

Research Article

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Analysis of the Role of Visual and Auditory Gnosis for the Early Diagnosis of Cognitive Disorders

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ABSTRACT

Background: Nowadays, there is a steady trend towards an increase in the prevalence of cognitive impairment. Early diagnosis of moderate cognitive impairment is of particular importance due to the possibility of conducting therapy at this stage that slows down the development or causes regression of cognitive deficit. Some modern studies indicate the possibility of using the level of visual and auditory perception as an early marker of the neurodegenerative process. However, the question of the role of agnosia in the spectrum of clinical manifestations of cognitive deficit still remains open.

Methods: The study was conducted using a random sampling method based on the results of testing patients who were undergoing treatment in the rehabilitation departments of city hospitals in Yekaterinburg. The state of cognitive abilities was recorded using traditional diagnostic scales. Visual perception was studied using questionnaires authored by A.R. Luria. The NEPSY test battery technique was used to test auditory perception.

Finding: The study involved 136 elderly patients in the early recovery period after ischemic stroke. According to the results of the study of cognitive status, deviations from 25-77% to 48-4% were found in the cohort. The results of the measurement of the paired correlation test between visual and auditory gnosis and cognitive status were equal to 0-63% and 0-51%, respectively.

Interpretation: During an analysis of the results of the paired correlation test, a positive relationship of high strength was determined between visual gnosis and cognitive status. Between auditory perception and intellectual abilities, the correlation was positive and weak.

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Introduction

Cognitive functions carry out a complex process of rational cognition of the world, including memory, attention, intelligence, speech, praxis and gnosis. There are three degrees of severity of cognitive impairment: mild, moderate and severe (dementia).

Cognitive impairments of all degrees of severity, including dementia, are of great interest to the global medical community, the World Health Organization and doctors, due to the growing trend of life expectancy and aging of the world population. Today, there are more than 46 million people worldwide with dementia. According to WHO forecasts, by 2050 this number will increase to 1315 million [1-3]. Today, the scientific community is working to identify the causes of cognitive impairments. However, the greatest interest is in the early diagnosis of mild cognitive impairment (MCI), not dementia. This is due to the possibility of prescribing therapy that allows stopping the progression of impairments while maintaining the patient's ability to work, social and everyday adaptation, and in some cases even allows achieving regression of cognitive deficit, in contrast to severe cognitive impairments.

The need to search for methods of early diagnosis of MCI in the clinical practice of a neurologist and general practitioner is due to the fact that MCI does not cause maladaptation of the patient, does not affect his autonomy in everyday life and patients do not seek medical help, thereby missing opportunities for effective and early treatment.

Currently, there is a persistent trend towards an increase in the prevalence of cognitive disorders worldwide [4,5]. According to various studies, the prevalence of mild cognitive impairment ranges from 6.7 to 25.2% [6,7]. According to other reviews, the prevalence of this disorder ranges from 1.2 to 87%. Studies on the prevalence of MCI have high heterogeneity of the results obtained due to differences in the composition of cohorts, diagnostic criteria, research methodology, etc [8].

Cognitive impairments, along with high prevalence, are also characterized by a high level of disability, which is estimated at 26.3–30.8% among individuals with subclinical cognitive impairment [9-11]. In addition to neurodegenerative processes, macro- and microvascular processes play an important role in the development of cognitive impairment. Vascular dementia or vascular cognitive impairment developing after a stroke and against

the background of cerebrovascular insufficiency are distinguished. Post-COVID syndrome still plays an important role. The incidence of complications, including cognitive impairment, after suffering from the disease caused by the SARS-CoV-2 pathogen in patients treated on an outpatient basis and at home ranges from 10-35%. However, among hospitalized patients, the prevalence can reach 80% [12-14].

An additional factor that exacerbates the situation with the prevalence of cognitive impairment is the aging of the population in developed countries around the world. By 2000, the proportion of the population over 65 years old was 18 percent. In 2020, the number fell slightly to 9.3%, which may be associated with the epidemic of the new coronavirus infection COVID-19. But, according to WHO forecasts, by 2050 the situation will deteriorate sharply, when the proportion of the elderly and old-age population will be 38% (2.1 milliard people) [15,16].

Thus, in connection with the relevance of the problem of cognitive disorders of varying severity, the issue of the earliest possible diagnosis of cognitive disorders becomes the most important in the practical activities of a physician.

One of the main areas of early diagnostics of cognitive disorders is the search for specific clinical markers that can indicate the development of cognitive disorders before the manifestation of all specific signs, or biochemical markers that reflect the launch of the pathogenetic chain of neurodegenerative processes. Some researchers argue that perception should be used as such a marker [17]. This theory is based on the hypothesis that gnosis is the main function, on the state of which all other components of intelligence depend. According to modern research, the disruption of various types of perception is involved in the pathological process of cognitive disorders at early stages [18,19].

In this case, we are talking not only about damage to the brain part of the visual or auditory analyzer, but also about the pathology of the sensory organ itself. Recent studies have confirmed the presence of visual disturbances in dementia with Lewy bodies in the form of contrast and color sensitivity disorders, as well as the presence of abnormalities in the electroretinogram in these patients [20-22].

As for auditory perception, modern studies note the existence of a relationship between cognitive status and some components of auditory gnosis: the level of dichotic sound processing, understanding of noisy speech or in conditions of speech masking [19-24].

Thus, given the relevance of the problem, a study on the level of visual perception as an early marker of neurodegenerative processes was conducted.

The aim of the study is to analyze the role of visual and auditory types of perception for the early diagnosis of cognitive disorders.

Material and Methods

Principles of Cohort Formation and Study Implementation

The study was conducted from September 2023 to April 2024 at clinics in Yekaterinburg, Russia: medical rehabilitation departments in Central City Clinical Hospitals No. 3, No. 6, No. 14. The study group included patients of the 24-hour inpatient departments of the specified hospitals using a random sampling method in accordance with the inclusion and exclusion criteria.

Inclusion Criteria

- age over 18 years
- early recovery period (from 29 days to 6 months) of ischemic stroke
- absence of aphasia or presence of mild/moderate motor or semantic aphasia
- signed informed consent to participate in the study.

Exclusion Criteria

- late recovery period after stroke
- aphasia, apraxia or agnosia of high or moderate severity
- severe visual or auditory disorders
- disorders of consciousness and/or mentality
- epilepsy
- diabetes type II
- occlusive atherosclerosis
- use of drugs that affect higher cortical functions (sedatives, hypnotics, tranquilizers).

The Study was Conducted in Accordance with the Following Regulatory and Legal Acts

- Ethical principles set out in the Declaration of Helsinki [25].
- Joint Guidelines for Good Clinical Practice E6 of the International Conference on Harmonization [26].
- National standard of the Russian Federation "Good Clinical Practice" (GOST R 52379-2005)
- All applicable laws and regulations, including (the list is not exhaustive) the Federal Law "On Personal Data" dated 27.07.2006 No. 152-FZ, the Federal Law "On the Fundamentals of Health Protection of Citizens of Russia" dated November 21, 2011 N 323-FZ and other regulations.

Methods of Data Acquisition and Processing

Registration of the State of Cognitive Abilities was Carried out Using the Main Traditional Neuropsychological Diagnostic Scales

- MiniCoq: the maximum possible number of points is 5, the range of points corresponding to the normal state of cognitive abilities is 5-4
- MoCA: the maximum possible number of points is 30, the range of points corresponding to the normal state of cognitive abilities is 30-26
- MMSE: the maximum possible number of points is 30, the range of points corresponding to the normal state of cognitive functions is 30-28, light cognitive impairment is 27-20, mild cognitive impairment is 19-10, severe cognitive impairment (dementia) is 9-0;
- ACE: the maximum possible number of points is 100, the range of points corresponding to the normal state of cognitive abilities is 100-88.

The study of visual perception was conducted using the methods authored by A.R. Luria, the Gollin figure test and the Poppelreiter test [27]. The list of tests used to determine the state of visual gnosis is presented in the table (Table 1).

Table 1: List of Neuropsychological Tests used to Determine the State of Separated Components of Visual Gnosis

Visual Gnosis Component	Test name
Object Agnosia	Simple Images
	Gollin's test
	Noisy Images
	"Shadows" test

	Poppelreiter's test
Optical-Spatial Agnosia	"Chimeras" probe
	Clocks and compasses without arrows
Color Agnosia	"Geometric Figures" test
Facial Agnosia	Portraits
Letter Agnosia	Letters
	Crossed-out letters
Simultaneous Agnosia	"Restore the Plot" test

The NEPSY auditory test battery method was used to test auditory perception [28-30]. Statistical analysis of the obtained data was performed using descriptive statistics methods. The hypothesis about the normality of the data distribution was tested using the Kolmogorov-Smirnov goodness-of-fit test. Outliers were identified using the three sigma method. Correlation analysis was performed using the pair correlation method. The tabular value of the Student's criterion was taken to be 1.98 at a confidence level of $p = 0.95$. Data collection and storage, as well as subsequent statistical processing, were performed using Microsoft Excel 2016 software.

Results

The study group consisted of 136 patients. There were predominantly women - 94 (69.12%), men - 42 (30.88%). The age distribution was as follows: middle-aged (45-59 years) - 64 (47.06%), elderly (60-74 years) - 51 (37.5%), and senile (75-89 years) - 21 (15.44%). The average age was 62.4 ± 1.99 years. Average cognitive indicators: MiniCoq - 2.58 ± 0.18 points, MoCA test - 19.49 ± 0.96 points, MMSE - 22.27 ± 0.94 points, ACE - 68.64 ± 1.88 points.

Thus, according to MiniCoq data, deviations of 40-50% from the norm were revealed. According to the MoCA and MMSE scales, deviations of 65-73% were determined in the study group, and according to the ACE results, of 68%. These differences may be due to different diagnostic capabilities and accuracy of neuropsychological tests. After eliminating outliers, a paired correlation test was conducted for the visual and auditory perception indicators separately with the results of each of the four presented neuropsychological scales. The obtained values are presented in the table (Table 2).

Table 2: Paired Correlation Coefficient Values of Visual and Auditory Gnosis with each type of Cognitive Status Questionnaire

	MiniCoq	MoCA*	MMSE*	ACE*
Visual Gnosis	0.441	0.701	0.790	0.626
Auditory Gnosis	0.494	0.517	0.563	0.456

- Montreal Cognitive Assessment
- Mini-mental state examination
- Addenbrooke's Cognitive Examination
- Confidence level $p = 0.95$

The highest value was found between the state of visual gnosis and the MMSE scale. Next in descending order are the values of the correlation of the level of perception with the MoCA and ACE tests. The minimum level of correlation was found between visual perception and the MiniCoq scale. As for auditory perception, its

correlation dependence repeats the dynamics of visual gnosis, but the correlation values are significantly lower compared to visual perception.

Discussion

According to the neuropsychological diagnostic scales, a high prevalence of cognitive impairment was found in patients undergoing rehabilitation in the early recovery period of ischemic stroke in the left carotid basin – 75 - 90.44%. When studying the correlation coefficients of the level of visual perception with four main diagnostic scales, it was found that visual gnosis demonstrates a strong positive relationship with the MMSE and MoCA scales. A positive moderate correlation was found with the Addenbrooke's cognitive scale, and a positive weak correlation with the MiniCoq test indicators. At the same time, auditory perception demonstrates moderate and weak correlation with all the cognitive status indicators used.

However, the analysis of individual scale indicators revealed that not all patients have a decrease in mnemonic functions that corresponds to the negative dynamics of the level of visual or auditory perception; various values of the studied indicators are noted. The difference in the degree of correlation can be explained by the different structure of tests for assessing cognitive deficit. If MoCA and MMSE are aimed at identifying mild and light cognitive disorders, and ACE, as a large-scale diagnostic tool, is aimed at a detailed study of cognitive functions, then MiniCoq is a quick method for determining cognitive status in emergency situations, as well as in conditions of time constraints during an appointment with a general practitioner.

Thus, according to the results of the study, a high potential for using visual gnosis as an early marker of mild to moderate cognitive impairment was revealed. However, this indicator cannot serve as a tool for determining the dynamics of the level of cognitive deficit in patients during treatment and rehabilitation, as well as for making a final diagnosis. Also, the direction of the cause-and-effect relationship between visual perception and cognitive abilities remains unclear, namely, what suffers first and which component triggers the pathological process. However, given the potential of visual gnosis to assess cognitive status, further more detailed study is advisable, including practical verification of this hypothesis.

The study of auditory perception showed low sensitivity to the assessment of cognitive status. It is important to consider that, unlike visual gnosis, there are no specific validated methods for the analysis of auditory perception, so at the moment, measuring auditory gnosis in an outpatient appointment with a general practitioner or neurologist is a labor-intensive, lengthy and unpromising method.

Conclusion

As a result of the study, it was revealed that there is a direct strong or moderate correlation between visual perception and cognitive abilities. Although the assessment of visual gnosis cannot yet be considered the most sensitive testing for clarifying the level of severity of cognitive impairment, this marker has the potential for early detection of the neurodegenerative process. At the same time, the inclusion of special scales for assessing visual gnosis in neuropsychological testing will help to more fully study the degree of cognitive deficit, since perception processes are important for the quality of life of patients and the development of an individual rehabilitation program.

As a result of the study, a moderate correlation was revealed between auditory perception and cognitive abilities. Given the high labor intensity of measuring the level of this type of perception, the assessment of auditory gnosis using the NEPSY test cannot be considered as an early marker for diagnosing and clarifying the level of severity of cognitive impairment.

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Conflict of Interest

The authors declare no obvious or potential conflicts of interest.

Compliance with Ethical Principles

The study was conducted in accordance with the ethical standards prescribed in the legislation of the Russian Federation and the Declaration of Helsinki. Voluntary informed consent was obtained from the patients who became the objects of the study or their legal representatives for the participation in the study and publication of its results in anonymous form.

References

- Prince M, Wimo A, Maëlen G, Ali GC, Wu YT (2019) World alzheimer report 2015. the global impact of dementia. An Analysis of Prevalence, Incidence, Cost and Trends. *Alzheimer's Disease International* 1: 1-87.
- Prince M, Bryce R, Albanese E, Wimo A, Ribeiro W, et al. (2013) The global prevalence of dementia: a systematic review and metaanalysis. *Alzheimers Dement* 9: 63-75.
- Canadian Study of Health and Ageing (1994) Canadian study of health and aging: study methods and prevalence of dementia. *CMAJ* 150: 899-913.
- Tsoi RT, Turuspekova ST, Klipitskaya NK (2018) Current state of the issue of prevalence of mild cognitive impairment and dementia. *Neurosurgery and neurology of Kazakhstan* 1: 47-53.
- Yakhno NN, Zakharov VV, Lokshina AB, Koberskaya NN, Mikhatoryan EA (2010) Dementia: a guide for doctors. 4th ed. Moscow: MEDpress-inform; 2010. 272p.
- Petersen RC, Lopez O, Armstrong MJ, Getchius TSD, Ganguli M, et al. (2018) Practice guideline update summary: Mild cognitive impairment: Report of the guideline development, dissemination, and implementation subcommittee of the american academy of neurology. *Neurology* 90: 126-135.
- Overton M, Pihlgård M, Elmståhl S (2019) Prevalence and incidence of mild cognitive impairment across subtypes, age, and sex. *Dement Geriatr Cogn Disord* 47: 219-232.
- Casagrande M, Marselli G, Agostini F, Forte G, Favieri F, et al. (2022) The complex burden of determining prevalence rates of mild cognitive impairment: A systematic review. *Front Psychiatry* 13: 960648.
- Artero S, Touchon J, Ritchie K (2001) Disability and mild cognitive impairment: a longitudinal population-based study. *Int. J. Geriatr. Psychiatry* 16: 1092-1097.
- Freels S, Cohen D, Eisdorfer C, G Paveza, P Gorelick, et al. (1992) Functional status and clinical findings in patients with Alzheimer's disease. *J Gerontol* 47: M177-M182.
- Melzer D, McWilliams B, Brayne C, Johnson T, Bond J (1999) Profile of disability in elderly people: Estimates from a longitudinal population study. *BMJ* 318: 1108-1111.
- Tenforde MW, Billig Rose E, Lindsell CJ, Shapiro NI, Files DC, et al. (2020) CDC COVID-19 Response Team. Characteristics of adult outpatients and inpatients with COVID-19—11 academic medical centers, United States, March–May 2020. *MMWR Morb Mortal Wkly Rep* 69: 841-846.
- Tenforde MW, Kim SS, Lindsell CJ, Shapiro NI, Files DC, et al. (2020) Symptom duration and risk factors for delayed return to usual health among outpatients with covid-19 in a multistate health care systems network - United States, March-June 2020. *MMWR Morb Mortal Wkly Rep* 69: 993-998.
- Grasselli G, Zangrillo A, Zanella A, Antonelli M, Cabrini L, et al. (2020) COVID-19 Lombardy ICU Network. Baseline characteristics and outcomes of 1591 patients infected with SARS-CoV-2 admitted to ICUs of the Lombardy Region, Italy. *JAMA* 323: 1574-1581.
- Rudnicka E, Napierała P, Podfigurna A, Męczekalski B, Smolarczyk R, et al. (2020) The World Health Organization (WHO) approach to healthy ageing. *Maturitas* 139: 6-11.
- Jakovljevic MM, Netz Y, Buttigieg SC, Adany R, Laaser U, et al. (2018) Population aging and migration - history and UN forecasts in the EU-28 and its east and south near neighborhood - one century perspective 1950-2050. *Global Health* 14: 30.
- Kaido M, Fukui M, Kawashima M, Negishi K, Tsubota K (2020) Relationship between visual function and cognitive function in the elderly: A cross-sectional observational study. *PLoS One* 15: e0233381.
- Mahoney JR, Verghese J (2020) Does cognitive impairment influence visual-somatosensory integration and mobility in older adults? *J Gerontol A Biol Sci Med Sci* 75: 581-588.
- Lee SJ, Lee S (2023) Clinical utility of response time in speech audiometry in elderly with mild cognitive impairment. *Int J Audiol* 62: 418-423.
- Maurage CA, Ruchoux MM, de Vos R, Surguchov A, Destee A (2003) Retinal involvement in dementia with Lewy bodies: a clue to hallucinations? *Ann Neurol* 54: 542-547.
- Devos D, Tir M, Maurage CA, Waucquier N, Defebvre L et al. (2005) ERG and anatomical abnormalities suggesting retinopathy in dementia with Lewy bodies. *Neurology* 65: 1107-1110.
- Devenyi RA, Hamedani AG (2024) Visual dysfunction in dementia with Lewy bodies. *Curr Neurol Neurosci Rep* 24: 273-284.
- O'Brien JL, Lister JJ, Fausto BA, Morgan DG, Maeda H, et al. (2021) Are auditory processing and cognitive performance assessments overlapping or distinct? Parsing the auditory behaviour of older adults. *Int J Audiol* 60: 123-132.
- Mamo SK, Helfer KS (2021) Speech Understanding in Modulated Noise and Speech Maskers as a Function of Cognitive Status in Older Adults. *Am J Audiol* 30: 642-654.
- General Assembly of the World Medical Association (2014) World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects. *J Am Coll Dent* 81: 14-18.
- Englev E, Petersen KP (2003) ICH-GCP ICH-GCP Guideline: quality assurance of clinical trials. Status and perspectives. *Ugeskr Laeger* 165: 1659-1662.
- Andronnikova EA, Zaika EB (2011) Methods of research perception, attention and memory: a guide for practical psychologists. 1st ed. Kharkov: Zebra.
- Brooks BL, Sherman E, Strauss E (2010) NEPSY-II: A Developmental Neuropsychological Assessment, Second Edition. *Child Neuropsychology* 16: 80-101.

29. Korkman M, Kirk U, Kemp S (2007) NEPSY II: clinical and interpretive manual. 2nd ed. San Antonio, TX: Harcourt Assessment, PsychCorp 290 p.
30. Yao SY, Bull R, Khng KH, Rahim A (2018) Psychometric properties of the NEPSY-II affect recognition subtest in a preschool sample: a Rasch modeling approach. Clin Neuropsychol 32: 63-80.

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