CLINICAL CASE

V.B. Nikishina, E.A. Petrash, E.Yu. Shuteeva,
N.V. Sharashkina, I.A. Zakharova

VISUAL AND SEMANTIC MEMORY FOR PARKINSON'S DISEASE: CLINICAL CASE ANALYSIS

DOI 10.25789/YMJ.2022.77.32

УДК 159.953:616.858

The aim of the work is to specify the mechanisms of transformation of the content to be memorized in the process of consolidation and reconsolidation in patients with Parkinson's disease (PD).

Materials and methods. The study involved three patients with PD (disease duration no more than three years; second stage) without cognitive impairment with mixed (akinetic-rigid-tremor), akinetic-rigid and tremulous forms of the disease. When studying the processes of consolidation-reconsolidation of visual-figurative and semantic memory in PD patients, a symbolic image and a text from the epic of the Indians of Canada were proposed as a stimulating material for memorization. The study of the processes of consolidation-reconsolidation was carried out sequentially: direct reproduction after presentation, reproduction after 40 minutes, after 4 hours, after 36 hours.

Results. When extracting visual-shaped information already at the stage of copying (storing information), a tendency appears to transform the symbol into a specific image ("bird", "owl"), which increases from stage to stage. As a result, there are not only distortions of the reproduced information up to its complete loss, but also simplification. The number of image details decreases, the accuracy of their reproduction decreases, and new elements that are absent in the original image are drawn. When the semantic content was reproduced immediately after presentation, the content loss was 25-27%. When playing text content after 40 minutes, the loss of semantic units was 50-52%. After 4 hours, the patients were able to reproduce 22-25% of the semantic content of the heard text. Revealed the suppression of verbal information in PD.

Conclusion. The presence of neurodegenerative changes due to a pathological process in PD significantly changes the quality (volume and accuracy) of the information retrieved or leads to its complete loss. In patients, regardless of the form of the disease (trembling, akinetic-rigid or mixed), a significantly smaller amount of information (both auditory-verbal and visual-shaped) is consolidated. This tendency is correlated with a pronounced distortion in the process of information extraction.

Keywords: visual-shaped memory, semantic memory, consolidation, reconsolidation, Parkinson's disease.

The main place in the clinical picture of Parkinson's disease (PD) is occupied by motor disorders (muscle rigidity, hypokinesia and rest tremor). However, non-motor manifestations also fall into the field of research interest: in particular, vegetative disorders, sensory disorders, pain, olfactory disturbances, increased sweating, changes in body mass index, gastrointestinal disorders, sleep disorders. Also, non-motor manifestations of PD include pain syndrome, cognitive and affective disorders [3,4,5,7,8].

The study of cognitive functions of people suffering PD, as well as specifically mnestic functions that are associated with the concept of non-motor symptoms, are presented in the works of Tweedy, J., Langer, K., McDowell, F. (1982); Flowers, K. A., Pearce, I. and Pearce, J. M. S. (1984); Weingartner H., Burns S., Diebel R., Le Witt P. A. (1984); Brown R.G., Marsden C.D. (1990); Gabrieli J. D. E., Singh J., Stebbins G.T., Goetz Ch.G. (1996); Hou J.-G.G., Lai E.C., (2007); Brefel-Courbon C., Ory-Magne F., Thalamas C., Payoux P., Rascol O., (2013); Barone P. et al. (2009); Berganzo K., Tijero B., González-Eizaguirre A., Somme J., Lezcano E., Gabilondo I., Fernandez M., Zarranz J.J., Gómez-Esteban J.C., (2016); Nikishina V.B., Shuteeva T.V., Zapesotskaya I.V., Petrash E.A. (2017); Siciliano M. et all (2021); Pourzinal D. et all (2021); Schmidt N. (2021).

According to the available data, cognitive impairment of people suffering PD significantly reduces the quality of their life [4]. The data from the study of non-motor symptoms in patients with PD indicate that there is no relationship between cognitive status (on the MMSE scale) and difficulties with attention and memory, which patients complained about. Patients noted violations of short-term memory, difficulty concentrating, as well as forgetting in everyday affairs. In tests for the study of memory, it was found that patients suffer more from difficulties of recall than recognition [7]. Unlike remembering and memorizing, recognition is a variant of "passive memory", when a person does not need to carry out purposeful activities in relation to the material. It is only necessary to make a choice between the available alternatives. Consequently, the greatest difficulties arise when active participation is required from the subject [8]. Recall is an active process, although it is also based on passive recognition [16]. It was also found that memory disorders in PD are similar to memory disorders in frontal lesions, which may be due to two factors. Firstly, a possible lesion of the frontal parts of the brain in PD. Secondly, there is a similar mechanism of dopamine deficiency in PD and in frontal localization of the defect [9]. Underestimation of cognitive functions in PD is associated with the severity of asthenization and depressive symptoms, but not with demographic or clinical features. Overestimation of cognitive functioning is associated with impaired frontal functioning [12].

A number of authors also note the connection of episodic memory impairment in PD with a violation in the functioning of hippocampal structures [11]. A general lack of the ability of patients with PD to use semantic signals as memory aids was also found [15]. Ann E. Taylor (1990) in his research indicates that patients with PD demonstrated a number of specific memory deficiencies: spontaneous organization of memorized material and increased sensitivity to interference during learning [14]. According to Schmidt N. (2021), there is an improvement in verbal and nonverbal memory 6 months after the start of cog-

Pirogov Russian National Research Medical University of the Ministry of Health of Russia, Moscow: **NIKISHINA Vera Borisovna** – Grand PhD in Psychology, prof., vbnikishina@mail.ru, ORCID ID: 0000-0003-2421-3652, **PETRASH Ekaterina Anatolievna** – Grand PhD in Psychology, associate Professor, prof., petrash@mail.ru, ORCID ID: 0000-0002-3177-088X, **ZAKHAROVA Irina Zakharova** – assistant, anwiw@yandex.ru, ORCID ID: 0000-0003-2299-1952; **SHUTEEVA Elena Yurievna** – student of KSMU, Kursk, ORCID ID: 0000-0001-9781-6169; **SHARASHKINA Natalia Viktorovna** – Candidate of Medical Sciences, Associate Professor, Head of Department, Pirogov Russian National Research Medical University, Moscow, sharashkina@inbox.ru, ORCID ID: 0000- 0002-6465-4842

nitive training in patients with PD [13].

Thus, patients with PD have violations in all parameters of strategic memory – free recall, self-ordered indication and temporary ordering. The patients had no violations in terms of non-strategic declarative memory (memory recognition test) and semantic memory (vocabulary tests and fluency of speech). It is noted that the use of associations significantly increases the percentage of recall.

Cognitive declines that can be observed in PD are due to a decrease in the amount of working memory, as well as a violation of the work of strategic memory. It is noted that a slowdown in perceptual-motor processing can lead to a decrease in the volume of working memory, which, in turn, is the result of dopaminergic insufficiency [12]. However, the question of the hierarchy of this system remains debatable.

The methodological foundations of our understanding of the processes of consolidation-consolidation of visual-figurative and semantic memory in PD were the provisions of the concept of working memory by B.B. Velichkovsky (2015). According to this concept, working memory is a system of cognitive processes that provide operational storage and processing of information. It has a heterogeneous structure, including components of operational storage and processing of information with various functional characteristics, as well as a system of functional mechanisms. Working memory is a multicomponent system, the functional organization of which ensures the implementation of the functions of storing and processing information [1,2].

The scheme of consolidation processes-consolidation of visual-figurative and semantic information is presented in Fig. 1.

The first stage is processing and storing information in working memory. Procedurally, the process of processing and initial preservation of information (both visual-figurative and semantic) is carried out through its direct reproduction. Visual-figurative information is reproduced through copying; semantic information is reproduced through oral reproduction of the text immediately after presentation by ear. In the process of processing, information is transformed into a primary mystical image (visual-figurative information) and semantic content (textual information). At the same time, it is natural to "collapse" the initial information while preserving its main (identifying) features. The storage of information in the RP is carried out using both short-term and long-term storage mechanisms. Short-term storage mechanisms are used for operational storage of information of particular importance for solving the current cognitive task.

After processing the information in the working memory system, it is stored in the form of transformed images in the structure of short-term memory. At the same time, it should be noted that short-term memory in this case acts as a kind of "transit" linking the stages of processing the initial information and its subsequent storage.

In the process of consolidation, which ensures the transition from short-term memory to long-term memory, there is also a transformation of stored information (both visual and semantic) in accordance with existing experience. The newly saved information is compared with the information already available in the long-term information storage. The result of the comparison is the fixation of key (object about significant identification) features in relation to the information already available in the experience (long-term storage). Long-term storage mechanisms are used to store information activated when solving a current cognitive task.

The subsequent extraction of information (referred to as the process of reconsolidation) is carried out from a long-term storage. At the same time, the information strengthened in the previous experience (both visual-figurative and semantic) is initially reconsolidated, which is transformed in the process of extraction taking into account the fixed object-significant identification features.

Any violations of working memory lead to a reduction in a person's ability to process information, make suboptimal decisions and, in general, to a decrease in adaptive potential.

Despite the fact that the analysis of clinical cases illustrates only the motor segment of this nosology (differentiation of the forms of the disease by the predominant clinical manifestations of motor disorders), it is in this segment that the presence of cognitive and mnemic features has not been investigated.

The aim of the study is to specify the mechanisms of transformation of the content to be memorized in the process of consolidation and reconsolidation in patients with PD.

Organization and methods of research. Under observation were 3 patients diagnosed with G20 "Parkinson's disease" (according to ICD-10), the average duration of the disease was 3.2 ± 0.29 years. All patients had secondary vocational education (technical profile). Levodopa preparations were received as a basic treatment (the average daily dose was 594.2+ 236.2 mg). The criteria for selecting patients for the analysis of specific clinical cases were: the age of patients from 60 to 65 years (the average age was 63.4 ± 1.49 years); male patients; the duration of the disease is not more than three years; clinical manifestations at the time of the study correspond to the second stage of PD (according to the Hen

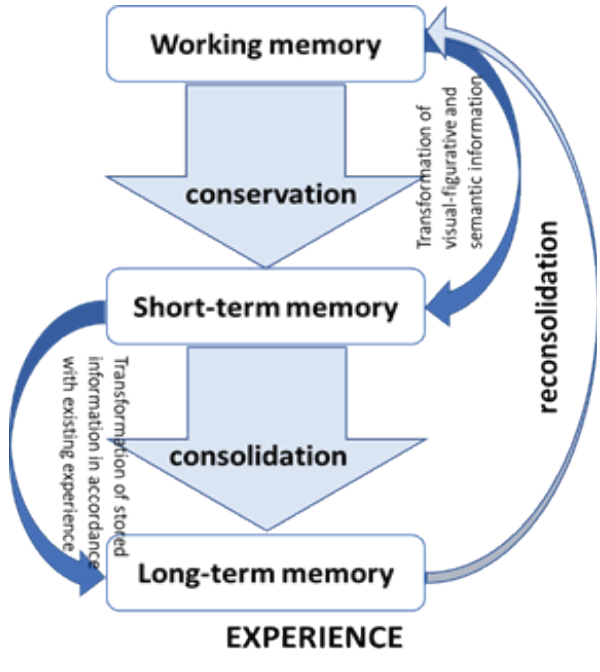


Fig. 1. Scheme of consolidation-deconsolidation processes of visual-figurative and semantic information

and Yara scale); absence of pronounced cognitive disorders (which in quantitative terms corresponds to indicators of at least 23 points on the MMSE scale). The PSP patient was diagnosed with a mixed (akinetic-rigid-tremulous) form of PD. The GAB patient was observed with an akinetic-rigid form. A tremulous form of PD was detected in an LNP patient.

At the first stage, the clinical examination included an assessment of somatic and neurological status. The degree of cognitive disorders was determined using the scale of a brief study of mental status (Mini-mental State Examination -MMSE).

The neuropsychological status was assessed by the neuropsychological research procedure, which includes a qualitative and quantitative analysis. The quantitative assessment was carried out according to the developed 0-3 scale (L. I. Wasserman, S. A. Dorofeeva, Ya. A. Meerson, 1997). The quantitative assessment was carried out according to the indicators "pace", "accuracy", "differentiation", where the dynamic component of activity was evaluated in the indicator "pace", in the indicator "accuracy" – operational, and in the indicator "differentiation" – motivational.

The neuropsychological status was assessed by the neuropsychological research procedure, which includes a qualitative and quantitative analysis. The quantitative assessment was carried out according to the developed 0-3 scale (L. I. Wasserman, S. A. Dorofeeva, Ya. A. Meerson, 1997). The quantitative assessment was carried out according to the indicators "pace", "accuracy", "differentiation", where the dynamic component of activity was evaluated in the indicator "pace", in the indicator "accuracy" – operational, and in the indicator "differentiation" – motivational.

The image and text from the epic of the Indians of Canada were offered as incentive material.

The reason for choosing the image (Fig. 2) was the reliable absence of this material in previous experience (a letter of the ancient Greek alphabet resembling an owl). The symbolic image (symbol) included four parts: "head", "trunk with leg", "wing", "leg". Elements were highlighted in each part of the symbolic image (for example, the "head" part contains two elements - the head itself and the inner part in the form of a "tick").

The instruction sounded as follows: when examining the image memory at the copying stage: "You have a certain image in front of you. Please copy it according to the sample." Then (after 40 minutes, 4 hours, 36 hours) the patients were given a deaf instruction: "Remember, we copied the image with you, draw it now, please, as you remember, as close as possible to the original. The evaluation of figurative memory was carried out according to four criteria: the integrity of the figure, the number of losses, the number of distortions, the number of stored elements.

The text from the epic of the Indians of Canada, presented in Russian, contained 79 semantic units (33 sentences, 1427 characters, 295 words). Semantic units are grammatical forms characterized by semantic content and implemented in various combinations of nouns as the main linguistic form with other forms (adjectives, verbs, pronouns). In the study of semantic memory, patients were offered the following instruction: "Now I will read the text to you. Listen to it and retell it as close to the text as possible." When the patient repeated the instruction, the text was not offered, it was suggested to recall the text without additional reliance on the stimulus. The evaluation of semantic memory takes place according to the criteria: the number of preserved sentences, the number of preserved semantic units, the number of distortions of sentences, the number of distortions of semantic units, the number of violations of the sequence of sentences, the number of violations of the sequence of semantic units. The following categories were taken as semantic units: object and attribute (who), object and time (when), object and action (what they did), object and place (where), as well as cause-and-effect relationships. To register the received data, a semantic map was developed and used, which made it possible to qualify errors in more detail and visually (two forms of errors were distinguished: replacement errors and loss errors).

The research results. As a result of the study of the processes of consolidation, deconsolidation of figurative memory, the following features were identified.

At the stage of copying a symbolic image, the transformation from a symbolic image to a figurative one is recorded as a general trend, regardless of the types of PD. The transformation of a symbolic image into a figurative one at the stage of memory preservation leads to the fact that a distorted image is initially fixed.

Minimal distortions of the visual image during copying were revealed in the akinetic-rigid form of PD (the GAB patient) (Fig. 3A). The patient correctly reproduces the number of image details, their size and relative location relative to each other. At the same time, it should be noted the overlap of lines, which is a specific feature of this particular form of PD (due to the general rigidity at the level of the graphical function, the patient repeatedly draws one line). In an LNP patient with a tremulous form of PD (Fig. 3B) already during rendering, there is a loss of image elements and distortion of their size. At the same time, the general outline of the image is preserved. In a patient with a mixed form of PD (Fig. 3B), we note already at the stage of drawing both the distortion of the silhouette as a whole and its individual details. A characteristic feature of rendering in this form is the repeated tracing of each of the image lines and the introduction of new image details that are absent in the original stimulus material.

At the next stage, when reproducing the visual image from memory 40 minutes after presentation, further distortion of the stored concretized image was revealed, mainly concerning the number of elements. As a general trend in three patients, regardless of the form of the disease, a simplification of the image was revealed, characterized by distortion of parts of the image with a decrease in the number of elements. All three patients revealed new (introduced) elements located mainly in the lower part of the image. Patients draw new elements in parts of the image, while the original elements present in the stimulus image are absent in the drawings of patients with PD (Fig. 4-I).

In the akinetic-rigid form of PD (GAB patient), new introduced elements are fixed in the form of additional lines partially or completely superimposed on each other (Fig. 4-I-A). These manifestations (overlapping image lines with each other under strong pressure) are a consequence of the manifestation of rigidity. With the tremulous form of PD (LNP patient), simplification of elements and their row-by-row arrangement is noted (simplified elements are depicted next to each other). The lines of the image partially intersect. As a result of the tremor, attempts to overlay lines lead to their multiplicity – some elements are drawn with a multiple

Fig. 2. Stimulus image for the study of implicit memory

line (Fig. 4-I-B). With a mixed form of PD (PSP patient), the patient adds new elements to the image, bringing them from the already existing image of the bird's memory. At the same time, parts of the image are clearly highlighted, such as the head, ears, beak and eyes, wing, paws (with an emphasis on the fingers) (Fig. 4-I-C). The pressure is uneven.

Memory reproduction of a figurative stimulus after 4 hours by patients with different forms of PD indicates that there is a transformation of the memory image (its reconstruction, according to Bartlett's terminology) with the loss of the original elements: combining several elements into one (with a tremulous form in a patient with LNP); introducing new additional elements (with akinetic-rigid and tremulous forms of PD). As a general trend in three patients, regardless of the form of the disease, a simplification of the image was revealed, characterized by a decrease in the number of parts with an increase in the number of elements: an increase in the number of lines that significantly enhance the boundaries of the image details (Fig. 4-II).

With a mixed form of PD, the simultaneous superimposition of new image elements that are absent in the original stimulus is clearly recorded (Fig. 4-II-B).

After 36 hours, regardless of the shape of the PD, there is a complete loss of the shape of the original symbolic information: the number of parts decreases to one (the figure itself); the number of parts also decreases to 1-2 (Fig. 4-III). At the same time, the trends identified during previous reproductions are preserved: layering of lines in akinetic-rigid (GAB patient) and mixed (PSP patient) forms of PD, one-linearity of the image in the tremulous form of PD (LNP patient). At the same time, it should be noted that in a patient with GAB and LNP, the number of details of the reproduced image is reduced to one (Fig. 4-III-A, 4-III-B), the patient has PSP - up to two (Fig. 4-III-C).

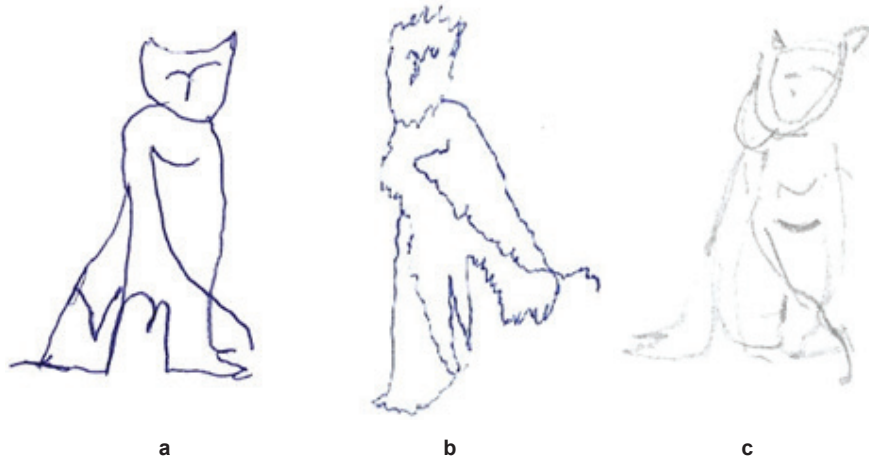
Thus, when extracting figurative information in patients with PD, regardless of the form of the disease (tremulous, akinetic-rigid, mixed), the transformation of the image into a specific image was established. It is established that already at the stage of copying (reproducing a symbol according to a visual pattern), characterizing the process of preserving information, there is a tendency to transform the symbol into a specific image ("bird", "owl"), which increases from stage to stage. As a result, there are not only distortions of the reproduced information up to its complete loss, but also simplification. There is a decrease in the number of image details, the accuracy of their reproduction decreases (the number of elements; their location both in the overall composition of the image and relative to each other; the shape and size of the elements are distorted), new elements that are missing from the original image are drawn.

When studying the processes of consolidation, deconsolidation of semantic memory in patients with PD, a text evaluation map was built for each patient, reflecting the quality of reproduction of semantic units in relation to their distribution according to text sentences (Fig. 5).

As a result of studying the processes of consolidation, reconsolidation of semantic memory in patients with PD, a complete loss of the semantic content of verbal information was revealed. When directly reproducing the text, a GAB patient with an akinetic-rigid form of PD significantly reduced the original text presented, while retaining its main idea. The loss of semantic content was 25%. It should also be noted that there are no distortions in the retelling of the text immediately after its presentation. In an LNP patient with a tremulous form of PD, when reproducing the text immediately after presentation, the loss of semantic content was 26.2%. The main idea of the text was also conveyed. During reproduction, the patient built simple short, mostly single-base sentences consisting of no more than four words. Distortions of semantic content were also not revealed. A PSP patient with a mixed form (akinetic-rigid-tremulous) PD during direct reproduction of the text demonstrated distortion of some semantic units (24 out of 79 original ones with adequate transmission of the general meaning of the reproduced text. At the same time, the loss of semantic content was 27%. It should also be noted, as with the tremulous form, the simplification of language structures: the patient retells the test using simple non-extended sentences, which, in turn, makes it difficult to convey semantic content.

40 minutes after the presentation of the text to patients, regardless of the form of PD, further loss of semantic content should be indicated. The number of semantic units was: in a PSP patient - 50.4%; in a GAB patient - 51.7%; in an LNP patient - 51.4%. With a mixed form of PD (patient PSP), the semantic content of only part of the sentences that make up the retelling reflected the semantic content of the original text (6 sentences). The remaining semantic units, describing mainly objects and actions occurring with them, have been distorted or replaced. A GAB patient with an akinetic-rigid form of PD in the process of retelling retained the original semantic content of the reproduced text in 11 sentences. But at the same time, it should be noted the repeated (two or three times) perseverative repetition of sentences. With the tremulous form of PD (LNP patient), the number of sentences in the retelling is 10, while descriptions of objects are predominant with minimal indication of their actions. The causal relationship is indicated by the patient only once. Distortions and substitutions of semantic content are recorded.

After 4 hours, patients, regardless of the form of PD, were able to reproduce 22-25% of the semantic content of the text they heard (PSP - 22.7%; GAB - 23.4%; LNP - 24.8%). At the same time, the enumeration of objects and their actions prevailed in the retelling. The substitution of objects presented in the source



a b c

Fig. 3. Images of patients with PD in sketches. In Fig. 3 and 4: a - a GAV patient (an akinetic-rigid form of PD); b - a LDL patient (a tremulous form of PD); c - a PSP patient (a mixed form of PD)

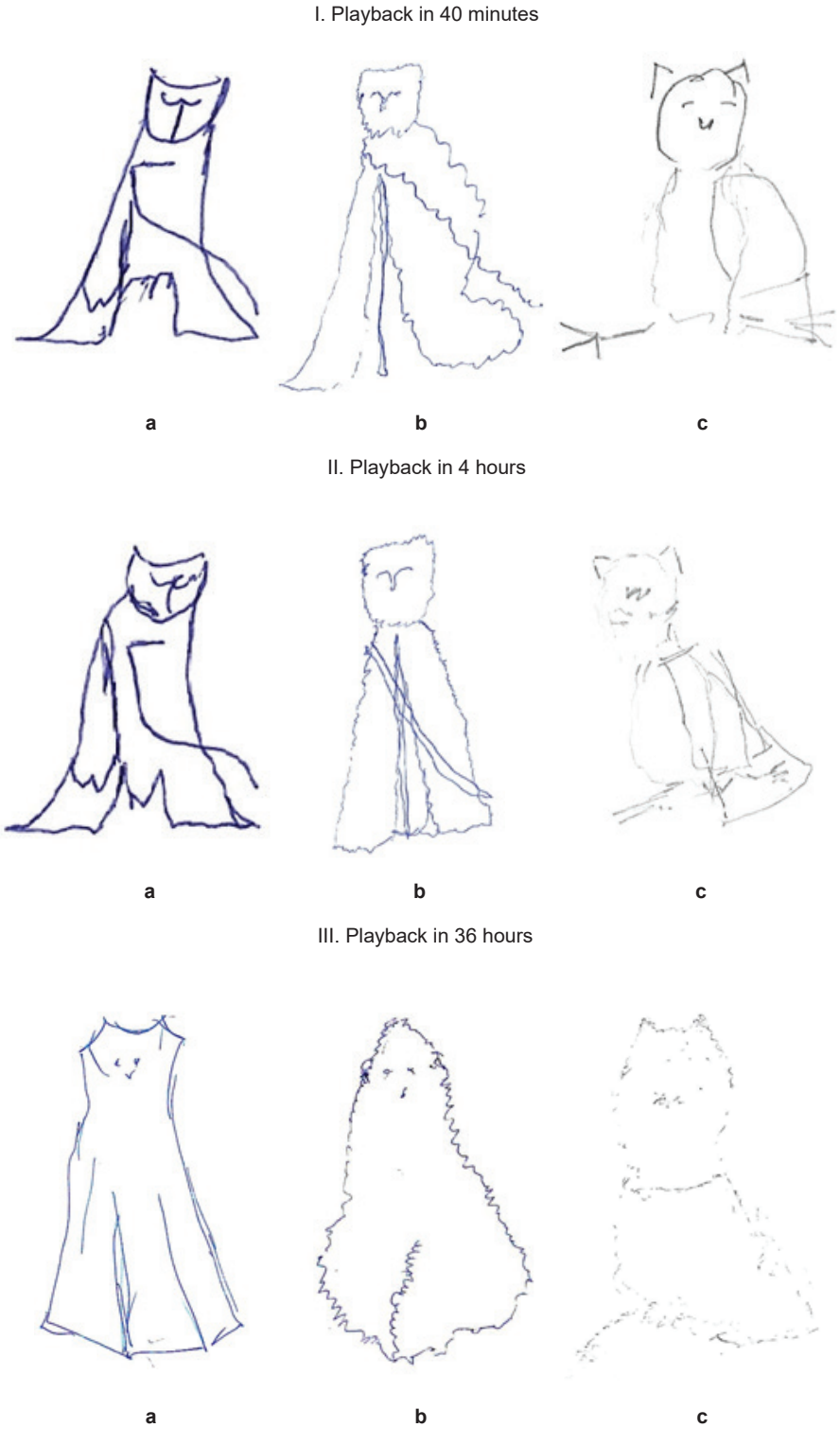


Fig. 4. Images of patients with PD in 40 min, 4h, 6h

text with their own content was clearly recorded in all three patients. The texts of the patients' retelling consist of simple monosyllabic sentences, including only the subject and predicate. At the same time, the construction of sentences is also not grammatically correct: inconsistency of sentence members is noted. With mixed (PSP) and akinetic-rigid (GAB) forms of PD, a perseverative tendency was revealed. When reproducing the text, patients repeatedly reproduce the composed sentences (the multiplicity is up to four repetitions). There were no causal relationships in full.

After 36 hours, all three patients with PD had a complete loss of semantic content. A PSP patient with a mixed form of PD as a retelling presented a text containing 8 simple, non-expanded single-base sentences that have nothing in common with the original text. 4 new objects have been introduced, and proposals have been submitted for their actions. There are no causal relationships in the retelling. In the akinetic-rigid form of PD (GAB patient), the text of the retelling contained 11 sentences, three of which were repeated twice each. The sentences were also simple, but, unlike the mixed form, had minor terms and were common. At the same time, there were no semantic units represented in the source text. There are also no causal relationships. With the tremulous form of PD (LNP patient), the volume of retelling was 9 simple monosyllabic unrolled sentences, with a minimal description of the actions of objects. At the same time, the semantic content of the source text in the retelling is missing in full. However, it should be noted the replacement (distortion) of the semantic content of the source text. Unlike the previous two patients, LNP describes three causal relationships in its retelling.

At the first stage, immediately after the presentation, the loss of content was 25-27%. Patients lost a significant part of semantic units when retelling the text. When reproducing text content after 40 minutes, the loss of semantic units was 50-52%. After 4 hours, patients were able to reproduce only 22-25% of the semantic content of the text they heard. At the same time, the enumeration of objects and their actions prevailed in the retelling. There were no causal relationships in full. After 36 hours, we can state the complete loss of 100% of the semantic content. The errors of substitutions were predominant in this case. To present a retelling, patients "invented" objects, described their actions and built causal relationships. But even when reproducing the "invented" text, the number of words (82 compared to the original 295) and semantic units (22 compared to the original 79) was significantly less than the original version. Patients demonstrated monosyllabic recollection, unrelated to the text. The results obtained indicate the suppression of verbal information in patients with PD.

Thus, the described clinical cases in the aspect of the peculiarities of the implementation of the process of consolidation-reconsolidation of visual-figurative and semantic memory allow us to identify and describe general and specific trends, taking into account the form of the disease in PD (Fig. 6).

As a general trend, in three patients with PD, regardless of the form of the dis-

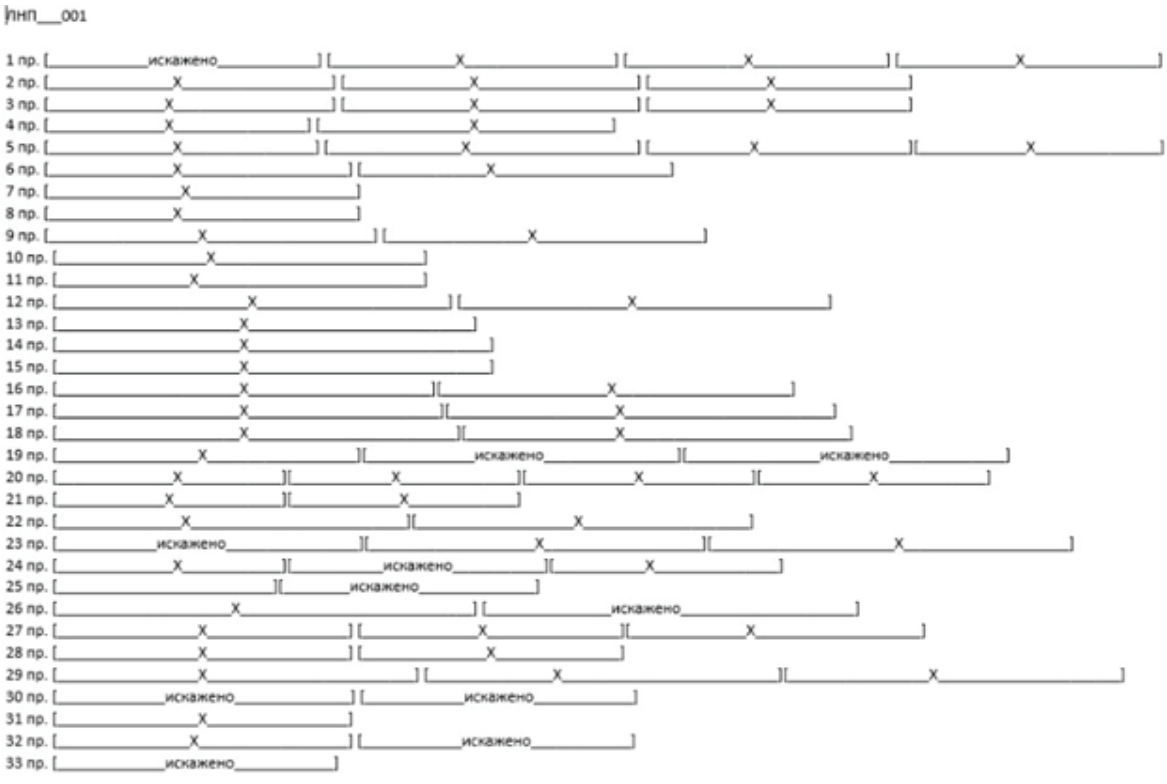


Fig. 5. An example of the text evaluation card (playback in 36 hours)

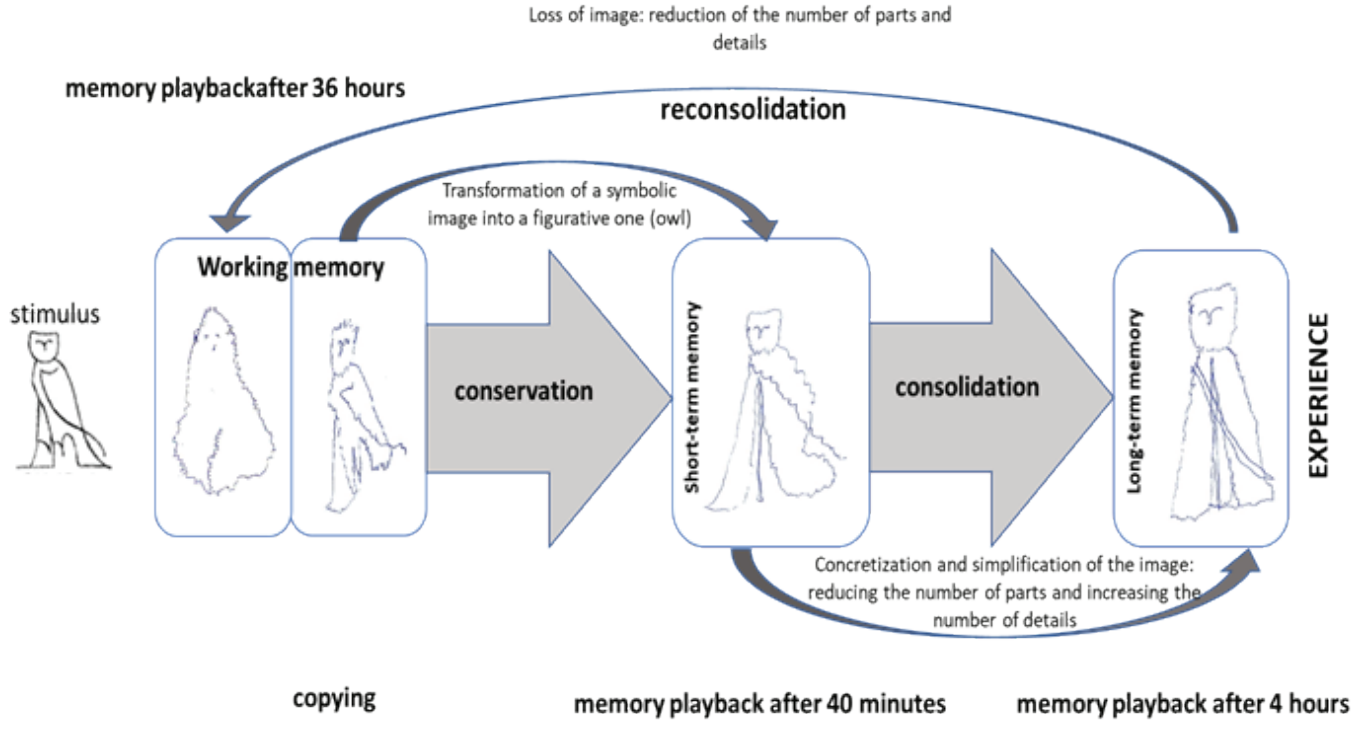


Fig. 6. The scheme of the study of consolidation processes-consolidation of visual-figurative and semantic information in PD

ease, in the absence of cognitive impairment, a complete loss of both figurative and semantic content is recorded. This indicates a violation of the processes of consolidation-reconsolidation of memory traces in PD. This trend may be due to the fact that already at the stage of information preservation (when copying a symbol from a visual sample, as well as when directly reproducing textual semantic content), its distortion occurs. A symbolic image is reduced to a specific image based on the principle of finding similarities with images of representations already available in experience and stored in long-term memory. Semantic content is also distorted by substitution of objects and transformation.

The presence of neurodegenerative changes due to the pathological process in PD significantly changes the quality (volume and accuracy) of the extracted information or leads to its complete loss. In patients, regardless of the form of the disease (tremulous, akinetic-rigid or mixed), a significantly smaller amount of information (both auditory and visual-figurative) is consolidated. This trend is correlated with a pronounced distortion in the process of extracting information. Taking into account the level and profile of education of the described patients, as well as the duration of their involvement in professional activity (the duration of the period from the moment of receiving vocational education to the manifestation of PD), it should be noted that manual (motor) memory is mainly activated during secondary vocational education of a technical profile. Consequently, this type of memory, which is specialized, was not included in the study.

In practical terms, the results obtained should be considered as tasks for inclusion in the processes of social rehabilitation of the mnemic component in the processes of consolidation and reconsolidation.

Reference

1. Velichkovsky B.B. Rabochaya pamyat' cheloveka: Struktura i mekhanizmy [Human working memory: structure and mechanisms]. Moscow: Kogito Center, 2015; 247 p (In Russ.).

2. Velichkovsky B.B. Testirovanie rabochej pamyati: ot prostogo k slozhnomu i snova k prostomu [Testing working memory: from simple to complex and again to simple]. Teoreticheskaya i eksperimental'naya psihologiya [Theoretical and experimental psychology]. 2014; (2): 133-142 (In Russ.).

3. Nikishina VB, SHuteeva TV, Zapesockaya IV, Petrash EA. Sub"ektivnaya ocenka boli v strukture nemotornyh proyavlenij bolezni Parkinsona [Subjective assessment of pain in the structure of non-motor manifestations of Parkinson's disease]. Kurskij nauchno-prakticheskij vestnik «CHelovek i ego zdorov'e [Kursk scientific and practical bulletin «Human and his health]. 2017; 4: 67-76 (In Russ.).

4. Barone P., Antonini A., Colosimo C, Marconi R., Morgante L., Avarello T. P., Bottacchi E., Cannas A., Ceravolo G., Ceravolo R., Cicarelli G., Gaglio R. M., Giglia R. M., Iemolo F., Manfredi M., Meco G., Nicoletti A., Pederzoli M., Petrone A., Pisani A., Pontieri F. E., Quatrale R., Ramat S., Scala R., Volpe G., Zappulla S., Bentivoglio A. R., Stocchi F., Trianni G., Dotto P. D on behalf of the PRIAMO study group Barone P. The Priamo Study. A Multicenter Assessment of Nonmotor Symptoms and Their Impact on Quality of Life in Parkinson’s Disease. *Movemant Disorders.* 2009; 24 (11): 1641-1649. DOI: 10.1002/mds.22643.

5. Berganzo K., Tijero B., González-Eizaguirre A., Somme J., Lezcano E., Gabilondo I., Fernandez M., Zarranz J.J., Gómez-Esteban J.C. Motor and nonmotor symptoms of Parkinson's disease and their impact on quality of life and on different clinical subgroups. *Neurologia*. 2016; 31 (9): 585-591. DOI: 10.1016/j.nrleng.2014.10.016.

6. Brefel-Courbon C., Ory-Magne F., Thalamas C., Payoux P., Rascol O. Nociceptive brain activation in patients with neuropathic pain related to Parkinson's disease. *Parkinsonism and Related Disorders.* 2013; 19 (5): 548-552. DOI: 10.1016/j.parkreldis.2013.02.003.

7. Brown R. G., Marsden C. D. Cognitive function in Parkinson's disease: from description to theory. *Psychology, Medicine. Trends in Neurosciences*. 1990; 13 (1): 21-29. DOI: 10.1016/0166-2236(90)90058-I.

8. Flowers K. A., Pearce I., Pearce, J. M. Recognition memory in Parkinson's disease. *Neurology, Neurosurgery and Psychiatry*. 1984; 47: 1174-1181. DOI: 10.1136/jnnp.47.11.1174

9. Gabrieli J. D. E., Singh J., Stebbins G. T., G. Goetz C. G. Reduced Working Memory Span in Parkinson's Disease: Evidence for the Role of a Frontostriatal System in Working and Strategic Memory. *Neuropsychology*. 1996; 10 (3): 322-332. DOI: 10.1037/0894-4105.10.3.321

10. Hou J.-G.G., Lai E.C. Non-motor Symptoms of Parkinson's Disease. *International Journal of Gerontology*. 2007; 1(7): 53-64. DOI: 10.1016/S1873-9598(08)70024-3

11. Pourzinal D., Yang J. H. J., Bakker A., McMahon K. L., Byrne G. J., Pontone G. M., Zoltan Mari Z. Dissanayaka N. N., Hippocampal correlates of episodic memory in Parkinson’s disease: A systematic review of magnetic resonance imaging studies. *Journal of Neuroscience Research*. 2021; 99 (9): 2097-2116. DOI: 10.1002/jnr.24863.

12. Siciliano M., Trojano L., Micco R. D., Sant’Elia V., Giordano A., Russo A., Passamonti L., Tedeschi G., Chiorri C., Tessitore A. Correlates of the discrepancy between objective and subjective cognitive functioning in non-demented patients with Parkinson’s disease. *Journal of Neurology*. 2021; 268: 3444-3455. DOI: 10.1007/s00415-021-10519-4

13. Schmidt N., Tödt I., Berg D., Schlenstedt C., Folkerts A-K., Ophey A., Dimenshteyn K., Elben S., Wojtecki L., Liepelt-Scarfone I., Schulte C., Sulzer P., Eggers C., Kalbe E., Wit K. Memory enhancement by multidomain group cognitive training in patients with Parkinson’s disease and mild cognitive impairment: long-term effects of a multicenter randomized controlled trial. *Journal of neurology.* 2021; 268: 4655- 4666. DOI: 10.1007/s00415-021-10568-9

14. Taylor A. E., Saint-Cyr J. A., Lang A.E. Memory and Learning in Early Parkinson’s Disease: Evidence for a “Frontal Lobe Syndrome”. *Brain and cognition*. 1990; 13 (2): 21l-232. DOI: 10.1016/0278-2626(90)90051-O

15. Tweedy J., Langer K., & McDowell F. The effect of semantic relations on the memory deficit associated with Parkinson’s disease. *Journal of Clinical Neuropsychology.*1982; 4 (3): 235-247. DOI: 10.1080/01688638208401132

16. Weingartner H., Burns S., Diebel R. and Le Witt P.A. Cognitive impairments in Parkinson's disease: Distinguishing between effort-demanding and automatic cognitive processes. Psychiatry Research.1984; 11 (3): 223-235. DOI: 10.1016/0165-1781(84)90071-4