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Elementaristic vs. holistic approaches to dissociation of agraphia symptoms following acquired brain damage

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ABSTRACT

Background: Two approaches to the explanation of dissociations of symptoms were established in the history of neuropsychology: through the structural changes and through the changes of activity form. The theoretical origins of these explanations are related to the two methodological traditions in psychology: elementaristic and holistic. In this study, the advantages of the elementaristic and the holistic approach to the explanation of dissociated neuropsychological agraphia symptoms are discussed.

Aims: The goal of our study was to reveal the variability of writing disorders following sensory agraphia depending on performance in writing tasks of different types. We hypothesise that manifestations of psychological disorders in Wernicke's agraphia vary in different types of writing tasks:

1.1. We expect the dissociated symptoms of Wernicke's agraphia to vary in tasks that actualise different culturally defined functions of writing;

1.2. Tasks actualising culturally determined functions of writing would lead to specific differences of symptoms in Wernicke's agraphia compared with the performance on traditional diagnostic tests.

Methods & Procedures: The study involved 29 individuals with Wernicke's agraphia due to left hemisphere stroke in the basin of the left middle cerebral artery. To identify agraphia symptoms, tasks traditionally applied in neuropsychological diagnostics of writing were used, representing typical cultural-historical functions of writing (communicative, mnestic, and regulatory). Analysis with the Chi-square Friedman test showed that the differences for all types of error rates were statistically significant ($p = .001$), which allowed the Wilcoxon test for further pairwise comparison ratios of errors in written tasks.

Outcomes & Results: Two approaches to the explanation of dissociations of symptoms have been used – through structural changes (elementaristic approach) and changes of a person's activity form (holistic approach). The advantages of the holistic approach were the most evident while analysing the significant prevalence of errors in orthography in the regulatory task compared with the task of sentence composition. These tasks did not differ in their structural components, so the elementaristic approach did not explain the

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resulting dissociation. The explanation of this phenomenon comes from the psychological importance of the cultural function of writing using a permissive psychological strategy.

Conclusions: The holistic approach can be a valuable complement to the more widely utilised elementaristic approach. Despite the fact that a holistic approach is less common in modern clinical neuropsychology, its advantages are evident in the analysis of dissociation symptoms within the same syndrome when performing identical tasks in a set of involved neuropsychological components.

Introduction

The principle of dissociation defined by Teuber (1955) is fundamental in neuropsychology. Although the Teuber study was published in the middle of the 20th century, the principle had been implicitly used from the first days of neuropsychological studies (Davies, 2010).

There are two approaches to the interpretation of dissociated symptoms.

According to the first approach, dissociation is a sign of structural inhomogeneity in the investigation process: if dissociation between the tasks is observed, there is a possibility that different cognitive blocks or connections are involved in these tasks. In the second approach of reasoning, dissociation can be explained by changes in the mode (way of functioning) of same cognitive process.

At the end of the 19th century, the dissociation between word perception and production was interpreted as proof of the existence of two structural elements of language in the brain: the centre of motor word representations and the centre of sound word representations (Lichtheim, 1885).

Similar examples can be found in contemporary theories, for instance, in the dual-route model where cognitive routes were suggested to explain the dissociation in performing tasks with real words and non-words. Fluctuations of the symptoms of dyslexia and dysgraphia are explained by the use of lexical and nonlexical reading and writing for tasks with words and non-words (Morton, 1969). Similar findings were presented in studies about praxis (Chainay & Humphreys, 2002; Cubelli, Marchetti, Boscolo, & Della Sala, 2000; Rothi, Ochipa, & Heilman, 1991). This view on dissociation is widespread in neuropsychology (Geschwind, 1974; Luria, 2002).

According to the second approach, one psychological system can change its mode of operation and manifest in different symptoms.

Thus, Jackson presented observations that could not be explained by the previous structural framework (Jackson, 1996). For example, a patient was able to talk spontaneously without producing words intentionally. Jackson claimed this case could not be explained by the assumption that these tasks are accomplished by different language components, as described by Broca and his followers (Broca, 2006). The tasks used by Jackson were identical in structure and required identical articulatory capabilities. It seemed that articulation was disturbed and, yet, preserved at the same time. Jackson hypothesised that the fluctuations in symptoms can be explained by changes in the function of the utterance. These functions are organised in a hierarchical manner to express thoughts or emotions. To fulfil these functions, the same ability of articulation is

realised in different modes, spontaneously or intentionally. The more complex of these modes can be disorganised, while the simpler one remains intact.

Head described patients similar to those presented by Jackson: they failed using words when communicating, but successfully used the same words when repeating. Head argued such disturbances could not be explained by structural theories and suggested that these symptoms appeared due to the degree of disturbance of the general faculty of symbolisation (Head, 2014, 1921).

These ideas were generalised by Goldstein (Goldstein, 1940). He described a patient who was unable to actualise a word on purpose, but could use this word in conversation; a patient who was unable to draw a square, but could draw a squared window; a patient who was unable to demonstrate a movement, but was successful in performing the same action in real life. Goldstein suggested that the patients performed all these tasks with two attitudes of personality: concrete and abstract, where the former is primitive and the latter is more complex (Goldstein & Scheerer, 1941).

Summarising the legacy of Jackson, Head and Goldstein on the one hand, and the achievements of the physiology of activity developed by Bernstein (Bernstein, 2003; Bernstein & Nazarov, 2004) on the other, the level theory of speech and aphasia was developed by Vinarskaya, Glezerman, and Vizel (Glezerman, 1986; Vinarskaya, 1971; Vizel, 2002). They demonstrated that using the same words, patients could differ in their performance depending on the language task: i.e., using words for communication, or just for articulation (repetition). To fulfil these goals, a person utilises the same language system in different manners.

Consequently, two approaches to dissociation were established: through the structural changes and through the changes of activity form. These explanations are related to the two traditions in psychology: elementaristic and holistic.

Elementaristic and holistic traditions in psychology

The elementaristic methodology was developed by Titchener and Watson (Titchener, 1898; Watson, 1913). As for neuropsychology, the elementaristic approach was developed by Gall (Finger, 1994; Spurzheim, 1832) and continued by followers of Broca and Wernicke (Lichtheim, 1885). The main questions of these investigations were: what are the components of psychological processes? Where are they localised in the brain? And what specific language disorders are caused by the disruption of these components? Fruitful results of this research were presented in a large number of publications (Beauvois & Derouesne, 1981; Bub & Kertesz, 1982; Caramazza, 1988; Caramazza & Mahon, 2006; Coltheart, Rastle, Perry, Langdon, & Ziegler, 2001; Ellis, 1982; Geschwind, 1974; Goodglass, 1993; Houghton & Zorzi, 2003; Jackson, 1996; Kussmaul, 1879; Lichtheim, 1885; Luria, 1950, 1973, 2002; Luzzatti, 2008; Morton, 1969; Rapcsak et al., 2009; Rapcsak, Henry, Teague, Carnahan, & Beeson, 2007; Shallice, 1981; Tainturier & Rapp, 2001).

The concept was developed that psychological process is a complex system of independent but interconnected elements localised separately in the brain. For example, there was an assumption that a number of language components support any language process by connecting with each other. Any complex form of activity was considered as a coordination of psychological components constant in their features and functions.

Good examples are the Wernicke-Lichtheim scheme and dual-route models. A distortion of a component does not change the functions of others, but leads to a particular form of disturbance. This statement became famous as a transitory assumption (Caramazza, 1988; Davies, 2010).

Following this logic, researchers tried to explain the shift of symptoms in one patient performing different tasks by postulating new components of the process. The dissociation between tasks is explained by the fact that the individual is dealing with different types of material processed by particular components.

Within the elementaristic approach it was claimed that new features appear when several components connect with each other in various structures (Wundt, 1912), but this was difficult to explain. To overcome this difficulty, the existence of higher mental faculties endowing components with additional characteristics was postulated by scholars including Ehrenfels (Kohler, 1930; Sokolova, 2005; Wertheimer, 2003).

This point of view was criticised by holistic traditionalists in psychology, in particular those supporting gestalt theory (Koffka, 1935; Lewin, 2001; Wertheimer, 2003). From the gestalt perspective, there is no need to deny the existence of different features of psychological processes, but it is important to realise that these features are not independent and invariable elements, they are produced as specific characteristics of a particular wholeness. Flourens, Jackson, Head, Lashley, and Goldstein were the spokesmen for holistic ideas in neuropsychology (Flourens, 1846; Goldstein, 1940; Head, 1921; Jackson, 1996; Lashley, 1929, 1930).

So, the second explanation of dissociation corresponds with the holistic approach: processes should not be considered as primordial elements with stable features, but rather aspects of particular holistic systems. In pathology, the same holistic systems can produce different symptoms. In this case, the dissociation of disturbances can be caused by modifications to the system as a whole.

To summarise, the two approaches differ in the following ways:

(a) in accordance with the elementaristic approach, elements with constant features are primary and the wholeness is a secondary result of their interaction;
(b) in the holistic tradition, features of parts of the particular wholeness are secondary.

At the same time there were attempts to combine both approaches. Examples can be found in works by Luria and his followers (Khomskaya, 1987; Luria, 2002, 2008; Tsvetkova, 2002). On the one hand, they attempted to discover the components of high mental functions. On the other, on the achievements of Jackson, Goldstein, and Vygotsky (Vygotsky, 1929), they described two general ways in which all mental processes function: voluntary and non-voluntary.

The notion of task

In both traditions, the concept of task is important. In the majority of elementaristic models, the configuration of components of the psychological process is determined by the task performed by the participant. As in the classical Wernicke-Lichtheim theory (Lichtheim, 1885), and in dual-route cognitive models (Coltheart et al., 2001), different organisations of language components are needed for different language tasks.

In the holistic tradition, the importance of the notion of task was stressed by Anokhin and Bernstein who claimed that the physiological task is the main factor that arranges the activity of the organism (Anokhin, 1971, 1975; Bernstein, 2012).

These tasks are physiological and are relevant for satisfying organismic needs: breathing, digestion, and so on. Psychological tasks are quite different in nature and content. Usually they correspond with psychological functions, for instance, writing, memorising, perception, and others. The statements by Vygotsky's and Leontyev's school of psychology are significant in defining the term "psychological task". The authors argued that human psychological processes and tasks have qualitative specifics when compared to the psychological processes of animals: they are cultural-historical by nature (Leontiev, 1981).

Often we deal with psychological tasks in the process of psychological diagnostics and rehabilitation. Of course, tasks involving common sense can be considered as cultural-historical by nature. However, the notion of task reflects the innumerable variability of actions that can be fulfilled by a person during their lifetime. Moreover, it must be stressed that every person lives in their own unique environment where unique demands are relevant. Thus, the list of everyday activities in a specific milieu is quite individual (Wilson, Herbert, & Shiel, 2004). However, the aim of this study was to focus on the universal features of psychological processes. The theoretical principles described above could be organised in a systematic way:

(1) The organisation of psychological process is determined by the task.
(2) Psychological process is holistic by nature. Its features are not independent and stable, but are able to change depending on the psychological process as a whole.
(3) Psychological tasks specific for humans are cultural-historical in origin and content.

Investigating the symptoms of agraphia within the framework of a holistic approach, we expect differences in patients performing task actualising culturally defined functions of writing.

Cultural-historical functions of writing

The above statements are useful for the study of agraphia, as writing is specific to humans and cultural-historical by nature. The analysis of the evolution of writing (Assmann, 2004; Brudnyi, 1972; Istrin, 1965; Kliks, 1983; Leontiev, 1981; Liaudis & Negure, 1983; Likhachev, 1951; Mazunova, 2006; Zinkovskaya, 2005) allows us to identify the main cultural functions of writing. Among them the most important are: communicative, mnestic, and regulatory functions. These functions first arose at the stage of pictographic writing circa 20,000 years BC (Doblhofer & Friedrich, 2002; Istrin, 1965; Jean, 2005; Kliks, 1983; Likhachev, 1951; Mazunova, 2006; Zinkovskaya, 2005). They are also fundamental at the pre-instrumental and instrumental stages of writing development in ontogenesis (Luria, 1950; Vygotsky, 2004).

Communicative function suggests the use of writing for information transfer. For example, it is most obviously manifested in the writing of letters. Mnestic function is

implemented when writing is used to store information, for example, when writing down an address that cannot be memorised. The regulatory function is implemented if a person tries to manage their future actions with the help of writing, for example, writing a to-do list.

However, the same written text can serve different functions. A long-term plan can be aimed at regulating behaviour (regulatory function), or to the storage of necessary future actions (mnestic function). In such cases, we distinguish the primary and subordinate functions. In our research, we developed tasks that actualise communicative, mnestic, or regulatory functions as primary.

The basic assumption of this study is that symptoms of agraphia vary when executing two different types of tasks:

(1) tasks traditionally used in the neuropsychological diagnostics of writing;
(2) tasks that represent typical cultural-historical functions of writing.

According to different theoretical schools (Caramazza, 1988; Chapey, 2008; Davies, 2010; Finger, 1994; Lewin, 2001; Vygotsky, 2005), basic characteristics are the same for normal and pathological psychological processes. This allows us to suppose that psychological symptoms are determined by tasks that correspond with the cultural-historical functions of psychological processes.

Therefore, based on the theoretical assumptions of the holistic approach, we considered writing as a psychological function that is cultural and historical in nature. We also assumed that writing is organised by specific cultural functions or tasks (communicative, regulatory, mnestic). We expected that when writing is performed due to one of those tasks it requires psychological operation that is changeable in its features. These changes can be manifested in different patterns of writing mistakes in people with aphasia when they write to communicate, to memorise something, or to regulate their actions. These disorders of writing are quite severe in people with Wernicke's agraphia. That is why these patients were chosen as participants in the research.

The goal of our study was to reveal the variability of writing disorders following sensory agraphia shown by performance in writing tasks of different types.

We hypothesise that manifestations of psychological disorders in sensory agraphia vary with different types of writing tasks:

1.1. The dissociated symptoms of sensory agraphia vary in tasks that actualise different culturally defined functions of writing;

1.2. Tasks actualising culturally determined functions of writing would lead to specific differences of symptoms in Wernicke's agraphia compared with performance in traditional diagnostic tests.

Methods

Participants

The study involved 29 individuals (12 females; mean age 53 ± 9; age range 34–67) with chronic aphasia due to left hemisphere stroke in the basin of the left middle cerebral artery. Time post-onset ranged from 3 months to 2 years (mean – 10,5 ± 5,9). All

participants were native speakers of Russian and were premorbidly right-handed. A total of 18 patients had higher education, 9 people special secondary, and 1 patient regular secondary.

At the core of sensory agraphia lies the weakness of auditory information processing due to lesions in posterior portions of the superior temporal gyrus of the left hemisphere (Akhutina, 2015; Luria, 1973, 2008; Tsvetkova, 2002). Disorders of the acoustic perception of language cause difficulties in the differentiation of phonemes. In the clinical picture of Wernicke's agraphia, impairment of writing manifests when writing words and letters either spontaneously or to dictation. Selection criteria in the experimental group were: (1) Wernicke's aphasia; (2) severity of language disorder according to the quantitative assessment of speech symptoms in aphasia by Tsvetkova, Akhutina, and Pylaeva (1981) differing from mild (12 individuals) to moderate (17 individuals); and (3) Wernicke's agraphia (coexisting with Wernicke's aphasia) according to neuropsychological testing. For the diagnostic tasks on automated writing and dictation of individual sounds and syllables, words of simple and complex structure and sentences were used.

Presence or absence of selection criteria was determined by performance on the quantitative assessment of speech symptoms in aphasia. This battery of tests is aimed at studying both impressive and expressive speech. The study of impressive speech explores the comprehension of simple questions, instructions, complex logical and grammatical constructions, and the state of phonemic analysis (understanding words among acoustic distractors). The study of expressive speech consists of tests of different levels of complexity in dialogical, repeated and nominative speech, the construction of sentences and narrative, and retelling. The sum of scores on these subtests on a 300-point scale allowed us to determine the severity of aphasia. To participate in the study, only mild to moderate speech disorders were selected, which corresponded to 175–260 points in the test. The selection of patients with this severity of aphasia was based on the presence of errors in written speech, but not to the level of complete disintegration of writing.

Exclusion criteria for the experimental group were: (1) age of the participants being more than 70 years; (2) education level below secondary; (3) organic pathology of brain regions according to MRI not affecting upper temporal zone of language dominant hemisphere; (4) hearing loss diagnosed by otolaryngologist; (5) visual agnosia; (6) presence of types of aphasia other than Wernicke`s aphasia; and (7) profession of the participants relating to the active use of writing (e.g., linguistics, philology, or creative writing).

Disorders of impressive aspects of language came to the fore. Participants were able to understand language in communication contexts, but more significant comprehension deficits were noted on tasks with multistep commands given by oral instructions. For example, executing the instruction to draw a circle on the sheet, bend the sheet in half and put it on the edge of the table, participants would draw a square instead of a circle. Impressive language skills and verbal memory capacity were sufficient for the proper understanding of instructions in experimental tasks.

In expressive language, literal paragraphias with acoustic-phonetic similarity were observed, as well as verbal paragraphias. There was an increase in the proportion of the auxiliary part of language compared with the notional. For example, in a mnestic task, one of the participants made the following text (an excerpt is given): "This one gives to these… food. Aged and a fence and a church. Around the guys, a girl on a swing",

instead of a more detailed version: "The boy is feeding hedgehogs. There is a grand-father standing by the fence and looking at the church. A boy is playing with a girl on a swing". Despite a lack of highly informative words in spontaneous language, the participants were able to convey the meaning.

In the writing, we observed some distortion of letter structure in the words, omissions of letters, substitution of letters for ones similar on the acoustic-phonetic basis, and similar-sounding verbal paragraphias.

The study was conducted at in-patient units of the Centre for Speech Pathology and Neurorehabilitation in Moscow, Russian Federation.

Experimental tasks

Two types of experimental tasks were used: traditional diagnostic tasks (TDT), and non-traditional diagnostic tasks (NTDT) representing the cultural function of writing.

Traditional diagnostic tasks

The TDT group included classic tasks such as written naming, written sentence composi-tion, and writing to dictation (Akhutina, 2001; Akhutina & Inshakova, 2008; Khomskaya, 1987; Luria, 1950; 1970, 2002; Tsvetkova, 2002).

Written naming task

Stimuli
The stimulus material consisted of 24 pictures of concrete objects, for example, reka (river), poezd (train), zerkalo (mirror), gostinitsa (hotel). All words were balanced by linguistic parameters to other tasks. (For the details of norming and the linguistic criteria, see below).

Procedure

Participants were asked to describe the picture in written form. The instruction was the following: "Describe the picture with one word and write down your answer".

Written sentence construction

Stimuli
The task included 10 pictures for creating simple SVO (subject-verb-object) type phrases. For example, Babushka pyot chay (grandmother is drinking tea), muzhchina lovit ryibu (man is fishing). The features of the task (visual presentation of stimuli, syntactic structure of sentences) make it the closest analogue to NTDTs, since the task actualises mnestic function.

Procedure

Participants were asked to describe the content of the picture using simple SVO (sub-ject-verb-object) type phrases. Instruction was the following: "Now I'll show you some pictures. For each of them make a sentence and write down your answer".

Writing to dictation

Stimuli

A simple text with a description of winter forest consisting of seven sentences (30 words in total). Stimuli were matched in phonetic complexity, lexical frequency and the number of words with other TDTs.

Procedure

Participants were asked to listen to the text and write it to dictation. Instruction was the following: "Now I will dictate the text that you need to write".

Non-traditional diagnostic tasks

Communicative task
Stimuli. No stimulus material was used for this task.

Procedure

The task was aimed at implementing the communicative function of writing. Patients were asked to write a letter to the social service department of a medical centre and describe their social status: information on the place of residence, educational grade and jobs, welfare level, family composition. The instruction was the following: "Our social service department collects more data about patients, data that are not specified in the medical documentation. This is the information about the social status of patients. This information consists of the following brief data: where you live, where you study and work, your well-being level, data about your family composition. We invite you to participate in this survey and write a letter to the social service department in which you have to present this information. All the received information needed for statistical calculations is confidential".

Mnestic task

Stimuli

One target picture representing a scene of country life with many characters, and 15 distractor images differing from the target by minor details. For example, in one of the distractor images smoke coming up from the chimney pipe was added, in another one the number of characters was changed – a boy watered one hedgehog instead of two.

Procedure

The mnestic function was implemented in the task of memorising the content of the picture. The participants were presented with a target picture and were asked to remember it, and choose it from another 15 distractors one week later. Then the experimenter demonstrated with two or three examples the minor differences between distractors and the target picture. Thus, the participant was provoked to make quite a

detailed description in order to be able to identify the target picture from the 15 distractors. The instruction was: "Now you are going to memorise pictures. All of these are scenes of rural life. These images differ in minor details (demonstration of 2 images as an example). You can make a written description of the picture, which will help you to remember this particular image, and how it differs from the others, in one week's time using your notes. Nothing can be drawn".

One week later, the patients were requested to remember the content of the target picture and to choose it from 15 others. So this task produced the situation in which the memory load due to the presence of numerous distractors and the time delay made it more sensitive. Similar conditions implement the mnestic function and written material fixation in daily activities.

Regulatory task

Stimuli

Twenty-two different tasks varying in degree of difficulty were offered to participants. For example, to find 5 differences between the pictures; to choose words by analogy; to determine the length of 15 segments without a ruler; a proofreading test with Landolt rings; to perform arithmetic operations with numbers up to 60; to make a word from syllables; to search numbers in Schulte table; to arrange a jigsaw puzzle of 25 elements.

Procedure

Actualisation of writing regulatory functions was carried out by requesting participants to draw up a plan of their actions during the execution of a series of separate tasks of varying difficulty. The participants had to perform the maximum number of tasks under time pressure. At the beginning of this study, a number of different tasks (22 in total) were laid out on the table in front of the participant. They were told that the time for the whole test would be limited to 30 min, and the participant should therefore sort the tasks according to their degree of complexity, ranging from the simplest to the most complex. In order to save time, participants were asked to develop and write a work plan including at least 15 tasks. The latter requirement was introduced in order to increase writing productivity, because in the pilot study patients did not always adequately assess their capabilities and selected only five to six most simple tasks for the allotted time. The instruction was: "There are different tasks on the table (it was explained what tasks were presented and how they should perform). You will have limited time – only 30 min to try to execute as many tasks as possible that seem to be the simplest. The minimum number of tasks to be executed is 15. You may write down the order of tasks for yourself to prevent wasting time for thinking".

In NTDTs, the participants had no idea that the object of the study was their writing. The instructions for the tasks suggested communicating, memorising, or planning as conscious goals. This feature differs significantly in NTDTs and TDTs, where the investigation of writing process was stated directly.

NTDT assumed free lexis usage, making phrases of any syntactic constructions, and had no restrictions on the quantity of written words. The different number of written words and the associated fatigue effect also did not affect the distribution of errors,

which was shown by comparing their number in different halves of a single task. Also, a special study showed that NTDTs were equalised for a number of linguistic parameters. NTDTs were matched on lexical frequency and phonetic complexity. For this purpose, in the pilot study 11 participants, selected by the same criteria used in the main experiment, were offered 3 tasks – communicative, regulatory, and mnestic. Lexical complexity of the words written by the participants was determined using the frequency dictionary of modern Russian (Lyashevskaya & Sharov, 2009). Phonetic complexity was calculated by the formula proposed in the quantitative assessment of language offered by L.S. Tsvetkova, T.V. Akhutina, N.A. Pylaeva (Tsvetkova et al., 1981): i.e., phonetic complexity = 1.0 * (number of consonants) + 1.0 * (number of consonant clusters) + 0.5 * (number of closed syllables). Words are considered simple under 3.5 points and complex with more than 3.5 points. Analysis of tasks in the NTDT group with Friedman and Wilcoxon criteria tests revealed no significant differences in the distribution of lexical frequency and phonetic complexity of words when comparing all three tasks.

TDTs were matched in lexical frequency and phonetic complexity with NTDTs using the communicative task as a standard, because only in this task could most participants freely use their vocabulary, since it did not involve incentives given by the experimenter. In this task, the frequency range of the mean values was between 25 and 75 percentiles. It had been used for the word selection in naming tasks, sentence construction, and dictation. The interquartile range, which includes all observations between 25 and 75 percentiles, is a central part of the distribution and covers half of the data. Within this range, the value of the word frequency coefficient was chosen as close as possible to the median value. Regarding the phonetic complexity, the dispersion in the communication task was rather small (on average from 2.5 to 4.0 points) and all the words were divided into two groups – simple or complex (with a prevalence of simple words). Therefore, the average number of simple words was used for calculations instead of percentile values. In communicative tasks the average number of simple words was 32% (18–52%). The same value was used for the selection of phonetically complex words in the TDTs.

Frequency range in the TDTs was 36–623 points with a median 130, and the percentage of phonetically simple words 31% (25–35%). The number of words in all TDTs was on average 28 (range – 24 to 30). Stimuli words did not differ significantly in frequency either within the TDT group or when compared with NTDT group. Thus, the tasks implement the same vocabulary in terms of frequency, and differences in the numbers of errors could not be caused by differences in the lexical complexity of tasks.

To control for the effect of the sequence, all tasks except dictation were presented in accordance with the scheme of a balanced Latin square design. Writing dictation was conducted at the last meeting with participants, in order to avoid bringing attention to the purpose of the study.

Results

Errors in written tasks

Writing errors were classified into 10 types: literal paragraphias; inserts of extra letters and syllables; letter and syllable omissions; unfinished words; letter transpositions; letter

anticipations; verbal paragraphias; sound lability type errors (multiple literal paragraphias which change significantly the structure of the word); spelling errors; perseveration of letter elements.

We will describe in detail the types of error that were significantly different between writing tasks in the following description of the results. Literal paragraphias include replacing voiced consonants with unvoiced consonants, and vice versa (doroga (a road)/**t**oroga; sobaka (a dog)/so**p**aka). Inserts are the addition of extra letters in the word (doroga (a road)/do**v**roga). This type of error should be distinguished from perseverations, which are characterised by difficulties in switching on a motor level manifesting in the repetition of a previously written letter or syllable. Verbal paragraphias are substitutions of one word with another one based on phonetic or semantic similarity. In the first case, the substitutions of individual letters result in the substitution of one word with another similar in sound (kot (a cat)/ko**d** (code)). In the second case, target words are replaced by other words belonging to the same semantic group (cat/dog). The analysis of semantic verbal paragraphias was excluded from the study due to difficulties in their detection in tasks with a high variability of vocabulary and a large number of personally relevant words (especially in communicative tasks).

Errors associated with the phonological writing of vocabulary words are classified as spelling errors, for example, replacing unstressed vowels (doroga (a road)/d**a**roga) and grapheme omission at the confluence of consonants (grammatika (grammar)/gra**m**atika).

Writing tasks were compared for each error type to estimate error distribution. Error rate was calculated as the relation of the absolute number of errors of a specified type to the general number of words. Analysis with the Chi-square Friedman test showed that the differences for all types of error rates were statistically significant ($p = .001$), which allowed the Wilcoxon test for further pairwise comparison ratios of errors in written tasks. For pairwise comparison of error rates Wilcoxon criteria were used. Furthermore, all significant results for error rate comparison were adjusted for multiple comparison.

By the total number of errors dictation exceeded communicative task ($z = -2.887$, $p = .004$), mnestic task ($z = -3.211$, $p = .001$), written naming task ($z = -3.914$, $p = .000$), and written naming task ($z = -3.480$, $p = .001$) (see Figure 1).

The prevalent type of writing errors was found to be literal paragraphias/substitutions. Differences were shown between dictation and the rest of TDTs, as well as all NTDTs. The number of literal paragraphias in dictation was significantly larger than in the communicative task ($z = -2.811$, $p = .005$), mnestic task ($z = -3.187$, $p = .001$), regulatory task ($z = -3.499$, $p = .000$), written naming task ($z = -4.254$, $p = .000$), and written sentences composition ($z = -3.782$, $p = .000$) (see Figure 2).

By the number of inserts, the only differences were revealed between tasks belonging to different groups (TDT/NTDT). Namely, when comparing communicative tasks with dictation the number of errors in dictation was significantly greater ($z = -3.531$, $p = .000$) (see Figure 3).

As in the case of inserts, the number of verbal paragraphias differed significantly between dictation and communication tasks: the number of errors in dictation was significantly greater ($z = -3.004$, $p = .003$) (see Figure 4).

For spelling errors, significant differences were found when comparing the error rates in TDT written sentence construction with the two NTDTs: mnestic and regulatory (see Figure 5).
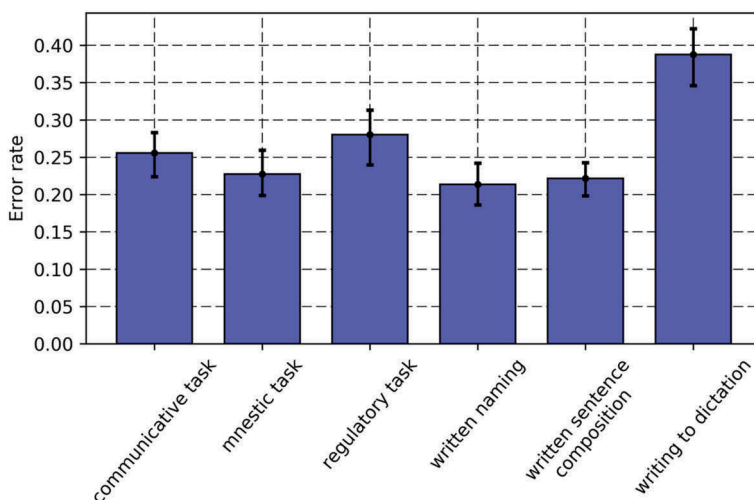
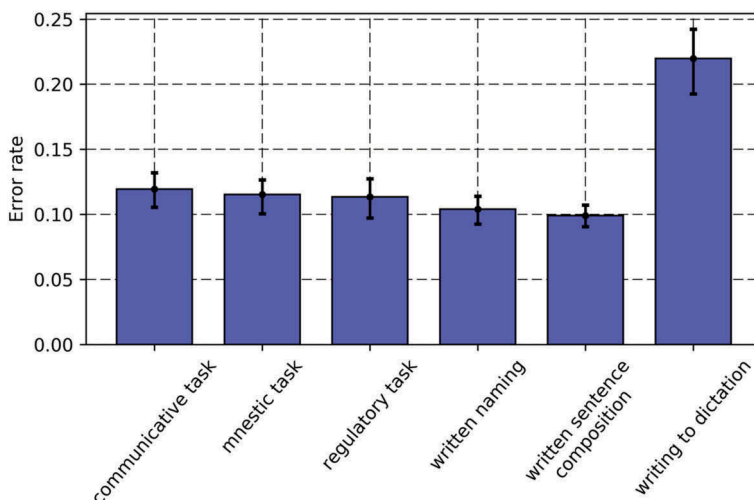**Figure 1.** Rate of total number of errors.

Figure 2. Literal paragraphias error rate.

The first difference is the prevalence of spelling errors in mnestic tasks compared with written sentences composition ($z = -2.981$, $p = .003$). The second difference is the significant prevalence of spelling errors in the regulatory task compared with TDT sentence composition ($z = -2.847$, $p = .004$).

By the number of omissions, unfinished words, transpositions and anticipations, multiple literal paragraphias due to sound lability and perseveration, significant differences have not been shown.

Thus, the analysis of error distribution in different writing tasks revealed significant differences in writing disorders for each task. Differences were shown within the TDT group, as well as between tasks in different groups (TDT-NTDT). Within the group of TDTs, differences in the number of literal paragraphias were found. All these differences
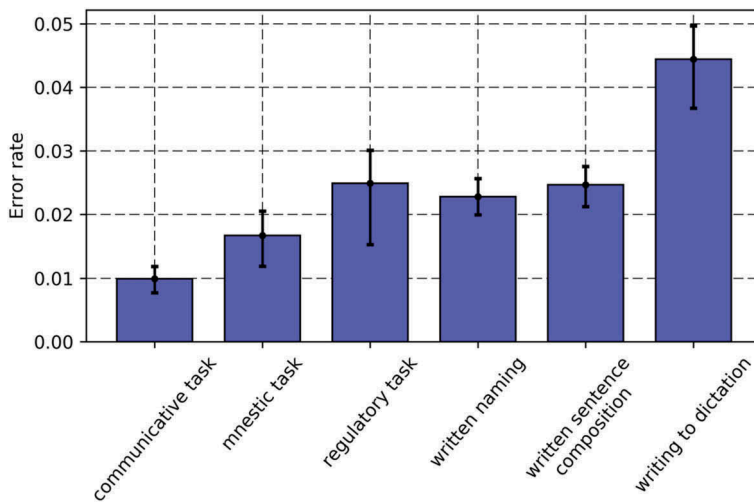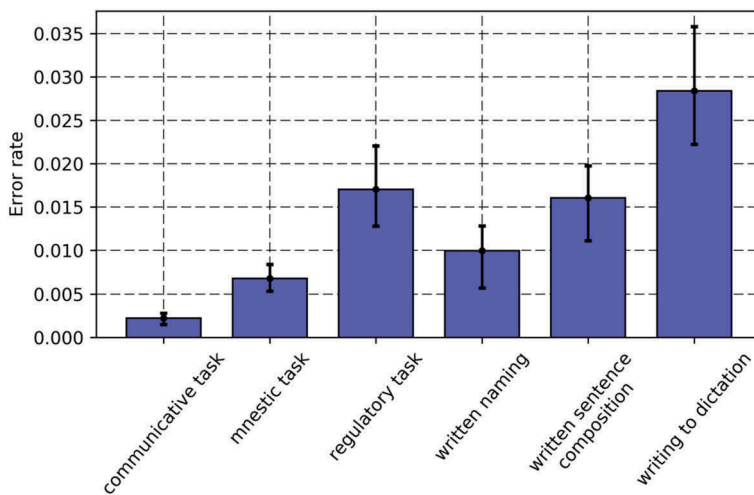
Figure 3. Inserts error rate.

Figure 4. Verbal paragraphias error rate.

were found in comparison with the dictation task. The number of literal paragraphias in this task was greater than in the rest of TDTs. The majority of significant differences (seven cases) were shown when comparing the number of errors in writing between tasks belonging to different groups (TDT-NTDT). Five differences were observed in comparison with the dictation task. So, an increase was found in the number of literal paragraphias in the dictation in comparison with all three NTDTs. The prevalence of the number of inserts and verbal paragraphias was found in dictation in comparison with the communicative task. Two differences for tasks belonging to different groups were found by comparing the number of spelling errors, which was significantly greater in mnestic and regulatory tasks in pair-wise comparison with TDT written sentence composition. NTDTs did not differ in the number of types of errors within the group.
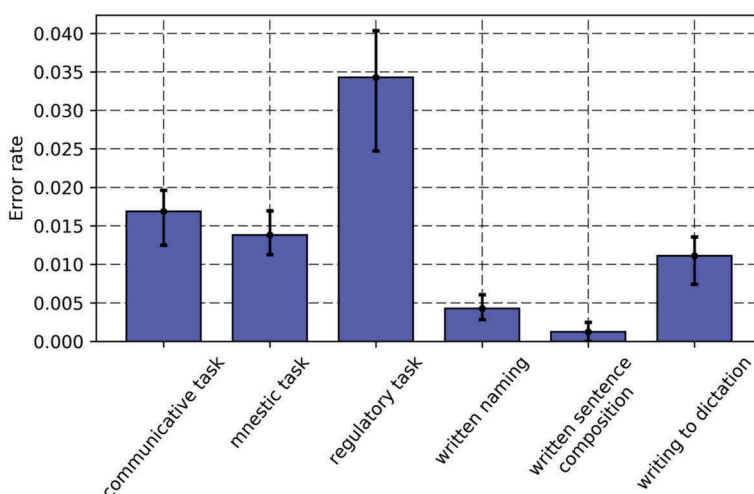
Figure 5. Spelling errors rate.

Discussion

Specific disorders in different tasks

To explain the significant prevalence of literal paragraphias (substitutions of graphemes) in the dictation task compared to all other tasks, we should refer to the elementaristic approach. From this point of view, patients with Wernicke's aphasia have problems both in the production and comprehension of language (Goodglass, 1993; Kussmaul, 1879; Lichtheim, 1885; Luria, 1973, 2002; Tsvetkova, 2002). Substitution of language sounds and graphemes (literal paraphasias and paragraphias), which are similar in auditory features, is one of the most common symptoms in Wernicke's aphasia (Luria, 1973, 2002; Tsvetkova, 2002).

These characteristics become crucial for the task of dictation, which differs structurally from other tasks. The distinctive features of the dictation task are that the processes of auditory perception and memorising of language sounds are at the initial stages of execution of the task. These processes were not executed in any other experimental conditions. So, it was expected that the participants would have difficulties with the dictation task, both at the stage of written production and language perception.

Similar explanations can be developed using the dual route cascaded model of writing (Coltheart et al., 2001). According to this model, in the dictation task it is necessary to consistently involve several separate mental mechanisms or cognitive routes. Initially, the impressive part of the route is activated. This enables mechanisms of auditory phonemic analysis, following memorising and decoding lexemes in words' meanings. The expressive part requires the involvement of graphemic output lexicons and graphemic buffers, where the decoding of word meaning in the sequence of graphemes takes place. Only the expressive part of the decoding was present in the other tasks used in this study. The participants had to write down their own ideas or the ideas presented on pictures, there was no impressive stage. So, literal paragraphias in all other tasks could be caused by the distortion of the expressive stage of writing, but not

by the impressive stage. The literal paragraphias observed in the dictation task could be generated by the dysfunctions of both parts of the writing process. In other words, the patients had more opportunities to make mistakes. This argument can explain the significant prevalence of literal paragraphias in the task of dictation, compared with all other tasks.

The second important result is the significant prevalence of verbal paragraphias in the task of dictation compared with the communicative task. Only auditory paragraphias were analysed in the research (e.g., tree/village, in Russian transcription: [d'erev'jev/derevnej]). In many studies verbal auditory paragraphias are found to reflect the nature of psychological defects in Wernicke's aphasia and are thought to be caused by difficulties in perception and holding information in working memory (the impressive stage of the dictation task) and the production of language sounds (expressive stage) (Goodglass, 1993; Kussmaul, 1879; Lichtheim, 1885; Luria, 1973, 2002; Tsvetkova, 2002). Consequently, the reason for the prevalence of verbal auditory paragraphias in the task of dictation compared with the communicative task is similar to the previous case with literal auditory paragraphias.

The advantages of the holistic manner of explanation become more evident when discussing the third main result of the study: the significant prevalence of errors in orthography in the regulatory task compared with the sentence composition task.

If we analyse these two tasks structurally we may conclude that the language components used in both cases, the organisation of the components and the cognitive route, were the same. The impressive part of both processes starts with the visual perception of pictures (written sentences composition) or objects lying on a table (regulatory task). These visual percepts activate the concepts of objects in the semantic system. After that, during the expressive part of the each process the information goes to the lexical graphemic output (lexicon).

Of course, in the task of sentence composition, grammatical competence played an important role, but in the regulatory task it did not. It should be noted that grammatical errors were not taken into account. Regardless, the addition of grammatical operations should have made the task of sentence composition more difficult for patients, and thus result in the production of more mistakes due to the general increase of resource consumption. For example, patients could make more omissions or verbal paragraphias because of the necessity to monitor the order of words in the phrase and to select lexemes corresponding to the picture. In fact the opposite effect is detected, which leads to the conclusion that grammar is not a significant factor here.

So, it should be admitted that the structural or elementaristic explanation is not enough to explain this result. To discuss these findings from the holistic point of view we should consider the sense of the tasks, and the corresponding change in participants' strategy.

It is important to mention here that the rate of orthographic mistakes in the regulatory task was higher than in all other tasks. The explanation of this phenomenon comes again from the psychological importance of the cultural function of writing. Orthographic accuracy is less important for the regulatory task than for any other tasks. On the one hand, this task is quite similar to the communicative task in its wide conceptual and verbal variance. But in the case of the communicative task, the participants had to pass a message that could be understood by another person. That is why

orthographic accuracy becomes significant to some degree. But the texts that are generalised in the regulatory task are addressed to the participants themselves. In these conditions, orthographic accuracy can be more or less ignored. If we make notes for ourselves there is no need for orthographic accuracy, we can understand our marks even when we use abbreviations and miss or change letters. This psychological strategy can be called permissive.

At the same time, the participants' texts are also addressed to themselves in the mnestic task, when patients describe the picture in a written form in order to recognise it in the future. However, in this task the participants were asked to memorise the material for a long period of time, for a week. Here the importance of orthographic accuracy increases. If the participant makes gross orthographic errors, there is a greater chance of failing to understand the text after such a long break. While in the regulatory task there is no such time delay between writing and reading. The patients were able to use the plan of their future actions right after finishing writing it down, so there was no need to be extremely literate. Even if the text was simply a list of symbols, it would still be clear to the participant. For example, if we have a goal to remember an intention it is enough for us just to draw a cross on a wrist (Leontiev, 2004; Vygotsky, 2005). Thus, orthographic accuracy is not a priority to fulfil the regulatory task, but it may be primary in the communicative or mnestic tasks.

On the other hand, the task of sentence composition is very similar to the tasks commonly used for literacy diagnostics. The instruction to describe particular pictures in a written form put the writing process and its orthographic accuracy into the focus of the patients' attention. They tried to be literate and to avoid orthographic mistakes as hard as they could. Consequently, the difference in orthographic accuracy between sentence composition and the regulatory task could be explained by the psychological strategies of the patients.

The same conscious goal to avoid orthographic errors was also found in the dictation and written naming tasks, but there was no significant difference between these tasks and the regulatory task. In the case of dictation, this fact can again be explained by the structural elementaristic approach. As mentioned earlier, there are two stages in this task: impressive and expressive. In the first stage, phonemic discrimination takes place, whereas in the second stage, graphemic lexemes are analysed in separated graphemes. Orthographic errors can be the results of difficulties in both stages. At the same time, there is only the expressive part of writing process involved in the sentence composition task, since the impressive part does not implement language capacities but rather perceptual ones. So, the participants were expected to make more orthographic mistakes in the task of dictation than in the task of sentence composition, and this is in fact what we registered.

As for comparing written naming and sentence composition, the elementaristic approach fails because, despite the presence of structural differences in these tasks, the number of errors in the more difficult task decreased. The addition of grammatical operations should provoke errors of different types (not only grammatical, which were not included in the analysis) but the opposite phenomenon was found. That is why there is a need to apply the holistic logic: the sense of the task, but not the structure specifically, produces the unique psychological wholeness that explains the shift of the symptom's proportion. Written naming is less linguistically homogeneous than the task

of sentence composition. If a person has to formulate an idea in a sentence, he can choose different words, structures of the sentence, and grammatical forms. For example, the same picture can be described by saying "a man is kissing a woman" or "a gentle-man is kissing a lady", or "a woman is kissed by a man", or "people are in love with each other and kissing each other" or "people are kissing" and so on. Consequently, the person can choose any sentence he likes, or in case of patients with aphasia, the participants could choose a sentence that seemed easier. They were able to use the words and structures of the sentence to make it possible to avoid written errors. At the same time, when participants were told to name single objects the linguistic variability decreased significantly. In this situation the choice was limited only by a relatively small list of synonyms, which made avoiding difficult words much harder. That is why there was a greater prevalence of orthographic errors in the task of written naming compared to the sentence composition task. This prevalence is not significant in itself, but it was enough to eliminate the significant difference in orthographic errors between written naming and the regulatory task.

Thus, the holistic approach allows us to explain the prevalence of orthographic errors in the regulatory task compared with the task of written sentence composition. The observed variations of symptoms cannot be explained by the work of functionally stable components, because they should manifest identically in different experimental conditions. Therefore, the symptoms in agraphia patients under these experimental conditions should also be compar-able. The variations can be interpreted on the basis of the assumption that characteristics of particular psychological wholeness are dynamically produced according to the sense of the task.

The above discussion may give the impression that the two different theoretical and methodological traditions presented, elementaristic and holistic, are considered as opposite and competitive. But their relationship is more complicated. Both positions have in common the assumption that psychological processes have different characteristics (normal or patho-logical) and that these characteristics depend on a particular task. The main difference is that the holistic approach does not consider different characteristics of psychological processes as basic elements independent and constant in their features, as does the elementaristic point of view. In the holistic tradition, they are analysed as a consequence of the particular wholeness. Therefore, the holistic approach does not deny the achievements of elementarism, but tries to reinterpret them.

One of the methods of investigating psychological processes as a meaningful whole is to use psychological tasks that reproduce cultural functions. They can be considered as the origins of psychological process in human history. So this may lead to uncovering the universal forms of human, cultural psychological wholeness that appear as typical but changeable strategies of activity.

A holistic approach can be used both in experimental studies and in clinical practice. In experimental research it is relevant in studying of the laws of quantitative (e.g., the number of errors) and qualitative (types of errors) parameters of mental functions when performing tasks identical in involved neuropsychological components. Changes in these parameters may be due to differences in participants' strategies. In clinical prac-tice, it can substantiate the methods of recovery of higher mental functions, expanding the functionality of the patient by changing the content of performed tasks that are

cultural-historical in nature. This approach increases the ecological validity of rehabilitation methods and makes them similar to tasks in the patient's daily life.

Conclusions

Two theoretical methodological positions were discussed by using the example of variant patterns of symptoms in patients with Wernicke's aphasia who performed different kinds of writing tasks. The observed variations of symptoms can be explained in two ways: (1) by the organisation of psychological components used during these tasks (elementarism); (2) by strategies of activity concerning the dynamic features of investigated processes (holism). Two psychological strategies were revealed as phenomena of the holistic principle: variant and permissive.

These issues can explain new clinical data (variations of symptoms in two tasks identical from the structural point of view) and demonstrate the key difference between the elementaristic and holistic approaches in neuropsychology. According to the holistic point of view, symptoms should be considered in the context of the particular psychological wholeness determined by a meaningful task. It was argued that the investigation of tasks that implement typical cultural functions can be valuable in revealing standard psychological strategies used by humans. So, the variant of the holistic approach presented here is the synthesis of the holistic and cultural-historical traditions in psychology. In accordance with this approach, the primacy of the holistic laws of psychological processes that are cultural-historical in nature is suggested. It is also possible to investigate these processes in normal and pathological conditions by considering their separate features in the context of the whole. It allows the application of a theoretical framework for facts and conclusions that also includes the achievements of elementarism.

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Disclosure statement

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