the meaning of repetitions ($r = .365$, $p = .047$) and contrasts ($r = .369$, $p = .045$), the main theme of the text ($r = .369$, $p = .045$), and the number of different elements of implicit text structure ($r = .525$, $p = .003$). We also found a correlation between field-independence and understanding of intertextual elements ($r = .462$, $p = .01$). Regarding the EQ, we observed a correlation between emotional regulation and understanding of verbal imagery ($r = .553$, $p = .002$). Finally, we revealed a correlation of the levels of understanding of implicit meanings with the number of different types of elements of implicit text structure ($r = .772$, $p < .001$).

Our results suggest that cognitive and emotional characteristics of a recipient might contribute indirectly to levels of text comprehension. Thus, we can conclude that taking implicit text structure into account can provide valuable insights about the mechanisms of text comprehension.

Supported by the grant of the Government of the Russian Federation №14.W03.31.0010.

SLIDE SESSION 2

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White matter correlates of spontaneous speech and communicative abilities in chronic aphasia

In several studies, language deficits in chronic aphasia have been linked to lesion characteristics and grey and white matter structural parameters (Marchina et al., 2011; Forkel et al., 2014; Ivanova et al., 2016; Forkel, Catani, 2018). However, none of these studies examined spontaneous speech, verbal communicative abilities and aphasia severity within one group of aphasic speakers. Also, the relationship between spontaneous speech and/or communication skills and the status of white matter tracts in both hemispheres has not been studied yet.

Twenty-seven individuals with chronic aphasia were included. Language assessment consisted of a semi-structured interview (with the mean length of utterance [MLU] as a global variable of speech output and syntactic complexity), the ANELT as a verbal communication task (Blomert et al., 1994; Russian version: Akinina, n.d.), and the Token Test measuring

the severity of aphasia (De Renzi, Vignolo, 1962; Bastiaanse et al., 2016; Akinina et al., 2017). Transformed T1, T2, and FLAIR MRI images were used to manually delineate individual lesion masks. DWI data were used for the reconstruction of the white matter tracts in both hemispheres.

The most severe grammatical deficit was found in individuals with combined damage to the left AF, the FAT, the IFOF, and intact ILF. Speakers with preserved left UF and IFOF performed better on the ANELT. Higher scores were also observed in cases with anatomically smaller right FAT and UF. Similar to verbal communication, aphasia severity correlated either with intact left UF or shorter right UF.

Measures for spontaneous speech, communicative abilities, and aphasia severity correlated with structural properties of white matter tracts in both hemispheres. The grammatical impairments were linked to combined lesions within the left dorsal and ventral pathways. Speech production also correlated with left frontal lobe damage, but not with the structural parameters of the right hemisphere tracts. Both communicative abilities and aphasia severity were influenced by damage to the left ventral pathway. Additionally, they were both negatively correlated with the structural parameters of the right hemisphere white matter tracts. The results of this study add to the understanding of the involvement of the white matter structures in language processing in chronic aphasia.

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Subjective and objective evaluation of naming ability in older adults with suspected mild cognitive impairment

In the memory domain, many studies have shown that older individuals' subjective complaints about memory difficulties are not highly predictable of objective memory performance. In fact, individuals with high memory

performance often exhibit the most complaints about memory difficulties, and vice versa (Jungwirth et al., 2004; Rasouli et al., 2019). But only few studies have investigated whether the same discrepancy holds for other cognitive domains, particularly the language function (Lopez-Higes et al., 2017). Our study contributes to filling this gap with regard to the naming ability in older patients of the Memory Clinic with suspected mild cognitive impairment.

The sample consisted of 88 patients of the Memory Clinic (81 female; age: mean 72 years, SD 7.7, range 55-89; Montreal Cognitive Assessment score: mean 24, SD 3.0, range 15-30). For objective evaluation of the naming ability, we used a computerized naming-by-definition task: participants read a definition of the target word's meaning and had to name the word (30 low-frequency Russian nouns) out loud. Accuracy and naming latency were measured. For evaluation of subjective language complaints, we used a custom questionnaire where participants had to score their agreement with 5 statements about their everyday communication skills and to assess how often they experience the tip-of-the-tongue state (average per week).

The mean naming accuracy was 80% (SD 14%, range 33-100%). The naming accuracy did not show significant correlations with either of the subjective measures: the overall agreement score on the 10 complaints, $r(88) = .05$, $p = .64$, or the estimated frequency of the tip-of-the-tongue state, $r(88) = .13$, $p = .24$. The mean naming latency was 4321 ms (SD 1285 ms, range 2127-8285 ms). Similarly to accuracy, the mean naming latency did not show significant correlations with either the overall agreement score on the 10 complaints, $r(88) = .10$, $p = .37$, or the estimated frequency of the tip-of-the-tongue state, $r(88) = -.03$, $p = .75$.

In line with previous studies in the memory domain, subjective complaints in the language domain did not predict objective naming performance. This points to the role of confounding factors (e.g., neuroticism, conscientiousness; Steinberg et al., 2013) in subjective language complaints and suggests that their diagnostic value in assessing objective language deficits may be limited.

The study was supported by the RFBR grant №20-04-6054.

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Speech recovery in chronic non-fluent aphasia after intensive language therapy: Clinical, behavioral and functional outcomes

Chronic aphasia is a speech disorder that frequently follows stroke; despite its high prevalence and severe consequences, existing aphasia rehabilitation techniques have limited efficiency and the precise mechanisms underpinning recovery remain underinvestigated. Our study aimed to clarify the neurocognitive mechanisms of speech recovery in chronic aphasics undergoing intensive rehabilitation therapy.

N=14 patients with non-fluent aphasia underwent a two-weeks course of intensive language-action therapy focused on language embedding into communicative interaction (ILAT; Pulvemüller, 2001, 2008), combined with either anodal or sham tDCS over the left IFG. Clinical outcomes were evaluated using the Russian aphasia test (Ivanova, 2021, preprint) and a behavioral task focused on the patients' verb generation deficits. The latter evaluated cued noun-to-verb generation in two conditions: with a strong (easy condition) and a weak (difficult condition) noun-verb association. Furthermore, recovery-associated neural dynamics was evaluated by comparing MEG data collected for the verb generation task before and after therapy. As previous studies point to a functional role of beta oscillatory dynamics in language, cognitive control and memory retrieval processes associated with speech production (Pulvermüller et al, 1997; Piai, 2015, 2019; Pavlova, 2019), we focused on beta-band activity.

At the behavioral level, we found a tendency for an increase in verb generation accuracy after therapy. Moreover, we found statistically significant improvements in both speed and accuracy of verb generation in the difficult

condition but not the easy one. However, none of these effects were sensitive to the tDCS regime (anodal vs. sham). At the clinical level, we also found an increase in speech production subtest scores after rehabilitation (but not in the other subtests). These changes were accompanied by a significant increase in beta suppression in dorsal frontoparietal MEG sensors, found immediately before verb production. Furthermore, this MEG signal change positively correlated with thea general increase in the behavioral accuracy of the verb generation.

The results obtained point to a recovery effect driven by ILAT therapy. The differential improvements in verb generation (specifically for the difficult task), along with the correlation between verb-generation improvement and frontoparietal beta-band activity, might indicate the involvement of language-specific and/or domain-general cognitive neural networks in recovery.

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Passive voice comprehension level influence the ERP during sentence-picture matching task in 4-5 years old Russian-speaking children

Passive voice acquisition is still in progress in preschoolers and primary school students. Different brain mechanisms of active (AV) and passive (PV) voice sentence comprehension are manifested in late ERP components. In free word order languages (Russian) allow using different strategies during sentence processing. For example, in the case of three-word sentences with direct word order (SVO) voice can be determined by using grammar markers (inflections) of the second and the third words, while in the reversed word order sentences (OVS) — by using inflections of the first and the second words. In this regard, the study aimed to describe the time course of the grammar voice analysis in children based on comparing ERP elicited by AV and PV sentences with direct (DO) and

reversed (RO) word order (four types of sentences). The study involved 38 children 4-5 years old. A sentence-picture matching test was carried out. According to their results in PV sentences comprehension two groups of children were formed: group 1, n = 17 (> 80 % of correct answers) and group 2, n = 21 (< 65%). The ERP's in 1000 ms time intervals were analysed during comprehension the second word in the sentence. ERP amplitudes averaged in frontocentral/parietocentral areas over time intervals were compared using the Wilcoxon test.

In both children groups between task differences (both voice-related and word order ERP differences) in parietocentral areas were obtained in 350-500 ms interval after stimulus presentation. Regarding the frontocentral areas between groups differences were revealed. In group 1 between task differences (both voice-related and word order ERP differences) in frontocentral areas were obtained in 300-400 and 500-600 ms intervals after stimulus presentation. Bigger peak amplitude was registered in RO in comparison to DO and in PV vs AV sentences ($Z = -3.059$, $p < .001$). Bigger peak amplitude was also registered in PV in comparison to AV and in DO vs RO sentences ($Z = -2.981$, $p < .001$). In group 2 between task differences were obtained in 350-450 ms interval only for DO vs RO comparison in PV ($Z = -2.240$, $p = .023$) and AV vs PV comparison in DO ($Z = -2.217$, $p = .044$).

In 4-5 years old children better complex grammar comprehension is related to frontocentral areas ERP sensitivity to grammar voice and word order characteristics, while parietocentral ERP sensitivity seems to be obligatory independently to comprehension skills.

This work was supported by the RFBR grant No 19-013-00923 A.

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Benchmark measures of eye movements during silent reading in Russian school students

Previous systematic studies of silent reading development in children are few in number and targeted European languages with Latin script (Rayner, 1986; Häikiö et al., 2009; Blythe, Joseph, 2011). For Russian, there were no systematic studies of eye movements during reading in children yet. We aimed to describe the main characteristics of eye movements during reading in schoolchildren from Grades 1 to 6 and to determine how the linguistic features of words influence reading behavior at different ages.

We tested 197 children from Grades 1-6 (104 boys). All children had non-verbal IQ (Raven, 2004) and oral reading fluency and comprehension (Kornev, 1997) within the normative range. Children read 30 sentences 6-9 words long while their eyes were tracked with Eyelink PortableDuo or EyeLink 1000+. All words (N = 228) were annotated for length, frequency, and word class. We analyzed how first fixation duration (FFD), gaze duration (GD), total reading time (TT), and the probability of skipping was influenced by linguistic features of words, children's grade, and saccade landing position in a word.

First, we found that mean fixation durations became shorter with grade (e.g. FFD from 237 to 198; TT from 795 to 356), but the probability of skipping remained 0.21. Saccade landing position shifted from closer to the beginning (0.31) to closer to the center (0.39) of a word. Second, we confirmed that longer words required longer GD and TT and were less likely to be skipped (all p's < .001) and that more frequent words required shorter fixation duration and were more likely to be skipped (all p's < .05). The effects of length and frequency became smaller with grade. Interestingly, older children made longer FFD on long words, probably because their lexical access became more efficient. Unlike adults (Laurinavichyute et al.,

2019), children read verbs and nouns for a comparable amount of time, but adverbs, pronouns, and auxiliary parts of speech — longer than nouns.

Progress in reading from grades 1 to 6 manifests in fixation duration, but not in word skipping, possibly, because children's perceptual span is not fully developed. Lexical access becomes more and more efficient with age, as more information is obtained during the first fixation. Similarly to the findings for English (Blythe, Joseph, 2011), the effects of length and frequency gradually decrease with age.

This work was supported by the RFBR grant No 19-313-51014.

SLIDE SESSION 3

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Neurocognitive processing of zero morpheme: EEG and MEG evidence

Linguistic theories of grammar are not always based on or incorporate the knowledge of neurocognitive mechanisms. Moreover, for some of theoretically established universal syntactic constituents there is no evidence of neural correlates. One such element is the so-called zero morpheme, assumed to carry morphosyntactic information, but not expressed acoustically/orthographically in an overt fashion (cf. "he brings" vs. "we bring_"). The present study addresses the question of the neurocognitive reality of such abstract constituents.

We ran two experiments, in which we recorded with the brain's auditory responses to Russian pronoun-verb phrases using EEG (Study 1) and MEG (Study 2). Experimental stimuli in Study 1 study included phrases with correct and incorrect pronoun-verb gender agreement ("он/he", "она/

she"; "он купил-Ø/he boughtMASC" vs. "*он купил-а/he boughtFEM") and single verbforms as a control ("купил-Ø /boughtMASC"). We manipulated the gender of the pronoun and verbal gender markers — masculine (zero morpheme) or feminine (filled). Study 2 experiment included an additional control condition — single verbform with preceded filled hesitation pause for better acoustic control of the stimuli. Based on the hypothesis of morpheme priming/preactivation during early automatic morphosyntactic processing (Shtyrov et al., 2003), we expected with early response enhancement for morphosyntacitally infelicitious combinations. Thus, observation of similarly enhanced responses for zero morpheme would support the reality of this element.

Results from both experiments suggest that zero morpheme activation occurs during morphosyntactic processing: early brain responses to zero morpheme agreement violations are stronger than for correct phrases (EEG: $p = .036$, MEG: $p = .002$). The observed effect started from ~200 ms, which is compatible with ELAN component, known to reflect early automatic syntactic processing. Moreover, higher activation for the control condition without pronoun as opposed to both correct and violated conditions supports putative preactivation/priming of gender template during (morpho)syntactic processing.

Our findings provide evidence of the neurocognitive reality of zero morpheme processing with observation of priming effect for it. This conclusion is supported by data of two experiments using different neuroimaging methods and control conditions.

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Frequency effects on spelling error recognition: An ERP study of Russian

Frequency and pseudohomophone effects are well-studied markers of lexical access and phonological activation, respectively. Usually, pseudohomophones are constructed by changing one or two vowels

or consonants from base words (e.g., brane-brain) (Vissers et al., 2006; Briesemeister et al., 2009; Costello et al., 2021). However, the use of real spelling errors as pseudohomophones is quite rare (González-Garrido et al., 2015). The frequency of pseudohomophones was taken into account only in the study of Braun and colleagues: the pseudohomophone effect was the strongest for stimuli derived from low-frequency base words (Braun et al., 2009). We investigated the time course of recognition of the most frequent orthographic errors in Russian (error in an unstressed vowel) and the effect of word frequency on this process.

During ERP recording 26 native Russian speakers (18 females; mean age = 24 years) read silently the words presented on the screen: HC words — high-frequency correctly spelled words (e.g., команда [kʋˈmandə], team); LC words — low-frequency correctly spelled words (e.g., новатор [nʋˈvatər], innovator); HE words — high-frequency words with errors (e.g., вапрос [vʋˈpros], question); LE words — low-frequency words with errors (e.g., матылёк [mətiˈlʲɵk], moth).

In the 160–280-ms time window RM ANOVA showed high significance for the factor of Spelling in the left posterior region ($p < .01$): the amplitude of N170 was more negative for correctly spelled words than for misspelled words (-2.03 vs. -1.59 μV). In the 400–700-ms time window, a significant Spelling x Frequency interaction was found ($p < .05$). More negative response (N400) was for misspelled words than for correctly spelled words only for high-frequency words in right anterior region ($p < .01$, HC vs. HE, -0.71 vs. -1.75 μV), midline central region ($p < .05$, HC vs. HE, -1.31 vs. -2.01 μV), right central region ($p < .05$, HC vs. HE, -0.71 vs. -1.38 μV). More positive response (P300) was for misspelled words than for correctly spelled words only for low-frequency words in right posterior region ($p < .01$, LC vs. LE, 0.98 vs. 1.83 μV).

Thus, phonological processing in visual word recognition in Russian begins rather early (160–280 ms). Word frequency affects phonological activation in later stages of word processing (400–700 ms): phonological effects are observed for both high-frequency and low-frequency words, but are reflected in different ERP components.

Supported by the RFBR grant 20-013-00514.

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Effects of cathodal and anodal tDCS of Broca's area on the acquisition of novel semantics

Despite numerous studies of neurophysiological mechanisms underlying acquisition of different types of semantics, the involvement of key cortical language areas in this process remains unclear. In the present study, we applied tDCS over Broca's area to investigate its role in learning abstract and concrete words.

Twenty novel word forms and twenty novel meanings (ten abstract and ten concrete) were created. Three groups of participants (N = 24 each, native Russian speakers) received 15 minutes of anodal or cathodal tDCS over Broca's area, or sham (placebo) stimulation before the learning session, which employed short text stories incorporating the novel words (5 sentences for each word). Participants had to read these sentences and tried to infer their meanings from the story context. To assess word acquisition quality, the participants were given a battery of behavioral tasks (Free Recall, Recognition and Free-form Definition) immediately after the training and with a 24-hour delay. Statistical analysis of accuracies and reaction times employed Mann-Whitney pairwise comparisons and Wilcoxon signed-rank tests (FDR-corrected).

On Day 1, participants recognized novel abstract words with higher accuracy and longer reaction times in both anodal and cathodal groups, as opposed to the sham condition (all p-levels < .044), which supports Broca's area's role in abstract semantics acquisition and processing. Also on Day 1, free recall accuracy for concrete words was significantly higher after cathodal than after sham tDCS ($p = .036$), indicating some involvement of Broca's area in learning concrete semantics as well.

Within-group analysis revealed significant performance drop on Day 2 in comparison with Day 1 across semantic types in all groups in Free Recall and Free-form Definition tasks: after an overnight sleep participants recalled fewer newly-learned words and gave poorer definitions of novel

concepts (all p-values ≤ .018). Recognition accuracy was lower on Day 2 vs. Day 1 in the anodal group for both concrete (p = .06) and abstract (p = .016) words, as well as was for concrete words in the cathodal group (p = .02).

In sum, anodal and cathodal tDCS of Broca's area appears to facilitate contextual acquisition of novel words, particularly influencing acquisition of abstract semantics. This influence is, however, short-lived and does not extend into the post-learning consolidation phase.

Supported by the grant of the Government of the Russian Federation №14.W03.31.0010.

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Take your chance: ERP evidence of single-shot word learning in the developing brain

Children are remarkably fast word learners with a unique capacity to learn from a single instance. This process of ultra-rapid mapping of word forms onto representations, dubbed as *fast mapping* (FM), is fundamental to children's success in mastering their mother tongue. Although behavioural studies showed a single exposure to be sufficient for a child to infer a novel word's meaning, neural underpinnings of FM are still debated. The current study aimed to neurophysiologically track the process of ultra-rapid word acquisition in the developing brain under the conditions of single trial learning.

Participants were 20 monolingual Russian preschool children (5-7 y.o). In a child-friendly FM paradigm, new items were introduced in the context of familiar ones such that the new word's meaning became apparent through inference/exclusion. Only one trial was used to present novel items. A balanced set of acoustic (dissyllabic native words and non-words) and

visual (photos of familiar and unfamiliar objects) stimuli was used. After the learning, ERPs to novel and control items were recorded in a passive auditory session. Cortical sources were estimated using sLORETA algorithm with age-specific MRI templates (Neurodevelopmental MRI Database).

We found that a single-shot learning task leads to significant fronto-central amplitude decrease (with a minor right-hemispheric shift) of N400 component for newly learnt words, taking place at 300–320 ms after the stimulus divergence point (2nd syllable onset). No similar effect was found for control stimuli (trained familiar or untrained novel words). sLORETA analysis confirmed this and indicated significant decrease in the right temporal pole activation elicited by novel words after the learning task, in comparison to control ones. Moreover, newly learnt words produced enhanced activation in the left supramarginal gyrus, with the same effect appearing for control new stimuli in comparison to familiar ones.

Overall, our results demonstrate a rapid and highly plastic mechanism for word acquisition in the developing brain. This FM learning mechanism is highly efficient for creating new word representations in the presence of semantic reference. It could be activated after a single exposure to the novel item and engages wide-spread cortical networks in build-up of memory traces for new word forms with native phonology in developing brain.

Supported by the grant of the Government of the Russian Federation №14.W03.31.0010.

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Dramatic increase of beta oscillations at the advanced stage of learning of pseudoword-movement association

Neural mechanisms leading to formation of an associative link between action words and respective movements remain largely unknown.

In motor learning, the post-movement increase in beta oscillations (BO) is implicated in the strengthening of the just learned motor program (Tan et al., 2014). Here, we tested hypothesis that the post-movement BO similarly promote a newly formed association between a movement and an auditory novel word that denotes this movement.

We recorded MEG while 24 volunteers performed a trial-and-error search for unique associations between four acoustically presented pseudowords and movements by hands and feet. We assessed pre-movement (Pre-M) and post-movement (Post-M) changes in beta power (i) at the beginning of learning when movements to the presented pseudowords were exploratory; (ii) at the advanced stage of learning when movements became uniquely associated with specific pseudowords; (iii) during self-paced movements. We hypothesized that Post-M BO would be expressed stronger at the advanced learning stage when the pseudoword-movement association was to be maintained, compared to the onset of learning when a change of a movement was probable, or during the self-paced movements when there was no memorization task.

In line with the previous findings, we observed decrease in BO during the movement preparation and execution, and increase after the movement completion in all three conditions. The strongest beta decrease in Pre-M period was observed at the beginning of the learning as compared to both the advanced learning, and, especially, to the self-paced movements ($p < .05$, FDR-corr.), reflecting the difficulty of choosing between several competing motor programs.

Crucially, Post-M BO were dramatically increased at the advanced learning stage as compared to both the self-paced and the exploratory movements ($p < .05$, FDR-corr.). The source-space analysis showed that the learning-related increase in Post-M beta power occurred in a widespread cortical network including not only sensorimotor cortex, but also memory-related regions (retrosplenial and parahippocampal cortex), the medial and lateral prefrontal cortex, and classical "language" area in left inferior frontal gyrus. We suggest that Post-M BO serve to promote and reinforce the evolving action word representation by strengthening of long-range interactions (Benchenane et al., 2011).

This research was supported by the Russian Foundation for Basic Research, grant 17-29-02168.

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Using the fMRI-equivalent linguistic MMN to determine how the frequency of Russian words influences on changes in BOLD-signal

Mismatch negativity is the one of the electrophysiological indices to recognize the acoustic (MMN) and linguistic (lingMMN) signal characteristics in the auditory modality. We used the fMRI to obtain an anatomically accurate neural source localization for the fMRI-equivalent lingMMN generated in response to changes in the lexical parameters of stimulation. The task was to determine whether there is a difference in the activation magnitude and localization of distributed neural networks for words of different frequencies.

To study how the frequency of Russian words affects the changes in BOLD-signal we used the adapted fMRI block design with deviant 1 and deviant 2. These were Russian low-/ high-frequency words under experimental and control condition with pseudowords, which were identical acoustic contrast to words. The stimuli were presented binaurally through non-magnetic headphones.

The results show that the MMN fMRI-equivalents in response to words (lingMMN) are significantly greater in the volume of activations in the region of local maxima than MMN in response to pseudowords ($p = .001$). Under control conditions using pseudowords, no significant differences were found between MMN1 and MMN2. However, with the same acoustic contrast as in the condition with pseudowords, significant differences were found between lingMMN1 (low-frequency word) and lingMMN2 (high-frequency word): in localization — on the left in the paracentral lobule ($p = .041$) and on the left in the inferior temporal gyrus ($p = .014$); in intensity — the lingMMN signal in the left hemisphere differs from the lingMMN signal in the right hemisphere ($p = .042$).

For the linguistic mismatch negativity with the use of a low-frequency word — lingMMN1 — there is a dominance of right-sided activation in the

superior temporal gyrus. Whereas for the linguistic mismatch negativity with the high-frequency word - lingMMN2 - there is an earlier left-sided activation in the inferior temporal gyrus ($p = .05$ with FWE correction). The results obtained demonstrate a relevant asymmetry for MMN: the mechanisms of automatic attention, activated by acoustic differences, are distributed to the right hemisphere. When a high-frequency word is used as a stimulus, the lingMMN asymmetry changes its character towards the left hemisphere, which is probably associated with the reaction to a change in the lexical characteristics of the signal and the activation of the neural mechanisms of speech processes.

SLIDE SESSION 4

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What picture to choose? On actual aid of alternative communication for those experiencing difficulties with written language

Augmentative and Alternative Communication (AAC) aids many of those in need to express themselves when conventional speech fails. This includes picture-exchange (PE) systems used by various groups of users. To understand what makes the AAC symbols easy to comprehend is of help, especially when referring to people with intellectual disabilities whose skills in writing and reading are affected, and who can, hence, benefit from PE systems. The current study aimed at determining specific features of visual perception of pictorial AAC systems by pupils with mild intellectual disability (MID; ICD-10 Code F70). An additional goal was to identify the hierarchy in terms of transparency for three AAC systems: Blissymbolics, LoCoS ©, and Pictogram.

The sample consisted of 120 middle-school students from St. Petersburg, of which 60 intellectually intact (age, M = 14.96, SD = .63), and 60 with MID (age, M = 15.35, SD = .98). Participants were presented with an original choice-task while recording their oculomotor activity with the use of the GazePoint eye-tracker (60 Hz). There were 6 screens, each with a Russian verb or noun (ipm in spoken Russian > 85) accompanied by 4 pictograms (3 synonymous to the word; 1 to be identified as irrelevant by the viewer). The analyzed parameters were fixations' average duration (T) and the total number of fixations (N).

The results of the Student's t-test showed decreased T ($p < 0.001$) and overall higher N ($p = .004$) for the pupils with MID compared to controls. In terms of hierarchy, according to logistic regression, using LoCoS © pictograms causes an 80% probability of correct answer, Pictogram — 58.3%, and Blissymbolics — 43.3%. Gaze characteristics of pupils with MID were found to correlate with pictograms' degree of iconicity: ANOVA indicated T as significantly longer for Pictogram symbols ($p = .000$), and N as significantly higher for Blissymbolics symbols ($p = .005$).

The results point out that a symbol's iconicity does not equal its transparency (e.g. Mizuko, 1987). Further, Pictogram icons may attract longer fixations being filled with colour, while Blissymbolics' arbitrary signs attract more fixations due to the higher number of details in symbol construction. LoCoS © symbols, having a middle ground in terms of colour fill and design complexity, are therefore the optimal choice to aid pupils with MID.

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Do diacritics play a role in the access to lexico-semantic information? Evidence from Spanish and German

Recent research with masked priming lexical decision experiments has shown that the omission of diacritics in words does not affect the very

early moments of word processing. For instance, the target word FÁCIL is processed equally fast when preceded by the prime fácil or the prime facil (Perea et al., 2020). Importantly, this pattern does not only occur in a language where the diacritics reflect lexical stress (i.e., Spanish), but also occurs in masked priming in a language in which the diacritics reflect vowel quality, but not lexical stress (i.e., Finnish; pöytä-PÖYTÄ vs. poytä-PÖYTÄ Perea et al., 2020). However, the above experiments do not speak as to whether diacritics play a role during the access to lexical-semantic information. In the present study, we directly examined whether the omission of diacritics slows down lexical access using a single-presentation semantic categorization task ("is the word an animal name?"). We did so in a language in which diacritics reflect lexical stress but not vowel quality (Spanish; Experiment 1) and in a language in which diacritics reflect vowel quality but not lexical stress (German; Experiment 2).

In Experiment 1 we compared word identification times to Spanish words that were presented with a diacritic (e.g., ratón [mouse]) or where the diacritical mark was omitted (raton). Experiment 2 used the same methodology with German words (e.g., Kröte vs. Krote). The latency and accuracy data were analyzed with Bayesian linear mixed-effects models.

In Spanish, word response times were remarkably for words with diacritics that were either present or omitted (e.g., ratón = raton). In contrast, German words were responded more slowly (around 30.5 ms) when the words' diacritics were omitted than when the diacritics were present (e.g., Krote > Kröte).

The function of diacritics in each language determines how words with diacritics are represented in the mental lexicon. While a and á can be treated as variants of the same letter in Spanish, a and ä should be considered separate letter units in German. These findings offer cues on how to model the letter level in computational models of visual word recognition and reading.

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A story of a paradox and an eggbeater: A deep learning approach to classify concrete and abstract words based on event-related potentials

Our brain can deal with words as different as paradox and eggbeater but the neural mechanisms involved in processing abstract and concrete words are not fully understood. Data-driven deep learning (DL) emerged as a useful tool to decode neural signals exploiting the richness of neuroscientific data. Here, we applied DL architectures to re-analyze ERP data (Bechtold et al., 2018) aiming to find out whether they can learn to decode relevant electrophysiological features to successfully classify abstract vs. concrete words.

We measured ERPs in 21 healthy young adults during explicit concreteness judgments on 30 abstract and 30 concrete, visually presented words. We trained DL models on 80% of the single-trial ERP data from different preprocessing stages (raw, filtered, and fully preprocessed), time bins (between 0-1200 ms) and regions of interest ([ROI]; anterior-left, anterior-right, posterior-left, posterior-right) and then tested the abstract vs. concrete classification performance on 20% of data. We report F1-scores, sensitive to accuracy as well as miss-classifications (.50 = chance-level performance).

Generally, neural network models trained on the full time range performed best. The best model trained on the fully preprocessed data reached an F1-score of .70 and outperformed the models trained on raw data (.68) and just filtered data (.69). This model scored higher when trained on the right anterior (.69) than on the left anterior ROI (.66) and comparably for bilateral posterior ROIs (both .68).

Reducing noise in the input data led to a slightly better classification performance. Further, including all electrodes outperformed the models trained on just one ROI, which suggests that each ROI contributes specific

[*] Both Laura Bechtold and Abhijeet Gupta made equal contribution to this research.

relevant features. The results suggest that the right anterior ROI contributes more relevant information than left and posterior ROIs. More sophisticated DL architectures (like, sequence learning BiLSTMs) might further improve classification. The robust above chance-level performance validates DL as tool to decode relevant electrophysiological features from ERP data with interesting applications for neuroscience and psycholinguistics.

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The facilitating effect of narrator variability in incidental word learning: Where did I hear it?

Recent studies have revealed that presenting novel words across various contexts while controlling for frequency help to consolidate the meaning of these words both in adults and children (i.e., contextual diversity effect; Johns et al., 2012, 2016; Rosa et al., 2017; Pagán, Nation, 2019). This effect has been typically explained in semantic terms (e.g., Semantic Distinctiveness model, Jones et al., 2012). However, the potential influence of other, non-semantic elements of the context is still unclear.

In this study, we examined the nature of the contextual diversity effect during incidental word acquisition by manipulating a purely perceptual element (i.e., pitch). Grade 3 children listened to three short fables, each containing four novel words. In the low diversity condition, the fables were read by the same narrator. In the high diversity condition, each fable was read by a different narrator. The number of times the children listened to each word was kept constant across conditions. The experiment consisted of three training days (three fables per day) and a final assessment using two orthographic-semantic integration tasks (multiple-choice and picture-word matching).

Generalized linear mixed-effects models showed that, for the picture-word matching task, accuracy rates were higher for the novel words uttered

by various narrators than when uttered by the same narrator, b = -.502, SE = .173, z = -2.912, p = .004. The multiple-choice task also showed higher accuracy for novel words when uttered by various narrators than when uttered by only one narrator, b = -.417, SE = .217, z = -1.92, p = .05.

Our results extend the benefits of contextual diversity to a scenario with purely perceptual, non-semantic differences among contexts. At a theoretical level, these findings strongly suggest that the Semantic Distinctiveness model (Jones et al., 2012) should consider non-semantic cues in addition to semantic cues. At an applied level, teachers may want to consider varying the perceptual contexts to enhance incidental vocabulary acquisition in the classroom.

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Visual recognition of English iconic words by native speakers

Iconicity is a systematic association between linguistic form and meaning of a word. Previously we studied visual recognition of English iconic words by Russian speakers (Tkacheva et al. 2021). We found that speed and accuracy of iconic words recognition are strongly connected to the stage of de-iconization (SD): most iconic words are recognized the slowest and less accurately. We decided to replicate the study with English native speakers for validation of the obtained results.

The same verbal stimuli were used, preliminary grouped into four categories (Flaksman, 2017) where SD-1 words are the most vivid imitative words, and SD-4 words are the words with the least iconicity. In total 128 stimuli were used, among them four groups of imitative words (8 words per group), 32 non-imitative words and 64 non-words. The Lexical decision task was used to examine the visual recognition of those stimuli by native speakers of English (N = 50).

The time of stimuli recognition significantly depends on the stimulus type. The effect is noticeable: partial Eta Square = .202, explaining 20.2% of the reaction time variance ($F(4; 46) = 10.401$; $p = .032$). However, only words from SD-2 group are identified slowly than non-imitative words ($p = .002$). The difference in response accuracy between iconic and non-iconic words is found only for SD-2 group (Chi-Square = 33.587; $df = 2$; $p < .001$) the effect is significant: SD-2 words are recognized with less accuracy than non-imitative words.

Apparently the delay and low accuracy in the recognition of SD-2 words are due to the combination of several factors: lower word frequency of SD-2 group (.075), its comparatively low neighborhood density (2.1) and the potential ambiguity of SD-2 words - some of them can be both an adjective, a noun, and a verb, as well as some of those words are used in modern slang. Degrees of de-iconization do not play a significant role in the accuracy and speed of English imitative words visual recognition performed by native speakers, while they are distinguished in Russian participants' results. Thus, iconic and non-iconic English words are recognized differently by Russian and English native speakers which may be explained by the difference between the languages themselves. The next stage of the study is identification of systematic brain activity in the process of iconic words recognition with EEG.

The research was supported by RFBR grant 20-013-00575.

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Different types of text presentation: Which is the best one?

In the study, we examined what format of text presentation contributes to more successful information processing. Mayer's (2009) Cognitive Theory of Multimedia Learning suggests that effective engagement with the material presented in the form of polymodal text occurs due to the need to switch attention between text and image, oral signal and text, and establish the connection between these elements. Our study investigates how people

process the information when reading and listening texts in four different formats: infographics, audiotext, infographics combined with audiotext, plain written format.

Four infographics containing interesting facts from the biographies of four Russian writers were used as the material. Infographics were extracted from Russian newspapers and then converted into regular text format. All the texts and infographics were of the same length and the same level of readability. The infographics contained the same proportion of verbal and non-verbal elements. Texts were read by the same dictor and audio-recorded. Thus, we got the stimuli to check how participants process and comprehend the same text in different formats. We hypothesized that multimodal text would be the best one for processing. In a four-group experimental design, 32 students learning Russian as a foreign language (B1-B2 level of Russian) and 32 native speakers of Russian examined four different texts in four different formats. Afterwards, they answered the factual and analytical after the text questions, identified the keywords and estimated the subjective difficulty of each text using five scales (from –2 to +2). Mann-Whitney U test was used to compare the results we obtained.

We revealed that audio text is the most challenging text format for both groups of participants. No significant differences were found in processing the text presented in infographics, written form and combined (audio + written) modalities in a group of Russian native speakers (all ps > .05). Written text is the easiest and better-perceived format for foreign students. The overall results made it possible to build a hierarchy of best-perceived formats for the foreigners: written text — infographics — ultimodal text (infographics + audiotext) — audiotext.

Presumably, these results are due to the difficulties in parallel cognitive processing of graphic and verbal elements (Blinova, Shcherbakova, 2019). Information perceived through different channels, including verbal and iconic, is integrated and processed by a person in a single universal subjective code of thinking (Zhinkin, 1982; Paivio, 2006; Fernández-Fontecha et al., 2018). Our results show that the so-called multimedia effect helps to integrate the new information in the cognitive system and to remember, though it is difficult and resource-intensive process, especially for non-native speakers.

The study was supported by the research grant no. 21-18-00429 from RSF.

FLASH TALKS SESSION 1

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Does grammar affect the psycholinguistic assessments of Russian words? The ratio of emotionality and size and location in space

The study researches if the grammatical characteristics influence the correlation between different psycholinguistic parameters. The purpose of the research is to analyze if there is a correlation of psycholinguistic parameters in randomly selected Russian words and if it depends on grammatical classes. Nouns, verbs, and adjectives were the focus of the research, as well as their grammatical classes: abstract vs concrete, transitive vs intransitive, qualitative vs relative. The main concentration of this analysis was on the assessments of emotionality, position in space, and size.

The study is based on the material of two databases, the RuWordPerception database (words' evaluation by Russian and Turkic-Russian participants within 5 perceptual modalities) and RuTurcPsychLing database (words'

evaluation by Russian participants within the psycholinguistic parameters of size, emotionality, location in space, manipulability, knowing and temperature), which include 200 verbs, 195 nouns, 194 adjectives. The databases were created at the Laboratory of Linguistic Anthropology TSU. Authors based on the theoretical foundations and methods of well-known psycholinguistic databases (Balota, 2002; Alexeeva et al., 2016; Miklashevsky, 2018).

We collected 133626 assessments. For all word classes, the significant correlations were found between emotionality and size (0.22 the more emotional the more size related word is (general) and 0.15 the more positive the bigger word is(particular)), emotionality and location in space (0.45 for the general and 0.38 for the particular). Among adjectives, words show the strongest correlations (between emotionality and location in space 0.6 for general and 0.53 for particular). We inspected how grammatical classes influence emotionality in words. Abstract nouns are better connected with emotionality than concrete ones ($p = .001$). Qualitative adjectives are better connected with emotionality than relative ones ($p = .00$). Intransitive verbs are better connected with emotionality than transitive ones ($p = .001$).

The results of the study show that there is a correlation between emotionality, size, and position in space as well as there is a dependency on grammatical classes. The mutual influence of linguistic formalization and psycholinguistic assessments correlate with the hypothesis of linguistic relativity and the theory of embodied cognition.

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The influence of differences in grammatical categorization on the conceptualization of objects: Russian-French language interaction

Categorization of the grammatical gender is associated with biological sex and is stated to be language-specific (Segel, Boroditsky, 2011; Vitevitch et al., 2013; Rezanova, Ershova, 2017; Maciuszek et al., 2019). Speakers of a

language with a category of gender endow feminine objects with "feminine" characteristics, and masculine objects with "masculine" characteristics. Previous studies in bilinguals demonstrated that the abstract grammatical properties of the native language affect the ability of gender attribution in the target language (Herschensohn, 2007).

The interaction between the three-gender system of the Russian language and the two-gender system of French is an insufficiently studied issue in the topic of the conceptualisation of objects. The aim of this study is to examine the influence of differences in the grammatical categorization of nouns on object perception of Russian-French bilinguals when assessing the similarity of images.

The experiment involved 11 Russian-French bilinguals (M = 22.45; SD = 1.21). All participants estimated their French proficiency level to be not less than B1 (intermediate). The linguistic base of the experiment consisted of preselected nouns, the gender of which either coincided or did not coincide in the studied languages. The participants' task was to assess the similarity of two images presented on the screen on a scale from 1 to 7. Counterbalanced stimulus pairs were formed using an image of either a man or a woman, and an illustration of an object from the linguistic base.

For stimuli with the same gender in Russian and French languages, the coincidence of the gender of the object and the sex of the person in the image led to the significantly highest average estimates of the similarity of images ($p < .001$). At the same time, depending on the case of the coincidence of the gender of a noun in two languages and the coincidence of the word gender and a person's sex, the average estimates of the similarity differed significantly ($p < .001$).

Thus, we observed that the grammatical category of gender, which differs in Russian and French, influences the perception of objects by bilinguals. The present preliminary data have proven the influence of grammatical gender on the conceptualization of objects. For our upcoming developments, we plan to add a control group of French native speakers to provide better control of the interaction of the analyzed influence with the factor of bilingualism.

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The bilingualism influence on the perception of emotional words (Khakass-Russian bilingualism)

To date, there are many studies on the problem of the emotional words perception by native speakers and bilinguals. In particular, a number of studies have argued that the first language (L1) is considered to be more emotional than the second (L2) or subsequent languages (Dewaele, 2004; Altarriba, 2008), but it has been proven that it`s necessary to take into account the bilingualism type and L2 age of acquisition (AoA) (Dewaele, 2006, 2008).

Also, emotionality is often analyzed in relation to such categories as valence, arousal, frequency and AoA, since they can influence the emotional words perception (Zevin et al., 2002; Mendez-Bertolo et al., 2011; Kuperman et al., 2014).

In our study we deal with the specific type of bilingualism — Khakass-Russian and with the special group of emotional vocabulary — diminutives. This stage was a continuation of our research aimed at solving the problem of Russian emotional words perception by bilinguals (Vasilyeva, 2020). We applied the developed methodology to the new language material to identify differences in the perception of Russian words associated with the influence of bilinguals mother languages.

The stimuli for the experiment were 290 Khakass words which were included into a questionnaire consisting from the 5 parameters: evaluation, emotionality, contextual implementation, frequency, AoA. The participants (21 people, average age — 47, 2) were asked to rate words on a scale from 1 to 7.

Samples with average word values for each parameter were introduced into the correlation analysis which showed the following statistically significant correlations: AoA/contextual implementation (r = .312); contextual implementation/evaluation (r = .305); AoA/evaluation (r = .149); AoA/frequency (r = -.275); emotionality/frequency (r = -.187).

Comparing obtained results with the data identified on the Russian material we revealed that the correlations and their rates are smaller.

Intergroup analysis showed that bilinguals estimate Khakass diminutives as more emotional than the L2 words (Russian).

The obtained conclusions correlate with the data available in the literature. However, the numerical indicators differ to an insignificant extent that can be also explained by the studied bilingualism type — unbalanced with L2 dominance. This is also evidenced by the similarities in other parameters and the revealed correlations.

The study was supported by the Ministry of Education and Science of the Russian Federation (the RF Government Grant №14.Y26.31.0014).

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The relationship of reading disorders with the asymmetry of optokinetic nystagmus in children

Optokinetic nystagmus (OKN) is a complex oculomotor act that includes reflex arcs involved in the performance of smooth tracking eye movements (slow phase of nystagmus) and saccadic eye movements (fast phase of nystagmus). The aim of the study was to assess OKN in children with reading disorders.

The study involved 100 schoolchildren aged 7-16 years. Group 1 (G1) — without reading disorder (n = 25), Group 2 (G2) — reading disorder (n = 29). The children were observed with both eyes with a fixed head alternating black and white stripes on the monitor: in the horizontal direction to the right, then to the left, and in the vertical direction up, then down for 20 seconds with a rest of 5 seconds between each direction (black screen). The gaze trajectory was recorded using an infrared camera in monocular mode (right eye) with a sampling frequency of Fd = 60 Hz on the Eyegaze Analysis System developed by LC Technologies, Inc. (USA), equipped with the NYAN 2.0 XT software of Interactive Minds.

Along with the physiological asymmetry caused by the predominance of activity of the left hemisphere (left vestibular formations), which was manifested by a higher frequency of OKN when the stimulus moved to

the left in about 2/3 of all examined patients, a pronounced predominance of the frequency of OKN when the stimulus moved up compared to the downward direction was revealed. The asymmetry was estimated by the formula: |(v1 — v2) |•100%/(v1+v2)), where v1 is the frequency of nystagmus in one direction, v2 is the frequency in the opposite direction. 45% (13 people) from G2 had an asymmetry of only the vertical window above the threshold set by us in 19%, while in G1 there were no such children. The pronounced asymmetry of the frequency of only horizontal nystagmus in the groups was as follows: 12% in G1, 28% in G2. The pronounced frequency asymmetry of both horizontal and vertical windows registered simultaneously in G1 was 20%, in G2 — 10%.

The revealed predominance of pronounced asymmetry of the frequency of nystagmus in G2 (83% (24 people) in general versus 32% (8 people) in G1) suggests the involvement of vestibular formations in the mechanism of dyslexia development, among others. Vestibular system is one of the first to be formed in ontogenesis. One of the functions of the vestibular system is the vestibulocular, which provides automatic control of eye movements, including during reading. In case of violations of the OKN, the child may have the illusion of text movement when reading, since the printed text is an alternation of white and black stripes. In this case, the child feels discomfort looking at the page. As a result of an intersensory conflict, he has to suppress reflexively arising saccades. Such children need training of the vestibular system.

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The role of emotions in cross-modal correspondence effect

An automatic mechanism for evaluating the emotionality of a stimulus in different cognitive tasks has previously been suggested (Yiend, 2010). It has

been shown that emotions could mediate differences in cognitive processing for both basic perceptual and more complex stimuli, and can therefore significantly influence the manifestation of the so-called cross-modal correspondence effect (response facilitation/inhabitation by stimulus features from a different modality) (Wang et al., 2016; Spence, 2020). In this study, the first attempt was made to induce the effect of cross-modal correspondence using semantic stimuli (words denoting positive or negative emotions) associated with spatial location. Furthermore, we also hypothesized that the cross-modal correspondence mechanism of basic perceptual processing also could be affected by individual's overall emotional state.

36 volunteers (26 females; aged 18 — 34) participated in our study. To induce an emotional state, videos of different emotional valences (positive, negative, and neutral) from a standardized database were presented. Then, participants were presented with a target sound of either 2000 Hz or 1000 Hz pitch, along with an instruction to press a button on the keyboard that corresponded to the sound property: high or low. The sounds were accompanied by the words displayed visually on the monitor screen for 100 ms. Each participant was shown 180 pairs of stimuli (15 words × 2 sounds × 6 repetitions) divided into three groups: 1) congruent (positive word / high pitch; negative word / low pitch); 2) non-congruent (positive word / low pitch; negative word / high pitch); 3) control (neutral word, high or low pitch). Reaction time (RT) was measured as a dependent variable.

Two-way mixed ANOVA revealed the expected effect of cross-modal correspondence: faster responses to congruent stimuli than to incongruent ones (within-group factor; $F = 6.65$; $p = .006$; $\eta^2_G = 0.008$). Also, a statistically significant main effect of the between-group factor — induced emotional state — was found ($F = 5.50$; $p = .013$; $\eta^2_G = 0.243$). The pairwise comparisons with Welch's t-test detected a noticeable reduction in RTs for both positive ($t = 1.92$; $p = .104$; $d = .785$) and negative ($t = 2.84$; $p = .03$; $d = 1.16$) videos compared to neutral ones. Thus, the results suggest that semantic stimuli used in the study induced the effect of cross-modal correspondence. Additionally, it was found that both negative and positive induced emotional states significantly affected the RTs, which may potentially be mediated by activation of cognitive control mechanisms.

Supported by the grant of the Government of the Russian Federation №14.W03.31.0010.

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Let's imagine: The abstractness of an iconic text and processing of semantic mismatch

There is some evidence that the role of pictures in comprehension of iconic texts may depend on the abstractness of the ideas described in a text. Although this process is mostly verbally-oriented (Hochpöchler et al., 2013), concrete and detailed pictures can distort reader's representation of a text's content (Schüler et al., 2019) due to their high imagery potential. In this study, we used semantic mismatch paradigm (by adding some mismatch between verbal and iconic parts of a text) to investigate the role of pictures in processing of iconic texts. We hypothesized that it may be influenced by the degree of text's abstractness.

During the experiment, participants (N = 26; 65% — females; aged 18 – 29, M = 21.1) read 2 texts that differed in (1) abstractness (concrete/ abstract) and (2) word-picture matching (with/ without semantic mismatch in the last slide out of 8 stimuli ones). Eye-movement data was collected with EyeLink 1000+ (500 Hz). Eye movements during reading the last slides of the texts were analyzed using Welch's t-test and ANOVA.

There were no differences in reading time (RT) for abstract text related to the semantic mismatch ($t = 1.982$, $df = 21.048$, $p = .060$), but RT for concrete text was significantly longer ($t = -2.348$, $df = 20.961$, $p = .029$) in case its verbal and iconic parts were mismatched ($M_m = 17.16$, $M_{mism} = 25.83$). Significant interaction was observed between two factors: text's abstractness and word-picture matching for the number of fixations on verbal parts of the texts ($F(1, 47) = 6.907$, $p = .012$). Participants made much more fixations on matched version of the abstract text ($M_m = 60.57$, $M_{mism} = 45.69$) and on mismatched version of the concrete one ($M_m = 53.42$, $M_{mism} = 71.36$). The same effect was found for the number of word-picture transitions ($F(1, 47) = 7.831$, $p = .007$). Participants switched more often between words and pictures when working with matched version of the abstract text ($M_m = 5.07$, $M_{mism} = 3.83$), but for the concrete text this pattern was reversed ($M_m = 4.25$, $M_{mism} = 7.29$).

Thus, we conclude that text-picture semantic mismatch is identified better in texts describing concrete ideas. It may be explained by specifics of mental imagery processes. Presumably, while working with concrete texts, participants rely on the in-text pictures, whereas their own mental representations are preferable in case of reading abstract texts.

Supported by the grant of the Government of the Russian Federation №14.W03.31.0010.

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Understanding of a text: Digital vs. printed format

Digital environment challenges a reader's cognitive patterns involved in information processing, and, particularly, imposes new requirements on the reading process. For instance, hyperlinked materials increase the cognitive 'cost' of reading in digital environment (Kerr et al., 2006), and the lack of familiar physical (paper) environment makes it difficult to build up a cognitive map of the text (Shi et al., 2020). We hypothesized that the level of understanding of a text presented in digital environment may differ from that of a text presented in traditional printed environment. In particular, we expected lower levels of understanding of a digital text as compared to its printed analogue.

60 volunteers (native Russian speakers, 39 females, mean age 20±0.6) participated in the study. They were randomly assigned into one of three groups, which were presented with stimulus text (short popular article) in either (1) digital, (2) hybrid (e-document with no hyperlinks), or (3) printed format.

The task was to read the text and then answer questions of a written test aimed at assessing the level of text's understanding. Following that, we conducted a semi-structured interview to assess the amount of cognitive efforts invested by each participant into understanding of the text's meaning. Additionally, we used Raven's Standard Progressive Matrices

(SPM) to control for general cognitive ability. All participants were tested individually.

No difference was found between the test scores and the levels of understanding of texts presented in different formats ($x^2 = 14.7$; $p = .144$). Also, there were no differences between the groups in the quality of retelling the texts ($x^2 = 3.112$; $p = .795$) and understanding their meanings ($x^2 = 1.448$; $p = .836$). In sum, the levels of text understanding did not differ significantly between digital, printed or hybrid formats of presentation.

These results do not provide any support for the original hypothesis and differ from the results obtained in previous studies (Mangen, 2008; Singer et al., 2019). However, the results may be indicative of a more global problem: most volunteers showed low levels of text understanding regardless of the text format. This finding is consistent with similar studies on understanding of texts with figurative meanings (Andriushchenko et al., 2021) and requires further research.

Supported by the grant of the Government of the Russian Federation №14.W03.31.0010.

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Writing in tongues: Naïve viewers with mild intellectual disability interpret pictorial sentences

Pictorial systems of augmentative and alternative communication (AAC) may be employed for education purposes by people with learning difficulties, in particular conditions preventing those suffering from effective reading and writing. Over 30 years ago a number of dimensions to be considered when assessing a symbol's functional characteristics were covered, incl. iconicity and transparency (Vanderheiden, Lloyd, 1986). The following study was conducted to assess which characteristics of pictorial AAC systems make them approachable to individuals with intellectual disability, specifically pupils required to perform multiple mandatory tasks

on reading and writing at school. Symbols from the three AAC systems were used for stimuli: Blyssimbolics; LoCoS ©; Pictogram by National Agency for Special Needs Education and Schools. These systems are communicated with by Internet communities, showing their availability both in a materialistic and mental way.

60 adolescents aged 14 — 16 years with mild intellectual disability (MID; ICD-10 Code F70; f = 18) participated in the study. The control group consisted of 60 intellectually intact pupils matched in age (f = 31). As stimuli, 3 SVO sentences were coded for each of the 3 AAC systems and then were presented together with three possible translations (one correct and two violating either transparent meanings of selected symbols or the SVO word order) on a monitor.

In accordance with expectations, the experimental group showed higher error rate (3.58 ± 1.544 vs 4.85 ± 1.645 out of 9; $p < .001$), yet there was no group difference for Bliss sentences via Student's t-test (MID: 1.20 ± .777, Controls: 1.38 ± .940 out of 3; $p = .247$). The most transparent system of the three proved to be LoCoS. Counterintuitively, Pictogram sentences were identified correctly only in 28% of cases, while LoCoS and Bliss in 50% and 40%, respectively.

Blissymbolics, a system used in many like studies, turned out to be equally confusing for both groups of students — intellectually intact and those with MID. Yet for reasons to be found it was x1.6 easier to grasp than Pictogram. The experiment run was also the second to show LoCoS' advantage (x2.5) over the other two pictorial systems. However, the fact that logistic regression with AAC systems as the input variable explained only 44% of the answers' variance and LoCoS sentences were solved correctly only at the chance rate must be considered when applying the results to classrooms.

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Talking of the mundane. What is different about pictorial public spaces' signs?

Public spaces' signs are either singular pictograms or simplistic imperative phrases, e.g. "slow children at play", "no parking violators will be towed". While the imagery on the signs passes Alan Cruse's test for "wordiness", i.e. singular pictograms are (i) the smallest elements that have positional mobility and at the same time (ii) largest units resisting insertion between constituent parts (Cruse, 1986), the phrases often serve as a fine example of syntactic ambiguity as seen in the examples above. In an eye-tracking study, it was shown that proficient drivers react poorly (with longer gazing duration and overall fixation times) on unfamiliar signs as well as on signs loaded with more information (Babić et al., 2020). Given that comprehensiveness of the signs is in inverse relation to a potential traffic hazard, it is important to know if and how public spaces' signs are understood by various groups of users.

60 participants from special needs schools, ICD-10 code F70, for the experimental group (EG; mean age = 15y3m) and 60 participants from public schools for the control group (CG; mean age = 15y) were presented with a choice-task on a monitor to name the correct meaning of a public sign out of three options.

The initial analysis of the Student's t-test resulted in a significant difference between the groups' overall number of correct answers (8.12±1.245 vs 8.9±1.757, $p = .006$). However, the following analysis of the Pearson's $\chi 2$ for each of the 11 pictograms revealed that students from the referent group performed significantly better only in two cases: WC and No Exit signs ($p = .027$ and $p = .003$, respectively). Another finding was that the signs SOS and Attention, Cyclists were identified correctly at the chance rate or below by both groups (67 out of 120, and 33 out of 120, respectively).

A posteriori it was found that the students' comprehension of the public signs was affected by the exposure to learning said signs as part of the school curriculum. The results, hence, might be interpreted as an example of a successful program appealing to the compensation abilities of

the students with special needs. On the other hand, when answering about SOS and Attention, Cyclists signs the students from both groups might have been confused by vague distractor options, which does not mean that in ecological situations they would misunderstand the meaning of the signs.

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Local and global mechanisms of perception in children with reading disorders

Every detail of the human perceived world that provides local information can be integrated into a more global structure. Thus, we can say that the visual scene has different hierarchical levels, from the most local elements to the highest global level of organization. Global Perceptual Mechanism is the process of processing visual stimuli in a holistic manner. The global perception mechanism correlates with a holistic (global) information processing strategy, while a better definition of local features indicates the predominance of an analytical (local) strategy. In typically developing children, the transition from a local to a global perception strategy occurs at the age of six and is finally consolidated at the age of nine (Poirel et al., 2012).

To study the global and local mechanisms of perceptual processing of complex hierarchical structures, "Navon figure" in geometric and letter modification was used (Navon, 1977). Two types of stimuli are used: congruent (the shapes of the global and local figures are the same) and incongruent (the shapes of the global and local figures do not match). The stimulus material for this technique is represented by large geometric shapes and letters, each of which consists of 12 small figures. The stimulus presentation time is not limited. The transition to the next stimulus was carried out after the subject's response. During the execution of the task, the accuracy (correct/incorrect) and the time (in ms) of the answer are automatically recorded. Each series contained 10 stimuli, the ratio of congruent and incongruent stimuli was 1:1, stimuli within the series were

presented in a random order. There were 20 episodes in total, 10 with the task of local perception and 10 with the task of global perception, the tasks alternated.

The sample included 20 second-graders without reading disabilities and 20 second-graders with reading disabilities (according to the defectologist's conclusion).

Analysis of the time and accuracy of the answer allowed us to reveal the prevalence of global perception mechanisms in typically developing second-graders, which corresponds to the age norm. They statistically significantly faster and more accurately recognize global incongruent stimuli (response time 1411.64 ± 461.78 ms and 1172.91 ± 497.71 ms, accuracy .74 ± .21 and .91 ± .14 for geometric and letter tasks, respectively) than local incongruent stimuli (response times 1714.73 ± 672.49 ms and 1572.14 ± 572.34 ms, accuracy .68 ± .19 and .61 ± .24 for geometric and letter tasks, respectively).

On the contrary, in children with developmental disorders of reading skills, local mechanisms prevail. When perceiving a global incongruent stimulus, the response time is 3258.56 ± 232.47 ms and 3810.57 ± 398.35 ms, the accuracy is .21 ± .08 and .13 ± .04 for geometric and letter tasks, respectively; when perceiving a local incongruent stimulus, the response time was 2934.34 ± 417.58 ms and 3671.61 ± 471.14 ms, the accuracy was .23 ± .16 and .17 ± .08 for geometric and letter tasks, respectively).

We can assume that children with reading disabilities have a strong local preference for individual letters in the surrounding context, which can negatively affect the development of synthetic reading techniques (Lachmann, van Leeuwen, 2008).

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Neurophysiological features of visual-verbal information processing in the form of a single word and a combination of words

The purpose of this study was to compare the brain stages of visual-verbal information processing during the semantic categorization of the word combinations and the simple reading. Another goal was to compare the obtained data with the results of our previous model (Nuzhina et al., 2020). In that model, the categorization of one of the two words was carried out, and differences at all stages of visual-verbal information processing were found.

Twenty-five students aged from 19 to 25 years were enrolled in the study. The combinations of an adjective and a noun were presented as a stimulus. In the first series, participants were asked to silently read each word combination, and categorize the following picture. In the second series, participants were asked to categorize each word combination by the presence or absence of meaning. The method of EEG registration was used in both series to identify the brain activity in response to the stimuli.

The amplitude of the negative wave in the parietal leads with a latency of 300-400 ms (N400) was increased during the categorization of nouns in comparison with the simple reading ($p<0.0342$ for P4; $p<0.004$ for Pz). The amplitude of the late negative wave in the parietal leads (800 ms post-stimulus) was increased during the categorization of nouns in comparison with the simple reading ($p<0.0318$ for P3; $p<0.0216$ for P4; $p<0.0108$ for Pz). The changes in the early positive components of event-related potentials (ERPs) in the parietal region were observed for the adjectives ($p<0.0198$ for H4; $p<0.0148$ for Pz).

In contrast to the differences between the single word categorization and the simple reading, in the present model, we observed more localized changes of the late ERPs' components and no changes in the early components for the nouns. In the present study, we observed changes in the early ERPs' components for the adjectives. These changes did not occur during the single-word categorization. Thus, during the categorization of the

whole word combinations, we observed changes in the early components of ERPs for the first word (the adjective) and changes in the late components for the second word (the noun). One of the two words categorization demonstrated similar changes for the categorized second word only at all stages of the information processing. This confirms the idea that the word combination is functionally similar to a single word and represents a unified, albeit structurally divided, meaning (Vinogradov, 1975).

Thus, ERPs in response to the presentation of nouns were sensitive to target and non-target conditions, both in the early and the late stages of word processing. The presentation of adjectives did not show high sensitivity to changes in these conditions.

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Eye movements during hybrid visual search for verbal information in various conditions

In hybrid visual search, subjects search in visual space for one or more targets in memory (Schneider, Shiffrin, 1977; Madrid, Hout, 2019). According to the three-stage model, in hybrid visual search, stimulus elements are selected, identified and categorized, and then compared with a pattern in working memory until the element is unambiguously identified as a target object or, on the contrary, a distractor (Wolfe et al., 2015).

In this study, subjects were presented with stimuli containing 225 words each. The aim of the study was to analyze the process of hybrid visual search under various conditions, namely: load on working memory (search for several different target words), search saturation (search for a target word repeated on a stimulus several times); frustration (the target word is absent on the stimulus), "noisy" conditions (the stimulus contains, in addition to words in Russian, words in English, pseudowords in Russian and English, as well as numerical combinations). The standard conditions were to search for one word that did not contain repetitions on the stimulus.

The sample consisted of 30 people from 21 to 52 years old. Registration of eye movements was carried out using the Neurobureau software and hardware complex.

Under standard conditions of visual search, the average duration of fixations was 215 ms, and the average saccade velocity was 181.27 angular degrees per second. These conditions were accepted by us as control ones.

When searching with a load on the working memory, the average velocity of saccades doubled - up to 360.79 °/s.

When searching for a word that is repeated several times on a stimulus (the number of repetitions is unknown), both the average duration of fixations (1.3 times, up to 274 ms) and the average velocity of saccades (2.8 times, up to 504.99 °/s). It was also noted that the subjects stopped searching on average after finding half of the words.

The frustration conditions forced the subjects to increase both the average duration of fixations (by 1.3 times, to 279 ms) and the average velocity of saccades (by 1.6 times, to 282.52 °/s).

The "noisy" search conditions led not only to a decrease in the search efficiency, but also to an increase in the average saccade velocity by 1.5 times (up to 267.87 °/s).

All found differences are at a statistically significant level.

An increase in the average duration of fixations and the velocity of saccades makes it possible to judge the increase in cognitive load during visual search in non-standard conditions, which indicates the complexity of such a process (Di Stasi et al., 2011). Repetition of the target word in the text several times leads to a decrease in search efficiency, this phenomenon is called "satisfaction of search" (Tuddenham, 1962) or "subsequent search misses" (Adamo et al., 2013). The data obtained in the course of this study on textual stimuli do not contradict the results of other researchers obtained when using images or symbols as objects for visual search.

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Predictive processing in children with developmental language disorder

Developmental language disorder (DLD) defined as an atypical language functioning without sensorimotor/cognitive disorders (Bishop et al., 2016). According to modern concepts, predictive processing (the ability to predict upcoming stimuli) can become an important factor in understanding the etiology of DLD (Jones, Westermann, 2021). Since the mechanisms of predictive processing are finally formed in older childhood, it is necessary to further investigate their possibility of using DLD differentiation in early childhood (Hahne et al., 2004). We also wanted to find out whether social factors affect the DLD differentiation.

Our study included children (7-12 y. o.) living in an isolated rural settlement (RS), and their peers living near a large city (LC). DLD was determined by using the cutoff criterion of a Z score at or below −1.25 on at least two scales of language test ORRIA (Kornilov et al., 2012).

Participants were drawn from four groups: 1) 11 children from RS without DLD: 8 male, M(SD) = 10.77(2.06); 2) 4 children from RS with DLD: 2 male, M(SD) = 9.67(1.6); 3) 15 children from LC without DLD: 8 male, M(SD) = 9.97(1.73); 4) 3 children from LC with DLD: 2 male, M(SD) = 9.52(1).

Participants were asked to perform a task on accessed sentences with syntactic errors during an EEG experiment. It was expected to receive the ELAN component, occurring from 100-300 ms from the beginning of the keyword with an error (Friederici, 2006).

The ANOVA analysis of peaks and latency of ELAN did not show significant differences between stimuli with and without errors. ANOVA demonstrated significant differences in latency for persons with and without DLD in the L-A (Left-Anterior) cluster: $F(1) = 5.47$, $p < .05$; DLD: M = 212.85 ms, TD: M = 171.52 ms, and differences at the trend level in the M-F (Medial-Frontal) cluster: $F(1) = 3.72$, $p < .1$; DLD: M = 196.571 ms, TD: M = 159.44 ms.

The absence of significant differences in ELAN between correct and incorrect sentences may indicate the lack of predictive processing in persons under 13 y. o. during recognizing difficult sentences. However, the data obtained confirm the delay in processing auditory information in persons with DLD with different quality of life. In a further study, we analyzed the results of participants of preschool and high school age and studied the potentials of P600 and N400 in this sample.

This research was supported by the RFBR (grant № 19-013-00912; PI: Irina Golovanova).

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Behavioral maladaptiveness as a predictor of language dysfunctions in Russian-speaking teenagers

Many studies have explored the social consequences of language dysfunction unexplained by neurological and/or intellectual problems in English-speaking children (Brownlie et al., 2016; Forrest et al., 2021). However, the question of behavioral maladaptiveness remains open in Russian-speaking children, mainly due to the lack of according research and diagnosis. In this study, we aimed to find what maladaptive behavior traits can predict degrees of such language dysfunctions.

Two groups of teenagers (aged 11-14: N = 27, M = 12.85, SD = 1.03, 10 females; aged 15-18: N = 29, M = 16, SD = .96, 15 females) completed the Achenbach Youth Self-Report (YSR, Achenbach, Edelbrock, 1991) questionnaire to measure a set of behavioral traits and the narrative task to collect their language samples. The samples were then analysed to yield three core parameters for detecting speech dysfunction: mean length of utterances (MLU), the proportion of maze words and subordinate index (SI) - a composite score that measures the complexity of sentences.

Teenagers aged 11-14. Multiple linear regression using backward data entry showed that somatic complaints, social problems, withdrawn and

rule-breaking behaviors parameters significantly predict MLU: R2 = .411, F(4,22) = 5.534, p = .003. Thought and attention problems, withdrawn, rule-breaking and aggressive behaviors predicted the proportion of maze words: R2 = .414, F(5,21) = 4.674, p = .005. Withdrawn behavior and social problems predicted SI Composite Score R2 = .296, F(2,24) = 6.473, p = .006.

Teenagers aged 15-18. MLU in words was best predicted by attention problems, aggressive and rule-breaking behaviors: R2 = .17, F(3,25) = 2.95, p = .052. Maze word proportion was predicted by thought problems: R2 = .13, F(1,27) = 5.217, p = .03. Thought and attention problems, aggressive and anxious behaviors predicted SI Composite Score: R2 = .219, F(4,24) = 2.958, p = .04.

The YSR factors can moderately predict several language parameters in teenagers aged 11-14. Same language parameters have a weak prediction capability by YSR in older teenagers aged 15-18. This suggests that behavioral problems underlying language dysfunction tend to accompany younger children more often, than the older ones.

The research was supported by RFBR grant No. 19-013-00912.

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Use of stress and statistical cues for speech segmentation by Russian infants and adults

Speech segmentation is a complicated task in which infants nevertheless succeed. They learn how to segment distinct elements from speech flow by the end of the first year of life. Previous studies for English have shown that infants can rely on prosodic cues (Jusczyk et al., 1999) and statistical cues (Aslin et al., 1998; Saffran et al., 1996) when detecting word boundaries. The reliance on each type of cues seems to depend on infants' age (Thiessen, Saffran, 2003) as well as native language. Our research aims to investigate which type of cues, prosodic or statistical, Russian infants will use for speech segmentation.

We have tested the control group of Russian adults (N = 31; 18-59 y.o.) and 6-to-7-month-old Russian-learning infants (N = 10; target sample is 24). Our experiment included a familiarization and a test phase. During familiarization, all participants learned an artificial language that consists of four CVCV nonsense words with iambic stress. In this string, prosodic and statistical cues conflict, because in most cases Russian has trochaic stress in CVCV words. During the test phase, all participants were tested with prosodic and statistical words that could be segmented from the string, or non-words that consisted of the same syllables but never appeared before. Stimuli and procedure were identical to those in (Marimon, 2019), but adapted to the Russian phonotactics. Infants were tested in the headturn preference paradigm, adults participated in an OpenSesame experiment with a recognition task (they answered whether each test word was present in the familiarization string).

The experiment with adults showed that they recognized prosodic words significantly more often than statistical and non-words ($p < .001$), thus they tended to rely on prosodic cues for segmentation and demonstrated the presence of trochaic bias. The tested group of infants showed no preference for one segmentation strategy over another (mean looking times for prosodic, statistical and non-words are 4560 ms, SD = 2953; 4159 ms, SD = 3035; 4145 ms, SD = 3240). Individual results show that five infants relied on prosodic cues and the other five — on statistical cues.

Our findings for adults are consistent with those for German speakers (Marimon, 2019), although the results for infants at this stage agree with neither English (Thiessen, Saffran, 2003), nor German (Marimon, 2019) data. Infants' preference probably would be prominent when we test our target sample.

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Typing skills depending on the executive functions in children with different levels of language development

Development Language Disorder, DLD is diagnosed as a language delay without neurological or intellectual disabilities (Bishop et al., 2016). Children with DLD have difficulties in executive functions, EF (Pauls, Archibald, 2016). EF is involved in typing as a complex hierarchical process based on executive control (Logan, Crump, 2011). We assume that the behavioral characteristics of typing coupled with the level of language development, LD can predict the EF.

Participants: 36 native Russian-speaking children (M(SD) = 14.94(1.17), male: 22) from an isolated population with a high risk of DLD and from a nearby settlement. Language samples were collected by the narrative task to assess the language's skills. Linguistic Indexes, LI indicated the LD were extracted from narratives (Weston et al., 1989). EF was measured through the BRIEF-2 questionnaire (Inhibit, Working Memory, Plan/Organize scales). Also, participants were asked to type 12 sentences based on picture prompts pictures.

We conducted a cluster analysis of the LI using the Ward method to divide participants into 5 significantly different groups by LD (Chi (4) > 13, $p < .01$ for all variables; index Rand = .74). Multiple linear regression using backward data entry showed that none of the models with behavioral typing indexes significantly explain the variance ($p > .05$, DW > 2). Linear models with a Gaussian distribution showed a significant LD effect on the Inhibition scale ($R2 = .26$, $F(4,31) = 2.79$, $p = .04$); on the Working Memory scale ($R2 = .31$, $F(4,31) = 3.57$, $p = .01$) and on the Plan/Organize scale ($R2 = .26$, $F(4,31) = 2.76$, $p = .01$). Follow-up tests indicated a positive correlation with the LD. LD1 showed significantly better results in comparison with others. LD2, LD3, and LD4 showed a pattern of lower EF. LD5 group demonstrates a high variance and a lack of significance.

Clustering results can be assumed possible determination of the DLD status: children from 2,3 and 4 clusters might have different

language difficulties. Since it could be predicted which BRIEF scales can be interrelated with EF in children with DLD. To confirm the hypotheses about DLD, it is necessary to conduct an additional analysis with an extra language method. The lack of significance for the typing behavior can be presumably associated with an insufficient amount of text for behavioral analysis.

Funding: Russian Science Foundation grant №18-18-00451 (PI: Grigorenko E.L.).

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How fast is fast mapping? Behavioural evidence from preschool children

A large body of studies indicate young children's unique capacity for ultra-rapid learning of new language elements, mediated by a neurocognitive mechanism called *fast mapping* (FM) that could be activated even after a single exposure to the novel item. In spite of many studies, the existing evidence remains controversial, with some studies failing to prove FM's efficiency or even questioning its existence. To address this debate, the current study aimed to assess immediate behavioural indices of a single-shot novel word learning.

Participants were 20 preschool children (5-7 y.o.). An FM procedure was implemented with a counterbalanced set of two familiar and two novel dissyllabic words (presented auditorily) in conjunction with familiar and

novel visual images. Child was asked to choose a new object defined by a novel word form, which could only be achieved by excluding other, familiar items. Only one trial was used to present each item. To evaluate learning outcomes at lexical and semantic levels, four behavioural tasks were used: free recall (FR), cued recognition (CR), semantic picture-word matching (SMT) and word definition (WD) tasks.

The analysis of task performance showed a number or results: (1) a very low number (.05 ± .*02*) of recalled novel words and higher ($p < .001$) recall rate for familiar than novel words (FR); (2) significantly lower error rate for all learned word forms than for control ones ($p = .049$) with no similar effect for control pseudowords (CR); (3) significantly longer response time to newly learnt items ($p = .003$) in comparison with familiar words (SMT); (4) only 25 % of the sample gave correct definition for both learned new items and 37.5 % - for one item (WD).

The results show generally poor acquisition of novel language elements across all tasks, which is in line with previous single-shot contextual learning studies that claimed slow learning on behavioural level. This is consistent with the idea that word learning as domain-general mechanism involves processes operating over distinct but interactive time scales. Initially, child infers a referent and produces a word-object pairing to support communication at the specific moment. Over a longer period, during repeated encounters with a word, a network of mappings between words and concepts is strengthened and refined. Further studies are needed to scrutinise the interplay between the "fast" and long-term stages of early word learning.

Supported by the grant of the Government of the Russian Federation №14.W03.31.0010.

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Learning through movement: Fast mapping and explicit encoding of novel vocabulary in VR and conventional environment

Embodiment and grounding theories propose a link between language and sensorimotor behaviour (Matheson, Barsalou, 2018). Previous research suggested that the acquisition of different types of novel word already at its earliest stages involves motor cortices in rapid encoding of motion/affordance-related aspects of word meaning (Taylor et al., 2017; Vukovic, Shtyrov, 2019). The present study aimed at investigating the effects of movement on learning novel vocabulary through the use of two different learning strategies: explicit encoding (EE), which is accomplished through direct instructions, and fast mapping (FM), which operates via context-based inference.

Preliminary data from a pilot experiment are reported. We used naturalistic audio-visual word-picture association learning design, which systematically manipulated hand-movement involvement (with/without) and learning strategies (FM/EE) in learning sessions provided in either a virtual reality (VR) or conventional visual-display unit (VDU) environment. Sixteen healthy right-handed adults (Russian speakers, 18–32 y.o.) acquired eight novel nouns in either VR or VDU environment. The nouns were repeated five times each in a sentential context in combination with pictures of novel objects in an FM or EE mode. The hand-movement trials required the subjects to manually point to the object in VR, or to touch the object's image on the screen in the conventional condition. Learning outcomes were assessed using a word recognition task administered immediately after the learning. Reaction times (RTs) were analysed using Wilcoxon test, and accuracies — using rmANOVA.

Participants correctly recognised on average 55% of the newly learned words after the VR task and 61% — after the VDU task ($p = .112$). Interaction

of learning environment, hand movement, and learning strategy was significant (p = .014): hand movements improved the recognition of the FM-learned words and made it more difficult to recognize EE-learned words in the conventional environment (p = .013), but not in VR (p = .289), where hand movements showed a tendency to negatively affect the recognition of FM-learned words. EE-learned words without movements were recognised faster after VR learning in comparison with the conventional learning environment.

To sum up, our data showed a different depth of embodied processing in FM and EE of novel vocabulary. Hand movements improved recognition of FM-learned words and made it more difficult to recognise EE-learned words in conventional VDU environment.

This work was supported by the RF Presidential Grant for Young Scientists No MK-2021.2021.2.

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The hearing thresholds of listeners and the recognition of speech features

The study was carried out within the framework of the problem of revealing the mechanisms of speech perception and factors affecting the recognition of information in voice and speech by human (Paulmann et al., 2008; Goy et al., 2016; Lausen, Schacht, 2018). The aim of the study was to determine the influence of the hearing thresholds of listeners on the recognition of verbal and non-verbal information when listening to different speech material.

The auditory perceptual experiment was used. In the perceptual study, we reviewed listeners' (Russian native speakers, adults) recognition of the function of mothers' speech directed to the children, mothers' state, lexical meaning of child speech, child's age, and gender.

6 test sequences including mother's speech (MS), the speech of typically developing (TD) children, and children with autism spectrum disorders

(ASD) were created. For 85 listeners (age 16-80 y), hearing thresholds were determined. All procedures were approved by the Health and Human Research Ethics Committee.

Results of the study showed that listeners' hearing thresholds (left ear) correlate $F(22,6) = 2.519$, $R^2 = .902$ with the definition in MS of the function of stimulation of ASD child to verbal answer ($\beta = -.864$, $p < .03$) and calm state of TD children's mothers ($\beta = 1.234$, $p < .01$). The hearing (right ear) correlates $F(22,6) = 5.108$, $R^2 = .943$, $p < .001$ with the determining the mother's state by the listeners: for mothers of TD children - angry ($\beta = -1.374$), for mothers of children with ASD - calm ($\beta = -.931$). The hearing of listeners (left ear) ($R^2 = .120$, $\beta = .324$) correlates with the correct determination of the meaning of TD children's words and words of ASD children $F(4,7) = 2.375$ $p < .150$ ($\beta = .732$, $R^2 = .576$). Recognition of the age of children correlates negatively with the age of listeners - pediatric students $F(3,13) = 4.326$, $R^2 = .499$ ($\beta = -.763$, $p < .009$) and with their hearing thresholds $F(2,14) = 5.28$, $R^2 = .429$ — right ear ($\beta = .459$, $p < .04$), left ear ($\beta = -.628$, $p < .01$). Spearman correlation ($p < .05$) shows a relationship between listeners' hearing thresholds (left ear) and gender recognition in 4-7 years old TD girls (.74).

The result shows the influence of listeners' hearing on the determination of information contained in voice and speech. These data should be taken into account when recruiting personnel to work with adults and children in different fields.

This study is financially supported by the RSF (18-18-00063).

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Corpus study of the early vocabulary acquisition by Russian children

The acquisition of children's vocabulary depends on several factors, i.e. volume of input (Hart, Risley, 1995); gender (Eliseeva, Vershinina, 2017); features of early vocabulary (Mani, Ackermann, 2018). In this corpus study,

we will test whether children acquire novel words from dense semantic categories faster than from sparse categories, which was previously shown in experiments (Borovsky et al., 2016). We will analyze the longitudinal corpus data of two Russian-speaking 1-to-3-year-old children and identify how the size of semantic categories change as children grow older. Additionally, we will analyze the parents' speech and compare the sizes of semantic categories in children's and child-directed speech. For the first time we will use semantic vector analysis of the corpus data to investigate the development of the early lexicon in children.

Child-parent everyday interactions were video-recorded and transcribed. The overall size of the boy's corpus is 37194 tokens and the size of the girl's corpus is 26648 tokens. We divided each corpus into two periods –10 (boy's corpus) and 12 (girl's corpus) months each — and separately analyzed children's and adults' speech. Russian Language model ruwikiruscorpora_upos_skipgram_300_2_2019 (Kutuzov, Kuzmenko, 2017) was used to build semantic vectors of words. This model contains vectors of all words from the Russian National Corpus and Wikipedia and it allowed us to extract the vectors of the words from our corpora to represent them in a vector space. Then we clustered semantically similar words using k-means with k equals 12 (boy's corpus) and 13 (girl's corpus) for the first period and 30 and 32 for the second.

For the first period, we found seven clusters (e.g. animals, people, motion verbs) in the boy's corpus and three clusters in the girl's corpus that increased by 20 and 16 clusters by the second period. Almost all clusters found in the first period increased by the second. We also found that almost all the clusters from the children's speech were also found in adults' speech. The size of clusters in children's speech gradually increases to the size of clusters in adults' speech by the second period.

Overall, we found that semantic categories which were already formed in the child's vocabulary "attracted" new words. However, contrary to our expectations and the findings from previous experiments (Borovsky et al., 2016; Mani, Ackermann, 2018), all clusters increased regardless of their initial size. The results of our corpus study should be tested in an experiment. It is also important to test how the sizes of semantic clusters in children's speech are related to the average sizes of different semantic clusters in adult language.

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Mechanism of metathesis: side vs site hypothesis

The phenomenon of phonetic metathesis (permutation of sounds) in adults is associated with damage to frontal lobes. In children's speech it is explained by the peculiarities of the localization language functions in the cortex with left-handedness and by the phenomenon of "reverse linguistic perspective", leading to a change in the order of sounds in a word (Tyurin, 2006; Dobrova, 2012). Lexical metathesis (permutation of words in an utterance) was explained by the peculiarities of interaction of semantic and syntactic levels of utterance generation (Akhutina, 2015).

Informants: 29 preschoolers, of which 16 children had phonetic and/or lexical metathesis in speech (M+ group) and 13 children had no metathesis (M- group). The t-test was used to compare the proportions of left-handed reactions in manual tests, and the proportion of failures caused by the dysfunction of the frontal and parietal cortex when repeating syllables in two groups.

There were no significant differences confirming the preference for left-handed responses in the M+ group: M+ mean = .33, sd = .053; M- mean = .329, sd = .052 ns. Failures in repeating syllables caused by the frontal cortex dysfunction (perseverations, phonetic assimilations, syllable omission) are much more frequent in the M+ group (mean = .086, sd = .004) than in the M- group (mean = .022, sd = .001, $p < .05$). In the M+ group the dysfunctions of the frontal cortex (mean = .086, sd = .004) prevail over the failures caused by dysfunction in parietal regions (replacement of sounds/syllables): mean = .022, sd = .003, $p < .1$.

Our data confirm the fact that metathesis is not associated with the features of interhemispheric asymmetry and is not a technical permutation of the order of elements in the utterance program. Difficulties in switching with dysfunction of frontal cortex in early childhood cause a tendency to label the meaning with one element instead of a multi-element sequence: one syllable instead of a polysyllabic word, one word instead of a multi-word utterance. Later, when programming an utterance, this element is stereotypically implemented first, and then the remaining syllables of a word

or words from an utterance are realized. As a result, the order of elements in an utterance is disrupted, leading to metathesis. A common mechanism of phonetic and lexical metathesis is associated with a stereotyped strategy of utterance generation, due to the primary dysfunction of the frontal cortex.

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Multichannel perception of irony in actors' speech

This study aims investigating auditory and visual perception of irony in Russian actors' speech. Although the separate perception of video and audio sources has been a topical issue (Krauss et al., 1991; Shi et al., 2017; Feyereisen, 2018), the analysis concerned the lexical meaning rather than phonetic features; irony has not been considered either. Therefore, in order to analyse perception of irony using acoustic and visual channels separately, two pilot perception experiments were conducted.

In the first experiment, we selected 20 ironic utterances from modern Russian films and series. Irony was considered as antiphrasis, when the direct lexical meaning is negated by linguistic or paralinguistic means. Then we extracted snippets without any lexical or semantic markers of irony in order to check the capacity of listeners to perceive irony expressed by actors relying on the phonetic features only. These snippets were mixed with non-ironic snippets and suggested to listeners in a randomized order. The task was to associate the snippet with one of the short texts (with ironic or non-ironic meaning). In the second experiment, we extracted the snippets from video corresponding to the excerpts from ironic or non-ironic utterances. The participants had to associate the viewed mute excerpt with one of the written contexts (with or without irony). The two experiments were carried out using the SoSci Survey platform (https://www.soscisurvey.de).

The recognition of irony in the auditory perception experiment was quite low. There was no ironic utterance recognized by more than 85% of

listeners. Only 48% of ironic statements were recognized satisfactorily (by more than 60% of listeners). In the visual perception experiment 35% of video snippets corresponding to ironic utterances were recognized by more than 85% of listeners. 75% of snippets with ironic meaning were recognized satisfactorily.

The results of the experiments showed that each of the channels (auditory or visual) is not absolutely sufficient for the perception of ironic meaning in actors' speech in films and series. The fact that visual cues occurred to be more reliable for the successful recognition of irony may be defined by the extensive use of gesture and mimics or other visual acting techniques in actor's performance.

The project "Acoustic correlates of irony with respect to basic types of pitch movement" was supported by the RFBR grant № 20-012-00552.

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Negative feedback coherence with narrator's expert position in case of poly-position comic stimuli

Expertise in humor is paradoxical. From the poly-narrative perspective to understand the poly-position joke means to construct the meta-position beyond two discourses actualized in the joke simultaneously. The expertise of humor thus demands the ability of experts to be flexible and easily shift I-positions (in terms of H. Hermans, 2006), including leaving the privileged ones. Expert's communicative position demand two competence: functional ability to solve the problem (for example, to explain the joke) and privileged discursive position (to be heard and convince the audience). To validate the privileged position the verification (testimony) of expertise's results is needed. The defense of the last could result in cognitive biases and falsifications (Gershrovich, 2006; Tetlock, 2009). Thus we expected to see fewer cognitive falsifications in defense of expertise of poly-position humor, compared to non-humor and memes.

Two groups (G1 - 53 people (31F, 22M), 18 to 55 years old, M = 34.6, σ = 10.7, G2 - 73 people (42F, 31M), 18 to 74 years old, M = 33.5, σ = 11.3) were recruited to rate and explain two types of jokes: graphical comics (poly-position stimuli) and internet meme's cliché like Creepy Wonka or Philosoraptor. Before and after the expertise one self-assessed their expertness in humor as a personal trait (5 questions, 11-Likert Scale). Participants received ambiguous feedback on their expertise — explicit positive feedback in form of acknowledgment of their personal impact on the rating process and implicit negative feedback in form of Top 10 selected jokes not including any one had recommended by a participant as an expert. We measured the shift of self-esteem and the retrospective falsification in form of false attribution of the top 10 jokes to one's recommendations.

As was expected, group 2 showed more retrospective falsifications — falsely attributing to themselves successful results of other people's expertise (67.1% compared to 49.1% in group 1, chi-square = 4.16, p = .041). Significantly more people In group 1 had the dynamics of the self-assessed expert position in humor (26.4% compared to 8.2% in group 2, chi-square = 7.61; p = .006).

Coherence of the expert's communicative position and implicit negative feedback of the expertise's results were re-established by shifting the partial self-esteem in the 1st group and by cognitive illusion in the 2nd. Hermans' and Vygotsky's interpretations have been compared.

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Ambiguous pronoun processing strategies: The role of reader's task and text properties

In the studies of ambiguous pronoun resolution, it was suggested that the strategy of pronoun processing depends on a task at hand: when questions require pronoun resolution, two interpretations may be constructed and maintained, while in the absence of such questions pronoun resolution may be delayed or even may not occur (Green et al., 1992; Rigalleau et al., 2004;

Stewart et al., 2007). However, evidence for various processing strategies was acquired in experiments with different types of stimuli and tasks, and mostly on separate sentences, not coherent texts. The aim of our study was to investigate dependence of processing strategies on experimental task and text properties in the same paradigm with comparable stimuli.

In a self-paced reading experiment with 96 participants 28 stimuli with an ambiguous pronoun were presented in two forms: (I) a 4-sentenced story with familiar cartoon characters, or (II) a 2-sentenced text fragment with unknown characters (the first and the last sentence of each story were eliminated and character names changed). For each stimulus an unambiguous version was constructed. Comprehension questions either followed ¼ of stimuli and did not require pronoun interpretation or were asked after each stimulus and required pronoun assignment. Thus, it was a 2x2x2 design with stimulus form (I) or (II) and experimental task as between-subject factors and ambiguity as a within-subject factor.

The GLMM analysis showed general effect of stimulus form on reading times: all analyzed areas were read slower in fragment condition (II) ($Fs > 5$, $ps < .05$). A significant Task*Ambiguity interaction ($F = 9.80$, $p = .002$) was found for the end of the sentence with the pronoun: in ambiguous condition this region was read significantly slower when there were questions to each stimulus ($t = 2.244$, $p = .025$). Question response times were significantly longer in case of ambiguous condition ($F = 50.782$, $p < .001$).

The results show that ambiguous pronoun processing depends on an experimental task. When questions require ambiguity resolution two interpretations are constructed, resulting in longer reading times of the sentence with the pronoun and longer question response times. Even though coherent story is processed faster and easier than a text fragment, pronoun processing seems to be untouched by this factor, and we may conclude that in both cases a default pronoun processing strategy is operating.

Approved for printing 23.11.2021.
Order 7264. Number of copies printed — 30.
Printed by «Skifiya-print» printing office.

197198 St. Petersburg, B. Pushkarskaya str., 10, build 3., room 32-H