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The Role and Importance of Neuroplasticity in Developing Psychological Resilience

Kamile Öner

Department of Health Care Services, Home Patient Care Program, Çankırı Karatekin University, Çankırı, Türkiye

Abstract

Neuroplasticity is expressed as the brain's ability to change and adapt. The brain, as part of the nervous system, integrates with its environment and allows for healing by altering its function. It has been documented in the literature that the structure of neurons can be renewed throughout one's lifespan. Consequently, neuronal changes and healing persist throughout life. Individuals encounter numerous positive or negative situations throughout their lives. In these processes, the ability of individuals to cope, adapt, and provide flexibility is termed psychological resilience. Additionally, factors such as regular physical exercise, meditation, and learning can assist in maintaining both physical and mental health while also enhancing brain plasticity to support psychological resilience. Both neuroplasticity and psychological resilience are dynamic processes. Individuals collaborate with the organism while attempting to adapt to or cope with challenges they face. As the brain forms new neural connections to cope with and heal from the situation, psychological resilience also develops adaptation and effective coping skills. Each individual is unique, and these interactions vary from person to person. Further research is necessary to clearly elucidate the effects between neuroplasticity and psychological resilience.

Keywords: Individuals, neuroplasticity, psychological resilience

Introduction

Neuroplasticity, or brain plasticity, is the natural capacity of nerve tissue and includes the ability to form new connections between neurons (synaptogenesis) or replace non-functioning neurons with new ones (neurogenesis).[1] The term neuroplasticity applies to the capacity of the brain to adapt and change in response to novel experiences. Neuroplasticity includes not only morphological changes but also biochemical and pharmacological adaptations, changes in neuronal networks, and the formation of new neurons.[2] Recent studies have shown that the brain continually renews itself throughout life by forming new neural connections, and the production and development of new neurons persist throughout the lifespan in both vertebrates and invertebrates.[3,4] Throughout life, individuals encounter many events from birth to death. During this process, individuals' primary needs evolve and change over time, starting with physical needs and then progressing to psychological ones. Life experiences encountered throughout life, in accordance with Maslow's hierarchy of needs, intrinsic and extrinsic motivations, sociological theories, and various environmental factors, among others, all play a role.[5] In this context, the successful adaptation of individuals to internal and external demands, as well as challenging life experiences, is termed "psychological resilience".[6] Psychological resilience is a dynamically changing process over time and is associated with being mentally healthy.[7]

In summary, the human brain is plastic, meaning it is dynamically organized rather than static. When addressing memory, learning, and trauma-related situations, an effective restructuring process of the central nervous system is required.[8] When an individual encounters challenges, the brain and body collaborate to adapt, adjusting brain function and structure according to the environment.[8,9] Therefore, this study aims to understand the role of psychological resilience and neuroplasticity as the brain changes.

The Relationship between Neuroplasticity and Psychological Resilience

Scientists used to believe that if a specific region of the adult brain was damaged, nerve cells would not be able to form new connections, leading to a permanent loss of

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Corresponding author: Kamile Öner
E-mail: kamileoner@karatekin.edu.tr

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functions controlled by that area. However, studies have shown the opposite: the brain continues to reorganize itself throughout life by forming new neural connections, challenging this view.[4] In the adult brain, neural stem cells continue to generate new neurons throughout life in the subgranular zone of the dentate gyrus. Furthermore, this process is associated with factors such as learning and memory, stress, and exercise.[5,10] A stimulated neuron can induce neuroplastic changes by activating other neurons around it.[11] This also demonstrates the existence of a biological process called neuroplasticity. For example, language research conducted on children who have experienced perinatal stroke proves that the brain has a highly plastic structure. Additionally, although conclusions are not definitive, it has been observed that children exposed to music at an early age show more distinct differentiation in their music abilities and in the motor and executive regions of their brains. Diamond, in another study conducted with laboratory mice, found that when spoken to, the mice exhibited neuroplastic gains and increased lifespans. In short, the brain has the potential to be reorganized by creating new neural pathways to adapt as needed.[4,12-14]

Psychological resilience, which is the process of adapting to challenges, is an important concept.[15] There are many situations in life that can cause distress. This distress varies from person to person, and even the ability of the same individual to cope with similar events may differ. Therefore, there is not a single form, duration, intensity, or type of psychological distress.[16] Differences in levels of resilience between individuals can be characterized by differences in the temporal dynamics of neurophysiological resilience. When individuals encounter challenges, the brain and body collaborate to adapt to them.[9] The brain is the central organ that adapts to experiences, including stressors that can change brain architecture, in addition to altering systemic function through the neuroendocrine, autonomic, immune, and metabolic systems. A healthy brain has a significant resilience capacity based on its ability to open plasticity windows and direct its function towards better health.[17] It has been observed that individuals with low psychological resilience who use ineffective coping strategies are more vulnerable in terms of maintaining their psychological health.[18] In the study by Lambert et al.[19] it was found that utilizing effective coping mechanisms by an individual under intense pressure allowed for a reduction in stress and the maintenance of neural and cognitive performance.

As mentioned above, there is a mutually supportive relationship between neuroplasticity and psychological resilience. Neuroplasticity facilitating adaptation to new situations or conditions and promoting functional recovery, may be considered to enhance psychological resilience.

Neuroplasticity-Supporting Factors

There are numerous factors that enhance neuroplasticity. Among these enhancing factors are elements such as exercise, meditation, and learning.

Physical Exercise

Physical exercise, originating from the earliest movements of humanity, encompasses all physical activities and serves as an indicator of vitality. Initially utilized for survival necessities such as hunting and protection, physical exercises have diversified over time into forms of entertainment and sports. As the effects of physical exercise on the body began to be recognized, it gradually became an indispensable concept in the field of health.[20] Recent studies have been supportive of this notion.[20-22] Exercise has been shown to positively impact motor, cognitive, and psychological behavioral characteristics.[23] It is known that physical exercise can trigger neuroplasticity, thereby enhancing an individual's capacity to respond to new demands with behavioral changes. It has also been noted as a helpful therapeutic strategy in cognitive decline.[21,22] During and after exercise, it has been observed in recent publication that a molecule called brain-derived neurotrophic factor (BDNF) is the factor triggering exercise-induced neurogenesis.[24] It is proposed that physical exercise may promote brain plasticity by increasing the release of Brain-Derived Neurotrophic Factor (BDNF), thereby potentially contributing to the recovery process of brain damage. BDNF plays a significant role in neuroplasticity in the brain.[25-27] A study conducted on mice regarding neurogenesis and BDNF showed that exercise induced neurogenesis and elevated BDNF levels, providing cognitive benefits to the mice.[28] In short, exercise-induced elevation of BDNF promotes neuroplasticity, which can potentially improve psychiatric, spatial learning, hippocampal, cognitive, and neurogenesis impairments. There are numerous studies in the literature indicating that exercise contributes to brain adaptation function, mental development, learning, and the formation of new neurons in the brain. The results of animal and human studies suggest potential implications for interventions aimed at healing brain damage and facilitating neuroplasticity.[26,29,30] These studies indicate the ability of physical exercise to introduce various neural mechanisms within the organism. It is evident that physical exercise can support physical health, brain health, and cognitive functions.

The importance of regular physical exercise for health is becoming increasingly evident. Regular physical activity has been found to be effective in both acquiring and maintaining psychological health, as well as being associated with happiness and psychological well-being.[31] It is evident that numerous studies have demonstrated that aerobic exercise can enhance various aspects of cognition and performance. Physical exercise is considered a lifestyle factor that can contribute to the enhancement of physical and mental health throughout life.[32,33] Additionally, regular practice of meditation is also recognized as a factor that enhances lifelong mental health.[34,35]

Meditation

Meditation is a skillful and effective mental practice that allows our mind to settle into its natural state. It enables us to become aware of the physical sensations happening within ourselves. For instance, noticing an increase in heart rate during a moment of stress can help you navigate around the experience rather than getting lost in it. This is the first step towards balance. Over time, these habits become ingrained, leading to a reevaluation of our experiences and an increase in our resilience.[36,37] It has been observed that meditation is associated with numerous beneficial effects on health, and mindfulness-based techniques are increasingly being implemented in psychotherapeutic programs.[38] Although there is diversity in meditation practices (such as Mindfulness, Loving-kindness, Transcendental, and Concentrative meditation), interventions indicate that meditation practices improve prefrontal cortex functions such as cognition, self-awareness, attention, and memory, while also reducing psychological symptoms.[39] Studies have suggested that long-term (months to years) mindfulness meditation induces structural plasticity in gray

matter, potentially enhancing the functions of specific regions in the right hemisphere, possibly attributable to neuroplastic changes in the brain. Comprehensive practices involving attention have been shown to lead to changes in brain structure, with findings of structural differences in the lower brainstem among participants engaged in long-term meditation practices. These neurological differences may be considered as indicators that long-term meditation practice can lead to neuroplastic changes affecting cognitive processes. Additionally, it has been found that even short mindfulness meditation triggers gray matter plasticity.[40-42] It is evident that meditation and cognitive techniques constitute effective psychological interventions for bolstering individuals' mental health.

Meditation practices appear to lead to structural and functional changes in the brain by increasing gray matter plasticity. Such changes can cause neuroplastic changes that affect cognitive processes and strengthen emotional intelligence by increasing attention. It is also thought that mindfulness meditation may strengthen underlying brain networks by increasing gray matter plasticity and attention in the brain.[39,40]

Learning

Learning induces structural changes in the brain. Life begins with the presence of cells. The cells in our bodies, like humans, can grow, replicate, process information, respond to stimuli, and enable an extraordinary number of chemical reactions. These abilities define life.[43] Neuroplasticity forms the neurochemical basis of learning and memory. Learning can become permanent through the reinforcement of information and the constant repetition of stimuli. The concept of neuroplasticity is associated with the ability to learn. The impact of this process is the rapid adaptation at different levels of the nervous system and the ability of neurons to reorganize their functions, leading to learning and memory processes.[1,44] When we learn something new, new connections form between our brain cells. Learning triggers continuous change in the brain and initiates neuroplasticity. This process allows the brain to reconstruct itself limitlessly, meaning there is no definite endpoint in learning processes. To adapt to new situations, we need to readjust and reorganize the connections in our brain. While there may be declines in this adaptation process over time, it occurs every day and at every age. Neuroplasticity encompasses both brain function and the change and adaptation within the brain. Therefore, its association with learning and education is inevitable.[30,45] The easier and greater learning ability during early childhood indicates that neuroplastic responses are more effective during childhood.[44]

The brain continuously updates itself through the restructuring of connections at the synaptic level. The increase in synaptic fields is manifested by the increase in environmental stimuli. Understanding the brain has become the focus of dynamics such as philosophy, science, technology, art, economy, and ideology in the new century. The adaptability of neuroplasticity to change with each new learning experience is associated with the function of glial cells and the integrity of brain connections in the formation of this neuroplastic change. Neuroplasticity, in its simplest sense, refers to the brain's ability to continually renew itself, adapt to new situations, and form richer and more functional neural connections. As observed, the human brain stands out with its ability to develop emotions, thoughts, and behaviors, possessing unique features such as originality, creativity, imagination, continuous learning capacity, ability to establish communication networks, and capability to recognize patterns within a distinct network structure.[46,47] In the study by Sabır-Taştan's (2020),[48] it is emphasized that, according to Uzbay (2010),[49] neuroplasticity allows for new learning, engaging in brain-stimulating activities, and restructuring negative experiences. Neuroplasticity enables the brain to undergo adaptive changes and reorganization. When learning is viewed as a process of change and transformation, it can be concluded that this is closely linked to neuroplasticity in the brain.[45] London taxi drivers were studied to investigate the impact of train ing on brain structure and elasticity. The research revealed that the navigational skills of taxi drivers led to morphological and structural changes in the hippocampus, a region associated with spatial naviga tion, in their brains. Moreover, the length of training was found to be directly proportional to the morphological changes in the brain and the strength of plasticity.[50] The learning affects neuroplasticity, and the brain supports change and neuroplasticity by establishing new connections through the learning process.

Conclusion

Both neuroplasticity and psychological resilience are dynamic processes that are evolutionary, adaptive, flexible, and subject to change. There exists an interplay between individuals' ability to adapt to challenges they encounter or their efforts to cope with these difficulties and the overall balance within the organism. In other words, neuroplasticity seeks to maximize the capacity for adaptation and recovery by reconfiguring neural connections in response to the difficulties individuals encounter. Psychological resilience, on the other hand, aims to enhance adaptation and effective coping skills. Therefore, it can be considered that neuroplasticity and psychological resilience are in mutual interaction.

In addition, 'neuroplasticity' and 'psychological resilience' are two important concepts for nursing care. With nursing care, appropriate care is planned by determining the patient's physical, spiritual, social and cognitive needs. With effective nursing care, the patient's ability to adapt and cope with difficulties can be increased by supporting neuroplasticity. The healing process can be supported by increasing adaptation and coping skills, which are also related to psychological resilience. Further research may be needed to gain a clearer understanding of the interactions between these two concepts.

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