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Facilitators and barriers to the development of giftedness in children

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Abstract

Giftedness can be interpreted as a multifactorial set of special abilities and skills, that the individual begins to express from an early developmental age. Many believe that the concept of giftedness goes beyond and includes not only IQ but also other factors. The purpose of this literature review is to collect recent data according to factors other than socio/cultural and economic that may influence the expression of giftedness in children. In the introduction giftedness is discussed according to several elements that may intervene in the acceptance of a universal definition and identification of this specific population and the main part explores several factors that may prevent giftedness through inhibition of cognitive and emotional aspects of daily living of children including children with Neurodevelopmental Disorders.

Keywords: Gifted children; Cognition; Neurodevelopmental disorders; Stress; Nutrition; Emotional intelligence; Executive functions

1. Introduction

Studies from the recent past have challenged the traditional notion of giftedness as an immutable human trait, related only to a person's cognitive abilities. Genetic factors may also be a factor to contribute to giftedness except from psychological and social factors that also play a crucial role in its development. IQ is an important predictor of success and academic performance, but it cannot explain differences between individuals. Given the prevalence of different factors at different levels, such as the individual, family ties, educational level, and community relations, these data provide an opportunity to redefine giftedness in terms of developmental aspects. Therefore, it is important to create conducive developmental environments that can provide adequate learning opportunities and appropriate supervision to promote the development of life skills (Renati et al., 2022).

Gifted children show an extensive skillset of advanced cognitive, emotional, and executive functioning traits (Vaivre-Douret, 2011; Bildiren, 2017; Eren et al., 2018). Research on gifted education is currently complicated by the lack of widely accepted procedures to guide the identification of intellectual giftedness and failure. Because there is no consistent method of identification, researchers include and exclude participants using a variety of criteria and metrics. These measures may include tests of cognitive ability, such as the Wechsler Intelligence Scale for Children (WISC), standardized progressive scales such as the Raven (Raven SPM), and/or other tests of academic achievement, such as school readiness tests. Measurement inconsistencies lead to differences in the number and type of students participating in the gifted child survey, affecting comparability, validity, and the applicability and generalizability of results (White et al., 2018).

It is also important to consider differences in perception and social support for gifted students when designing services for them, which can be difficult. The study by VanTassel-Baska et al. (1994) examined variations among high school students with high intelligence attending full-time, intensive programs for the gifted. Comparisons were made to

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determine differences in gender, ethnicity, and socioeconomic status. Despite some differences by ethnicity and gender, results showed that most differences were found between lower and higher socioeconomic groups, with a particular focus on social support and behavioral and social self-awareness.

From a genetic perspective, giftedness in cognitive development results from the contribution of many common genetic variants with small effect sizes, known as polygenicity (Spain et al., 2015). For example, Celec et al. (2013) studied possible genetic factors associated with testosterone metabolism in gifted boys compared to a control group. The results showed lower prepubertal testosterone levels in gifted boys. The results of the study support the role of genetic factors associated with testosterone metabolism in intellectual ability. Increased androgen signaling may explain previous findings of lower testosterone levels in intellectually gifted boys and contribute to understanding variation in cognitive ability.

2. Methods and materials

To conduct this literature review, Google Scholar, PubMed, ResearchGate, and PsycINFO databases were searched for the years 2009-2023. The following keywords were used including “gifted children”, “giftedness”, “cognition”, “environment”, “nutrition”, “stress”, “neurodevelopmental disorders” and a combination of them. The selected articles are categorized according to their content, and subgroups within each group are used to create subchapters. Documentation and analysis of the results was the final action performed.

Through this review, four research questions are attempted to be answered. The first question concerns how giftedness is influenced by the environment. The second is whether stress can have an impact and the third one is if diet can potentially affect the emergence of giftedness. The final question concerns whether children with neurodevelopmental disorders can be considered gifted and what characteristics prevent them from developing giftedness.

3. Environmental effects on giftedness

The environment plays a vital role as a nursery that guides and nurtures, providing opportunities for gifted people to express their potential and help build connections between different kinds of intelligence. It also gives gifted individuals the opportunity to express their potential and supports their abilities through various interactions. Giftedness requires a social context that allows for the development of an individual's abilities. The child is surrounded by environments such as family, friends, school, and community, in addition to social, economic, and political institutions that can help identify the talent areas that society expects (Al-Shabat et al., 2009).

Garn et al. (2010) in their study investigated through self-determination theory how parents of gifted children perceive their child's academic achievement and what methods parents of gifted students use at home to develop their children's motivation to learn. Interviews with 30 parents of gifted children across the United States revealed higher-level themes, including parents as experts and issues related to behavior modification. In terms of self-determination theory, the results suggest that, despite their best intentions, parents in this study did not provide their children with a family environment that supported the development of intrinsic learning motivation.

The Kubilius et al. (2014) study examined the impact of the home environment on the social skills of students with academic giftedness, with more than 1,500 individuals and their parents participating. Compared to previous studies, this study highlighted the importance of a loving, supportive, and respectful family environment in the development of individual skills and interpersonal relationships in gifted individuals.

Based on the achievement orientation model, the qualitative case study by Brigandi et al. (2018) examined the enrichment engagement and environmental perceptions of gifted middle school students. Participants consisted of 10 gifted high school students, their parents, and teachers. Data included student, parent, and teacher responses from semi-structured interviews, short-answer surveys, and student projects. Results show a correlation between enrichment participation and environmental perceptions. Participating students benefit from a teacher trained in gifted education that promotes both emotional and cognitive development. These findings have important implications for designing learning environments that effectively meet the unique needs of gifted middle school students.

Teachers have a great responsibility to identify gifted children and then create an effective program for them. According to KAYA (2020), the special needs of gifted preschool children should be taken into consideration by parents and teachers to create appropriate learning environments.

The results of Vialle's (2017) study highlight the importance of access to quality education for gifted children from an early age. This high-quality education not only requires a differentiated curriculum to ensure an appropriate challenge but also requires teachers to be well-trained in gifted education.

According to research by Eren et al. (2018), gifted children are at risk for mental illness. The study included 49 gifted children aged 9 to 18 years and 56 typical children of the same age and gender with typical intelligence. Compared to children with typical intelligence, the gifted children described themselves as less focused and active, as having poor social functioning and poorer self-perception of their physical health.

4. The effects of stress on giftedness

Stress is generally defined as an actual or anticipated threat or disruption to the body's homeostasis, often leading to an acute stress response that allows adaptation to the new situation. In contrast, chronic stress often leads to maladaptive responses in various organs and systems, triggering pathophysiological mechanisms such as mental disorders, neurological disorders, and cardiovascular disease. The effect of chronic stress on cognition and motivation has been widely described in the literature (Sousa, 2016; Pergantis & Drigas, 2023a).

Psychosocial stressors, especially when occurring during early life, contribute to the development of anxiety and depressive disorders. In the cognitive domain, changes were also observed in children exposed to chronic stress early in life. These changes persisted even when socio-demographic factors such as maternal IQ, birth difficulties, gender, ethnicity, and birth weight were removed. The domains involved are language, memory, attention, and executive function. In addition, infants exposed to early life stress often show higher cognitive biases than controls. For example, they are more likely than non-abused children to interpret social cues as hostile and are less likely to recognize positive facial expressions. On measures of intelligence and academic performance, these children had lower academic performance and scored lower on intelligence tests, with lower IQ scores and showcasing twice as likely the need to repeat a year of school, have poorer work habits, and difficulty developing them independently. In addition, children who are victims of neglect develop more behavioral problems. The cause of some of these behavioral problems may be reduced cognitive flexibility. Something that is still affected is psychosocial functioning. After being assessed by their teachers, they showed findings associated with poorer behavioral control and reduced social skills (Banqueri et al., 2017).

Parental stress can negatively affect cognition during the developmental period, as there is a correlation between parental stress and child behavior problems. In the study by Neece et al. (2012) out of 237 children aged 3 to 9 years, 144 were typically developing and 93 were developmentally delayed, from their findings it was found that parental stress can cause behavioral problems that can affect learning.

Long-term changes in the central nervous system are caused by early life trauma (ELT) which includes abuse (sexual and/or physical) and neglect. The results of Gould et al. (2012) found significant correlations between ELT challenge status and CANTAB measures of memory as well as executive and affective functioning. The results also showed that exposure to ELT causes neurobiological changes that coincide with cognitive decline as adults age, regardless of trauma type.

5. Nutrition and Giftedness

Nutrition from early development plays an important role in children's cognition by shaping myelination which can affect cognitive outcomes. In addition, deficiency and risk of disease in the fetus are closely linked to the intrauterine environment and the nutritional status of the mother, which may have short-term effects. Nutritional changes in the fetal brain result from their involvement in the programming of later development and cognitive processes during pregnancy (Arija & Canals, 2021).

More specifically, research by Deoni et al. (2018) revealed that global myelination improved significantly in breastfed infants, accompanied by increases in general cognitive, verbal, and non-verbal abilities compared to infants fed exclusively with formula milk. Significant developmental differences were also identified depending on the composition of the formula received, namely long chain fatty acids, iron, choline, sphingomyelin, and folic acid which were significantly associated with the course of premature myelination.

Research by Cohen et al. (2016) examined whether executive function is affected by eating healthier foods in children and adolescents. Among the ten studies that looked at food, there was generally a positive association between healthier

foods such as whole grains, fish, fruits and/or vegetables with executive function, while the opposite was true for less healthy snacks, sugary drinks and red/processed meat.

Ershidat's (2014) research summarized the following characteristics that should be considered for the proper development of children with giftedness regarding nutrition. These include the need to take care of pregnant women in terms of nutrition and health, as well as following the doctor's instructions to take only the necessary nutritional supplements. In addition, she stressed that the nutritional needs of children for their health must be met, with an emphasis on breastfeeding, appropriate weaning, appropriate complementary feeding and the existence of systematic provision of healthy eating guidance programs for mothers, families and gifted children.

The study by Beisser and Gillespie (2021) revealed that gifted individuals have an increased risk of developing eating disorders. In their study, 33 screened charismatic youths for eating disorders. The research was conducted using the Eating Disorder Examination-Questionnaire (EDE-Q), which contains subscales of food restriction, eating concern, body shape, and weight. This study demonstrated that 20% of gifted adolescents exhibited worrisome reactions about their weight, body shape, and eating restrictions.

Mukhamedzhanov et al. (2023) in their research investigated how nutrition education could influence students' attitudes and behaviors towards food, sports, or school sports, and their performance in the classroom. The results showed that students who completed the nutrition education program showed improved eating attitudes and behaviors, as well as higher sports performance and attitudes compared to the control group who did not undergo any experimental procedures. The experimental study design was based on a before and after control group. A group of 60 students participated in the study from both the experimental and control groups and data were collected using the following measurement tools: Eating Behavior Scale, Eating Attitude Scale, Sports Performance Scale, Attitudes towards Sports and Collective Academic Achievement Test.

6. Neurodevelopmental Disorders (NDDs) and characteristics that affect giftedness

The term neurodevelopmental disorders (NDDs) is a complex and heterogeneous group of disorders with symptoms related to abnormal brain development, which can lead to impairment in cognitive function, communication, adaptive behavior and psychomotor skills. Many causes are associated with AD, including genetics, environment, infection and trauma, which often do not act in isolation but interact with each other. Importantly, the coexistence of different NDD entities is frequently reported in the literature, suggesting the existence of common underlying biological and cellular mechanisms (Cardoso et al., 2019).

Children with neurodevelopmental disabilities have deficits in many areas that prevent them from developing giftedness. Emphasis will be placed on emotional intelligence and executive functions which are directly related to the development of cognition and high performance in daily life (Khajehpour, 2011; Li & Shi, 2019; MacCann et al., 2020; Rosenberg, 2014; Gunzenhauser & Nückles, 2021; Pergantis & Drigas, 2023c).

6.1. Emotional Intelligence

Emotional intelligence surrounds a wide variety of skills. These skills are developed through different stages of a child's development including the ability to self-regulate, express language and general knowledge of emotions. All of these skills continue to develop in parity with other basic cognitive skills such as executive function and metacognition. As a child develops emotional intelligence through neuropsychological methods, the brain is morphologically prepared to acquire full and in-depth knowledge and learning about the world through a system of emotional attitudes in the process of perceiving real cognitive states in conjunction with the real world to develop higher cognitive functions (Pergantis & Drigas, 2023c).

The emotional intelligence abilities of people with ASD show deficits, which entail difficulties in understanding, expressing and regulating their emotions, as well as the inability to understand the emotions of others and demonstrate empathy. Along with these problems, there is also poor integration of socio-emotional behaviors as well as challenges in social interaction and communication (Papoutsi et al., 2018; Pergantis & Drigas, 2023c)

ADHD is also an NDD that is related to low performance of emotional intelligence. The purpose of the study by Yazdi et al. (2018) was to compare the emotional intelligence of cognitive flexibility of children with and without ADHD. The participants were 20 children (mean = 10.25, SD = 2.12) with ADHD and 30 typically developing children (mean = 10.96, SD = 1.32). All participants completed the Emotional Intelligence Questionnaire (Schutte et al., 1998) and the classic

Stroop test as a measure of cognitive flexibility. The results showed lower performance of children with ADHD in both assessment measurement tools than the control sample.

Similar findings are suggested by research by Turkia et al. (2023), designed to examine the emotional and social functioning of children aged 6 to 19 years who had a diagnosis of ADHD compared to those who did not. The results of the comparison showed that the Emotional Quotient (EQ) was significantly lower in the group of children with ADHD (p=0.01).In addition, findings showed that there was a statistically significant difference in personal communication skills (p<0. 0010), Adaptability Scale (p=0.005), General Mood Scale (p=0.004) and positive impression (p=0.001) of emotional intelligence between children with ADHD and the control group. For the purpose of the present study, the Bar On Emotional Quotient Inventory: Youth Version (YVTM) was used to assess n = 60 children with ADHD and n = 60 control group children.

6.2. Executive functions

Executive functions, also known as cognitive control, are critical higher-order cognitive functions that are critical for goal-directed adaptive behaviors and are severely impaired in most NDDs. Several models and approaches have been proposed to explain the organization of executive functions in the brain. The distinction between "hot" (regulation of emotions, social skills theory of mind and decision making) and "cold" (attention, inhibition cognitive flexibility working memory and metacognition) executive functions is a widely accepted and recently proposed organizing principle (Chavez-Arana et al., 2018). Although executive functions are traditionally associated with the prefrontal cortex, they are also performed by the anterior and posterior parietal cortex. The good and smooth functioning of executive functions has a positive correlation with the individual's functioning in daily life regarding academic and work performance, interpersonal relationships, emotional maturation and decision-making (Salehinejad et al., 2021).

Executive dysfunction is an impairment that characterizes individuals with ASD. To investigate these impairments, Robinson et al. (2009) examined executive functions in a group of children with ASD (n = 54, IQ > 70), which was matched with a typical developmental control sample.

The present study examined differences between groups according to age, gender, IQ and vocabulary. The results showed findings regarding the inhibition of potential responses. Compared to the control group, children with ASD were found to show more age-related activity patterns during response inhibition and self-monitoring tasks.

The systematic meta-analytic study by Demetriou et al. (2017) confirms the generalized executive dysfunction in ASD with its findings suggesting that it is relatively stable across development. For this research, Embase, Medline and PsychINFO databases were reviewed to identify studies published from the inclusion of autism in the DSM-III (1980) to the end of June 2016, comparing executive function in children with ASD with neurotypical controls. A total of 235 studies involving 14,081 participants were included (n, ASD = 6,816; control group = 7,265).

May and Kana's (2020) research examined the executive functions of children with ASD by analyzing 16 fMRI studies using coordinate-based activation likelihood estimation (ALE), conducting meta-analyses of data from 739 participants, with 356 with ASD and 383 of typical development, at different developmental ranges from 7 to 52 years of age. Their findings support the hypothesis of executive dysfunction in ASD and suggest that poor prefrontal recruitment may underlie some of the executive function difficulties experienced by people with ASD, with similar levels of influence in each domain.

Individuals with ADHD are widely known research-wise to have difficulties localized to the executive function apparatus. The purpose of the study by Elosúa et al. (2017) was to investigate differences in executive functioning of working memory between 4th graders with and without ADHD (26 and 29 children, respectively). For the purpose of the study, four epistemic functions, including the distribution of attention, shifting, refreshing, and inhibition, were examined between two groups of subjects. Results showed that participants with ADHD, compared to typically developing children, had a shorter range of verbal memory as well as deficits in updating and shifting attentional functions.

The study by Townes et al. (2023) examined whether children and adolescents diagnosed with ASD or ADHD have distinct executive function profiles. To this end, articles comparing diagnosed individuals with ASD, ADHD and typically developing individuals under the age of 19 were identified. The domains assessed were working memory, response inhibition, planning, cognitive flexibility, attention, processing speed, and visuospatial ability. Results from the 58 included studies showed that individuals with ASD and ADHD show impaired skills and abilities in all areas of testing

compared to the neurotypically developing control sample. The study also revealed that no differences in executive functioning were found between individuals diagnosed with ASD and ADHD.

People with Specific Learning Disorder (SLD) are also a category that has deficits related to executive functioning. The aim of Capodieci et al.'s (2023) study was to investigate the effect of subprocesses related to executive function, such as processing speed and stimulus processing of children with SLD. Using an online remote assessment platform, 57 children with SLD and 114 typically developing children were matched for gender and age and performed four tasks that measured interference control, response, updating and shifting. Results showed that children with SLD performed worse on all executive function tasks than typically developing children, regardless of stimulation type and condition.

Crisci et al. (2021) in their study examined the association between SLD and ADHD by comparing the neuropsychological characteristics of children with and without SLD. A total of 97 students aged 8 to 14 years were clinically examined, with 49 having ADHD, 18 with SLD, 13 with comorbidity of ADHD and SLD, and 48 with typical development. Findings showed that all children in the clinical samples showed impairment in executive function measures (inhibition and task switching) compared to typically developing children.

Developmental Coordination Disorder (DCD) is also an NDD that appears to present deficits related to executive functioning (Pergantis & Drigas, 2023b; Pergantis, 2023). The research of Satori et al. (2020) studied the executive functions of children with DCD (n=63), risk of DCD (n=31) and typical development (n=63) in a sample of 397 children assessed with the MABC-2 to create control groups. Subsequently, they were administered the MABC-checklist and the WASI. The results showed that the group with DCD showed lower scores than the typically developing group on verbal and visuospatial working memory, inhibitory control, and cognitive flexibility tasks. The group at possible risk for DCD showed lower scores than the typically developing group on visuospatial working memory and cognitive flexibility.

6.3. The role of digital technologies

Last but not least, we emphasize the significance of digital technologies in the educational domain and Giftedness, which are very productive and successful, and how they facilitate and improve assessment, intervention, and educational procedures via mobile devices that bring educational activities everywhere [46-49], various ICTs applications that are the main supporters of education [50-69], and AI, STEM, and ROBOTICS that raise educational procedures to new performance levers [70-77]. Additionally, ICTs are being improved and combined with theories and models for cultivating emotional intelligence, mindfulness, and metacognition [78-106]. accelerates and improves more than educational practices and results, especially in Gifted children, treating domain and its practices like assessment and intervention.

7. Conclusion

From this literature review, we observe that the factors that influence the development and expression of giftedness in children mainly concern the children's environment. Apart from social/cultural factors, the environment mostly refers to family, school and teachers. The role of teachers is important to detect giftedness to be able to provide an appropriate frame for these children. Stress is also an important risk factor whether it is indirectly expressed to the child through the environment and family or directly experienced by the child himself. Finally, nutrition has now been proven to be another important factor, that can positively or negatively affect the development of a person's cognition and intelligence, right from pregnancy and the mother's diet, with effects that last throughout the developmental course.

Regarding the emergence of giftedness in children with NDDs, the focus is on factors that may limit its development based on characteristics that have a neurobiological basis and relate to neurodifferentiation in terms of structural and functional differences that arise in the normal functioning and development of the brain. More specifically, in children with ASD, emotional intelligence, as well as executive functions, seem to significantly affect their functioning as well as their engagement in daily and essential life skills related to social interaction, understanding their own and others emotions and developing empathy. Individuals with ADHD also exhibit characteristics that may affect giftedness related to emotional control and inhibition, attention (shifting and sharing), working memory, and cognitive flexibility, which can significantly impact interpersonal relationships, academic and work performance, and decision-making. Finally, DCD has also been shown to present as a disorder with deficits in verbal and visuospatial working memory, inhibitory control and cognitive flexibility.

Compliance with ethical standards

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