ISBN: 978-65-83849-00-7

Aurum EDITORA

CHAPTER 7

THE SINGULARITY OF NEUROPLASTICITY IN THE GIFTED: HOW INCLUSIVE EDUCATION CAN TRANSFORM POTENTIALS INTO ACHIEVEMENTS

https://doi.org/10.63330/aurumpub.010-007

Vanessa Roda Pavani Mello[1]

ABSTRACT
This article aimed to analyze how the uniqueness of neuroplasticity manifests itself in gifted individuals and how this influences their educational development. Methodologically, an integrative literature review was conducted based on recent neuroscientific studies, using as primary reference neuroimaging research (fMRI and PET) and analyses of the specialized literature on giftedness. The findings demonstrate that gifted individuals possess a superior capacity for brain reorganization, especially evident in areas related to logical reasoning, creativity, and complex problem-solving. These neurobiological characteristics allow them to adapt more quickly and effectively to cognitive challenges. In conclusion, the study highlights that such scientific evidence demands changes in traditional pedagogical practices. It was concluded that inclusive education for gifted individuals must go beyond mere curricular adaptation, incorporating innovative pedagogical approaches and environments that continually promote intellectual challenges compatible with high neurocognitive capacity. Furthermore, the urgency of specific public policies is emphasized to ensure the early identification and comprehensive development of these students, contributing to their unique capabilities being explored to the fullest.

Keywords: Neuroplasticity; Giftedness; Inclusive Education; Cognitive Development; Educational Policies.

[1] Postgraduate in Neuroscience, Institutional and Clinical Psychopedagogy with an emphasis on inclusion from Uniminas, certified in “Introduction to Family Engagement in Education” by Harvard University, Bachelor of Law from CESMAC/AL, registered with the OAB/AL no. 7.498, undergraduate student in Pedagogy at UNIBF, Master's student in Neuroscience at the University of Orlando, postgraduate student in Institutional and Clinical Neuropsychopedagogy and Institutional Neuropsychopedagogy and Special Education at Uniminas, postgraduate student in Special Education with an emphasis on giftedness at Faculdade São Luís.
ORCID: 0009-0002-1355-9607
E-mail: pavanimello@gmail.com

INTRODUCTION

Neuroplasticity, the remarkable ability of the brain to reorganize itself and create new neural connections throughout life, has been the focus of intense study in recent decades, especially regarding cognitive differences among individuals. This article proposes a detailed investigation into how neuroplasticity manifests uniquely in gifted individuals and how these brain characteristics directly influence their learning and development trajectories.

In this context, the article seeks to answer the following question: How can the singularity of neuroplasticity in gifted individuals influence inclusive pedagogical practices?

The importance of this study lies in the growing need to adapt educational practices to be truly inclusive, fully recognizing and supporting students whose exceptional cognitive abilities demand innovative pedagogical approaches. Historically, giftedness has been associated with brain functioning that deviates from the typical pattern, presenting a complexity that often challenges traditional educational systems. In this context, neuroscience offers a deep understanding of the brain mechanisms involved, providing essential support for creating learning environments that not only accommodate but also stimulate these individuals with unique potentials.

In Brazil, despite the legal framework provided in Article 59 of the Law of Guidelines and Bases of National Education, educational and institutional practices capable of fully meeting the specific needs of gifted students are still scarce, requiring more effective action from public educational policies.

This article, therefore, aims to explore the relationship between neuroplasticity and giftedness, with an emphasis on how inclusive educational practices can be fundamental in transforming the potential of these individuals into concrete achievements. The analysis is based on relevant neuroscientific studies that highlight the challenges and practical opportunities for implementing an education that celebrates and enhances cognitive differences.

The expectation is that this study will offer concrete support for educators, educational managers, and policymakers, aiming at effective improvements in the educational support for gifted students.

Furthermore, this work seeks to foster a dialogue between scientific evidence and educational policies, emphasizing the importance of a pedagogical approach that respects and values the unique abilities of the gifted. The organization of the article will proceed as follows: initially, the concepts of neuroplasticity and giftedness will be addressed; next, the application of these concepts in inclusive educational practice will be discussed, with examples of methodologies that can be adopted. Finally, the article will conclude with an analysis of the implications of these practices for the integral development of gifted individuals and for society as a whole.

LITERATURE REVIEW

NEUROPLASTICITY IN GENERAL

Neuroplasticity, also referred to as neural plasticity, is the brain's extraordinary ability to modify its structure and function throughout life in response to experiences, learning, or injuries. This phenomenon allows the brain to reorganize itself by forming new synaptic connections, adjusting existing neural networks, and, in some cases, reallocating functions to different areas to adapt to new demands or repair damage. This characteristic is essential for cognitive development, continuous learning, and recovery after brain injuries (Luders et al., 2009).

Among the mechanisms through which neuroplasticity manifests, the most notable are synaptogenesis, synaptic plasticity, and neurogenesis. Synaptogenesis refers to the creation of new synapses between neurons, a process that is highly active during childhood development but persists throughout life in response to new experiences and learning (Kievit et al., 2016). This process is fundamental for the formation of neural networks that support the storage of new information and skills.

Another relevant mechanism is synaptic plasticity, which involves the modification of the strength of existing synaptic connections. This modification can be either positive or negative, depending on the type and frequency of stimuli received. It is crucial for learning and memory, as it enables the retention of acquired information and skills (Luders et al., 2009).

Additionally, neurogenesis—the formation of new neurons—occurs in some regions of the adult brain, such as the hippocampus, an area essential for memory and learning. This process, once thought to be exclusive to embryonic development, is now recognized as a continuous part of the brain's adaptation throughout life (Kievit et al., 2016).

Scientific evidence suggests that neuroplasticity is mediated by significant changes in neural connectivity, which may include everything from the formation of new synapses to the complete reorganization of brain areas in response to different stimuli. Synaptic plasticity, for example, is a central feature in learning and memory processes, allowing synapses to strengthen or weaken according to the individual's experiences (Luders et al., 2009).

Neurogenesis, especially in the hippocampus, also plays an important role in lifelong neuroplasticity. Studies indicate that adult neurogenesis can be significantly stimulated by activities such as physical exercise and continuous learning, suggesting that both the environment and experiences play a crucial role in maintaining and enhancing brain plasticity (Kievit et al., 2016).

Brain plasticity is most pronounced during childhood and adolescence—critical developmental periods in which the brain is extremely receptive to new learning and experiences. During these stages, brain structure is significantly shaped by interactions with the environment, establishing the foundation for subsequent cognitive and emotional development (Kievit et al., 2016).

However, neuroplasticity is not limited to these early stages. The adult brain also retains a considerable capacity for adaptation, although generally less intense. For example, individuals who suffer brain injuries may experience neural reorganization, in which other parts of the brain take over functions previously performed by damaged areas, demonstrating the brain's continuous adaptive capacity throughout life (Luders et al., 2009).

The implications of neuroplasticity for education are vast, especially for gifted individuals, whose cognitive abilities often exceed the expectations of traditional educational practices. Since these individuals have a heightened potential for learning and development, an educational environment that constantly stimulates the formation of new neural connections can be especially beneficial (Carlsson et al., 2000).

Understanding how neuroplasticity operates can help educators develop teaching programs that maximize this capacity, promoting the formation of new synapses and the strengthening of existing neural networks. This may include the adoption of dynamic teaching methods that continuously challenge gifted students, stimulating their creativity and ability to solve problems in innovative ways (Luders et al., 2009).

Neuroplasticity is, therefore, a central phenomenon for brain development and adaptation throughout life. Studies such as those by Luders et al. (2009) and Kievit et al. (2016) underscore the importance of this capacity for cognitive development, especially during critical life stages such as childhood and adolescence.

Recognizing brain plasticity as a vital mechanism for learning and recovery suggests that educational approaches that stimulate this plasticity may be particularly effective, especially for gifted individuals. Education should, therefore, be adapted not only to meet but also to enhance cognitive and emotional development through the continuous stimulation of neural plasticity (Carlsson et al., 2000).

STUDIES ON GIFTEDNESS AND NEUROPLASTICITY

Giftedness is often understood as a condition that goes beyond exceptional cognitive and creative abilities, being deeply associated with a distinct form of neuroplasticity. This differentiated neuroplasticity enables gifted individuals not only to absorb and process information more quickly but also to adapt more effectively to new cognitive challenges.

Research indicates that this unique brain plasticity is fundamental to the gifted individual's ability to handle cognitive complexities in ways that most people cannot. Studies related to Dabrowski's Theory of Positive Disintegration suggest that the intense emotional reactivity and overexcitability observed in gifted individuals may be linked to a greater capacity for neural reorganization, facilitating adaptation and innovation in response to new stimuli (MENDAGLIO; TILLIER, 2006).

Although Daniel Goleman (1995) does not specifically address gifted individuals, he argues that the way emotions are processed can profoundly impact anyone's cognitive abilities. Goleman proposes that emotional reactivity—a trait that may be intensely present in gifted individuals—has the potential to stimulate creativity and, more broadly, influence neuroplasticity. This intense emotional reactivity may allow for more efficient neural reorganization, resulting in greater cognitive flexibility and the ability to find innovative solutions to complex problems. Applying these ideas to the context of giftedness, one can infer that the way these individuals process emotions may, in fact, amplify their cognitive and creative abilities, partly due to the role of neuroplasticity in adapting and innovating in response to new challenges.

Carlsson et al. (2000) observed that highly creative individuals demonstrate greater activity in the frontal cortex, a brain region associated with abstract thinking and problem-solving. This heightened activity reflects an enhanced capacity for adaptation and cognitive flexibility in these individuals—central characteristics of neuroplasticity. This flexibility allows the brain to reorganize its connections more efficiently in response to new stimuli, facilitating the processing of complex information and the creation of innovative solutions.

Davidson and McEwen (2019), in their study on neuroplasticity and social influences, point out that the brain's adaptive capacity can be significantly enhanced in environments that promote well-being. This is especially relevant for gifted individuals, whose brains appear to be "tuned" to respond more dynamically and effectively to cognitive challenges, facilitating the creation of innovative solutions.

These studies suggest that the brain plasticity of gifted individuals is not merely a passive trait but an active mechanism that enables efficient reorganization in response to new information and challenges. This capacity not only facilitates rapid learning and the resolution of complex problems but is also closely linked to how these individuals experience and process their intense emotions, promoting a more holistic and integrated cognitive and emotional development.

Vygotsky emphasized the importance of the social and educational environment in cognitive development, suggesting that individuals—including the gifted—can achieve higher levels of development through pedagogical practices that foster curiosity and creativity. Although Vygotsky did not directly discuss the concept of neuroplasticity, his developmental theory emphasizes that when exposed to environments rich in stimuli and challenges, individuals have the potential to develop cognitive and creative skills at higher levels, particularly through social interaction and cultural mediation (VYGOTSKY, 2007).

The relationship between giftedness and neuroplasticity is widely supported by research indicating how exposure to enriched environments can strengthen neural connections and promote the development of new synapses. Gifted individuals, whose brains are predisposed to greater plasticity, tend to respond exceptionally well to such stimuli. This interaction between biological predisposition and educational environment is, therefore, fundamental to the full development of these exceptional abilities (DAVIDSON; McEWEN, 2019; MENDAGLIO; TILLIER, 2006).

Pedagogical practices that recognize and stimulate neuroplasticity are essential to maximizing the potential of gifted individuals. By creating environments that encourage exploration, innovation, and problem-solving, educators can help these individuals fully develop their abilities. This is because neuroplasticity, more active and adaptive in the gifted, responds especially well to challenging stimuli, facilitating the reorganization of neural connections and the acquisition of new skills. In this way, neuroplasticity not only supports but also amplifies the cognitive and creative abilities of these students, becoming a crucial element in their education (GOLEMAN, 1995; MENDAGLIO; TILLIER, 2006).

COMPARISON OF NEUROPLASTICITY IN GIFTED AND NEUROTYPICAL INDIVIDUALS

The comparison between gifted and neurotypical individuals reveals significant differences in how neuroplasticity manifests in the brains of these two groups. Neuroplasticity, defined as the brain's ability to adapt and reorganize its neural connections, plays a crucial role in cognitive and emotional development and is particularly distinct in gifted individuals. Research by Luders et al. (2009) indicates that the density of gray matter in brain areas associated with intelligence is greater in gifted individuals, suggesting more pronounced plasticity in these regions. This increased density may be related to an enhanced ability to form new synaptic connections and reorganize neural networks, allowing these individuals to process information more efficiently and develop superior cognitive skills.

Carlsson et al. (2000) observed that brain activity during creative tasks is significantly more intense in gifted individuals. This suggests that these brains are more effective at adapting to new challenges and reorganizing neural networks in response to creative and complex stimuli. This heightened capacity for cognitive flexibility and neural adaptation is a central feature of neuroplasticity and may explain the gifted individual's ability to handle complex problems and innovate in ways that neurotypical individuals cannot as easily.

In addition to these findings, other studies corroborate that neuroplasticity in gifted individuals may be modulated in a distinct manner. For example, Shaw et al. (2006) demonstrated that the cerebral cortex in gifted children matures differently compared to neurotypical children. The cortical thickness in gifted individuals peaks later, but the subsequent thinning occurs more rapidly, possibly associated with greater efficiency in synaptic pruning and, consequently, more refined plasticity.

These significant differences in brain structure and function have profound implications for education. Neurotypical individuals may benefit from standardized pedagogical approaches that are effective for most students, but gifted individuals often require more dynamic and flexible teaching methods. The greater neuroplasticity in gifted individuals suggests that these students develop better in environments that offer continuous challenges and opportunities for innovation and problem-solving, rather than following a linear and uniform curriculum.

Inclusive education must, therefore, not only recognize but also celebrate and enhance these differences. The brains of gifted individuals are particularly sensitive to intellectual stimuli that promote neural reorganization (LUDERS et al., 2009; Carlsson et al., 2000; Shaw et al., 2006). For these individuals, a learning environment that constantly stimulates neuroplasticity can provide more complete and meaningful cognitive development, enhancing their creative and intellectual capacities.

Thus, the educational proposal for gifted individuals should be built around pedagogical practices that foster creativity, complex problem-solving, and critical thinking. These practices need to be adapted to capitalize on the superior brain plasticity observed in these individuals. In conclusion, while neurotypical individuals may follow more predictable learning paths, gifted individuals require an approach that acknowledges their heightened brain plasticity and offers an educational environment that fully explores their capabilities.

The difference in the manifestation of neuroplasticity between these two groups demands an education that goes beyond simple accommodation, requiring an approach that respects, understands, and values the unique characteristics of giftedness, stemming from atypical brain functioning and structure. This approach must be capable of continuously adapting, providing challenges that encourage the integral development of the gifted individual and allow them to fully realize their potential, transforming their cognitive singularities into meaningful contributions to society.

METHODOLOGY USED IN NEUROSCIENTIFIC STUDIES

Studies on neuroplasticity in gifted individuals, as well as in other populations, employ advanced neuroimaging methodologies to explore changes in brain structure and function in response to different stimuli and conditions. Techniques such as functional magnetic resonance imaging (fMRI) and positron emission tomography (PET) are essential for observing brain activity in real time, allowing for a detailed understanding of how the brain reorganizes and adapts its neural connections.

For example, a study using fMRI investigated neuroplasticity in blind individuals, demonstrating that areas of the brain traditionally associated with visual processing can be recruited for other functions, such as hearing and touch, in response to visual deprivation (Bedny et al., 2011). Although this study did not focus directly on gifted individuals, it illustrates a fundamental principle of neuroplasticity: the brain's ability to reconfigure its functions to optimize information processing under different environmental conditions. This principle can be extrapolated to understand how gifted brains reorganize to process information more efficiently, especially in contexts that demand high creativity and complex problem-solving.

Moreover, studies employing techniques such as fMRI and other forms of neuroimaging have revealed that the density of gray matter in specific brain areas—such as those related to intelligence and creativity—is generally higher in gifted individuals. This increased density can be observed and measured through these techniques, offering objective evidence of brain plasticity in individuals with high cognitive abilities. fMRI, in particular, allows for mapping changes in brain activity while individuals perform complex cognitive tasks, enabling the identification of the most active brain areas and how they communicate with each other during these processes (Luders et al., 2009).

Positron emission tomography (PET), in turn, complements this view by measuring cerebral blood flow and metabolism, offering a deeper understanding of how the brains of gifted individuals operate differently compared to neurotypical brains. Studies using PET can demonstrate how different brain regions consume energy during specific tasks, revealing activation patterns that correspond to the high cognitive capacity observed in these individuals.

These methodologies are essential for understanding neuroplasticity in gifted individuals, allowing not only the visualization of changes in brain structure and function but also the quantification of these changes in response to educational and environmental stimuli. These findings are fundamental for developing educational strategies that maximize the neuroplastic capacity of these individuals, ensuring that their cognitive abilities are fully realized.

The application of these techniques highlights the importance of educational environments that promote continuous stimulation and intellectual challenges—elements essential for fostering neural plasticity in gifted individuals. Understanding how these changes occur at the neurobiological level is crucial for formulating pedagogical practices that can enhance the cognitive and creative development of these individuals, promoting an education that not only adapts individually but also maximizes the extraordinary potential of gifted brains.

APPLICATION OF NEUROPLASTICITY IN GIFTED EDUCATION

Understanding neuroplasticity in gifted individuals has profound implications for education, particularly regarding the adaptation of pedagogical practices that can maximize the cognitive potential of these individuals. Neuroscientific studies, as previously mentioned, offer valuable insights into how the gifted brain reorganizes and adapts in response to different stimuli. This suggests that a differentiated educational approach—one that recognizes and enhances the increased capacity for neuroplasticity—is essential for the integral development of these students.

Research indicates that the density of gray matter in areas associated with intelligence and creativity is greater in gifted individuals, pointing to superior neuroplasticity in these individuals. In educational terms, this means that standardized curricula may not be sufficient to meet their needs. Instead, it is necessary to adopt differentiated curricula that offer constant cognitive challenges and encourage creative exploration. Such curricula could include, for example, complex problem-solving and interdisciplinary activities that promote critical thinking and innovation (Luders et al., 2009).

Furthermore, advanced educational technology plays a crucial role in applying neuroplasticity findings to gifted education. Technological tools that personalize learning, such as adaptive educational software, are particularly effective for these students. These technologies adjust the difficulty level of tasks based on student performance, providing continuous challenges that promote neural reorganization and the formation of new synaptic connections (Kadosh; Dowker, 2018). Virtual learning environments and simulators, which offer immersive and interactive learning scenarios, are also extremely beneficial for fostering brain plasticity (Sampedro-Piquero; Begega, 2017).

Michael Piechowski and Kazimierz Dabrowski, for example, emphasize that emotional development is as crucial as cognitive development in the holistic formation of gifted individuals. They suggest that giftedness involves intense emotional experiences, which implies that education must support both cognitive and emotional development. This creates an environment where gifted individuals can fully explore their neuroplastic capacities in a context that values both their abilities and emotional experiences (Piechowski, 1991; Dabrowski, 1964).

Miraca Gross advocates for the importance of academic acceleration for gifted students, arguing that when these students are appropriately challenged, their cognitive and creative capacities develop more effectively. Acceleration can be seen as a direct application of knowledge about neuroplasticity, as it provides the necessary stimuli for the gifted brain to continue adapting and growing in response to appropriate challenges (Gross, 1994).

Early identification and proper monitoring of gifted children are essential for them to develop their full potential. Gagné (2004) suggests that creating an appropriate educational environment is crucial to capitalize on these individuals' innate abilities, ensuring that their exceptional skills are fully developed and that they can contribute meaningfully and innovatively to society.

Inclusive education, in this context, must go beyond merely accommodating these students; it must also respect, value, and enhance their cognitive differences. Inclusion should not only guarantee access but ensure that this access results in educational experiences that challenge and develop the unique capacities of these students. This can be achieved through pedagogical practices that continuously stimulate neuroplasticity, promoting the formation of new synapses and the cognitive flexibility needed to tackle complex problems and create innovative solutions (Davidson; McEwen, 2019).

Thus, applying findings on neuroplasticity to gifted education suggests an approach that is simultaneously personalized and challenging, incorporating differentiated curricula, advanced technologies, and learning environments rich in stimuli. By adapting the educational system to capitalize on the neuroplastic capacities of gifted individuals, we can ensure their full development.

RECENT ADVANCES IN RESEARCH ON NEUROPLASTICITY IN THE GIFTED

In recent years, advances in research on neuroplasticity have revealed new perspectives on how this brain capacity manifests in gifted individuals. Researchers are investigating not only the relationship between neural plasticity and high cognitive ability but also how this plasticity may contribute to greater resilience in the face of cognitive and emotional challenges. Recent studies highlight that stress and social interventions can influence neuroplasticity, and that environments promoting well-being have the potential to enhance the brain's adaptive capacity. These findings are especially relevant for understanding plasticity in gifted brains, which tend to benefit from enriched educational environments to maximize their potential (Davidson; McEwen, 2019).

Similarly, research shows that environmental enrichment throughout life is crucial for maintaining and developing neural plasticity. Applied to the context of gifted individuals, it becomes evident that diverse and complex educational curricula are especially effective in stimulating their cognitive development (Sampedro-Piquero; Begega, 2017).

Studies indicate that logical-mathematical reasoning plays an important role in how gifted individuals identify patterns, analyze complex situations, and develop creative solutions. Gagné (2004) reinforces the importance of educational environments that challenge these abilities, allowing gifted individuals to make quick connections and recognize underlying structures in distinct problems, facilitating the generation of innovative and effective solutions. Thus, creating a learning environment that challenges and stimulates these capacities is fundamental to the full development of these individuals.

Moreover, understanding neuroplasticity in numerical cognitive development is particularly relevant for these students, as their exceptional abilities are closely linked to the capacity to solve problems efficiently and innovatively. Pedagogical practices that adapt to the needs of these students and continuously challenge their neural plasticity can promote more balanced development, maximizing their cognitive potential (Kadosh; Dowker, 2018).

Research has also examined how the brains of children who suffered perinatal brain injuries reorganize to maintain cognitive functions even under adverse conditions. These results suggest parallels with gifted brains, where neural plasticity enables more efficient and creative responses to environmental stimuli (Stiles et al., 2012).

A systematic review of the neuropsychological profile of gifted children revealed that neuroplasticity plays a crucial role in their superior cognitive abilities, highlighting the unique capacity for neural reorganization that grants these children exceptional performance across various knowledge domains (Cassidy et al., 2018).

The exploration of executive functions and their variations among gifted individuals reveals a deeper understanding of how neuroplasticity may manifest differently in these highly adaptable brains. Executive functions such as inhibitory control, working memory, and cognitive flexibility are essential for planning, decision-making, and solving complex problems. In gifted individuals, these functions tend to be more developed, allowing them to process information more efficiently and adapt quickly to new challenges (Friedman; Miyake, 2017).

These executive functions are mediated by neural networks that continuously reorganize in response to varied stimuli, suggesting heightened brain plasticity. This adaptive capacity not only facilitates superior academic performance but also contributes to creativity and innovation—traits frequently associated with gifted individuals. Understanding these variations in the manifestation of executive functions reinforces the importance of educational practices that recognize and continuously stimulate these differences.

To ensure the integral development of these individuals, it is essential that the educational environment offers challenges that activate and develop these executive functions. This may include tasks that require critical thinking, complex problem-solving, and the application of concepts in new contexts. By promoting an environment that continuously challenges the neural plasticity of gifted individuals, education can maximize their cognitive and creative potential, allowing their abilities to be fully explored and meaningfully applied in society.

This educational approach, which integrates knowledge about neuroplasticity and executive functions, is essential to ensure that gifted individuals not only reach their academic potential but also develop the skills necessary to face life's challenges in innovative and effective ways. The most recent scientific findings make it clear that, to promote true inclusion, educational practices must be adapted to recognize and nurture the differences of these individuals. Only then can we ensure that each gifted person has the opportunity to fully develop their unique potential, contributing significantly to society.

METHODOLOGY

TYPE OF RESEARCH

The present study is characterized as qualitative research, of an exploratory nature and integrative bibliographic approach. Qualitative research allows for the evaluation of complex phenomena through the interpretative analysis of non-numerical data, while the exploratory nature is justified by addressing a topic that is still insufficiently systematized: the interface between neuroplasticity and giftedness within the framework of inclusive education.

The integrative review was chosen for its ability to provide a critical synthesis of theoretical and empirical results, benefiting the articulation between neuroscientific foundations and educational applications.

SEARCH TECHNIQUES AND SELECTION CRITERIA

Data collection was carried out through a systematic survey of relevant scientific publications in the databases Scielo, PubMed, Google Scholar, and CAPES Journals. The searches were conducted between February and April 2024, using the following descriptors combined in Portuguese and English: "neuroplasticidade" / "neuroplasticity", "superdotação" / "giftedness", "educação inclusiva" / "inclusive education", "desenvolvimento cognitivo" / "cognitive development", and "políticas educacionais" / "educational policy".

The following inclusion criteria were established: i) publications with a theoretical or empirical approach relevant to the topic; ii) peer-reviewed articles, scientific books, or systematic reviews; iii) studies that directly addressed neuroplasticity in gifted individuals or the educational impacts resulting from this interaction; iv) publications from the year 2000 onward, with emphasis on the last 15 years.

Conversely, the following were excluded: works with an exclusively biomedical or neurological focus without connection to learning; opinion pieces or texts lacking scientific grounding; reductionist approaches that limit giftedness to high academic performance or IQ as an absolute criterion.

ANALYSIS PROCEDURES

After the initial filtering, the selected materials were read in full and categorized into five thematic axes: (i) foundations of neuroplasticity, (2) brain manifestations associated with giftedness. (3) comparison with neurotypical individuals, (4) educational implications, and (5) public policy proposals. The analysis followed a qualitative interpretative approach, seeking convergences, divergences, and gaps in the literature.

The interpretation of the data aimed to integrate empirical findings with the theoretical approaches of authors such as Linda Silverman, Kazimierz Dąbrowski, Michael Piechowski, Daniel Goleman, and Lev Vygotsky, as well as recent neuroscientific studies by Abraham (2018), Luders et al. (2009), Cassidy et al. (2018), and Davidson and McEwen (2019), among others.

DISCUSSION ON METHODOLOGICAL CHOICE

The choice of an integrative review is based on the need to understand giftedness from a broad and contemporary perspective that integrates neuroscience, developmental psychology, and inclusive education. This approach makes it possible not only to scan the current state of research but also to propose practical paths for the pedagogical implementation of findings, considering the neurobiological and emotional specificities of gifted individuals.

In addition to encompassing different areas of knowledge, the adopted methodology enables the formulation—based on scientific evidence—of proposals for educational policies that respect the neurodiverse functioning of gifted individuals. Thus, this article aims to contribute theoretical and practical support to the construction of a more responsive, inclusive, and neuro-compatible education.

RESULTS AND DISCUSSION

The results obtained from the literature analysis demonstrate that neuroplasticity in gifted individuals manifests in a unique manner, characterized by greater gray matter density, intensified brain activity in regions associated with creativity and intelligence, and a more efficient pattern of neural reorganization (LUDERS et al., 2009; SHAW et al., 2006). These particularities enable faster cognitive adaptation and a heightened capacity for solving complex problems and fostering innovation (CARLSSON et al., 2010; DAVIDSON; McEWEN, 2019).

The analyzed studies also show that the environment directly influences the expression of this neuroplasticity, especially when it offers challenging and emotionally positive stimuli (SAMPEDRO-PIQUERO; BEGEGA, 2017; PIECHOWSKI, 1991).

In this context, standardized and linear pedagogical practices tend to limit potential, whereas differentiated approaches tailored to the special needs of each gifted individual—such as flexible curricula, adaptations in learning and assessment methods, academic acceleration, and curricular deepening—not only favor the full development of their neurobiological capacities but also promote well-being and holistic health.

Dialogue with authors such as Vygotsky (2007) and Dąbrowski (MENDAGLIO; TILLIER, 2006) reinforces the importance of responsive educational environments that value not only cognition but also the affective and social dimensions of development. These results point to the need for public policies that not only understand giftedness as a form of neurodivergence but also ensure concrete practices of school and institutional support—from early identification to the implementation of compatible teaching strategies.

CONCLUSION

This article aimed to analyze how neuroplasticity manifests in gifted individuals and what the implications of this cerebral singularity are for inclusive education. Based on an integrative literature review, it was possible to gather neuroscientific evidence that confirms the high capacity for brain reorganization in gifted individuals, especially in regions associated with intelligence, creativity, and problem-solving.

The main findings reveal that this heightened neuroplasticity depends not only on biological predispositions but also on the quality of educational and emotional stimuli received. The analyzed literature indicates that differentiated and specific pedagogical practices, combined with the recognition of giftedness as an expression of neurodiversity, are essential for the integral development of these individuals.

The primary contribution of this research is to offer scientific foundations to support the urgency of educational practices and policies that respect and enhance the capacities of gifted individuals. This includes the effective implementation of strategies such as academic acceleration, personalized curricula, reduction of content repetition already mastered, horizontal expansion of content with the inclusion of topics of interest to the student, projects based on themes chosen by the student integrating areas of knowledge, inquiry-based learning and complex problem-solving, project-based learning (PBL), academic mentoring or tutoring, emotional self-regulation and metacognition techniques, debates, seminars, and the production of original content, use of adaptive technologies, sensory-adjusted environments, flexible schedules and workloads, as well as continuous teacher training.

In summary, ensuring the full development of these individuals requires more than mere access to school: it demands policies and practices that effectively provide them with the conditions to transform potential into contribution, respecting their singularities and guaranteeing them a dignified and productive place in society.

REFERENCES

1. Abraham, A. (2018). The Neuroscience of Creativity. Cambridge: Cambridge University Press. Retrieved from https://www.cambridge.org/core/books/neuroscience-of-creativity/BBF08C601C4FF4B4E23004FBB0BD88F4. Accessed April 1, 2024.

2. Bedny, M., Pascalis-Leone, A., & Scott, S. K. (2011). "A Sensitive Period for Language in the Visual Cortex: Distinct Patterns of Plasticity in Early and Late Blindness." Brain, 134(4), 1408–1415.

3. Brasil. (1996). Lei nº 9.394, de 20 de dezembro de 1996: Estabelece as diretrizes e bases da educação nacional [Law No. 9.394 of December 20, 1996: Establishes the Guidelines and Foundations of National Education]. Diário Oficial da União: seção 1, Brasília, DF, December 23, 1996. Retrieved from http://www.planalto.gov.br/ccivil_03/leis/l9394.htm. Accessed April 1, 2024.

4. Carlsson, I., Wärneryd, B., Smith, G., & Ekehammar, B. (2010). "Openness to Experience, Intelligence, and Creative Achievement in Academia: A Moderated Mediation Model." Creativity Research Journal, 22(2), 196–202.

5. Cassidy, A. R. et al. (2018). "Neuropsychological Profile of Intellectually Gifted Children: A Systematic Review." Journal of the International Neuropsychological Society. Retrieved from https://www.cambridge.org/core/journals/journal-of-the-international-neuropsychological-society/article/abs/neuropsychological-profile-of-intellectually-gifted-children-a-systematic-review/E4DE226BAA7ED66B762945EE5C9568BF. Accessed April 15, 2024.

6. Davidson, R. J., & McEwen, B. S. (2019). "Social Influences on Neuroplasticity: Stress and Interventions to Promote Well-Being." Nature Neuroscience, 22(5), 689–695.

7. Friedman, N. P., & Miyake, A. (2017). "Unity and Diversity of Executive Functions: Individual Differences as a Window on Cognitive Structure." Cortex, 86, 186–204.

8. Gagné, F. (2004). "Transforming Gifts into Talents: The DMGT as a Developmental Theory." High Ability Studies, 15(2), 119–147.

9. Goleman, D. (1995). Emotional Intelligence (pp. 38–42). New York: Bantam Books.

10. Kadosh, R. C., & Dowker, A. (Eds.). (2018). The Oxford Handbook of Numerical Cognition (pp. 485–502; 612). New York: Oxford University Press.

11. Kievit, R. A., Davis, S. W., Gage, S. H., Pengeroth, E., Axlerod, S., & Tyler, L. K. (2016). "Developmental Cognitive Neuroscience Using Latent Change Score Models: A Tutorial and Applications." Developmental Cognitive Neuroscience, 18, 30–42.

12. Luders, E., Narr, K. L., Thompson, P. M., & Toga, A. W. (2009). "Neuroanatomical Correlates of Intelligence." Intelligence, 37(2), 197–203.

13. Mendaglio, S., & Tillier, W. (2006). "Dąbrowski's Theory of Positive Disintegration and Giftedness: Overexcitability Research Findings." Journal for the Education of the Gifted, 30(1), 68–87.

14. Piechowski, M. (1991). "Developmental Potential of the Gifted." Roeper Review, 13(3), 190–197.

15. Sampedro-Piquero, P., & Begega, A. (2017). “Environmental Enrichment as a Positive Behavioral Intervention Across the Lifespan.” Current Neuropharmacology, 15(4), 459–470.

16. Shaw, P. et al. (2006). “Intellectual Ability and Cortical Development in Children and Adolescents.” Nature, 440(7084), 676–679.

17. Stiles, J. et al. (2012). Neural Plasticity and Cognitive Development: Insights from Children with Perinatal Brain Injury. Oxford: Oxford University Press.

18. Vygotsky, L. S. (2007). A Formação Social da Mente (6th ed.) [The Social Formation of the Mind] (pp. 102–130). São Paulo: Martins Fontes.