Psicologia: Teoria e Prática, *21*(2), 316-335. São Paulo, SP, maio-ago. 2019.
ISSN 1516-3687 (impresso), ISSN 1980-6906 (*on-line*). doi:10.5935/1980-6906/psicologia.v21n2p316-335. **Sistema de avaliação**: às cegas por pares (*double blind review*).
Universidade Presbiteriana Mackenzie.

Psychology and Education

Interventions with games in an educational context: Improving executive functions

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To cite this paper: Ramos, D. K., Bianchi, M. L., Rebello, E. R., & Martins, M. E. O. (2019). Interventions with games in an educational context: improving executive functions. *Psicologia: Teoria e Prática*, *21*(2), 316-335. doi:10.5935/1980-6906/psicologia.v21n2p316-335

Submission: 20/11/2017
Acceptance: 04/04/2019

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Abstract

This study aims to evaluate the improvement in the executive functions of the students using games in an educational context. For that, a field research was conducted using a qualitative-quantitative approach based in structured interventions based on the use of cognitive games with small groups, taking in account the participation of fifteen children. The evaluation of the contributions was made through interview with the teachers and also using subtests of WISC-IV before and after the intervention, in an interval of four months. The results pointed better performance in operating memory, processing speed and attention. Those aspects were also observed by the teachers, who also highlighted behavioral and social improvements. Although such results are not attributable exclusively to intervention, it is suggested that the use of games, in an intentional and mediated way, can help to improve executive functions.

Keywords: digital games; games; executive functions; learning; education.

INTERVENÇÕES COM JOGOS EM CONTEXTO EDUCACIONAL: CONTRIBUIÇÕES ÀS FUNÇÕES EXECUTIVAS

Resumo

Este estudo tem o objetivo de avaliar se o uso de jogos em contexto educacional pode contribuir com o aprimoramento das funções executivas dos alunos. Para tanto, foi realizada uma pesquisa de campo com abordagem quali-quantitativa a partir da proposição de intervenções estruturadas como o uso de jogos cognitivos. A avaliação das contribuições foi realizada por meio de entrevista com as professoras e aplicação de substestes do WISC-IV antes e após as intervenções em um intervalo de 4 meses. Os resultados indicam melhor desempenho em relação à memória operacional, a velocidade de processamento e a atenção. Os aspectos também foram observados pelas professoras, as quais ressaltaram ainda melhoras comportamentais e sociais. Apesar de tais resultados não serem atribuíveis exclusivamente à intervenção, sugere-se que o uso de jogos, de maneira intencional e mediada, pode ajudar a aprimorar as funções executivas.

Palavras-chave: jogos digitais; jogos; funções executivas; aprendizagem; educação.

INTERVENCIONES CON JUEGOS EN CONTEXTO EDUCATIVO: MEJORA DE LAS FUNCIONES EJECUTIVAS

Resumen

Este estudio evalúa si el uso de juegos en un contexto educativo puede contribuir al mejoramiento de las funciones ejecutivas de los estudiantes. Para eso, se realizó una investigación de campo con un enfoque cualitativo-cuantitativo basado en la proposición de intervenciones estructuradas basaron en el uso de juegos cognitivos digitales con grupos pequeños, que involucró quince niños. La evaluación de las contribuciones se hizo a través de una entrevista con los maestros y una evaluación con el uso de subtests de WISC-IV antes y después de la intervención. Los resultados indicaron un mejor rendimiento en la memoria operativa, la velocidad de procesamiento y la atención. Aspectos también observados por los maestros, que también resaltaron las mejoras conductuales y sociales. Los resultados no son solo atribuibles a la intervención, se sugiere el uso de los juegos, la intencionalidad y la mediada, se puede hacer un examen de las funciones ejecutivas.

Palabras clave: juegos digitales; juegos; funciones ejecutivas; aprendizaje; educación.

1. Introduction

The executive functions integrate different cognitive abilities involved in the performance of behaviors directed to specific objectives, in the capacity of adaptation to the demands and environmental changes (Morton, 2013; Diamond, 2013). These functions are fundamental to human beings and have in childhood a more intense development phase (Oda, Sant'ana, Carvalho, 2002). The present study aims to evaluate if the use of games in an educational context can contribute to a better performance of students in tasks that involve the use of executive functions.

According to Morton (2013), one can describe these functions in three dimensions. The first refers to self-regulation, which involves the ability to control desires to do what is right at a given moment and is related to the sustenance of attention to perform a task. The second consists of working memory, which one can understand as the ability to store information temporarily and manage to articulate it mentally. The third is cognitive flexibility, linked to the ability to adapt to change and to use creative thinking, and can be related to problem-solving. These three dimensions operate in an articulated and integrated way, working together to achieve efficient executive functioning (Center on the Developing Child at Harvard University, 2011).

The articulation of such dimensions can be observed, for example, in the ability to maintain good relationships with other individuals, to perform various tasks at the same time, to follow instructions, to maintain focus and to have self--control, among others that are essential for performance in school, professional and interpersonal environments (Diamond, 2013).

It is worth noting that some interventions may contribute to the development of executive functions, such as those focused on physical exercise, martial arts, meditation and computer training (Diamond & Lee, 2011). In this study, the proposed interventions use analog and digital games, since it recognizes that their characteristics, which include rules, challenges, action planning and their execution, and feedback (Schuytema, 2008; Prensky, 2012), exercise cognitive functions related to executive functions.

The games used for training and intervention can be denominated cognitive, referring to a set of different games that aims to contribute to the improvement of cognitive aspects (Ramos, 2014). One understands that the games, based on their characteristics, contribute to the improvement of executive functions, since they stimulate their training in a safe context and are capable of generating learning that goes beyond the moment of the game.

Studies indicated contributions of the use of digital games to the improvement of the cognitive functions in adults, such as visual and attention skills (Li, Polat, Scalzo, & Bavelier, 2010), perceptual and cognitive skills (Eichenbaum, Bavelier, & Green, 2014), as well as the ability to do more than one task at the same time and to make executive decisions (Boot, Kramer, Simons, Fabiani, & Gratton, 2008).

Evidence for improvement is also found in studies evaluating the effects of using digital games on children's interventions on working memory and attention (Thorell, Lindqvist, Bergman, Bohlin, & Klingberg, 2009; Rueda, Checa, & Cómbita, 2012), flexibility and reasoning (Dovis, Van der Oord, Wiers, & Prins, 2015) and executive functions more broadly (Diamond & Lee, 2011).

This work evaluated the use of the Brain School (Escola do Cérebro), an application that integrates digital games to a database of players, capable of creating classes and rankings within the application. Therefore, it is intended to present it as a supplement to the school for the exercise and development of children's cognitive abilities, by presenting games that exercise attention, problem-solving ability and working memory, enabling monitoring and evaluation of the performance of these functions (Ramos, 2014).

One can express these skills by processing speed, which consists of the subject's ability to maintain attentional focus in performing simple tasks in situations where attention is needed promptly (Primi, 2003). Therefore, the processing speed can be considered an indicator of the completion time of a task with considerable precision, integrating the use of several cognitive abilities.

The tasks proposed by the games involve the exercise of various cognitive abilities that integrate the executive functions. Thus, when we use these games in the school context, they provide experiences and conditions of learning and cognitive development (Diamond & Lee, 2011; Baniqued et al., 2013). For that, it is essential to highlight games' characteristics, such as challenges, decision making and feedback (Kirriemuir & McFarlane, 2004; Sandberg, Maris, & Hoogendoorn, 2014; Chen, Tseng, & Hsiao, 2018).

Among relevant research, a study conducted by Rueda et al. (2012) involved 37 5-year-old children, divided into two groups: one participated in ten sessions of computerized attention training and the control group did not participate in any intervention session. Children' performance assessments happened before, after, and two months after the end of training related to a variety of tasks, such as attention, intelligence, and affection regulation. The results showed that the children who were part of the trained group obtained faster and more efficient activation of the executive care network than the untrained children (Rueda et al., 2012).

Another study by Thorell et al. (2009), with preschool children, proposed a computerized memory training of space-visual work and inhibition for five weeks. An active control group played commercial computer games, while a passive control group participated only in the initial and final tests. Children who have undergone training related to working memory have achieved a significant improvement in trained tasks, showing training effects in the areas of work, spatial and verbal memory as well as positive effects on attention functions. On the other hand, children who had their inhibition trained showed an improvement over time in two of the three paradigms of trained tasks. However, there were no significant improvements over control groups in tasks that measure working memory or attention (Thorell et al., 2009).

A study by Rosas et al. (2003) proposed the use of digital games for three months in school to achieve the educational objectives with 1,274 students of the first and second years of schooling. The assessment of children included aspects related to reading acquisition and comprehension, spelling, math skills, and motivation to play. The results showed significant differences between the experimental and control groups in mathematics, reading, and writing. The authors conclude that digital games can be a useful tool in the promotion of learning in the classroom.

These studies reinforce that the use of games in the school environment, especially in an intentional and mediated way, can not only exercise cognitive abilities but also provide the development of social and emotional skills, since the use of games occurs in the social interaction context among peers. Such skills develop under the influence of social interaction, the need to deal with loss/frustration, success, conflict, and negotiation. Through interaction with games, children practice social interaction and develop skills and interests that contribute to their development (Wang & Aamodt, 2012). Besides, the child's contact with the partner is an integral part of the process, because, in addition to sharing the same space, they learn to respect other children, build affective bonds and discover new ways of dealing with the other.

Therefore, this study evaluates the effects of the use of the Brain School's digital games in small groups of children chosen by the teachers, who understand that they have some attention trouble. The intervention activities were developed outside regular classroom, weekly and in 50-minute sessions. The research followed intervention procedures based on mediation for the participants' guidance and orientation.

2. Method

The study is characterized as a mixed methods field research. It took place in a nongovernmental organization, in agreement with the city council, that offers educational activities out of regular classes to children who study in the public education school in the city of Florianópolis.

2.1 Participants

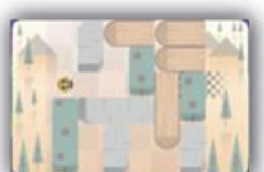
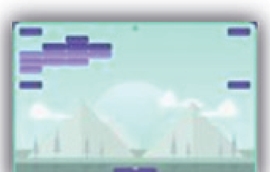
Fifteen children aged between 6 and 13 years (mean age 9.46; standard deviation 2.29) participated in the activities, 12 boys and 3 girls attending different k12 classes, without diagnosis of disability or developmental disorder in school records. These children live in a low socio-economic community.

The institution in which the research was carried out assists 170 children, from 6 to 15 years of age, offering socio-educational activities after school. Children are organized by age into five groups per shift (morning and evening). The sample was composed by convenience from the five groups attending the afternoon shift, following the indication of the teachers responsible for conducting the activities with the five groups organized by age that attend the institution and the pedagogical coordinators of the institution. Inclusion criteria for selection came from the perception of these professionals who selected children with low school performance and attentional difficulties in the classroom. Then, the adults responsible for the children signed the free and informed consent term and the consent form.

2.2 Instruments and materials

The interventions used cognitive digital games available through the Brain School, using the computers of the computer lab of the NGO. Table 2.2.1 describes the games used.

Table 2.2.1. Description of the objectives of the Brain School games and cognitive functions.

Screen	Objectives	Cognitive Functions
	*Ladybug* Release the ladybug, moving blocks in only two directions, so that she can exit.	Attention to the initial conditions and arrangement of the parts. Planning and developing strategies (problem-solving) to move parts efficiently. Memorization of actions performed and solution hypothesis already tested.
	*Breakout* Destroy the blocks by bouncing the two balls and trying to keep at least one to complete the task.	Attention to follow the movement of the balls. Analysis of the trajectory of the ball to elaborate strategies to hit the blocks (problem-solving).

(*continue*)

Psicologia: Teoria e Prática, 21(2), 316-335. São Paulo, SP, maio-ago. 2019. ISSN 1980-6906 (*on-line*).
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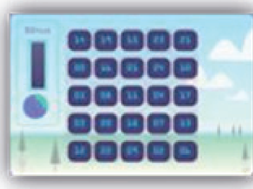
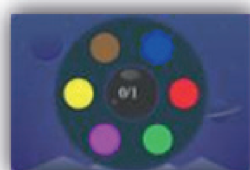
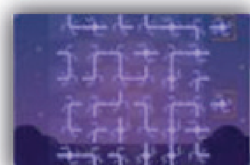
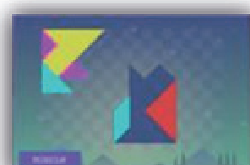
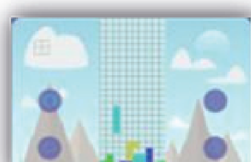
Table 2.2.1. Description of the objectives of the Brain School games and cognitive functions (*conclusion*)

Screen	Objectives	Cognitive Functions
	*Looktable* Find and click the numbers, scrambled in the grid, in ascending order.	Attention to track the numbers that complete the sequence. Problem-solving to justify the decision on how to better act. Memory to save the completed sequence.
	*Genius* Play back the growing color sequences that are displayed.	Attention to follow the presentation sequence. Memorizing the sequence for later reproduction. Depending on the amount of stimulus, a strategy must be used to reproduce the sequence (problem-solving).
	*Connectome* Connect two neurons, organizing the links between them, selecting and changing the position of the neurons to create the path.	Attention concerning the conditions and possibilities of solution. Problem-solving by developing strategies and planning actions to find the path in less time and with fewer clicks. Memorization of the strategies already used and the objective to be achieved.
	*Tangran* Use all geometric pieces to complete the displayed figure.	Attention to discriminate the pieces and analyze the form. Problem-solving when develop hypotheses about the layout of the pieces to complete the figure. Memorization of the attempts already made.
	*Tetris* Move the pieces to draw lines and gain points, without letting the pieces reach the top.	Attention to analyze and discriminate each new piece. Problem-solving to determine the best movement to draw lines considering the possibilities.

Source: Ramos & Melo (2016, p. 26).

Before and after participating in the sessions, children were assessed through the Wechsler Intelligence Scale for Children (WISC VI) subtests. The assessment aimed to compare the results obtained in the two moments of application.

The use of the subtests that make up the Working Memory Domain (WMD) and Processing Speed Domain (PSD) indexes is justified by the fact that it is an adequate test for the age group, are cited in several studies and propose tasks that involve the exercise of cognitive abilities that are part of executive functions such as working memory, attention, cognitive flexibility, and planning. These are the subtests, according to Wechsler (2013):

- Digit Span: a series of numerical sequences is presented orally, and the child is required to repeat some in direct order and others in reverse order. The subtest evaluates skills such as attention, concentration, sequencing, and short-term memory;
- Letter-Number Sequencing: a series of letters and numbers is presented orally for the child, who repeats them by arranging numbers and letters in order, involving sequencing, attention, short-term memory and processing speed;
- Arithmetic: presents a series of arithmetic problems that the child solves mentally and answers orally, requiring skills such as reasoning, attention, short-term and long-term memory;
- Coding: a series of shapes or numbers are presented on a sheet, each paired with a simple symbol for the child to draw the corresponding symbol; this subtest involves short-term memory, perception, cognitive flexibility, and attention;
- Symbol Search: a set of stimuli (symbols) are presented on a sheet and the child must examine whether they appear in a set of other symbols. In addition to processing speed, the subtest involves cognitive flexibility, attention, and short-term memory.

Finally, after the interventions, the teachers were interviewed following a semi-structured script. The script addressed questions related to the perception of the teachers about the participating children concerning focus and attention in the classroom, performance in carrying out activities and social interactions. This interview aimed to establish a dialogue about the perceptions of the activity developed, the possible identification of behavioral changes and the children school performance, focusing mainly on the skills that are part of the executive functions.

2.3 Procedures

The research was submitted to and approved by the Research Ethics Committee (CAEE 67638216.5.0000.0121), planning interventions that were performed weekly in groups of three to four children during 50-minute sessions. These sessions used analog and digital games of the Brain School using the computers in the computer lab.

In the first care sessions, the children were evaluated based on WISC IV subtests. This evaluation was repeated at the end of the sessions, which lasted approximately four months. The children did not participate in the same amount of interventions, due to absences or other activities performed at the institution that prevented participation. On average, the children participated in 9.06 sessions (standard deviation = 2.76), ranging from 5 to 13 sessions (median = 9).

Besides the use of games, the sessions structure was inspired by cognitive-behavioral therapy. However, adaptations were made to the educational context, focusing on the attention capacity.

In the sessions, the children were initially offered an exercise on self-perception, using an attention scale, in which the child paints the smile closest to their attention at that moment. The scale ranged from 1 to 5, represented by smiles with expressions that represented states of attention. This step lasted an average of 5 minutes to 10 minutes.

After that, an agenda was established on which games to play and the rules and combinations of the session were reinforced. The development also included the use of analog cognitive games – such as challenge, memory, board, and oppositional games, as well as the Brain School digital games. Each session one of the games was established for interaction, trying to go through all the available games at least once during the interventions. This stage was the longest and used to take an average of 30 minutes.

In the last 5 to 10 minutes, there was an evaluation phase of children's behavior during the session using a reinforcement table. This table evaluates children concerning their attitudes, attention, commitment, and interaction with the group (Ramos, 2014). Finally, the child had to do work on an activity for the next session.

2.4 Data analysis

The data collected, through the application and grading of the tests, were tabulated using Excel for building the database. After the organization of the information, these data were analyzed in Statistical Package for the Social Sciences (SPSS) version 24.

Based on the normality of the data, using the Shapiro-Wilk test, statistical tests were performed to compare the results before and after the performance in the WISC IV subtests, searching for indicators on the influence of the interventions on the cognitive aspects of children. The results obtained before and after the interventions were submitted to the paired sample t-test, with a 95% confidence interval.

The qualitative data obtained through the interviews with the teachers were transcribed and analyzed based on the content analysis proposed by Bardin (1977). The pre-analysis was carried out through an exploratory reading of the transcripts to identify categories and indicators, as well as preparation of the material for analysis. The analysis and coding based on the indicators were carried out using the NVivo software. Finally, results were treated, generating inferences and interpretations.

3. Results

3.1 Quantitative analysis

Considering that the dependent variables have a normal distribution revealed by the Shapiro-Wilk test, $p>0.05$, the data collected were analyzed by the paired sample t-test (Table 3.1.1). The results show an increase in the scores obtained in the tests applied when comparing the pre and post-intervention results.

Psicologia: Teoria e Prática, *21*(2), 316-335. São Paulo, SP, maio-ago. 2019. ISSN 1980-6906 (*on-line*).
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Table 3.1.1. Paired sample t-test results in the subtest scores.

Test	N	Pre Mean (SD)	Post Mean (SD)	t	p
WMD Digit Span	15	10,13 (4,45)	12,73 (3,93)	-3,189	0,007*
WMD Letter-Number Sequencing	14	8,78 (6,35)	12,28 (5,81)	-2,756	0,016*
WMD Arithmetic	14	5,21 (3,59)	7,35 (3,95)	-2,760	0,016*
PSD Coding	15	31,53 (9,26)	35,66 (11,81)	-1,721	0,107
PSD Symbol Search	14	12,85 (5,99)	18,71 (7,30)	-2,913	0,012*

Note: (SD) Standard Deviation; (*) $p < 0.05$

Operational memory was measured using the suggested subtests to evaluate the Working Memory Domain (WMD): Digit Span, Letter-Number Sequencing, and Arithmetic. The processing speed was measured based on the WISC IV Coding and Search Symbols subtests. The difference between the first (pre) and the final (post) sessions revealed an increase in the participants' mean score in four of the five subtests applied.

In the Digit Span tests, there was a significant difference of 2.6 $t = -3.189$, $p < 0.05$; in the Letter-Number Sequencing subtest, the difference was 3.50, $t = - 2.756$, $p < 0.05$; in Arithmetic, the resulting difference was 2.14, $t = - 2.760$, $p < 0.05$; and in the subquery Search Symbols, there was 5.85 of difference of $t = - 2{,}913$. $p < 0.05$. In the subtest Coding, although there was a difference of 5.85, it was not considered statistically significant.

3.2 Qualitative analysis

In addition to the results obtained in the tests, the interviews with the teachers reinforce that the sessions offered contributions to the children. The interviews asked the teachers about the changes and improvements observed in the ten children in the classroom.

The coding through categories performed by the NVivo Software from the transcript of the interviews revealed changes, mainly in the attention, motivation and social interaction of the participating children. Figure 3.2.1 shows the frequency of codes.

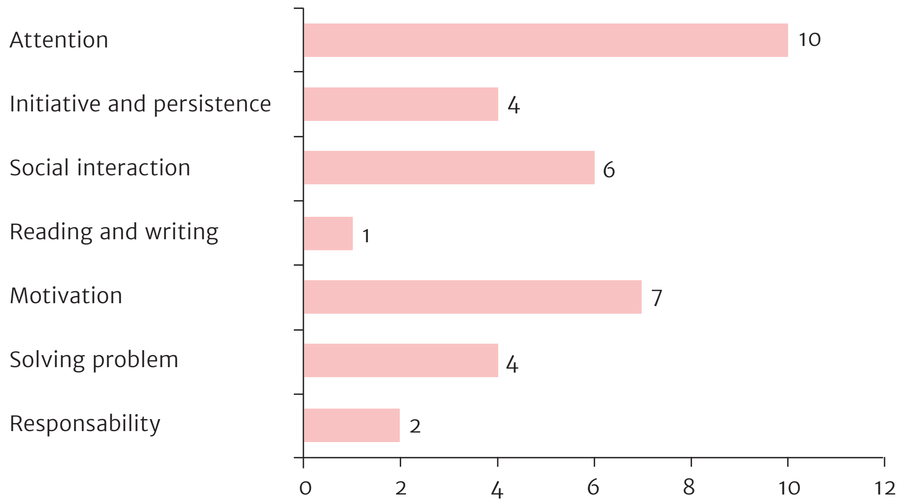

Figure 3.2.1. Frequency of codifications concerning the categories analyzed.

The improvements described and codified were based on transcriptions such as "Stay tuned" or "Now you can understand what it is to do" for the attention category; according to one of the teachers, "Before you had to insist on paying attention, now she wants you to explain to learn" (Participant 1) and "Now you can get a little more focused and listen a little better." (Participant 4); another teacher observes that, of the four children participating in her class, three "They now understand what it is to do, to finish an activity" and adds that "Everyone has shown improvement to seek solutions in playful activities, to find a way to solve."

The changes in social interaction were observed in aspects such as the greater manifestation of opinions, the establishment of bonds of friendship and greater participation in the room. In the interviews related to this category, there are observations such as: "She is very timid and had difficulties making friends, she even said at home that she did not want to go. Now she makes more friends, talks to the colleague next to her, improved interaction." (Participant 2); and "I noticed more interaction with peers, she is more comfortable. She expresses more her opinion, is

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more confident, and is very quiet and reserved. If she does not know, asks for help" (Participant 14).

Motivation, another highlighted category, refers to the greater involvement with activities, willingness to learn and higher interest for the institution after the beginning of the sessions. Comments on this category are: "likes learning, everything that is offered to her she wants to do well. She advanced significantly, and she is responsive, she wants" (Participant 13) and "she comes to the class happy when she comes from the sessions" (Participant 4).

The analysis of the interviews allowed to identify the main changes and contributions described by the teachers observed in the children from the start of the sessions. Table 3.2.1 highlights the main changes described by the teachers during the interviews.

Table 3.2.1. Main improvements observed by the teachers in the participants.

	Interaction	Attention	Motivation
Participant 1		X	X
Participant 2	X		X
Participant 3			
Participant 4		X	X
Participant 5	X		X
Participant 6		X	X
Participant 7			X
Participant 8			X
Participant 9	X	X	X
Participant 10	X		X
Participant 11			
Participant 12			
Participant 13		X	X
Participant 14	X	X	X
Participant 15			X

Table 3.2.1 shows that, according to the teachers, the majority of the students, 12, at least, had an area of improvement among the three mentioned.

4. Discussion

The results indicate the best performance of the participants in the comparison before and after the interventions with the games in the educational context. However, we can not link improvement to game use only, once a case-control design was not performed. Besides that, the own intervention structure, which includes in addition to play, various stages, mediation, and social interaction, may influence the children's final performance.

Another aspect to consider is the application of the WISC subtests at a lower interval than suggested by the manual, which recommends reapplication one year after the first evaluation (Wechsler, 2013). Nevertheless, other studies apply the test before and after interventions to demonstrate improvements. The research developed by Zampieri, Schelini, and Crespo (2012), for example, aimed to implement and evaluate a program of stimulation of intellectual abilities. The study of Mezzacappa and Buckner (2010), on the other hand, used subtests of the WISC, along with other tests, to seek evidence of the effectiveness of a computer program to train the working memory of attention-deficit or hyperactivity in children attending a public school. In addition, we must note that the instrument was not used to assess and classify the children regarding their intelligence level and the quantitative data obtained in the test were triangulated with the teachers' perception about the children in the classroom.

We should note that the interview with the teachers reinforced the improvement in some cognitive abilities exercised using cognitive games, which can be considered an indicator that the interventions lead to changes. The observation of the teachers based on the observation of some behaviors in the classroom also indicates that it is possible to transfer the skills exercised to other tasks different from those performed in the games. This aspect reinforces what some researchers suggest about the fact that contextualized training may facilitate the generalization of the cognitive improvement obtained for other situations (Chen et al., 2008; Rosas et al., 2003; Sandberg et al., 2014; Thorell et al., 2009).

The subtests that were used evaluate different skill sets, which may justify the different results obtained in the Coding and Search Symbols subtests, which are linked to the processing speed. The Find Symbols subtest showed significant improvement, which may be associated with skills exercised in the proposed task, which includes perceptual discrimination, abilities to explore visual stimuli, speed,

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and accuracy, unlike the Coding subtest that involves cognitive flexibility and persistence in a sequential task (Wechsler, 2013).

In the subtests Digit Span and Letter-Number Sequencing, however, a significant difference was identified, comparing the application before and after. The former involves capacity for attention and working memory. The latter involves attention, short-term memory, and processing speed (Wechsler, 2013).

Wechsler (2013) highlights the importance of assessing processing speed because this cognitive attribution is related to neurological development, cognitive functions, and learning. Besides that, according to the manual, those who have a fast processing speed have a diminished demand for working memory and reasoning facilitated. Comparing the results of the evaluations, there is evidence that the use of the Brain School may have contributed to improve such points.

In addition, the results corroborate the findings of Rivero, Querino, and Starling-Alves (2012), who carried out a study that aimed to investigate the positive evidences of the use of videogame on the cognitive functions, resulting in a considerable improvement in attention, in visual and spatial processing, in executive functions, with an emphasis on operational memory. For these authors, who carried out a systematic study to arrive at these conclusions, the videogame also influences the users in behavioral attitudes. This variation is perceived by the answers of the questionnaires by the teachers.

Another aspect noted was the motivation and the engagement of the children in the activities using games that involve challenges, rules, and actions in a playful and fun way (Schuytema, 2008). The engagement required for the identified improvements can be understood as the result of some lightness that the use of digital games can offer. Among them, are the advantages over other tools to stimulate cognitive functions: 1. games engage more; 2. offer an effective reward system; 3. are fun; 4. have lower cost; and 5. can be performed in therapeutic settings and at home (Rivero et al., 2012).

Concerning the positive changes reported by the teachers, we should highlight attention, strongly linked to the dimension of inhibitory control in executive functions (Diamond, 2013). This dimension can be understood as the capacity to direct the mental processes to stimuli that are considered relevant, excluding the irrelevant ones (Lima, Travaini, & Ciasca, 2009).

The results point to changes and gains in tasks that involve different dimensions of the executive functions in the participating children, which are evidenced in the improvement in the performance in the tasks proposed by the subtests and in the observations made by the teachers. However, several factors such as biological maturation, routine, and school activities can influence the development of executive functions. A wide range of activities that require some aspects, such as creativity, quick responses, planning, and cognitive flexibility can contribute to the improvement of executive functions (Oliveira-Souza, Moll, Ignácio, & Tavar-Moll, 2013). Complementarily, Diamond and Lee (2011), based on the review of several studies, reinforce that some activities can contribute more effectively to the improvement of executive functions since time is devoted to the activity and constitutes a repeated practice, emphasizing that the best results are produced when we have motivation, fun, progressive levels, feelings of belonging and social acceptance.

In this sense, according to Uehara, Charchat-Fichman, and Landeira-Fernandez (2013), executive functions are understood to cover a wide range of interrelated and high-level cognitive processing skills. Studies have suggested that executive functions can be improved through training and that such interventions impact on brain functioning and may contribute to behavioral and emotional regulation skills in children (Rueda et al., 2012).

The results also reinforce the research developed by Thorell et al. (2009), which found a significant difference when comparing the performance of the control group and the participant group in the tasks that measured the memory or work attention. In the same sense, this study identified improvements in the tasks proposed by WISC IV subtests that also involved attention and working memory.

The intervention based on the interaction with the games resulted in changes that were perceived in the accomplishment of the school activities and in the social interaction. This aspect reinforces that these functions are "a cognitive, behavioral and affective partner domain of great relevance for the human being" (Uehara et al., 2013, p. 10).

Evidence of improved skills associated with executive functions, such as attention, visual processing and working memory, through interaction with games, mediation, and social interaction, reinforces the importance of an educational methodology that aims to stimulate the functions of cognitive development of children in school settings, as well as reinforce the effectiveness of these cognitive development programs.

Psicologia: Teoria e Prática, *21*(2), 316-335. São Paulo, SP, maio-ago. 2019. ISSN 1980-6906 (*on-line*).
doi:10.5935/1980-6906/psicologia.v21n2p316-335

Despite the limitations of the study, especially concerning the lack of a control group and the large number of variables that can influence the skills evaluated, the results point to the possible contributions of new methodologies and resources for the cognitive development of children in school. This study reinforces the need to advance research that seek to evaluate and indicate the effects of interventions with digital games for the improvement of executive functions, seeking to analyze the role of mediation, the influence of social context and the relevance of routines in the school context.

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