

## GENDER FEATURES OF THE COGNITIVE RESERVE

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### SUMMARY

**Background:** The high risk of cognitive impairment in people of older age groups determines the relevance of the study of factors contributing to the preservation of cognitive potential at a young age, which is necessary to develop a cognitive reserve model aimed at preventing the transformation of physiological aging into pathological. Purpose: to identify the importance of the "gender" factor for the formation of a cognitive reserve.

**Materials and methods:** The research material was scientific publications on the topic of work. The general scientific method was applied: analysis of modern scientific literature on the research problem, generalization, comparison, systematization of theoretical data regarding the "gender" factor, which helps preserve the normative parameters of cognitive functions in the late period of life. The research material was scientific publications on the topic of the work. The General scientific method is applied: analysis of modern scientific literature on the problem of research, generalization, comparison, systematization of theoretical data in relation to factors that contribute to the preservation of normative parameters of cognitive functions in the later period of life.

**Results:** The "gender" factor is one of the factors determining the parameters of the cognitive reserve at a late age. Scientific novelty: for the first time, a systematic review of scientific literary sources was conducted, devoted to the analysis of the contribution of the "gender" factor to the formation of an individual's cognitive reserve. The concept of cognitive reserve is usually used in relation to old age, but there is no doubt that it is the total result of various activities that a person has performed throughout life. Factors that determine the cognitive reserve, acquired factors that are implemented during the life of the individual and biological factors, one of which is the "gender" factor. The "gender" factor has a certain effect on the risk of developing late dementia. The proven Polo-specific differences in the structure of the brain, the dynamics of cognitive functions, which are implemented differently in men and women in ontogenesis, suggest the need for different approaches to the formation and maintenance of the cognitive reserve in men and women.

**Key words:** cognitive reserve - cognitive aging - aging - intellectual longevity

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### INTRODUCTION

The aging of the population is one of the great challenges of our time, which is due to the intensive age demographic shift. According to WHO, in 2017, the number of people aged 60 and over reached 962 million people, accounting for 13% of the world's population. Traditionally, the most vulnerable areas of old age are considered to be somatic health and cognitive sphere, especially memory processes. In 2013, the problem of severe cognitive disorders (dementia) was declared by WHO a public health priority (Dementia 2013). Retained cognitive efficiency is a fundamental condition for optimal aging and an important determinant of quality of life (Medaglia et al. 2017, Clare et al. 2017). The formation of cognitive deficit is of great medical and social importance, since it causes significant financial expenditures associated with the patient's treatment and care, not only from the state, medical services, but also from the families of patients (Myakotnykh et al. 2020).

### MATERIALS AND METHODS

The research material was scientific publications on the topic of the work. A general scientific method was applied: analysis of modern scientific literature on the research problem, generalization, comparison,

systematization of theoretical data in relation to factors that contribute to the preservation of the normative parameters of cognitive functions in the late period of life.

### RESULTS AND DISCUSSION

Analysis of scientific literary sources, mainly 5 years old or less, revealed several concepts used by researchers in describing the phenomenon of brain resistance and its functions to pathological factors at the stage of gerontogenesis. Some authors point out that an individual's susceptibility to the development of brain pathology is the result of the interaction of multi-directional processes: damage to brain tissue and the ability of the brain to maintain high functional activity due to the "brain reserve" (BR) (Barulli & Stern 2013). Followers of this opinion believe that a calculable measure of the "brain reserve" is a set of "quantitative" parameters of the brain: total brain size, the number of neurons, synapses, dendritic density, etc. (Bhat 2015). This interpretation of the concept of "brain reserve" considers BR as a passive threshold model predicting that after reaching a certain quantitative ratio of pathological changes in the central nervous system, the functioning of the brain will inevitably deteriorate. Some authors describe the "cognitive reserve" (CR) in the framework of an active model indicating that the

threshold of functional decline is determined not by quantitative measurements of the brain, but by the totality of changes determined by the individual's experience (Cadar et al. 2017). From these positions, CR is defined as a brain resource that develops through lifelong, stimulating cognitive activity and protects the individual from clinical signs of cognitive decline (Perquin et al. 2017). Thus, the concepts of "brain reserve" and "cognitive reserve" make an independent and synergistic contribution to understanding individual differences in the resistance of brain functions to brain pathology (Steffener & Stern 2012). The current stage in the study of the problem of CR is represented by an active study of the psychophysiological mechanisms of CR and the factors influencing its formation. The existing data indicate that CR acts both as a protective mechanism of cognitive impairments and as a factor that increases the potential for restoration of cognitive functions in the event of impairments (Myakotnykh et al. 2020). The initial conceptual model for studying the CR problem was the definition of a set of many interacting, often multidirectional, pathogenic and compensatory factors acting in the dynamics of the development of dementiating disorders (atrophic-degenerative, cerebrovascular diseases), leading, according to some authors, to different outcomes in case of serious diseases. The analysis of the heterogeneity of the prognosis in Alzheimer's disease and vascular lesion of the brain contributed to the construction of a new theoretical construct - a holistic, separable theoretical entity, inaccessible to direct observation, but deduced on the basis of the observed signs (different outcome in serious diseases) - the concept of "cognitive reserve". It was severe cognitive impairment that was the initial conceptual model for studying brain resources in persons with a favorable course, contrary to the expected dramatic one observed in the vast majority of patients. A number of authors suggest that the factor of belonging to the male or female sex influences the CR level. Historical information about sexual dimorphism of the brain in all periods of ontogenesis is confirmed by modern studies, which indicate the difference in the structure (number and structure of neurons, myelination parameters, dendritic and axonal branching), functioning (parameters of glucose metabolism and cerebral blood flow rate) of the brain, dynamics of maturation its structures in men and women (Sidenkova et al. 2019). According to studies, different parts of the brain in women and men have different activities, which is due to the different structure of neuronal connections, different activity between the regions of the brain. There was a higher connectivity between the hemispheres in women and closer intrahemispheric interactions in men. Studies of functional connectivity of intercerebellar synaptic interactions have shown the opposite result, which led Madhura Ingalhalikar and colleagues (2014) to conclude

that the male brain is structured to facilitate the connection between perception and coordinated action, while the female brain is designed to facilitate the connection between analytical and intuitive processing modes (Ingalhalikar et al. 2014). Satterthwaite T. et al. (2015) pointed out different cognitive areas of the preferred success of men and women, motor and spatial cognitive tasks are more efficiently solved by men, the tasks of identifying emotions and non-verbal reasoning - by women (Theodore et al. 2015). Foreign researchers have revealed a significant influence of the factor of masculinity / femininity on the dynamic parameters of neuronal interaction. In a comparative aspect, adult women are characterized by decreased dynamic connectivity and a decrease in the number of switching operations between brain states, which contributes to the prolongation of these states, fixation on them, a "sticky" functional substrate associated with a slow inhibition of the reaction. The ability for high rates of intersynaptic switching in adult men allows them to change centers of brain activity more often in a wider spatial range, providing high performance when switching between tasks (De Lacy et al. 2019). The study of the functional connectivity of the network of the passive mode of brain operation revealed a higher intensity of communication in girls than in boys (Teeuw et al. 2019). Differences in sex also exist in the structure of working memory, limbic (tonsils and hippocampus) and prefrontal structures (right inferior frontal gyrus) are more intensively activated in women (Hill et al. 2014). The concept of the cognitive reserve is more fully formed within the framework of a dynamic, ontogenetically determined view of the problem, refracted through the prism of sexual differentiation of the brain of men and women, which, however, is not supported by all authors. In a number of studies, a difference was revealed in the areas of the brain of men and women that are vulnerable to aging, in men such loci were the parietal cortex associated with visual-spatial abilities, in women - speech processing centers - Broca's area (Kakimoto et al. 2016). Sex differences were also found in patients with Alzheimer's disease (as a dynamic model of pathological aging of the central nervous system), a correlation was found between sex and predominantly affected areas of the brain; in men, the posterior temporo-parietal association is more often and more intensely affected, in women, the frontal and limbic associations (Malpetti et al. 2017). According to Keith R., Laws K., Irvine K., Gale T. (2016) the great linguistic, semantic and visual-spatial abilities inherent in men, beyond age and the level of education received in adulthood, are a factor insuring a man from severe manifestations of Alzheimer's disease (Laws et al. 2016). In some studies, the significance of gender differences is emphasized by indicating the preferred risk of hippocampal dysfunction in women with Alzheimer's disease (Yagi & Galea et al. 2019). At the

same time, scientists from Arizona conducted a study, as a result of which it was concluded that gender does not affect the rate of progression of Alzheimer's disease in patients with APOE epsilon 4 (Caselli et al. 2015). A systematic assessment of protective valeologic factors in individuals with Alzheimer's disease has provided compelling evidence of the long-term effects on cognitive function of several potentially modifiable and adjustable parameters: lifestyle, psychophysiological and biological factors. Physical activity, cognitive stress, positive emotional mood have a strong evidence base in relation to the prevention of cognitive decline, which allows us to consider them as protective factors opposing cognitive collapse (Sidenkova et al. 2018). Separate studies have shown that the revealed positive correlations between the factor of "education" and indicators of working memory have gender and age-specific coloring. Analysis of the combination of the factor of "education" and growing up showed a greater increase in the volume of working memory in women than in men. With comparable education and intellectual activity in adulthood, the transition to late adulthood in men is accompanied by a more intense decrease in working memory (Pliatsikas et al. 2019). A retrospective study of the contribution of cognitive and physical activity to cognitive function in a sedentary group of postmenopausal women showed that a higher frequency of different types of activity, and not just time, was protective for cognitive function (general cognitive performance, attention and executive function), which indicated the importance of variety of stimulation (Budde & Wegner 2018). Interestingly, the degree of cognitive activity was measured by the frequency of participation in everyday activities, which is considered a cognitive but not a physical process, which suggests the active involvement of performing cognitive functions, as a set of cognitive abilities necessary for control and self-regulation of behavior, in the protection of the cognitive reserve (Stern 2009).

## CONCLUSION

In modern literature, the concept of cognitive reserve is usually used in relation to old age, but there is no doubt that it is the sum total of various types of activities that a person has performed throughout life. The factors that determine the cognitive reserve, the acquired factors, realized during the life by the individual himself and biological factors, one of which is the factor "sex". The gender factor has a definite impact on the risk of developing late dementia. The proven sex-specific differences in the structure of the brain, the dynamics of cognitive functions, differently realized in men and women in ontogenesis, suggest the need for different approaches in the formation and maintenance of the cognitive reserve in men and women.

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All authors reviewed and discussed the manuscript draft and contributed to the final manuscript and all authors give final approval of the version to be submitted.

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