Unveiling the intelligence spectrum: Neuroscientific insights into giftedness

https://doi.org/10.56238/sevened2024.018-012

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ABSTRACT

This academic work encompasses neurosciences, high abilities, and giftedness. It aims to present a review that integrates areas involving the neurosciences of behavior and cognition, and their contribution to the gifted, potentially proving useful for educators in the field of high abilities and giftedness. The study is justified by the fact that despite the aforementioned assistance to gifted students being controversial and their identification difficult, Brazil's Resolution No. 4 (2009) establishes operational guidelines for Specialized Educational Assistance in basic education, in the special education modality, which encompasses students with high abilities and giftedness. The methodology used was a narrative review. It is emphasized that an educator who ventures into the neurosciences and learns about brain functioning begins to exercise their work more meaningfully and efficiently, considering that it is possible to relate certain neuroscientific evidence with theoretical-pedagogical bases.

Keywords: Education, Giftedness, High Abilities, Intelligence Spectrum, Neuroscience.

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INTRODUCTION

According to Lent (2004, p. 6), what is simplistically named neuroscience is actually neurosciences due to the multiplicity of approaches. A simpler and schematic way of classifying them is through categorization into five major areas: molecular neuroscience, cellular neuroscience, systemic neuroscience, behavioral neuroscience, and cognitive neuroscience. The author warns that the boundary between these disciplines is not clear due to the interdisciplinarity between the areas of neurosciences, which implies alternating from one discipline to another whenever one intends to understand the functioning of the nervous system. The author also states that professionals dealing with this system are usually of two categories: neuroscientists, whose activity involves conducting scientific research in the areas of neurosciences, and health professionals, whose activity involves the preservation and restoration of the functional performance of the nervous system.

Considering the above, professionals dealing with neurosciences usually have their training in biology, biomedical sciences, or health sciences colleges. These professionals then undertake a postgraduate program specifically focused on the nervous system and finally become university professors or researchers at non-university scientific institutions, with their work funded by government or private resources, and their results published in specialized scientific journals.

However, contemporaneously, Lent (2004, p. 6) states that other professionals have shown interest in studying the nervous system, such as engineers, especially those focused on computer science, as computers and some robots have architectures designed based on concepts originating from Neurosciences. In an attempt to master concepts such as the visual perception of colors and movement, graphic artists and visual programmers have also approached Neurosciences. Concerning professionals seeking neurosciences, educators and pedagogues are mentioned as being interested in understanding how the nervous system exercises the capacity to select and store information, an important attribute of learning processes.

The aforementioned author highlights the relevance of multidisciplinary action in the field of neurosciences, which is becoming progressively indispensable, considering the reality that the nervous system has various layers of existence and its complete understanding requires multiple approaches. It is observed that hospital health teams are generally multi-specialized, and current neuroscientific research involves collaboration among different specialists.

According to Kandel (2014, p. 5), the last frontier of biological sciences involves understanding the biological basis of consciousness and the brain processes by which humans feel, act, learn, and remember. In his work, the author seeks to unite the study of behavior (the science of the mind) and neurosciences (the science of the brain). In a unified approach, in which mind and body are not seen as separate entities, he supports the view that all behavior results from brain function. What is usually called the “mind” consists of various operations performed by the brain,

whose processes form the basis not only of motor behaviors but also of complex cognitive acts and behaviors. Therefore, all behavioral, affective, and cognitive disorders that characterize psychiatric diseases result from brain function disorders.

According to Kandel (2014, p. 5), neurosciences integrate the task of explaining behavior in terms of brain activity and progress in explaining human behavior. According to Kandel (2014, p. 6), during the 20th century, a vision emerged about how nerve cells, the brain, and behavior are viewed. This vision arose from the synthesis of five experimental traditions: anatomy, embryology, physiology, pharmacology, and psychology. It is known that in the second century, the Greek physician Galen proposed that nerves would conduct a fluid secreted by the brain and spinal cord to peripheral tissues; this view dominated Western medicine until the microscope revealed the true structure of cells in nervous tissue. As the author reports, nervous tissue did not become a subject of special science until the late 19th century when detailed and accurate descriptions of nerve cells were produced by the Italian Camillo Golgi and the Spaniard Santiago Ramón y Cajal.

Behavior in the context of psychological thought, according to Kandel (2014, p. 6), emerged when ancient Greek philosophers speculated about the causes of behavior and the relationship of the mind with the brain, a period dating back to the beginning of Western science. However, it was only in the mid-19th century that Charles Darwin set the stage for the modern understanding of the brain as the origin of all behavior. According to the author, Darwin considered that animals could serve as models for studying human behavior, and thus, the study of evolution gave rise to ethology, which involves investigating the behavior of animals in their natural environment; later, through experimental psychology, human and animal behavior is studied under controlled conditions. In the early 20th century, Sigmund Freud introduced the first systematic cognitive psychology, psychoanalysis, which structured the enormous problems faced in trying to understand the human mind.

In Kandel's (2014, p. 6) view, around 1800, attempts began to integrate biological and psychological concepts in the study of behavior, a time when the Viennese physician and neuroanatomist Franz Joseph Gall was a pioneer in attempting to enumerate the regions of the brain and their functions. However, as the author points out, Gall's experimental approach was quite naive, as he ignored all evidence derived from examinations of brain lesions, discovered clinically or produced surgically in animal experiments. Erroneously influenced by physiognomy, a popular belief in the idea that facial features reveal character, Gall believed that bumps and indentations on the surface of the skull of gifted people with certain faculties identified the centers of these faculties in the brain.

From Kandel's (2014, p. 7) perspective, it was in the late 1920s that Gall's ideas were subjected to experimental analysis by the French physiologist Pierre Flourens, through the systematic

destruction of the functional centers outlined by Gall in the brains of experimental animals. Flourens tried to isolate the contribution of each supposed brain organ to behavior and concluded that specific brain regions are not responsible for specific behaviors but that all regions of the brain, especially the cerebral hemispheres of the forebrain, participate in each mental operation. Thus, the researcher believed that any part of a cerebral hemisphere would be capable of performing all the functions of that hemisphere and that a lesion in any area of the cerebral hemispheres should, therefore, affect all its functions equally.

From the perspective of Guerra and Cosenza (2011, p. 142), among the areas of study in neurosciences are cognitive functions and behavior, resulting from the activity of the nervous system and its specific functions. According to the authors, neuroscientific knowledge has developed significantly in recent years, particularly since the "Decade of the Brain," proposed by the United States Congress for the years 1990 to 1999, but they state that cognitive processes are still not fully understood due to the technical and ethical limitations that the study of human behavior imposes.

In the educational context, Guerra and Cosenza (2011, p. 141) present the purpose of education, which aims at the development of new knowledge or behaviors. The evidence of learning occurs when the individual is able to exhibit and express this new knowledge or behavior acquired, which allows them to transform the world they live in, fulfilling themselves as an individual in society. Contemporarily, according to Guerra and Cosenza (2011, p. 141), it is known that human behaviors originate in the nervous system and mental functions are associated with the functioning brain.

Regarding education, Guerra and Cosenza (2011, p. 141) state that when the educator understands brain functioning, their work becomes more meaningful and efficient, as it is possible to relate some neurobiological explanations with pedagogical subjects. Guerra and Cosenza (2011, p. 145) also state that the inclusion of topics related to neurosciences in the initial training of educators is an urgent challenge, as most educators have fundamentally humanistic training, essential for understanding education but insufficient, in this millennium, to meet the demands of learning for life in society.

Another challenge proposed by Guerra and Cosenza (2011, p. 145) involves proposing relevant topics to be studied, such as the functioning of the nervous system in learners with different brains, including in this case, knowledge that could integrate the training of special education teachers. Among learners with different brains, Soares, de Souza Arco-Verde, and Baibich (2004, p. 125) indicate that the special education of the gifted may seem controversial, as individuals with high abilities and giftedness are often seen as genetically privileged beings who do not need any type of assistance.

On the other hand, Soares et al. (2004, p. 125) evaluate that the role of the educator is fundamental for the student with high abilities and giftedness, so that they can perceive their talents and not see themselves just as different students. Soares et al. (2004, p. 126-127) also indicate that, in addition to the aforementioned controversy regarding special assistance for these students, their identification is also complex, involving more than just measuring intelligence through tests. In relation to behavior, the aforementioned authors also defend that the traits that separate gifted individuals from others are rarely perceived by teachers or the school's pedagogical team.

Thus, this work encompasses giftedness and neurosciences and aims to present a review that integrates giftedness and the neurosciences of behavior and cognition, potentially proving useful for special educators in the field of high abilities and giftedness. According to Lent (2004, p. 6), behavioral neuroscience: "...is dedicated to studying the neural structures that produce behaviors and other psychological phenomena such as sleep, sexual, emotional behaviors, and many others. It is sometimes also known as Psychophysiology or Psychobiology." According to Lent (2004, p. 6), cognitive neuroscience: "...deals with more complex mental capacities, usually typical of humans, such as language, self-awareness, memory, etc. It can also be called Neuropsychology."

As a starting point, considering the concepts of giftedness presented by various theories, including primarily ideas about the supposed peculiarities of gifted individuals, the following question arises: "Does the cognitive and behavioral uniqueness of the gifted individual, defended since the early days of psychometrics, reflect the results of current neuroscientific research?"

The present article is justified by the fact that despite the aforementioned assistance to gifted students being controversial and their identification difficult, recalling Soares et al. (2004, p. 126-127), on the other hand, Resolution No. 4 of Brazil (2009) establishes operational guidelines for Specialized Educational Assistance in basic education, special education modality. Thus, it is observed that the inclusion of gifted students is mandatory, as pointed out by Article 1 (Brazil, 2009, p. 1), stating that for the implementation of Decree No. 6.571/2008, the education systems must enroll, in regular education classes and in AEE, students with disabilities, global developmental disorders, and high abilities/giftedness.

METHODOLOGY / MATERIALS AND METHODS

The methodology used in the development of this work was a narrative review, based on the definition of Sallum, Garcia, and Sanches (2012, p. 151):

> Narrative reviews are broad publications suitable for describing and discussing the development or "state of the art" of a particular subject, from a theoretical or contextual point of view. They consist mainly of analyzing literature published in books, printed or electronic journal articles, and the author's personal critical interpretation and analysis. This category of articles plays a fundamental role in continuing education, as they allow the reader to acquire and update knowledge on a specific topic in a short period of time. (SALLUM, GARCIA E

SANCHES, 2012, p.151)

Through the aforementioned methodology, by means of a review of psychometric concepts, through Mäder (1996), Ramos (2007), Tyler (1966), Renzulli and Reis (1997), and Antipoff (1999); the article presents a counterpoint, resorting to neurosciences, through Lutzenberger et al. (1992), Almeida et al. (2010), and Shearer and Gaesser (2015).

RESULTS

To understand the concept of giftedness, it is necessary to seek the conceptual origins of this theory, related to IQ (intelligence quotient) tests and the advent of psychometrics. According to Mäder (1996, v. 16, p. 13), Ramos (2007, p. 11), and Tyler (1966, p. 61-62), IQ tests emerged after the advent of psychometrics. The history of this branch of psychology originated shortly before the beginning of the 20th century, when psychologists began their efforts to measure human intelligence; however, they lacked a precise idea about the nature of this quality. These efforts were more prolonged and intense than any other project involving psychological measurement. To achieve this, through quantitative assessment of an individual's psychological traits and attributes, psychometrics began to develop.

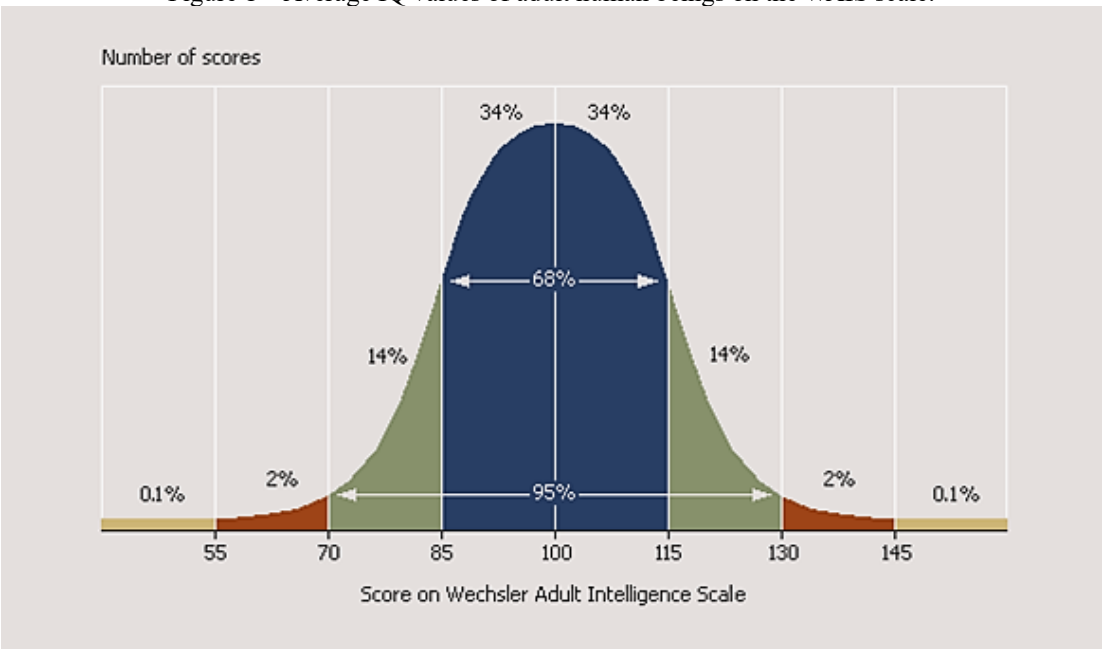
During the aforementioned period, according to Mäder (1996, v. 16, p. 14), it was in France that the basic principles for a psychometric assessment battery were established. The Binet-Simon Intelligence Scale was published in 1905 and was considered the first practical intelligence test. For the conception of the scale, which aimed to grade mental retardation, mental age and cognitive development concerning the biological age of the tested individual were considered. Mäder (1996, v. 16, p. 14-15) states that the Americans had great interest in the work of the French, and in 1908, Goddard standardized the Binet-Simon Scale for 2000 American children. In 1916, the aforementioned scale was revised by Terman, who adopted the concept of "Intelligence Quotient."

According to Mäder (1996, v. 16, p. 15), in 1936, David Wechsler published the Wechsler Bellevue Scale, marking the beginning of a series of intelligence assessment batteries, structured into two large groups of tests, verbal and non-verbal, called performance or execution; this structure remains in all batteries, for all ages, still used today. Among the Wechsler scales, the Wechsler Adult Intelligence Scale (WAIS), published in 1955 and revised (WAIS R) in 1981, covers the age range from 16 to 74 years.

The Specialedonthebellcurve website presents numerical IQ values obtained on the Wechsler Adult Intelligence Scale (WAIS), comparing the values obtained among adult human beings (Figure 1). It is observed that the average score is between 85 and 115; this means that most people are classified within this corresponding range, and that is why the top of the bell curve is over these scores. On the WAIS scale, while a score above 130 indicates high cognitive ability (giftedness), a

score below 70 indicates low cognitive ability (mild intellectual disability). However, the website informs that the actual criteria for identifying giftedness depend on the reference used.

Figure 1 – Average IQ values of adult human beings on the WAIS scale.



Source: Specialedonthebellcurve, 2024.

Contrasting the value of IQ tests as predictors of success, Tyler (1966, p. 75-76) already stated that there are several qualities not measurable by IQ tests. For example, children considered "gifted" may not achieve special talents in art, music, mechanics, or human relations. Therefore, the results obtained in the aforementioned IQ tests do not successfully predict an individual's adaptability (or lack thereof) to new situations.

Regarding intellectual development in terms of giftedness, it is worth mentioning Renzulli and Reis (1997, p. 73) apud Brasil (2007, p. 1); the authors make a distinction between being gifted and being able to develop gifted behaviors, which can be developed by some people at certain times and under certain circumstances. These behaviors and characteristics are presented by Antipoff (1999, p. 155-157).

The characteristics involving the social conduct of the gifted, in Antipoff's view (1999, p. 155), involve the fact that these individuals are entrepreneurs of social and constructive activities, enduring difficult situations with intelligence and good humor. These individuals are governed by the following behaviors: in childhood, they create a greater number of imaginary friends; when young, they tend to be playful and approach older people; they are sensitive, courteous, and cooperative; although not very willing, they easily relate to others; they aspire to freedom to perform their tasks; they entertain themselves alone; they prefer games governed by rules or systems.

In the school environment, according to Antipoff (1999, p. 156), the gifted student rejects repetition, prefers intellectual activities and individual work, shows independence and initiative, approaches older individuals, prefers cultured teachers, and avoids following orders.

Even concerning brain functioning, a differentiated behavior is observed regarding the brains of the gifted compared to those of individuals with average IQ, both in activity and at rest. This fact can be observed in Lutzenberger et al. (1992, p. 10-14), where the authors present a study whose objective was to determine the dimensional complexity of the electroencephalogram (EEG) concerning intelligence levels in humans. In two experiments, 34 male individuals were divided into two groups, with high and low intelligence levels (measured by IQ). During a resting phase and various mental imagery conditions, the EEG was recorded at several scalp locations.

According to Lutzenberger et al. (1992, p. 10-14), through non-linear analysis based on the theory of deterministic chaos, it was revealed that individuals with high IQ demonstrate greater dimensional complexity of EEG attractors than individuals with low IQ, but only during resting conditions; during the performance of imagery tasks, less intelligent individuals increase brain electrical complexity in such a way that, in this experiment, the differences between low and high IQ values disappear.

Regarding the terminology gifted, in Antipoff (1999), it is observed that the author uses various expressions to refer to the gifted, such as "well-endowed" or "talented." According to Antipoff (1999, p. 111), as a speaker at the 1st National Seminar in Brasília in 1971, Helena Antipoff preferred to adopt the nomenclature "well-endowed" to refer to the gifted; this term was better accepted, including by the talented individual, who felt less pressured by society.

As for the concept of well-endowed, according to Antipoff (1999, p. 111), in the conception provided by CENESP, based on J. Gallagher's studies, gifted children were considered those who presented remarkable performance and/or potential, either in isolation or combined, in the following aspects: general intellectual ability, specific academic aptitude, creative or productive thinking, leadership ability, special talent for the arts, and psychomotor ability. It is worth mentioning that the conception provided by CENESP, created in 1971, is still practically the same used today, as seen in Brasil (2007, p. 1) and Brasil (2009, p. 1).

Returning to the Three-Ring Conception, according to Renzulli and Reis (1997, p. 73) apud Brasil (2007, p. 1), creativity is presented as an ability not exclusively related to the artistic field but to any area of the student's interest. Thus, it is believed that the development of creativity and motivation, within the areas of interest and/or abilities of the student, extends the perspectives on the student's success and satisfaction.

The Three-Ring Conception (Figure 2), proposed by Renzulli and Reis (1997), was purposefully designed for a programming model that provides both academic development and high

achievement and creativity. In this model, the intersection of three items leads to giftedness, and they are: above-average ability, but not necessarily superior, as measured by cognitive ability and achievement tests; task commitment (motivation); creativity and its relationship with general and specific areas of human performance.

Figure 2 – The Three-Ring Conception.

Source: Own authorship, 2024.

However, in the view of the Ministry of Education, presented by Brazil (2001, p. 39), students with high abilities/giftedness are those who:

> … have great learning ease that leads them to quickly master concepts, procedures, and attitudes and who, having the ability to deepen and enrich these contents, should receive supplementary challenges in common class, in resource room, or other spaces defined by education systems, including to complete, in less time, the series or school stage. (BRASIL, 2001, p.39)

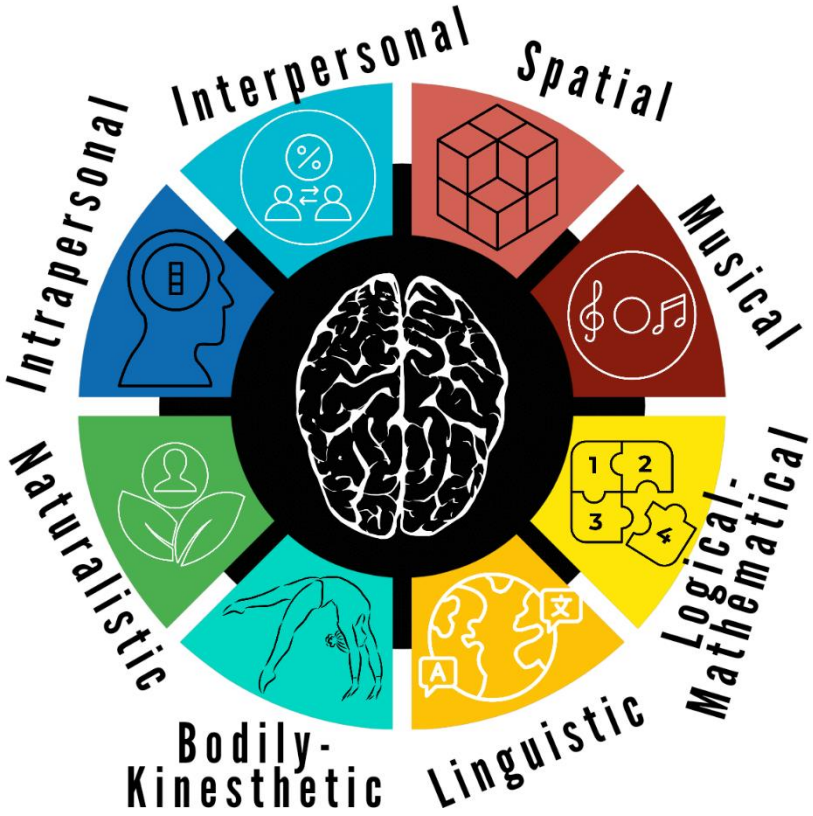
According to Brasil (2007, p. 1), gifted and talented children are those who present extraordinary performance, either in isolation or combined, concerning the following aspects: general intellectual ability, specific academic aptitude, creative or productive thinking, leadership ability, special talent for the arts, and psychomotor ability. These aspects resemble the theory of multiple intelligences proposed by Gardner (1995).

Gardner (1995, p. 22-29) presents what he calls "the seven intelligences," which are: musical, bodily-kinesthetic, logical-mathematical, linguistic, spatial, interpersonal, and intrapersonal. Gardner (1995, p. 46) also mentions a reasonable candidate for the eighth intelligence: moral or spiritual intelligence. However, the author states that this intelligence could be considered an amalgamation of interpersonal and intrapersonal intelligences.

A few years later, according to Sodré (2006), presented by Gama (2014, v. 27, p. 668), Gardner identified and recognized naturalistic intelligence. This intelligence can be summarized as

follows, according to Gama (2014, v. 27, p. 669): "...ability to recognize flora and fauna, to make distinctions and to act productively in the natural world. This intelligence characterizes people like Darwin." However, according to Gardner (1995, p. 45-46), if every capacity found in humans were considered an intelligence, there could be up to "seven hundred" intelligences. Therefore, the search for a smaller number of intelligences was deliberate (Figure 3).

Figure 3 – Eight intelligences identified by Gardner.



Source: Own authorship, 2024.

In the realm of multiple intelligences, according to Almeida et al. (2010, p. 225-230), new and more contextualized cognitive tests are suggested as alternatives to more traditional psychometric tests. The objective of this article was to examine whether these two types of instruments converge or not in a general factor of cognitive performance, conducted through the application of two tests in 294 children aged 5 to 7 years: General and Differential Aptitudes Battery (BADyG - reasoning, memory, verbal aptitude, numerical aptitude, and spatial aptitude), a test for assessing Gardner's multiple intelligences (integrating: linguistic, logical, visual/spatial, physical-kinesthetic, naturalistic, and musical). After the results, the authors state that there is relative independence between Gardner's multiple intelligences test and classic intelligence tests, so that both are not mutually exclusive. The authors also suggest that the tests converge on a single factor, suggesting that the general dimension of intelligence is an undeniable reality and somewhat corroborates Sternberg's theories (1994), in which the theory of multiple intelligences resembles.

Shearer and Gaesser (2015, p. 96-131) conducted an investigation reviewing 318 neuroscience reports to conclude that there is strong evidence, regarding multiple intelligences, that each intelligence has neural coherence. The investigation revealed a wealth of neuroscientific evidence describing the neural foundations of abilities associated with both general intelligence and the eight multiple intelligences. The description of the incompatibility between theories involving general intelligence and multiple intelligences seems to arise from a cultural preference, incompatible with the conclusions derived from neuroscientific evidence. According to the authors, perhaps the greatest challenge is creating a bridge between IQ and multiple intelligences, so that the "art of teaching" can also be improved, allowing all students to develop both academically and in other abilities.

DISCUSSION

What is simplistically named neuroscience is actually neurosciences due to the multiplicity of approaches, whose boundary between their disciplines is not clear due to the interdisciplinarity among their areas. Professionals dealing with neurosciences have their training in biology, biomedical sciences, or health sciences colleges; however, other professionals have shown interest in studying the nervous system, such as educators, who are interested in understanding how the nervous system handles learning processes.

Considering that most educators have fundamentally humanistic training, it is understood that this is sufficient to understand the theoretical foundations of education, but contemporarily, insufficient to meet the demands of learning for life in society. It is suggested then the inclusion of topics related to neurosciences in the initial training of educators. It is worth remembering that an educator who ventures into neurosciences and learns about brain functioning begins to exercise their work more meaningfully and efficiently, as they relate some neuroscientific explanations with pedagogical subjects.

To facilitate the teaching-learning process of individuals with different brains, it is necessary that the functioning of their nervous system is understood by their educators, making this process more efficient and effective. However, in the case of individuals with high abilities and giftedness, there is a certain controversy, as it is mistakenly believed that these genetically privileged beings do not need any type of assistance, which is fundamental for them to perceive their talents and not see themselves just as different.

Identifying gifted students is a complex task, considering that high abilities and giftedness go beyond measuring intelligence through tests. However, authors Soares et al. (2004) and Antipoff (1999) argue that there are traits that differentiate so-called normal individuals from gifted individuals. Within this context, Renzulli and Reis (1997) present a model with three variables that,

if met, could lead an individual, for a certain time and under certain circumstances, to exhibit gifted behaviors, reinforcing the aforementioned difficulty of identifying these individuals.

Recalling Gardner (1995) in the sense that humans possess multiple intelligences, new and more contextualized cognitive tests are suggested as alternatives to more traditional psychometric tests, and it is in this context that Almeida et al. (2010) examine whether these two types of instruments converge or not in a general cognitive performance factor. Although this possibility of convergence in which the authors believe is not excluded, it is observed that there is relative independence between Gardner's multiple intelligences test and classic intelligence tests, so that both are not mutually exclusive.

Shearer and Gaesser (2015) review 318 neuroscience reports to conclude that there is strong evidence, regarding multiple intelligences, that each intelligence has neural coherence. The authors present a wealth of neuroscientific evidence describing the neural foundations of abilities associated with both general intelligence and the eight multiple intelligences.

The description of the incompatibility between theories involving general intelligence and multiple intelligences seems to arise from a cultural preference, incompatible with the conclusions derived from neuroscientific evidence, as in Almeida et al. (2010) and Shearer and Gaesser (2015). The aforementioned authors believe that general intelligence and multiple intelligences tests converge on a single factor, thus, through future studies, there is the possibility of creating a bridge between IQ and multiple intelligences.

Regarding the psychobiology of gifted brains, Lutzenberger et al. (1992) reveal that individuals with high IQ, through an experiment using electroencephalogram, demonstrate greater dimensional complexity in brain functioning when at rest, compared to individuals with lower IQ. However, the differences in EEG results practically disappear when individuals, with low or high IQ, perform imagery tasks.

The analysis of Lutzenberger et al. (1992) raises the question of the possibility of biological differences between a gifted individual and an individual with an average IQ. Based on the aforementioned Lutzenberger et al. (1992) and Renzulli and Reis (1997) and their concept regarding the existence of individuals who exhibit gifted behaviors, this present article points to the need for Lutzenberger's experiment to be repeated with two clinically tested groups: non-gifted individuals who exhibit gifted behaviors and gifted individuals, to determine whether in this case, biological differences will reflect in divergent results or if gifted behaviors (between gifted and non-gifted individuals) will ensure parity between the results of the two tested groups.

FINAL CONSIDERATIONS

Integrated educational methods play a crucial role in understanding and promoting adequate education for students with High Abilities/Giftedness (HA/G). While giftedness is often associated with high general intellectual potential, typically identified by the numerical value of IQ (Intelligence Quotient), high abilities are characterized by more subjective and complex identification criteria, referring to exceptional capacities in specific areas. The combination of neuroscience with pedagogy promises more personalized and in-depth teaching, capable of meeting the distinct needs of these two groups.

The integration of neuroscientific knowledge into the education of students with HA/G is a vital strategy, recognizing that exceptional capacities transcend what is measurable by conventional IQ tests, encompassing a wide range of cognitive and behavioral complexities. Therefore, the article highlights the importance of holistic educational approaches for both high abilities and giftedness, which should support the social and academic development of these individuals.

FUTURE STUDIES

Based on the analyses and discussions presented in this article, several directions for future research can be suggested to deepen the understanding of giftedness and high abilities from a neuroscientific and educational perspective.

REPLICATION OF LUTZENBERGER'S EXPERIMENT

The analysis of Lutzenberger et al. (1992) raises the question of the possibility of biological differences between gifted individuals and those with average IQ. Based on the results of Lutzenberger et al. (1992) and the concepts of Renzulli and Reis (1997) regarding the existence of individuals who exhibit gifted behaviors, this article points to the need to replicate Lutzenberger's experiment with two clinically tested groups: non-gifted individuals who exhibit gifted behaviors and gifted individuals. This study would help determine whether, in this case, biological differences will be reflected in divergent results or if gifted behaviors (between gifted and non-gifted individuals) will ensure parity between the results of the two tested groups.

LONGITUDINAL INVESTIGATION OF GIFTED BEHAVIORS

Another area of interest would be conducting longitudinal studies that follow individuals with gifted behaviors over time. These studies could provide insights into how these behaviors develop and manifest at different stages of life, as well as the conditions that may favor or inhibit their development.

INTEGRATION OF NEW COGNITIVE TESTS

As discussed by Almeida et al. (2010), there is relative independence between Gardner's multiple intelligences tests and classic intelligence tests. Future studies could investigate the integration of these new cognitive tests into the process of identifying gifted individuals, examining how these different measures can complement each other and provide a more holistic assessment of cognitive abilities.

IMPACT OF PERSONALIZED EDUCATION ON HIGH ABILITIES

Based on the proposals of Guerra and Cosenza (2011) and the guidelines of Brazil (2009), it would be valuable to investigate the impact of personalized educational programs that incorporate neuroscientific knowledge on the development of students with high abilities and giftedness. Studies could focus on how these personalized approaches influence academic performance and the socio-emotional development of these students.

COMPARATIVE STUDIES BETWEEN DIFFERENT MODELS OF GIFTEDNESS

Finally, it would be interesting to conduct comparative studies between different models of giftedness, such as Renzulli's Three-Ring Conception and other models based on IQ or multiple intelligences. These studies could clarify the advantages and limitations of each model and provide recommendations for educational practices and public policies.

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