

## CONSOLIDATION AND RECONSOLIDATION OF VISUAL AND SEMANTIC MEMORY IN PARKINSON'S DISEASE

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Cognitive and mnemonic impairments have a significant negative impact on the quality of parkinsonian patients' life. Memory impairment causes changes in the mechanisms of information processing. The aim of this study was to investigate the characteristics of transformations undergone by memorized visual and semantic content during memory consolidation and reconsolidation in patients with Parkinson's disease. The study was conducted on 32 male patients with PD (ICD code: G20). Among the patients, 9 had rigidity/bradykinesia-dominant PD, 11 had tremor-dominant PD, and 12 suffered from a mixed type of PD. Short-term memory span was assessed using the 10 words and the visual memory tests proposed by Luria. As stimulus materials we used a symbolic representation of the old Greek letter resembling an owl and a translated excerpt from a Canadian aboriginal epic. Regardless of the PD form, the quality of the memorized information was either altered or completely lost. The mechanisms underlying such transformations differed quantitatively depending on the PD form. Transformation of the memorized information occurred in the conditions of both incidental and deliberate memorization and was represented by distortions (substitution of the original content with confabulations) and simplifications of the structural and semantic organization. We consolidated significantly lesser amount of auditory verbal ( $p = 0.018$ ) and visual ( $p = 0.029$ ) information. This trend was consistent with the pronounced distortion of content during its retrieval.

**Keywords:** visual memory, semantic memory, deliberate memorization, incidental memorization, consolidation, reconsolidations, Parkinson's disease

**Author contributions:** Nikishina VB — study concept; interpretation and summarization of the obtained empirical data; Petrash EA — study concept; processing, interpretation and summarization of the obtained empirical data; Kuznetsova AA — interpretation and summarization of the obtained empirical data; Shuteeva TV — implementation of the experiment, collection of primary empirical data; Zakharova IA — implementation of the experiment, collection of primary empirical data.

**Compliance with ethical standards:** the study complied with the legislation on public health protection; informed consent was obtained from all study participants (Protocol of the Ethics Committee No. 207 dated April 19, 2021).

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## КОНСОЛИДАЦИЯ–РЕКОНСОЛИДАЦИЯ ЗРИТЕЛЬНО-ОБРАЗНОЙ И СЕМАНТИЧЕСКОЙ ПАМЯТИ ПРИ БОЛЕЗНИ ПАРКИНСОНА

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Когнитивные и мнестические нарушения играют существенную роль в снижении качества жизни пациентов с болезнью Паркинсона (БП). Нарушения памяти приводят к изменению (трансформации) механизмов переработки информации. Целью работы было изучить особенности трансформации зрительно-образного и семантического содержания, подлежащего запоминанию, в процессах консолидации и реконсолидации у пациентов с БП. Объем выборки составил 32 пациента мужского пола с диагнозом G20 «болезнь Паркинсона»: 12 пациентов со смешанной (акинетико-ригидно-дрожательной) формой, 9 пациентов с акинетико-ригидной формой и 11 пациентов с дрожательной формой болезни Паркинсона. Объем кратковременной памяти оценивали с помощью методик «10 слов» и «Зрительная память» А. Р. Лурия. Стимульный материал для экспериментального этапа исследования представлял собой символическое изображение буквы древнегреческого алфавита, напоминающего сову, а также текст из эпоса индейцев Канады на русском языке. Установлено, что вне зависимости от формы заболевания при БП фиксируется изменение качества запоминаемой информации либо ее полная потеря. Механизмы потери информации имеют качественные различия при разных формах заболевания. Трансформация сохраняемой информации при целенаправленном и при нецеленаправленном запоминании происходит либо в форме искажения (подмены исходного содержания конфабуляторным), либо в форме сокращения (упрощения структурно-семантической организации). Консолидируется значительно меньший объем информации как слухоречевой ( $p = 0,018$ ), так и зрительно-образной ( $p = 0,029$ ). Данная тенденция соотносится с выраженным искажением в процессе извлечения информации.

**Ключевые слова:** зрительно-образная память, семантическая память, целенаправленное запоминание, нецеленаправленное запоминание, консолидация, реконсолидация, болезнь Паркинсона

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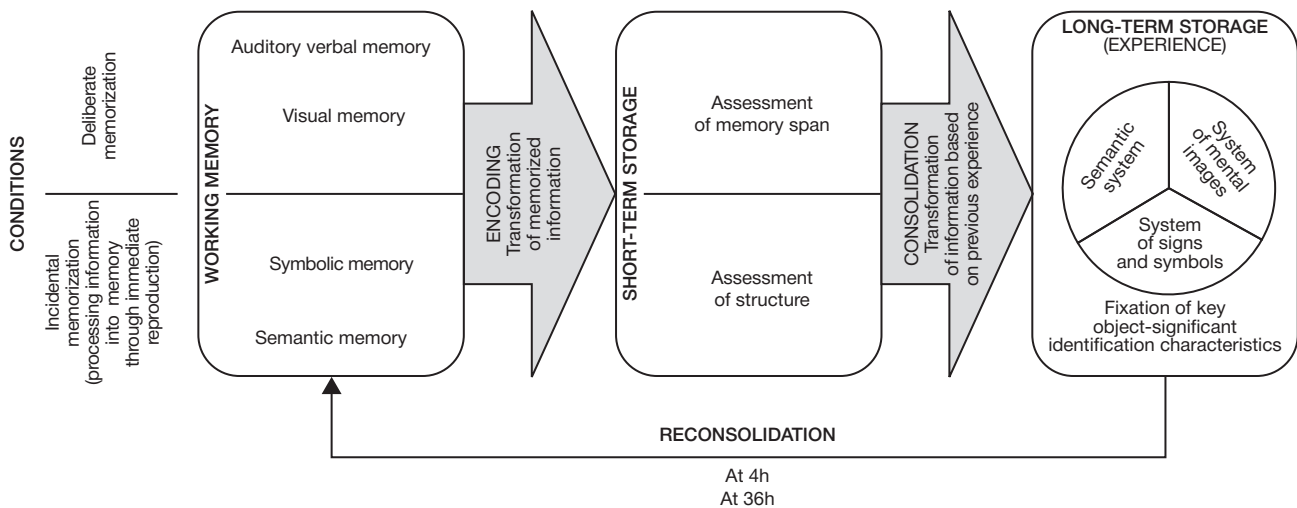


Fig. 1. Schematic representation of consolidation and reconsolidation of visual and semantic information

Parkinson's disease (PD) is an age-related progressive neurodegenerative disorder characterized by high rates of disability and poor prognosis. Being the second most common neurodegenerative disorder, PD poses a serious challenge to healthcare and society.

The diversity of clinical manifestations of PD is linked to the death of dopaminergic neurons in the striopallidum system. In addition to motor symptoms, which are highly common in parkinsonian patients, PD has varied non-motor manifestations, including autonomic and sensory dysfunction, pain, affective disorders, and cognitive impairment. The diversity of symptoms and the high rate of cognitive impairment diminish the quality of life of parkinsonian patients and their families and are the focus of clinical attention.

In all its diversity of forms and processes, memory has adaptive potential that maintains the quality of life in parkinsonian patients.

Studies of cognitive and, more specifically, mnemonic functions in PD patients have been implemented by Russian [1] and foreign [2–21] researchers.

Parkinsonian patients are reported to suffer a significantly declining quality of life [2]. No association has been found between the cognitive status of PD patients on the MMSE scale and attention/memory deficit experienced by the patients.

PD is characterized by a long preclinical stage lasting up to 20–30 years. The clinical manifestations of the disease appear when degeneration of substantia nigra neurons and striatal axons reaches 50–60% and 70–80%, respectively [11]. In addition to dopaminergic neurons in the striatum, dopaminergic neurons in other brain regions, including the tuberoinfundibular system, are affected. Disruption of the dopaminergic pathway in the striatum critically affects the continuous process of working memory updating [7]. Neurodegeneration begins in the dorsal vagal and the anterior olfactory nuclei and then spreads sequentially to the locus coeruleus, substantia nigra and basal regions of the anterior brain; it is only in the advanced stages of the disease that neurodegeneration hits the neocortex, especially the limbic and the multimodal association cortices of the frontal and temporal lobes [18].

The underlying mechanism of PD involves intraneuronal aggregation of pathological alpha-synuclein, the primary component of Lewy bodies. In neurodegenerative disorders, chronic activation of the microglia and astrocytes results in reactive microgliosis and astrogliosis. In PD, oligodendrocytes

are also involved, which suggests that PD affects signal transmission in the brain. Gliosis caused by neurodegeneration blocks transmission of nerve impulses and impedes formation of new neuronal connections, which form the morphological and functional basis of memory consolidation and reconsolidation. Impairment of temporal processing is associated with neuronal apoptosis, which hampers information transfer from short-term to long-term memory and back [6]. In addition to the overall visuospatial dysfunction, patients with PD have verbal memory impairment. A direct association has been established between the duration of the disease and visuospatial short-term memory impairment [13].

The methodology of our research into consolidation and reconsolidation of visual and semantic memory in parkinsonian patients is premised on the concept of working memory developed by Velichkovsky BB (2015). Working memory (WM) is a system of cognitive processes that enable temporary information storage and processing. Being structurally heterogeneous, WM consists of multiple components for temporary information storage and processing that have various functional characteristics; WM also includes a system of functional mechanisms. [20, 21]. WM is not stimulus-specific, and its content is determined by the type of memory involved in input processing. Based on the functional outcome, memory can be classified into nonverbal (visual, symbolic and auditory) and semantic. Based on the type of regulation, memorization can be classified into deliberate (intentional) and incidental (unintended).

Regardless of whether memorization is deliberate or incidental, incoming information is simplified (compressed) at the encoding stage. During processing, information is converted into a primary mnemonic image or primary semantic content. In WM, storage is implemented by means of short-term and long-term storage mechanisms. Short-term storage mechanisms are used for temporary storage of information essential for solving a current cognitive task [1, 2].

Fig. 1 shows schematic representation of consolidation and reconsolidation of visual and semantic information.

During memory consolidation, short-term memories are converted into long-term memories, and the retained information, be it visual or semantic, undergoes further transformations in accordance with the previous experience. Freshly learned experiences are compared to "old" information stored in the long-term memory. Long-term memory harbors information that can be re-activated to solve a current

task. Consolidated memories are retrieved (i.e. undergo reconsolidation) from long-term memory, which comprises a system of images, symbols, signs, and a semantic system organized into a coherent experience. Both visual and semantic information learned in the previous experience undergoes reconsolidation and is transformed in accordance with fixed object-significant identification characteristics.

Any WM impairment reduces human capacity to process information or make an optimal decision and lessens the overall adaptive potential [1, 2].

The aim of this study was to investigate the characteristics of visual and semantic content transformation during memory consolidation and reconsolidation in patients with PD. We hypothesize that information acquired through either deliberate or incidental memorization by such patients is distorted or completely lost in the absence of pronounced cognitive dysfunction and regardless of the PD form (rigidity/bradykinesia-dominant, tremor-dominant or mixed).

## METHODS

A total of 32 male patients diagnosed with Parkinson's disease (ICD disease code: G20) were enrolled in the study. Clinical manifestations assessed on the Hoehn and Yahr scale were consistent with stage 2 of the disease at the time of this study. The participants were stratified into 3 groups by the form of the disease: group 1 ( $n = 12$ ) included patients with mixed PD, group 2 ( $n = 9$ ) comprised patients with rigidity/bradykinesia-dominant PD, and group 3 consisted of patients with tremor-dominant PD ( $n = 11$ ). Inclusion criteria: age of 60–65 years (mean age:  $62.4 \pm 2.1$  years), duration of PD no more than 3 years (mean duration:  $2.2 \pm 0.57$  years), absence of cognitive disorders (MMSE score: at least 24 points). All patients were receiving levodopa therapy at baseline (average dose:  $594.2 \pm 236.2$  mg a day).

Exclusion criteria: severe chronic disorders, TB, viral hepatitis, HIV, and other recurrent infections.

The study was conducted in 3 stages. In the first stage, the patients underwent a physical and neurological examination.

In the second stage, the storage capacity of explicit (intentional) short-term visual and auditory verbal memory was assessed. The span of auditory verbal memory was assessed using a Luria memory words test. Briefly, the patient was read a list of 10 semantically unrelated monosemantic one- and two-syllable words denoting concrete objects and was asked to recall the words immediately after presentation. The procedure was repeated 5 times. The following parameters were recorded: the number of correctly recalled words, the number of repeated words during each recall round, and the number of words that were not on the list. Short-term visual memory span was assessed using a Luria visual memory method. Briefly, the patient was shown a table of 16 cells; each cell contained an outline drawing of an object (a geometric shape or an item). The patient was given 2 min to look at the images. Then, the patient was asked to name the objects they were able to memorize. The procedure was repeated 5 times. The following parameters were recorded: the number of correctly reproduced visual stimuli, the number of repeated objects during each recall round, and the number of new words that were not present in the original table.

In the third stage, we empirically studied consolidation and reconsolidation of explicit and implicit visual and semantic memory types in patients with PD. The methodology for this stage was adopted from Bartlett's experiment on memory

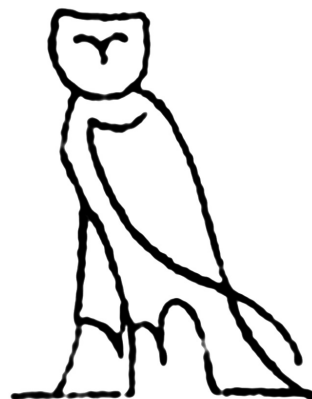


Fig. 2. A stimulus drawing selected for the study of implicit memory

reconstruction during its active retrieval. Each patient was instructed about the experiment individually.

During the experiment, the patient was presented with a visual stimulus — a symbolic drawing shown in Fig.2. This particular stimulus was reliably unfamiliar to the patients, hence its choice. The drawing was a letter from the old Greek alphabet that resembled an owl. The symbolic drawing (symbol) had 4 parts: a head, a body, a wing and a leg. Each of these parts consisted of smaller elements, e.g. the head consisted of 2 elements: the head itself and a tick, etc.

The stimulus material for the study of semantic memory was a Russian translation of an excerpt from a Canadian aboriginal epic. The excerpt contained 79 units of meaning (33 sentences, 295 words, a total of 1,427 characters). The units of meaning were defined as grammatical forms charged with semantic content and implemented in different combinations of nouns (the central lexical units of the language) with other forms (adjectives, verbs, pronouns). Semantic memory was assessed using the following parameters: the number of correctly reproduced sentences, the number of correctly reproduced semantic units, the number of incorrectly reproduced sentences, the number of semantic errors, the number of errors in the order of sentences, the number of errors in the order of semantic units. The data were collected into a specially designed semantic card.

For immediate reproduction of the presented stimulus material, the patients were instructed to draw a copy of the original visual stimulus. Next, the patients were asked to retell the Indian story immediately after hearing it. Reproduction ensured that information was retained. Then, the patients were asked to draw the presented visual stimulus from memory and to retell the text 40 min, 4 h and 36 h after the initial presentation.

Statistical analysis was conducted using descriptive (means and standard deviations) and comparative (the nonparametric Mann-Whitney U and Wilcoxon sign-ranked tests) statistics. Absolute values were analyzed.

## RESULTS

The experiment revealed that the span of short-term visual and auditory verbal memory was reduced in parkinsonian patients regardless of the PD form. The graphic representation of the results in Fig. 3 reflects the number of reliably correct responses following presentation of the verbal stimuli.

The comparative analysis of short-term auditory verbal and visual memory aided by the non-parametric paired Mann-

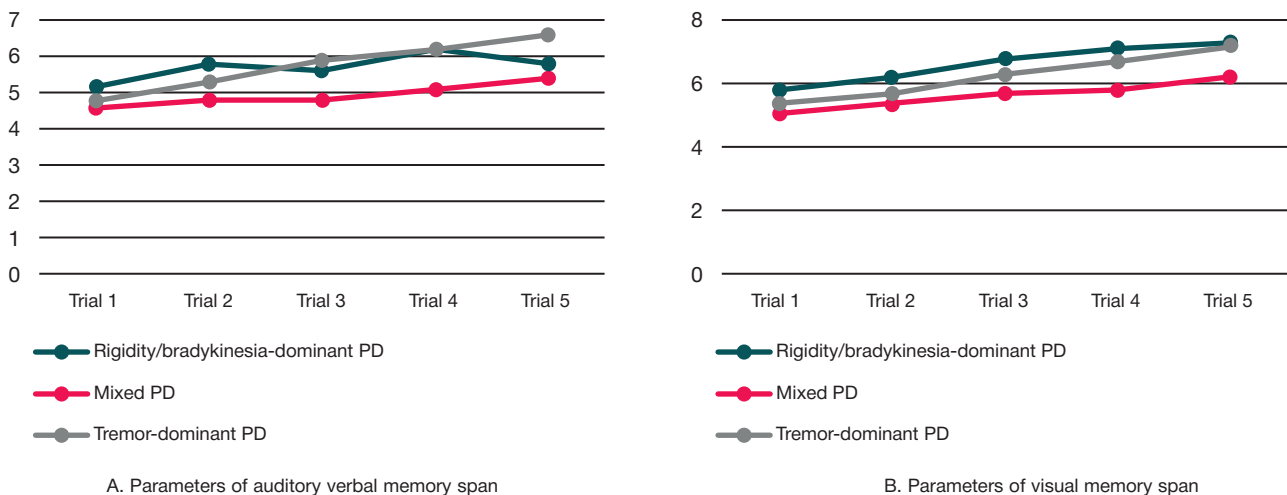


Fig. 3. Auditory verbal and visual memory curves for patients with different forms of PD

Whitney U test detected no significant differences ( $p \leq 0.0$ ) in the span of the studied short-term memory types between the patients with different forms of PD. However, there were some qualitative differences.

Errors made by the patients with bradykinesia-dominant PD were mostly perseverative reproduction of the actual visual and auditory verbal stimuli without confabulation (addition of new information, false memories). The patients with the mixed form of PD made a lot of confabulation errors, i.e. repeatedly reported words and objects that were absent in the initial presentations. The proportion of such additions was as high as  $51.18 \pm 6.34\%$ . About half of the reported visual and verbal stimuli were additions semantically unrelated to the presented stimulus material. The proportion of confabulation errors made by the patients with tremor-dominant PD was also significant ( $34.44 \pm 5.12\%$ ). However, unlike patients with mixed PD, the additions made by this group of patients when reporting the auditory verbal stimuli were mostly verbs semantically related to the presented verbal stimuli. Responses to the presented visual stimuli were word combinations of two types: noun + adjective and noun + verb. The patients with tremor-dominant PD demonstrated these response types when reproducing the presented and false stimuli.

These findings suggest that, regardless of the PD type, both visual and auditory verbal information underwent a transformation (was altered) at the stage of deliberate memorization during the presentation of the stimuli. With every subsequent presentation and reproduction of the stimuli, the patients did not correct the errors, but instead persisted in reproducing false memories, or confabulations. This suggests consolidation of false memories by means of their transfer to the long-term memory storage.

In the next stage, incidental memorization was studied by studying consolidation and reconsolidation of visual and semantic memory. We discovered that the semantic content of verbal information was completely lost during incidental memorization by patients with PD. The semantic information was altered at the stage of its encoding during immediate reproduction of the heard text. In total, 23–28% of the semantic content was missing. During story retelling, a significant proportion of semantic units was lost. The proportion of the omitted semantic units increased to 50–53% after a 40-minute delay. Four hours after the initial presentation, the patients with any form of PD were able to reproduce only 1/4 of the story's semantic content (21–23%).

The loss of the original semantic content was accompanied by the simplification of linguistic and semantic structures: the patients used syntactically simple sentences and named only objects and actions. Some sentences were merely object descriptions; structurally, they were a combination of a noun and an adjective. Story retelling was reduced to the description of objects and their actions; causal relationships were totally missing. Regardless of the PD form, a complete loss of the semantic content was demonstrated by all the patients after a 36-hour delay. Substitutions were the most prevalent type of error: the patients named the objects, described their characteristics and actions but did not make causal connections. And even with substitutions, there was a 3-fold reduction in the qualitative and quantitative structure of the text: the retold story contained 81 words and 23 semantic units vs 295 words and 79 semantic units in the original text. This reduction occurred regardless of the PD form. The retold story was lexically and syntactically simplistic and was unrelated to the original text. These findings suggest inhibition of verbal information in patients with PD.

While retelling the story immediately after its presentation, patients with rigidity/bradykinesia-dominant PD cut down the original story considerably but preserved its gist. There were almost no alterations during immediate recall. The participants with tremor-dominant PD reproduced the original semantic content overall correctly but still abridged it and made some insertions. This group of patients created causal links between the newly introduced and the initially present objects. The participants with tremor-dominant PD uttered short simple sentences consisting of 4 words at best, with preserved semantic content. The patients with mixed PD incorrectly reproduced a few semantic units during immediate recall (24 correct semantic units vs 79 units in the original text) but preserved the main idea. Similar to the patients with tremor-dominant PD, the patients with mixed PD simplified language structures while retelling the story, using unexpanded sentences, which obfuscated its understanding.

Story retelling 40 minutes after its initial presentation revealed further loss of the semantic content regardless of the PD form. In the stories retold by the patients with mixed PD, only 6 sentences were consistent with the initial text in terms of semantic content. Other semantic units, which were mostly descriptions of objects and actions, were altered or substituted. The patients with rigidity/bradykinesia-



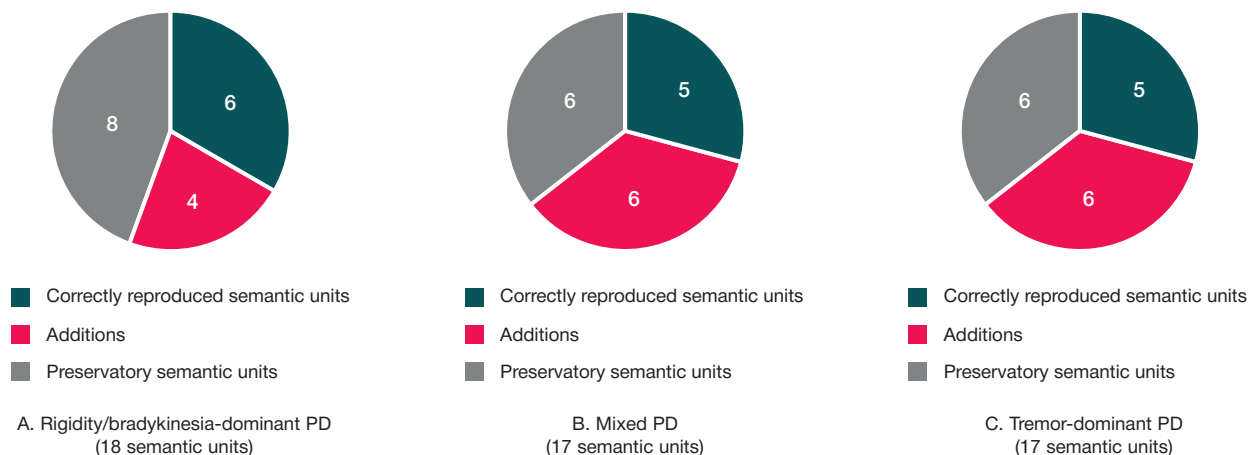


Fig. 4. Characteristics of the reproduced semantic units in patients with different forms of PD

dominant PD preserved the original semantic content in 11–13 sentences. In this group of patients, perseverative (2–3 times) repetition of sentences was observed. The patients with tremor-dominant PD retold the story using 8 sentences. The retold stories were dominated by descriptions of objects but there was a dearth of actions and their descriptions. Causal links were present in 1–2 sentences. The semantic content was altered or substituted.

After a 4-hour delay, the patients with any form of PD were able to reproduce 22–25% of the original semantic content. Their stories were dominated by object and action naming. The objects mentioned in the initial text were substituted. The story was retold in short kernel sentences (subject + predicate). The sentences were ungrammatical and lacked agreement. A tendency to perseveration was observed in the patients with mixed and rigidity/bradykinesia-dominant PD: sentences were repeated up to 4 times. The causal relationships were totally missing.

After a 36-hour delay, the total loss of the original semantic content was demonstrated by all the patients regardless of the PD form. The number of causal relationships ranged from 1 to 4. The number of insertions (new objects) varied from 5 to 7, which was comparable with the number of objects in the presentation (Fig. 4).

After a 36-hour delay, the patients with rigidity/bradykinesia-dominant PD were able to reproduce 18 semantic units, of them 6 were consistent with the initial semantic content of the presented text, 4 units were confabulations (the patients introduced new objects, object characteristics or causal relationships). The overwhelming majority of semantic units in the retold story were perseverative, i.e. repeated multiple times in different parts of the retold text. Perseverative confabulations (falsely reproduced semantic units absent in the initial text) were the most prevalent errors made by the patients with mixed PD. The patients with tremor-dominant PD correctly reproduced only 5 of 79 semantic units contained in the original text. Confabulations (semantic units containing information about objects and their actions from the initial text) were used by the patients in other semantic fields. For example, the initial text contained a sentence about seal hunting: *One night two young men from Egulac went down to the river to hunt seals.* The retold story did not contain information about seal hunting. The sentence reproduced by the patient was as follows: *Men liked seals, big and beautiful animals. They were resting on the shore, basking in the sun.* This example

demonstrates that the semantic content of the reproduced statement deviated from the original sentence; information about seals was semantically misrepresented.

The following patterns were detected while studying visual memory consolidation and reconsolidation (Fig. 5).

Regardless of the PD form (tremor-dominant, rigidity/bradykinesia-dominant, mixed), the patients transformed the presented symbolic drawing into a non-abstract image at the stage of visual information retrieval. When the patients were drawing a copy of the presented symbolic picture (i.e. the stage of encoding, or, in other words, reproduction of the symbol from the template), they tended to transform the symbol into a non-abstract image (bird, owl). This tendency intensified with every subsequent reproduction. The original content was altered, simplified or totally lost. The number of major elements present in the original drawing and the accuracy of their reproduction (number of smaller elements, their arrangement in the picture, including relative to each other, the shape and size of elements) decreased; new elements absent in the original drawing were introduced to the composition.

At the stage of incidental memorization of the presented drawing, the latter underwent transformation from being symbolic to becoming descriptive. This resulted in memorizing the altered image.

All the patients with rigidity/bradykinesia-dominant PD altered the presented visual stimulus only slightly during copying. The number of details, their shapes and inter-element arrangement were reproduced correctly. The patients with tremor-dominant PD omitted some elements of the original drawing and altered their size but preserved the general layout. The patients with mixed PD reproduced a very altered silhouette; the details were also very different from the original drawing.

After a 40-minute delay, further alteration of the memorized, now non-abstract image of a bird (an owl) was observed, mostly in the number of the details. Regardless of the PD form, the drawing looked simplified: its parts were distorted and the elements were few. There were new additions positioned predominantly in the bottom of the drawing. Introduction of new elements to the drawing was accompanied by the omission of the original elements. The patients with rigidity/bradykinesia-dominant PD added partially or completely overlapping lines. The patients with tremor-dominant PD simplified the elements and their initial arrangement. Because some lines in the drawing partially overlapped, this created a variety of new elements initially



Fig. 5. Drawings made by the patients with different PD forms in the immediate recall test and after a 40-minute, 4-hour and 36-hour delay

absent in the presented stimulus. The patients with mixed PD added new elements to the drawing by retrieving them from the non-abstract image of the bird they memorized. The following elements could be clearly identified in the reproduced drawing: a head, ears, a beak, eyes, a wing, legs, and fine details like toes.

After a 4-hour delay, we observed a transformation of the memory image (its reconstruction, in Bartlett's terms) characterized by the loss of the initial elements: several elements were fused into one (tremor-dominant PD) and new elements were introduced (rigidity/bradykinesia-dominant and mixed PD). Regardless of the PD form, the patients tended to simplify the image by reducing the number of parts initially present in the drawing and adding new lines that significantly enhanced the contours of the elements. Superimposition of new elements not found in the original drawing was typical for the patients with mixed PD.

After a 36-h delay, the shape of the initial symbol was completely distorted: the number of parts was reduced to one (the contour of the figure in the drawing) or 2.

Pairwise comparison revealed no significant differences between the groups of patients with different PD forms in the number of correctly reproduced semantic units during the text recall task and the number of correctly reproduced details of the symbolic drawing after a 36-hour delay following incidental memorization (Fig. 6).

The statistical analysis of significance of differences uncovered the following trends. Regardless of the PD form, the patients demonstrated a complete loss of the visual and semantic content in the absence of cognitive impairment. This indicates impairment of consolidation and reconsolidation of memory traces in PD. The trend may be explained by the fact that at the stage of encoding (copying the symbol from the presented visual template and then during immediate recall

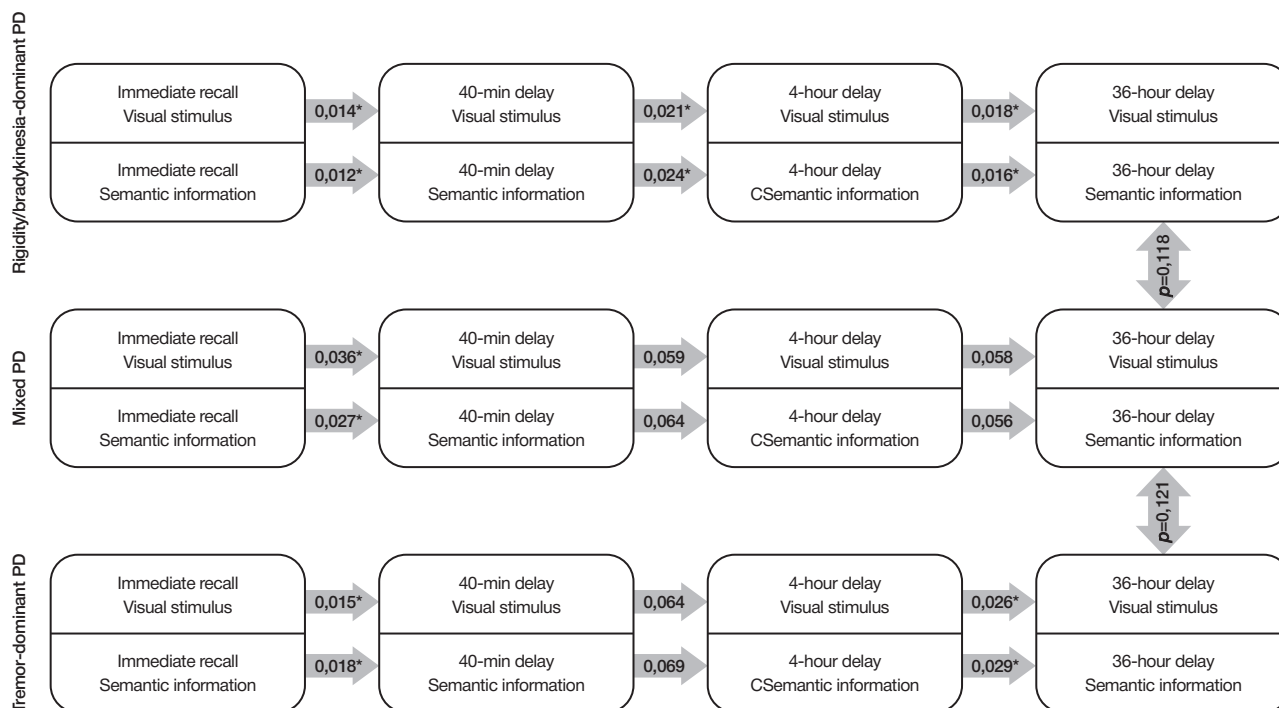


Fig. 6. Schematic representation of the significance of differences in the number of reproduced semantic units by patients with PD grouped by the form of the disease

of textual semantic content) information undergoes a certain transformation: the symbol becomes distorted and more concrete, the linguosemantic structure of the initial texts gets simplified, the sentences become shorter, less expanded and are often substituted by a combination of words.

The quality of retrieved information (its amount and accuracy) undergoes significant changes or can even be completely lost. Regardless of the PD form (tremor-dominant, rigidity/bradykinesia-dominant, mixed), a significantly smaller amount of information, both auditory verbal and visual, is consolidated. This is consistent with the distortion of information during its retrieval.

Differences observed between the groups during immediate recall and after 40-minute, 4-hour and 36-hour delays suggest that each form of PD is characterized by a specific type of information transformation. A significant amount of information, be it visual or semantic, is lost in rigidity/bradykinesia-dominant PD. Information is simplified and the resultant gaps are filled with perseverative simplified structures. Patients with mixed PD alter the content by introducing confabulations and also by perseveration. Similar to patients with mixed PD, patients with tremor-dominant PD distort information at the stage of encoding by introducing confabulations semantically close to the presented stimulus. This trend detected during the study of consolidation and reconsolidation of visual and semantic memory is corroborated by the results of research into the span of short-term visual and auditory verbal memory types. Regardless of the PD form, short-term memory span was reduced in all the patients. The errors made by the patients depended on the form of the disease.

## DISCUSSION

Short-term visual and auditory verbal memory span was reduced in the patients with any PD form. This finding was consistent with the reports of other researchers describing short-term memory impairments, attention deficit, and poor memory for routine activities in patients with PD [5]. Memory tests demonstrate that patients with PD have recall rather than recognition difficulty [5]. An attempt to identify PD-specific

memory problems was made in an earlier study [16]. The study reported spontaneous organization of memorized information, which is also consistent with the results of our study of deliberate and incidental memorization and recall.

## CONCLUSIONS

Mnemonic changes due to the pathological processes associated with PD affect the qualitative and quantitative characteristics of memory consolidation and reconsolidation, including accuracy and memory span, regardless of the disease form (rigidity/bradykinesia-dominant, tremor-dominant or mixed) or result in the lack of presentation of the reconsolidated content during recall. Alterations depend on the type of the disease: elements fusion is typical for tremor-dominant PD, addition of new elements is observed in tremor-dominant and rigidity/bradykinesia-dominant PD, whereas the superimposition of new elements absent in the presented visual stimulus occurs in mixed PD. Transformations of consolidated and reconsolidated information during incidental and deliberate memorization were represented by substitution (confabulation) of the original content and reduction (simplification of the structural and semantic structure of content organization). The patients were able to consolidate only a smaller amount of visual and auditory verbal information. With every recall, memory is reconstructed and its content is recategorized. Reconsolidation always follows recategorization. This trend is consistent with pronounced distortion of information during reconsolidation.

Considering the need for improving the quality of life of parkinsonian patients, mnemotechnics should be included in the programs of social adaptation. Mnemotechnics will facilitate consolidation and reconsolidation of visual and semantic information regardless of PD type and, therefore, involvement of cortical and subcortical brain structures into the process at the morphofunctional level through creation of new neuronal connections. Optimization of mnemonic processes of consolidation and reconsolidation will in turn increase the compensatory and adaptive potential, as well as the quality of life of patients with PD.

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