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Research Article

Comparison of gifted and non-gifted students' executive functions and high capabilities

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Abstract

In recent years, the analysis of the relationship between cognitive skills and student learning has focused mainly on research into the impact of executive functions on academic performance and success. This study seeks to compare the cognitive performance of gifted or high-capacity students to students with a typical development in the performance of psychological tests aimed at the evaluation of executive functions. Two groups of students were considered (gifted and regular) with the intention of matching them in terms of school level and age (ages included are 10-15). The results indicate marginally significant differences in the cognitive flexibility function and statistically significant differences in working memory, as well as in the higher cognitive functions of problem solving and reasoning, with no statistically significant differences in the tests that evaluate inhibitory control and planning. These data suggest that psychological tests centred on the assessment of cognitive functions may complement the more traditional use of IQ tests for signalling and evaluating students with traits of giftedness.

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Introduction

Research suggests that students with gifted characteristics or high capacities have more complex, structured, and efficient cognitive skills for information processing, using inductive and deductive processes in information processing (Kim & Hays, 2005). In this regard, more than a generic or global intellectual capacity, for example the classic concept of Intelligence Quotient (IQ), it is important to analyse the cognitive functions or intellectual skills most directly associated with such information processing. While recognising the undeniable importance of intelligence for learning, namely for academic performance (Debatin, Harder, & Ziegler, 2019; Demetriou, Kazi, Spanoudis, & Makris, 2019; Diamond, 2013; Lemos, Almeida, Guisande, & Primi, 2008; Harder, O'Reilly, & Debatin, 2018; Soares, Lemos, Primi, & Almeida, 2015; Ziegler, Debatin, & Stoeger, 2019), it is important to be aware of the cognitive processes that explain this relationship. The objective is to identify and analyse the functioning of these cognitive processes and their impact on intellectual functioning (Goldstein, Naglieri, Princiotta, & Otero, 2014), as well as on learning (Zelazo, Blair, & Willoughby, 2016). Such care will support the signalization of students with high capabilities, opposing the absence of a systematic evaluation and its identification of gifted students (Garcia-Perales & Almeida, 2019).

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Executive Functions in Cognition and Learning

In recent decades, particular emphasis has been placed on executive functions in psychology and neuroscience (Zelazo et al. 2016); these being understood as superior cognitive functions that control and regulate the most basic cognitive processes (Alvarez & Emory, 2006; Corso, Sperb, de Jou, & Salles, 2013; Miller & Wallis, 2009). This group includes skills related to voluntary initiation or behaviour inhibition, as well as skills related to planning, monitoring, and problem solving (Arffa, 2007).

Diamond (2013) mentions three main factors or cognitive functions: namely, Working Memory, Inhibitory Control (behavioural self-control and cognitive inhibition), and Cognitive Flexibility. The first factor is responsible for the maintenance and processing of previously acquired information; inhibitory control involves the action of pondering and not acting at a cognitive and/or behavioural level in a premature or impulsive manner, which assumes a function of reflexive control of attention, thinking, and behavior. Finally, cognitive flexibility is the factor that supports the analysis of multiple perspectives and possible approaches to a problem by adjusting to its own and contextual conditions. These three factors are independent but support each other, thus allowing conscious control of attention and behaviour to achieve a purpose (Diamond, 2013; Zelazo et al. 2016).

For several authors, the development of these three functions leads to more complex or higher-order cognitive skills, such as planning, reasoning, and problem solving (Collins & Koechlin, 2012; Diamond, 2013; Lunt et al. 2011). In an approximation to the theory of fluid intelligence (Gf) and crystallized intelligence (Gc) (Cattell, 1987), these last factors come close to fluid intelligence, that is, the ability to solve problems and analyse patterns and relationships between variables in an approach to logical, inductive, and deductive reasoning (Diamond, 2013). Planning refers to the ability to intentionally stipulate and structure a sequence of actions to achieve an objective (Yang, Shields, Guo, & Liu, 2018).

Another model in the analysis of executive functions, and its relevance in intelligence and learning, is the PASS system (Planning, Attention, Successive, and Simultaneous processing) by Das, Naglieri and Kirby (1994). In a brief summary of research in the area, the cognitive functions associated with the planning function are particularly relevant for self-regulated problem solving; simultaneous processing allows a child to differentiate, (inter) relate, and integrate elements; successive processing is essential to compare new information with previous knowledge, while sustained and selective attention helps to stay on task and to code the relevant elements of the problem to the detriment of others (Kroesbergen, Van Luit, & Naglieri, 2003; Naglieri & Das, 1997, 2005; Vanbinst, Ghesquière, & De Smedt, 2014).

Recent research relates the executive functions and academic success (Benedek et al. 2014; Friedman et al. 2006; Visu-Petra, Cheie, Benga, & Miclea, 2011). Since intelligence is marked by the acquisition of knowledge (Blair, 2006), executive functions may translate into more general skills or the ability with which students apply their knowledge in problem solving (Zelazo et al. 2016). It is noticeable that the relationship between executive functions and fluid intelligence, self-regulation, executive attention and control, as well as the relationship between working memory and inhibitory control, impact on learning and academic excellence (Diamond, 2013; Muñoz & Filippetti, 2019). The development of executive functions impacts on academic success (Monette, Bigras, & Guay, 2011; Viterbori, Usai, Traverso, & De Franchis, 2015), being this impact superior to IQ and socio-economic conditions (Clark, Pritchard, & Woodward, 2010; McClelland et al. 2014; Moffitt et al. 2011; Zelazo et al. 2016). The explanation for this relevance is associated with the fact that executive functions promote meaningful, self-regulated, and reflective learning (Lyons & Zelazo 2011; Marcovitch et al. 2008; Zimmerman, 2008). Such functions not only condition learning, but also the quality of the learning contexts themselves that enable the development of these functions (Zelazo et al. 2016), making it relevant to research this development as a way to support learning in students with less executive function development (Benson, Sabbagh, Carlson, & Zelazo, 2012; Sastre-Riba & Viana-Sáenz, 2016).

Executive Functions and Giftedness

The concept of giftedness is too broad and prone to controversy when the authors try to define it (Sak, 2020; Smedsrud, 2020). Intelligence, and in particular IQ, is traditionally assumed to be the most decisive variable in the definition of giftedness, however several authors point out its ambiguity and insufficiency for this definition, including other variables related to motivation, personality or creativity in the explanation of high capabilities and high performance (Gagné, 2018; Krumm, Arán, & Gutierrez, 2018; Renzulli, 2012; Sternberg, 2005). This broadening of the variables involved in giftedness highlights the psychological processes inherents to development and learning, introducing the relevance of the executive functions in explaining intelligence and giftedness.

Several studies have linked high capabilities to superior executive function development (Dai, Müller, Wang, & Deoni, 2018; Dunst et al., 2014; Fiske & Holmboe, 2019; Schnack et al. 2015; Shi et al. 2013), with evidence of an early and efficient use of executive functions by these children. Compared to their peers, these children have higher levels of cognitive flexibility, inhibitory control, working memory and planning (Vaivre-Douret, 2011), which may be related to a stronger, flexible, and dynamic reconfiguration of brain networks in the frontoparietal regions of the executive system, promoting a superior development of fluid intelligence (Barbey, 2018) and superior effectiveness in tasks that require working memory, flexibility, and automation of cognitive control (Fiske & Holmboe, 2019). Gifted children and young people may have a complex neuronal network capable of analysing information more efficiently, favouring neuronal plasticity (Goriounova & Mansvelder, 2019) and neuronal communication (Solé-Casals et al. 2019). For example, Alnæs et al. (2018) defend the existence of a number of superior connections and activities in the medial cyst-striatal-thalamic-cortical circuit, promoting greater anticipation and sensitivity to reward during the learning process. In addition, there is evidence of a greater inter-hemispheric and inter-functional area connection, especially in the frontoparietal regions and the cerebellum (Sastre-Riba & Viana-Sáenz, 2016), with an increase in myelin in the latter area, as well as in the corpus callosum and in the right and left occipital lobes, which triggers a higher speed of perceptual processing of visuospatial information (Chevalier et al. 2015) and a higher development in cognitive skills in general (Dai et al. 2018). Finally, Goriounova and Mansvelder (2019) report the existence of gifted children or those with high capacities of cerebral volume of the temporal lobe and in the upper hippocampus, with pyramidal neurons of a larger size and complexity, which allows for a superior general cognitive capacity, with working memory, reasoning, perception and language standing out.

Problem of Study

Due to the relevance of executive functions in cognition and learning, this study aims to analyze the performance of gifted students in psychological tests that evaluate these functions. More specifically, this study compares children and adolescents with characteristics of giftedness to their peers with typical cognitive development in the performance in a wide range of psychological tests. Therefore, this study aims to answer the following two questions:

- Are there differences in task performance that involves cognitive flexibility, inhibitory control and working memory among children and adolescents with giftedness and peers with typical cognitive development?
- Are there differences in task performance that involves reasoning, planning, and problem solving among children and adolescents with giftedness and peers with typical cognitive development?

Method

Research Method

This study is part of a correlational quantitative investigation, analyzing differences in the means of performance in cognitive tasks by two groups of students. This research is based on the Diamond (2013) model, which highlights the existence of three executive functions (cognitive flexibility, inhibitory control, and working memory), as well as three other higher cognitive functions (reasoning, planning, and problem solving), in explaining superior performances in the area of intelligence and learning.

Participants

This study considers two groups of children and adolescents in second (5th and 6th grades) and third (7th to 9th grades) cycles of basic education aged between 10 and 15 years old (M = 12.13; SD = 1.51). In these two school cycles students attend a curriculum divided into different curricular units taught by different teachers, unlike the first cycle of basic education in which the curriculum is taught globally and by a single teacher.

These students were divided according to a previous identification of giftedness; the first group (n = 42) is represented by gifted students (GS), mostly male (81%), unlike the group of regular students (RS) (n = 52), where the majority are female (59.6%). Most GS students are in third cycle education (54.8%) and belong to a family with a middle to upper socioeconomic level (59.5%), with the concern of equating students in the RS group (61.5% in third cycle education, and 46.2% from a medium to high family socioeconomic level).

Materials

In addition to a socio-demographic questionnaire, several psychological tests were applied. Therefore, for the analysis of Working Memory, the Rey Complex Figure test (memory reproduction) and the WISC-III - Memory of the Digit test - were used; for Inhibitory Control, the D2 test was applied, as well as the Five Digit test, which also supported the analysis of Cognitive Flexibility. For the analysis of higher cognitive skills, the Numerical Reasoning and Verbal Reasoning tests from the Battery of Reasoning Tests were applied, as well as the Expressions test of the Cognitive

Assessment Battery for evaluating Reasoning, the copy phase of the Rey Complex Figure for the Planning factor, and mathematical problem-solving tests to assess the Problem-Solving factor.

The Rey Complex Figure is a test that assesses perceptual activity and visual memory from the age of five (Rocha & Coelho, 1998). This instrument is validated for the Portuguese population with a Cronbach's alpha of .88 (Mós, 2016). The Weschler Intelligence Scale for Children – III (WISC-III; Simões, Rocha, & Ferreira, 2003), a scale for assessing intellectual functioning aimed at children and adolescents, includes 13 sub-tests that support the assessment of verbal IQ and achievement, in addition to the global score. This test has an internal consistency .62 and .93 in the various sub-tests, scales, and indices (Simões et al. 2003).

The Brinckenkamp's D2 attention test (1962), validated for children between 8 and 18 years old, is an instrument that supports the assessment of selective attention and the ability to concentrate. This test has fidelity coefficients greater than .90 (Ferreira & Rocha, 2006).

The Five Digits Test (Sedó, 2007) seeks to assess executive functions, processing speed, and attentional functioning using high internal consistency values ranging from .86 to .94 in the Spanish normative sample (Rodríguez et al., 2012) and higher than .90 in the Brazilian sample (Campos, Silva, Florêncio, & Paula, 2016).

The Battery of Reasoning Tests (BRT; Almeida & Lemos, 2015) is an instrument that assesses the ability to infer and apply relationships based on differentiated content tasks. The factorial structure of the five tests suggests the evaluation of a general reasoning capacity that is differentiated according to the content of each sub-test, with the precision values varying between .63 and .84 (Almeida & Lemos, 2015). For this research, versions 5/6 (5º and 6º grades) and 7/9 (7º to 9º grades) were used.

The Cognitive Assessment Battery (CAB; Lemos & Almeida, 2015) is a cognitive assessment tool that focuses on the comprehension, reasoning, and problem-solving processes in the spatial, verbal, and numerical contents. This battery, which is validated for the Portuguese population, has adequate indices of high internal consistency, varying between .70 and .88 in version A, and between .82 and .93 in version B (Lemos & Almeida, 2019). For this study, version A was used.

A set of mathematical tests that featured two versions composed of 4 items (PM1 for students aged 10 to 11 and PM2 for students aged 12 to 14); each version contains 4 items that focus on problem solving. The internal consistency of the items was .99 in version 1 and .72 in version 2.

Procedures

In order to collect the sample of gifted students, a request was made for collaboration to a national institution for intervention in high capacities and the respective guardians of children and young people attending the school years under study. As regards the group of regular students, authorisation was requested from a private education institution and their parents. After the groups were formed, the tests were administered at two distinct times, more specifically, a joint session where the BRT, CAB and problem-solving tests were applied; and individual sessions where the D2, 5 digits and the Rey Complex Figure tests were applied.

For data analysis purposes, the total number of correct answers is considered in the BRT, CAB, D2 test, and problem-solving tests; the score obtained in the phases of copying and reproducing the Rey Complex Figure from memory, as well as the sequential structure of the reproduction of the figure, and the calculation of Cognitive Flexibility and Inhibitory Control by subtracting exercise times from the Five Digit test. More specifically, Inhibitory Control results from subtracting the time of choice from the time of reading and the Cognitive Flexibility results from subtracting the alternation time to the time of reading.

For the differential analysis of performances in the two groups of students (students with giftedness/high capacities and regular students), the SPSS/IBM version 26.0 software was used. Since the versions of the BRT tests (VR and NR) and problem solving differ according to the students' school year, the results were analysed taking this into account.

Results

Results of Research Question 1 : Task Performance in Cognitive Flexibility, Inhibitory Control and Working Memory

Tables 1 and 2 show the descriptive values on executive functions (working memory, inhibitory control, and cognitive flexibility) tests for second and third cycles of basic education. This presentation differentiates students with characteristics of giftedness (GS) and students with typical cognitive development (RS).

Table 1.
Results of Second Cycle of Basic Education Students (5th and 6th grades) with Giftedness (GS) and Regular Students (RS) in the Wor
Flexibility Tests

Tests	GS								
	Min	Max	M	SD	Skewness	Kurtosis	Min	Max	
WM									
RCF – MR	9	31	24.00	5.44	-1.31	2.43	4	35	2
DIRECT MD	6	14	10.53	2.22	-.41	-.88	8	13	1
INVERSE MD	4	9	6.26	1.70	.08	-1.19	3	13	(
IC									
Five digits	18	66	27.89	11.62	2.34	6.13	5	37	2
D2	98	159	124.32	15.06	.27	.09	89	207	1:
CF									
Five digits	15	56	36.58	11.29	.16	-.50	11	48	3

Note. WM = working memory; IC = inhibitory control; CF = cognitive flexibility; RCF = Rey Complex Figure; MR = memory reproduction; MD = Memory of the Digits.

Table 2.
Results of Third Cycle of Basic Education Students (7th to 9th grades) with Giftedness (GS) and Regular Students (RS) in the Wor
Flexibility Tests

Tests	GS								
	Min	Max	M	SD	Skewness	Kurtosis	Min	Max	
WM									
RCF – MR	9	36	26.04	5.66	-.70	.83	23	36	3
DIRECT MD	9	28	17.81	4.01	.48	.37	6	15	1
INVERSE MD	3	13	7.39	2.69	.45	.06	2	12	(
IC									
Five digits	1	38	19.70	10.09	-.17	-.55	5	35	1
D2	84	237	144.74	31.56	1.05	2.40	98	214	1
CF									
Five digits	15	45	29.48	9.59	.02	-1.23	14	52	2

Note. WM = working memory; IC = inhibitory control; CF = cognitive flexibility; RCF = Rey Complex Figure; MR = memory reproduction; MD = Memory of the Digits.

Having analysed the oscillations of the results in each test by the two groups of students (t-test of comparison of means), there are statistically significant differences in the Working Memory factor, in the RCF - Memory Reproduction test ($t [92] = 2.24$, $p =.027$), and marginally significant differences in Cognitive Flexibility ($t [92] = 1.82$, $p =.072$). Thus, students with giftedness obtain higher scores on Working Memory (difference of 3.1 in the averages) and Cognitive Flexibility (difference of 3.8 in the averages).

Taking into account the variables that present unacceptable values in skewness and kurtosis (i.e., RCF - Copy, RCF - Memory Reproduction and Five Digits - Inhibitory Control), the Mann-Whitney non-parametric test was performed. The values corroborate with the data from the t-test by highlighting statistically significant differences in the RCF memory reproduction test ($U = 834.00$, $p =.050$).

Results of Research Question 2: Task Performance in Reasoning, Planning, and Problem Solving

Tables 3 and 4 show the descriptive values on superior functions (reasoning, planning, and problem-solving tests) tests for second and third cycles of basic education. This presentation differentiates students with characteristics of giftedness (GS) and students with typical cognitive development (RS).

Table 3.

Results of Second Cycle of Basic Education Students (5th and 6th grades) with Giftedness (GS) and Regulars (RS) in the Reasoning, Plan

Tests	GS							
	Min	Max	M	SD	Skewness	Kurtosis	Min	Max
R								
BRT - NR	17	30	24.95	4.09	-.32	-.99	10	30
BRT - VR	10	20	16.37	3.27	-.70	-.78	8	20
CAB - Exp	8	24	16.05	5.22	-.12	-1.41	6	18
P								
RCF - Copy	29	36	33.89	2.16	-.85	-.28	22	36
PS								
PST	0	7	4.33	2.30	-.49	-1.25	0	8

Note. R = reasoning; BRT = Battery of Reasoning Tests; NR = numerical reasoning; VR = verbal reasoning; CAB = Cognitive Assessment Battery; P = planning; RCF = Rey C
PST = Problem Solving Test.

Table 4

Results of Third Cycle of Basic Education Students (7th to 9th grades) with Giftedness (GS) and Regulars (RS) in the Reasoning, Plannin

Tests	GS							
	Min	Max	M	SD	Skewness	Kurtosis	Min	Max
R								
BRT - NR	11	39	26.13	7.76	-.05	-.76	2	36
BRT - VR	11	23	17.48	2.92	-.94	1.14	5	21
CAB - Exp	10	24	19.17	4.19	-.80	-.97	3	23
P								
RCF - Copy	32	36	34.48	1.442	-.55	-1.10	23	36
PS								
PST	2	7	3.95	1.36	.36	-.35	0	7

Note. R = reasoning; BRT = Battery of Reasoning Tests; NR = numerical reasoning; VR = verbal reasoning; CAB = Cognitive Assessment Battery; P = planning; RCF = Rey C
PST = Problem Solving Test.

There are also statistically significant differences in favour of students with giftedness characteristics in higher cognitive skills in all Reasoning tests. As regards the CAB - Expressions test ($t_{[92]} = 3.65$, $p = .000$), there is a superior performance in the group of gifted students, standing out with an average higher than the result of the group of regular students, which was 3.7 points. The same is true in the BRT tests. As regards the second cycle of basic education students (5th and 6th grades), there are statistically significant differences in the BRT-NR test ($t_{[37]} = 2.64$, $p = .012$), and the group of gifted students has a superior performance (difference of 4 in the averages), as in the BRT-VR ($t_{[37]} = 2.34$, $p = .025$) with a discrepancy of 2.5 in the averages. The same is verified in third cycle of basic education students (7th to 9th grades), in which the group of gifted students has an average higher than the results of the group of regular students in the BRT-NR test ($t_{[53]} = 2.60$, $p = .009$), with a difference of 7.0 in the averages, and in the BRT-VR ($t_{[53]} = 3{,}774$, $p = .000$), with a difference of 3.8 in the averages. Furthermore, for students in 7th to 9th grades, there are statistically significant differences in the Problem Resolution factor ($t_{[51]} = 2.68$, $p = .006$), in which the gifted group has a better performance than the group of regular students, with a difference of 1.3.

Discussion and Conclusion

The results of this study suggest that gifted students show a superior performance than the group of regular students in the executive functions of Working Memory and Cognitive Flexibility, as well as in the higher functions of Reasoning and Problem Solving. This differentiation is not seen in the factors Inhibitory Control and Planning, in which there are no statistically significant differences between the groups in question. This differentiation in cognitive performance in favour of students with giftedness characteristics was expected, since the identification of these students as gifted or with high abilities was made on the basis of their performance in cognitive tests, corroborating other studies in the area (Barbey, 2018).

Other investigations also highlight greater cognitive flexibility in high-capacity students (Buttelmann & Karbach, 2017; Sastre-Riba & Viana-Sáenz, 2016). Children with high capacities present better cognitive flexibility in the analysis and processing of information, with an impact on their own learning abilities (Ropovik, 2014; Vaivre-Douret, 2011). This difference in favour of gifted students also occurs in working memory tests with verbal or visual content (Barbey, 2018; Goriounova & Mansvelder, 2019; Lee et al. 2006), suggesting their better performance in executive functions compared to peers with a typical cognitive development (Kornmann, Zettler, Kammerer, Gerjets, & Trautwein, 2015; Rodríguez-Naveiras, Verche, Hernández-Lastiri, Montero, & Borges, 2019).

As regards the absence of superior performance in the field of inhibitory control, the present data conflict with other research that verifies a higher development of this factor among children and young people with high capacities (Fiske & Holmboeb, 2019; Sastre-Riba & Viana-Sáenz, 2016). Since this occurrence is not easy to explain, it should be noted that some authors point out that the association of this cognitive factor with high capacities depends on the ages of the children, and such differences can be perceived in groups between 11 and 12 years old (Duan & Shi, 2011). The results for higher cognitive skills in favour of gifted students corroborate research in the area. There are several studies that associate this function in the academic capacities of students with high capacities, more specifically in inductive reasoning (Dunst et al. 2014) and in mathematical reasoning tasks (Berg & McDonald, 2018). This fact reinforces the association of giftedness with fluid intelligence and problem solving (Berg & McDonald, 2018; Bianco & Leech, 2010). Students with gifted or high abilities tend to excel in performing mathematical problem-solving tasks, using more complex and efficient mathematical reasoning strategies and skills (Baltaci, 2016).

Considering the results of this research, it is possible to identify differences in the performance of cognitive tasks involving executive functions when comparing students with giftedness characteristics or high capacities compared to their peers with typical cognitive development. Such differences were evidenced in the Working Memory and Cognitive Flexibility functions but were not seen in the inhibitory control functions. In turn, also in terms of reasoning and problem-solving skills, the same group of students showed a higher cognitive performance than their peers. All these cognitive abilities can be considered in giftedness screening procedures as complement to traditional IQ intelligence tests.

Given the relevance of executive functions in learning and academic success, and their relatively autonomous functioning of intelligence, it is important to promote their development in students, particularly at an early age (Liu, Zhu, Ziegler, & Shi, 2015). It is interesting to identify and develop such functions in pre-school education (Ackerman & Friedman-Kraus, 2017), where at this stage their relationship to children's metacognitive abilities is already visible (Buttelmann & Karbach, 2017). On the other hand, students with characteristics of giftedness or high capacities may present specific difficulties in the performance of these executive functions; it is important to ensure a differentiated educational attention that promotes them (Buttelmann & Karbach, 2017; Chevalier & Blaye, 2016; Gotlieb, Hyde, Immordino-Yang, & Kaufman, 2016). In the context of an inclusive school and education, students with such characteristics and abilities justify differentiated pedagogical practices.

Recommendations

Since this is a cross-curricular and correlational investigation, it is important that new studies seek to analyze how gifted students develop their executive functions and higher cognitive functions. The need for such studies arises from the relevance of executive functions in cognition, learning and school success, and their relatively autonomous functioning from intelligence. The information derived from this may contribute to the definition of programs to promote such cognitive functions in gifted students, as in students in general. Some authors suggest this development at an early age, pointing to the need to identify and develop such functions already in preschool education (Ackerman & Friedman-Kraus, 2017), where their relationship to children's metacognitive capacities is already visible at this stage (Buttelmann & Karbach, 2017).

On the other hand, since students with giftedness or high capabilities may present specific difficulties in performing these executive functions, it is important to guarantee a differentiated educational attention that promotes them (Buttelmann & Karbach, 2017; Chevalier & Blaye, 2016; Gotlieb, Hyde, Immordino-Yang, & Kaufman, 2016).

Finally, within the framework of an inclusive school and education, students with such characteristics and capacities justify differentiated pedagogical practices. Thus, it is important to sensitize the educational community to meet these needs and to value in their practice the role of executive functions in the very definition of enrichment strategies. In addition to the care to be taken in the evaluation and intervention with these students, it is considered pertinent to carry out more investigations of the components evaluated in the different age groups and with a longitudinal content, in order to understand the development of such functions following the development of human potential.

Limitations of the Study

The study developed presented some limitations that deserve to be highlighted, on the one hand, the reduced number of participating students, and it is important in future studies to increase this number and broaden the range of ages and school years. In addition, the sample of gifted students was limited to a single context, i.e., the association where they are followed and carry out enrichment activities. Thus, it would be appropriate to conduct the same study also with gifted students from other areas of the country and even students who do not attend extracurricular enrichment programs. Another limitation is the lack of validated psychological assessment tools for the Portuguese population to assess some of the cognitive functions considered, and some of these tests are old and have not been the subject of new versions or recent validations.

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