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The Relationship of the Preferred Types of Digital Games and Executive Functions in 6—7-Year-Old Children

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This study aimed to examine the relationship of the types of digital games preferred by preschoolers and their executive functions. For a more detailed study we created a classification of the games in question based on the content analysis of the participants' interview, game mechanism, and the required cognitive functions. 6 types of digital games were developed: quick reaction games, logic games, educational games, strategic games, drawing games, and simulators. The overall sample comprised 335 children (48,6% girls) aged 6—7 (M=74,6 months, SD=6,06 months). The study included assessment of the executive functions and an interview about digital games. We used the NEPSY-II subtests to measure the examinees' executive functions level: visual and verbal working memory, and inhibition. We also used "The Dimensional Change Card Sort" to assess cognitive flexibility. Data analysis revealed that quick reaction games were the most popular at this age. The next favourite were logic games, strategic games, and simulators'. The study demonstrated quick reaction game players' visual working memory was better developed than in the non-players. Logic game players processed information at a higher speed than the non-players. Simulation game players obtained higher score in cognitive inhibition, than the children who didn't like this type of games.

Keywords: early childhood; digital games; executive functions; quick reaction games; working memory; inhibition; cognitive flexibility; information processing speed.

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Взаимосвязь предпочитаемых типов цифровых игр и регуляторных функций у детей 6—7 лет

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Работа направлена на изучение взаимосвязи типов цифровых игр, которые предпочитают дошкольники, с развитием у них регуляторных функций. На основе анализа интервью дошкольников, а также с учетом игровых механизмов и задействуемых в играх когнитивных функций была разработана классификация цифровых игр. Было выделено 6 типов цифровых игр: игры на быструю реакцию, логические игры, обучающие игры, стратегические игры, игры-рисование и игры-симуляторы. Общая выборка включала 335 детей (48,6% девочек) в возрасте 6—7 лет (M=74,6 месяца, SD=6,06 месяца). Исследование состояло из оценки регуляторных функций и беседы о предпочитаемых цифровых играх индивидуально с каждым ребенком. Были использованы субтесты NEPSY-II для измерения уровня регуляторных функций испытуемых: зрительной и вербальной рабочей памяти, а также когнитивного и поведенческого сдерживающего контроля. Также была использована методика «Сортировка карточек по изменяемым параметрам» для оценки когнитивной гибкости. Результаты показали, что игры на быструю реакцию были самыми популярными среди дошкольников 6—7 лет. Далее по популярности следовали логические игры, стратегические игры и игры-симуляторы. Исследование показало, что зрительная рабочая память лучше развита у тех, кто играет в игры на быструю реакцию, чем у тех, кто не играет в такие игры. Дети, играющие в логические игры, обрабатывали информацию с большей скоростью, чем те, кто не играет в данный вид игр. Респонденты, которые играют в игры-симуляторы, получили более высокий балл по когнитивному сдерживающему контролю, чем дети, которые не играли в этот тип игр.

Ключевые слова: дошкольный возраст; регуляторные функции; цифровые игры; игры на быструю реакцию; рабочая память; сдерживающий контроль; когнитивная гибкость; скорость обработки информации.

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Introduction

Executive functions (EF) belong to the family of top-down mental processes that provide purposeful problem-solving and adaptive behavior in new situations [28] In the research literature, EF are discussed in the context of self-regulation [24; 44]. The most common assessment model applicable to the children's EF skills [4] is proposed by Miyake. Following Miyake's approach, basic EF skills include working memory, cognitive flexibility, and inhibition [45]. Working memory allows us to retain the memory target items during the performance of the task. Cognitive flexibility enables us to switch the attention from one task to another, and to adapt to changing conditions. Inhibition is understood as the ability to regulate dominant but inappropriate impulses. EF skills are most rapidly developed in childhood [21; 30; 69]. EF are important predictors for child's social, cognitive, and psychological development at school and later. Thus, children with better EF skills show higher results in mastering math [26; 67], and speech development [41; 47]. Their transition to school [20] goes easier, they have higher academic achievements [46; 64], and behave more appropriately in the classroom [52].

Both genetic [34] and environmental factors [29; 59] influence the EF development. Therefore, the search for conditions and factors that surround children on a daily basis and affect the development of the EF skills is of topical interest for psychology. For example, digital devices are an important constituent part of modern childhood [10; 11; 37]. Relevant studies revealed that screen time among children has increased significantly through the recent years [11; 58]. Children spend more than 3 hours every day using digital devices [12; 39; 60]. Playing digital games in everyday life affects children's cognitive development including EF [43; 60]. Thus, the prevalence of digital games among preschoolers and the "sensitivity" of this period to the development of the EF skills emphasize the importance of studying the correlations between playing digital games in everyday life and the development of EF in children. Identifying optimal conditions for the use of digital games can facilitate parental support of a child's digital activity. This, in turn, can reduce the negative effects of digital games, and contribute to its developmental and educational potential [6].

Digital games as a tool for training EF skills

According to research, play activity is of the utmost importance for the cognitive, emotional, and personal development of preschoolers [14, 29]. It was demonstrated that play has a high developmental potential also, in case of the EF [22; 30; 59]. In comparison to other activities, the biggest advantage of play in the context of the development of the EF skills is its naturality and spontaneity. Moreover, play is enjoyable [14: 5]. Since recently, digital game occupied a solid position among traditional types of play [38, 61]. Let us emphasize, though, that digital games are not a complete alternative for traditional games. From the perspective of the cultural-historical approach, these are the key characteristics of children's play: 1) a child creates an imaginary situation and acts within it, and 2) play develops through the changes in the relationship between the roles, rules, and play actions [61; 63]. Digital games don't always meet these requirements. Nevertheless, the interest of the scientific community to this type of games is constantly growing due to the fact that children spend more and more time using digital devices for playing [39; 58]. The potential of using digital games for the development of the EF skills is under active consideration and study in the expert community. A number of research works revealed that digital games can affect the development of the working memory [17; 51; 56] and inhibitory [27] in a positive way. The results of certain training experiments also confirmed that the effect of digital games on the EF skills' development is more noticeable than the one of traditional games and other developmental means such as sports education, drawing, etc. [42; 48; 59; 65].

For example, in the study by Xiong and colleagues (2019), 60 4—6-year-old preschoolers attended 20-minute intervention sessions for 8 weeks. The participants were divided into groups randomly: the first group played specially selected exergames (a new generation of digital games that provide a more active, whole-body play experience), and the second followed a traditional teacher-led physical activity program. Apparently, the children who played exergames, demonstrated much more significant dynamics in the development of skills и social acceptance, if compared to those who participated in the physical activity program. This outcome can be also explained by the fact that exergames are an innovative physical activity combining traditional physical exercises and an engaging video-game, which results in additional developmental effect.

Similar results were obtained in the study by Rafiei Milajerdi and colleagues (2021). It explored the influence of the "Sports, Play and Active Recreation for Kids" program and exergaming on EF in 6—10-year-old children with ASDs. The results revealed that the use of digital games for the development of the EF skills was more efficient than the conventional sports and play programs, due to a higher motivational involvement of children.

The development of the EF skills by means of digital games proved its efficiency both for girls and boys [59; 65]. However, certain gender differences were registered in the digital game preferences. Boys chose competitive games more often, for example, "military games", action-games, or racing games, while girls rather opted for puzzle games [13; 35; 55]. Both genders were equally interested in the creative and construction games [23]. Nevertheless, at the moment, there is still a serious lack of research aimed at the gender-based digital game preferences and the development of the EF skills.

Thus, digital games can be used not only for entertainment but as a tool of correction, training, and development at preschool age [60]. Because of the deep engagement [16] and the direct skill training by means of digital simulators, the EF skills' development in children becomes possible. It is essential to note that the active involvement of adults into the organization, selection and discussion of digital games considerably enhances their developmental potential [8, 60]. The reason is that it is the adult who transmits to children the ways of use of digital devices and digital games as psychological and cultural means, as well as demonstrates all the range of options of interacting with them [54]. So, if digital games are played by children on a regular basis, and are an efficient developmental tool in the preschool age, it provides the grounds for the following questions. Are all types of digital games equally efficient for the EF development? How is the content and the mechanism of a digital game related to the development of the EF skills?

Different types of digital games and the EF development

Cognitive psychology mostly relates the development of the EF skills to action video games that require an active use of voluntary attention and a well-developed perception from the player [15; 18]. Digital action-games are complex 3D games with fast-moving goals that quickly appear and leave the range of the player's vision. Digital action-games include such genres as fighting games, beat 'em ups (hand-to-hand fighting against multiple opponents), shooter games, and platform games. All of them require an agile reaction to multiple quickly-moving visual and audial stimuli, a flexible adjustment of behaviour to the constantly evolving conditions of the play situation, and the development of control strategies for one's actions.

However, other research results contradict the theory of action video games as the most efficient for the development of the EF skills [33; 66]. For example, 119 3—6-year-old children participated in the study by Yang and colleagues (2020), and it revealed no connection between action video games with the total EF skills score. Moreover, action content of digital games was correlated with the inhibition development negatively. The lack or even a complete absence of positive effect of action video games is related to the fact that this genre requires a very quick reaction almost at every moment of playing process which leaves no room for strategic planning.

At the moment, it is the efficiency of a new generation of digital games, the exergames, is of immediate research interest. This genre combines exercises and play, i.e., physical activity and cognitive involvement. This is why many authors believe them to be the most effective type of digital games in regard to development of the EF skills [32; 34; 65]. For example, Gashaj and colleagues (2021) undertook a study that included 97 preschoolers and their parents in order to explore the relationship of classical digital games, exergames, non-digital board games, and EF. Parents evaluated their children's play behaviour by the criteria of frequency, duration, and type of game. It was revealed that in comparison to other digital games (3-dimensional, balance-objects games, etc.), exergames, non-digital board games, and puzzle digital games positively correlated with the development of the EF skills. Let us indicate the fundamental difference between exergames and other types of digital games, it is the criterion of physical involvement. Other than that, in their mechanism, rules, engagement of psychological functions, and content, exergames can be identical to other digital games, such as fast-paced arcade games, first-person shooter games, puzzle games, and others. Therefore, the analysis of the specifics of digital games promoting the EF skills' development needs more explicitation.

Currently, the research of digital games is contradictory and not sufficiently systemic. Comparative studies distinguish different game types at the author's will, because already existing popular classifications of digital games are mostly based on genres and the criteria of the plot, design, and tasks [3]. This approach is not sufficient for the definition of a potential correlation between games and cognitive development. Another categorization of digital games in comparative studies is based on the analysis of parent surveys [7]. The parents describe the games their children prefer in interviews or surveys, and the categories are drawn according to these responses. However, this data may not reflect the real interests of the preschoolers, since parents are not always aware of the digital content their children are dealing with [54]. Moreover, there is almost no research that would include the data obtained directly from the preschoolers. All the above-mentioned complicates the definition of the specifics of digital games contributing to the development of the EF skills. Still, it is essential to underline that the exploration of spontaneous use of digital games by children in real life together with children's preferences is of the urgent interest for us.

The present study

This study was aimed at the correlation between the types of digital games preferred by preschoolers and their EF skills. We wanted to find out what types of games were popular at the moment among present-day preschoolers in general, and the preferences of boys and girls, in particular. Secondly, we aimed to examine the relationship between those preferred types of digital games and the EF skills in children. For a more detailed study of the connection of types of digital games and the specification of their key features defining their efficiency, we created a classification of the games in question. It was based on the children's responses about the digital games they preferred and the current vision of their genres and mechanism [1; 3]. We selected two parameters as the classification criteria: the game mechanism, and the required cognitive functions. We pointed out 6 types of digital games: quick reaction games, logic games, educational games, strategic games, drawing games, and simulators.

The first category included action-games, platform games, and racing games. They require an active processing of visual information in the conditions of fast appearance and disappearance of multiple objects in the player's range of vision. It is also crucial to retain multiple objects in focus. These specifics activate visual working memory. Quick reaction games also imply that the player makes very quick but precise decisions which requires an inhibition of impulsive reactions.

Logic games included arcades, puzzles, and causal games. This category is characterized by relatively simple control mechanism, and simple rules. Logic games don't require an active voluntary attention, but do need strategic thinking and use of logic. Creating their own strategy requires the skills of control of spontaneous actions in favour of the ones that are strategically necessary.

Educational games are basically adjusted educational programs, for example, for English, ABC, maths, and other disciplines. Normally, they have an attractive multicoloured interface, include virtual rewards, video instructions to perform the tasks, and the actual tasks. Educational games are aimed at the training of a particular skill.

Strategic games include sandbox mode (configuration and moving of objects, mapping), Battleship, chequers, and chess. Games that belong to this category have a more complex mechanism than the logic ones. This genre requires planning of the player's activity, coordination, and control of the sequence of actions, and remembering a certain volume of visual information to be able to use it later. Strategic games activate planning skills and visual working memory. It is important to note, that often, preschoolers don't use the benefits of all the potential of strategic games.

We assigned a separate category to the drawing games. In order to draw an object, a visual analysis is required, along with the examination of the details and features of the object. It is also necessary to remember its physical properties. Therefore, drawing activates the mental functions related to the retaining and transformation of images. Besides, the games of this type imply active use of motor skills.

The last but not least category comprises simulation games, or simulators. They create an image imitating real conditions, they reflect a certain part of reality in the virtual environment. A child gets a chance to try to imitate handling some objects. Simulators offer trying out "adult" roles to children: taking care of an animal, decorating a house, doing grocery shopping, and so on. This characteristic is common for simulation and plot role play.

Deriving from this classification of the digital games preferred by preschoolers and the analysis of corresponding research literature we assumed the following: 1) boys would prefer quick reaction games to the others, and 2) girls would rather choose logic games over other genres. We also proposed four specific hypotheses regarding the preferred game types and the EF skills:

Quick reaction game players and strategic game players will demonstrate higher visual working memory scores than the non-players.

Quick reaction game players and strategic game players will demonstrate higher scores in verbal and auditive working memory than the non-players.

Quick reaction game players will demonstrate higher cognitive flexibility scores than the non-players.

Quick reaction game players, strategic game players, and simulation game players will demonstrate higher inhibition scores than the non-players.

Methods

Participants

335 children (48.6% girls) aged 6—7 (M=74.6 months, SD=6.06 months) were recruited for this study. All children were attending public kindergartens in the districts characterized by the same infrastructure level, and designed to accommodate primarily medium-income families.

Procedure

The study included two stages: EF skills assessment and an interview. Both were conducted individually with each child using electronic versions of the tests and questions on a tablet. This made the testing procedure identical for all participants. Three meetings with each child were held to complete all tests and the interview. During the interview about digital devices, the children were asked: “What games do you like to play?”. Participants could name several favorite games. These answers formed the basis of the proposed classification. The assessment took place in a secluded quiet place, familiar for the child in one of the kindergarten rooms.

Parents of all the participants gave written consent for their child to participate in the study. The study was approved by the Ethics Committee of the Faculty of Psychology of Lomonosov Moscow State University.

EF assessment

We used the NEPSY-II subtests [4; 40] to measure the examinees’ EF level: visual (“Memory for Designs”) and verbal working memory (“Sentence Repetition”), and inhibition (“Naming and Inhibition”, “Statue”). We also used “The Dimensional Change Card Sort” [68] to assess cognitive flexibility. It allowed us to measure various components of the preschoolers’ EF.

The NEPSY-II “Memory for Designs” (MD) subtest was used to assess visual working memory. This test reflects the correct memorization of image details and their spatial location

The NEPSY-II “Sentence Repetition” (SR) subtest was used to assess verbal working memory**.** This test consists of 17 sentences that gradually become more difficult to remember due to their length and grammatical structure.

The “The Dimensional Change Card Sort” (DCCS) test was used to assess cognitive flexibility. This technique consists of three tasks for sorting cards. First, the child must sort the cards by color, then by shape, and eventually, to follow a complex rule: if a card has a frame, it must be sorted by color, and if there is no frame, by shape.

To assess the cognitive component of inhibitory control, we used the NEPSY-II “Naming and Inhibition” (Inhibition) subtest in order to measure the information processing speed and inhibition of impulsive reactions. This technique consists of two blocks: a series of white and black circles and squares, and a series of white and black arrows pointing in different directions (up and down). Two tasks were performed with each series of pictures: first, to identify the form (in this case, the child simply had to quickly name the forms that he/she saw), and an inhibition task. In the latter case, the child had to do everything contrariwise: for example, if a square was demonstrated, he/she was supposed to say “circle” and so on. For each task, the researchers recorded the number of mistakes the child made and corrected or could not correct, as well as the time it took to complete the task.

The “Statue” subtest was used to evaluate behavioral inhibitory control. In this test, the child needs to maintain a stationary body position with his/her eyes closed for 75 seconds, restraining impulsive reactions in response to distracting sounds.

Data analyses

A frequency analysis of participants’ responses was conducted to determine the types of digital games children preferred. Then Pearson’s chi-squared test was used to reveal gender-based differences in the preferences of digital game types. The Mann-Whitney test was performed to compare the EF in children playing different types of digital games. Significance was set at a p-value of 0.05 throughout the analysis.

Results

Preliminary analyses

A frequency analysis of children’s responses to the question “What games do you like to play?” was carried out. First, the answers were categorized according to the proposed classification of digital games (quick reaction games, logic games, educational games, strategy games, drawing games, simulators). Second, a percentage distribution of preferences was calculated. In 55.2% of the responses quick reaction games were mentioned. Children were the least likely to name games involving drawing (10.4%). Table 1 provides an overview of the frequency statistics for the six preferred types of digital games for the entire sample, and separately for each gender. The descriptive statistics for the measures of the executive functions are presented in Table 2. The Shapiro-Wilk test demonstrated that the distribution was abnormal (see Table 2). Thus, nonparametric criteria were used in further analysis.

Analysis of gender preferences of digital game types

Pearson’s chi-squared test was applied to display the differences in the preferences of digital game types between boys and girls. The results confirmed that the boys played quick reaction games (Chi-square test, $x = 26.6$, $p < 0.001$) and strategic games (Chi-square test, $x = 9.55$, $p = 0.002$) significantly more frequently than the girls (*see Table 1*). The girls preferred logic games (Chi-square test, $x = 4.65$, $p = 0.031$), educational games (Chi-square test, $x = 7.81$, $p = 0.005$), drawing games (Chi-square test, $x = 10.4$, $p = 0.001$), and simulators (Chi-square test, $x = 38.7$, $p < 0.001$) significantly more often than the boys (*see Table 1*).

The mean scores (mean values, the median, and standard deviation) in the EF tests meet the normal values for the 6—6.5-year-old preschoolers, both for girls and boys (Veraksa et al., 2020).

The analysis of the correlation between preferred digital game types and the EF skills

An intergroup comparison of the EF in children playing different types of digital games was carried out to reveal the correlation between the preferred type of digital game and the EF skills. The Mann-Whitney test was used to analyze the following six pairs: 1) quick reaction game players (n=185, 35% girls) and quick reaction game non-players (n=150, 63% girls); 2) logic

Table 1

Frequency distribution of preferred digital game types

Digital game type	Sample	Boys	Girls
	N=335	N=173	N=163
Quick reaction games	55.2%	[a]68.8%	40.7%
Logic games	28.1%	23.0%	[b]33.5%
Educational games	11.6%	6.9%	[b]16.7%
Strategic games	27.2%	[a]34.5%	19.5%
Drawing games	10.4%	5.2%	[b]15.9%
Simulators	29.5%	14.5%	[b]45.4%

Note: [a]Boys play this type of digital game significantly more frequently than girls; [b]Girls play this type of digital game significantly more frequently than boys

Table 2

Descriptive statistics for the executive functions measures

		N	Mean	Median	Standard deviation	Minimum	Maximum	Shapiro-Wilk W	Shapiro-Wilk p
MD_Content	boys	161	40.9	41	5.21	22	48	0.950	<.001
	girls	152	40.9	41.5	5.10	22	48	0.954	<.001
MD_Spatial	boys	161	20.6	21	3.55	9	24	0.856	<.001
	girls	152	20.0	21.0	3.58	7	24	0.893	<.001
MD_Bonus	boys	161	26.5	28	13.3	0	48	0.959	<.001
	girls	152	22.9	20.0	13.0	0	48	0.949	<.001
MD_Total	boys	161	88.0	89	20.3	38	120	0.966	<.001
	girls	152	83.7	81.5	19.7	42	120	0.970	0.002
SR_Sum	boys	161	19.3	19	3.39	12	31	0.967	<.001
	girls	152	19.7	20.0	3.54	11	30	0.979	0.022
DCCS_Sum	boys	163	19.9	20	2.68	13	24	0.948	<.001
	girls	173	19.7	19	2.81	12	24	0.941	<.001
Naming comb. score	boys	163	11.0	11	3.14	1	17	0.959	<.001
	girls	173	11.1	11	3.15	3	18	0.950	<.001
Inhibition comb.score	boys	163	11.1	11	3.10	4	19	0.982	0.023
	girls	173	11.2	11	2.98	4	19	0.981	0.026
Statue	boys	163	26.6	28	4.60	4	30	0.708	<.001
	girls	173	27.3	29	3.70	10	30	0.682	<.001

game players (n=95, 57% girls) and logic game non-players (n=93, 51% girls); 3) educational game players (n=39, 69% girls) and educational game non-players (n=39, 72% girls); 4) strategic game players (n=92, 34% girls) and strategic game non-players (n=93, 38% girls); 5) drawing game players (n=35, 77% girls) and drawing game non-players (n=35, 77% girls); 6) simulation game players (n=98, 74% girls) and simulation game non-players (n=97, 78% girls). The compared groups (except quick reaction game players and quick reaction game non-players) did not differ by gender, age, and the number of digital game types that children played. The quick reaction game players and non-players differed by gender. All pairs, except quick reaction game players and non-players were formed purposefully, so that for each child playing each type of digital game, a child of the same age and gender was selected from those who did not play that type of games. For quick reaction games, this procedure omitted because there were more players than the non-players.

Significant differences in visual working memory were registered for the quick reaction game players and non-players. Children who played quick reaction games showed better results in memorizing image details in the visual working memory task than children who did not play such games (Mann-Whitney test, $U = 10686.500$, $p = 0.039$; $M = 23.42$, $SD = 12.9$ for non-players; $M=26.56$, $SD = 13.7$ for players). The quick reaction game players also obtained higher total scores in visual working memory tasks than those who did not play this type of games (Mann-Whitney test, $U = 10557.500$ at $p = 0.033$; $M = 83.44$, $SD =19.17$ for non-players; $M=88.32$, $SD =20.75$ for players).

Significant differences in information processing speed were revealed for the logical game players and non-players (Naming combined score in the Inhibition test) (Mann-Whitney test, $U =3453.000$, $p = 0.009$; $M = 10.5$, $SD = 3.16$ for non-players; $M=11.7$, $SD = 2.78$ for players).

For simulation game players and simulation game non-players, significant differences were revealed as well. Children who played simulators showed significantly higher results in cognitive inhibition than those who did not play simulators (Manna-Whitney test, $U = 3727.500$, $p = 0.009$; $M = 10.58$, $SD = 2.80$ for non-players; $M=11.66$, $SD = 2.94$ for players). No significant differences were registered for other game types.

Discussion

The main goal of this work was to examine the preschoolers' preferences in digital games, and their correlation to the EF skills. Our data analysis revealed that quick reaction games were the most popular at this age. The next favourite were logic games, strategic games, and simulators. Educational games and drawing games were mentioned by the examinees much less frequently. Moreover, boys preferred quick reaction games and strategic games more often than girls, while the latter chose four other types of digital games, compared to the boys: logic games, educational games, drawing games, and simulators. The study also demonstrated quick reaction game players' visual working memory was better developed than in the non-players. We also discovered that logic game players processed information at a higher speed than the non-players. Simulation game players obtained higher score in cognitive inhibition, than the children who didn't like this type of games.

The obtained data confirms the popularity of quick reaction games (action-games, shooter games, racing games, and platform games) among present-day preschoolers. This type of games is the most widespread, and this is why its influence might be both the most noticeable and the most accessible for studying. This fact partially explains the high interest of the scientific psychological community for the analysis of action video games in the context of the EF skills' development [2]. These results coincide with the previous research data that it was the genre of action video games that was mostly related to the EF development in cognitive psychology [15; 18]. On the other hand, the obtained data complements and specifies already existing ideas about contemporary children's interests.

The gender differences discovered in the digital game preferences match our first hypothesis that boys would play quick reaction games more eagerly than the girls. This data also coincides with previously obtained information that boys tend to prefer competitive and sport games [13; 35; 55]. However, our second hypothesis assuming that girls would choose logic games above others, remained unconfirmed. Same as with the boys, of all digital game types, the girls preferred quick reaction games which may be explained by their dynamism and intensity. Yet, girls still preferred logic games more often than the boys, and in general, demonstrated more diverse play interests. These gender differences match the research data revealing that girls tend to prefer more intellectually challenging digital games [35; 55]. A higher diversity of girls' interests in regard to digital games can be related to their broader non-digital play repertoire than the one of the boys. For example, at preschool age, boys usually play with construction blocks and all kind of cars, while girls prefer puzzle games and crafts, play with stuffed toys and dolls, and enjoy "family" role play [57; 58]. Girls' more miscellaneous interests in toys ad plots in conventional play activity can be transferred to digital games as well. Besides, the revealed gender differences can be also explained by the influence of marketing. The manufacturers and the sellers of games tend to orientate boys and their parents on the games related to explorations, victories, and aggression [9]. Meanwhile, girls are offered the games based on consumer behaviour (shopping, beauty parlour, clothes, etc.), communication, demonstration of care, and intellectual development [42]. Thus, all these factors together can indeed, form the ground for the gender differences in digital game preferences.

Quick reaction game players demonstrated a higher level of visual working memory, than the non-players. The cause of these differences can derive from the very mechanism of quick reaction games and the most required and active mental functions of the players. This genre requires immediate reaction to multiple quickly moving visual stimuli [15; 18]. The child needs to quickly perceive and focus on many objects at the same time, as well as make decisions based on this information. Therefore, quick reaction games imply active engagement of visual working memory. Moreover, the differences in visual working memory scores can be related to gender differences in digital game preferences. Among children who played quick reaction games, boys prevailed (65%), while among the non-players, there were more girls (65%). However, some studies revealed that at the age of 5—7 years boys generally have a better developed visual working memory [2; 49]. The combination of these two factors can potentially explain the higher scores for visual working memory in children who played quick reaction games, compared to the non-players. Yet, more recent meta-analyses didn't reveal any gender differences in visual working memory at preschool age [62], which is why the explanation suggested above may be not sufficiently valid. Let us also note that the comparison of other groups of players didn't evidentiate any significant differences in visual working memory. Therefore, the hypothesis that higher score in visual working memory is related to the preference of quick reaction games, drawing games, and strategic games, is only partially confirmed.

The obtained results demonstrated that logic game players processed information at a higher speed than the non-players. This difference can be related to the specifics of the mechanism of logic games. They don't activate voluntary attention directly, but often imply making the decisions based on the logical analysis of the situation in the limited time conditions. Therefore, the child playing a logic game has to process a significant volume of information at the same time. For example, he/she has to analyse all possible outcomes of a certain event, and choose the most favourable. The obtained results match earlier research data that revealed that digital games could positively affect the perception speed and the speed of activation of executive attention network in children [49; 53].

Stimulation game players demonstrated a higher level of cognitive inhibition control than the non-players. This difference can also be caused by the mechanisms of this genre of games. Simulators imply taking up a play role (a pet-owner or a hairdresser) that requires performing certain role functions. This is a common feature for simulators and plot role play. In other words, in a simulation game, the child has to follow the rules and requirements of a virtual role, for example, to feed a virtual cat at the established time, and take proper care of it. Same as in plot role play, in a simulator, the child has to play up the role correctly to receive bonuses and rewards. He/she should comply with the rules and control his/her impulsive reactions. A constant obligation to follow the role pattern activates inhibitory control in children. Besides, at the age of 5—7 years, this mental function is developing most dynamically [19]. This EF component is the most sensitive to the external influence such as digital games. Another possible reason for a higher level of inhibitory control in simulator players, compared to the non-players, is related to the parental control. Simulators don't have a logical end, nor levels to complete, or any other limits, like other games featuring an end of playing session. There, you complete a mission, perform an educational task, draw something, etc. Apparently, one can play a simulation game endlessly, which means, the parents of the children preferring this genre would more probably have to be strict about their screen time. This, in turn, would contribute to the inhibitory control development. In other groups, no differences in the level of inhibitory control were registered. Therefore, the hypothesis that a higher inhibition level is related to the preference of quick reaction games, strategic games, and simulators, was only partially confirmed.

This study didn't reveal any differences in the indicators of the EF skills between the children that played strategic, educational, and drawing games, and the non-players. This was an unexpected result. However, the absence of correlation might be caused by the fact that in these games, the activation of other cognitive processes was required, rather than the classic EF components. For instance, strategic games imply an active but not an on-stream planning of the players' activity. Despite that planning is closely related to the EF development, the most popular theories see the function of planning and the EF as separate phenomena [28; 45]. Moreover, preschoolers usually use the most primitive features of strategic games that are comprehensible at their age. This relatively low level of cognitive complexity does not foment EF development. Drawing games, in turn, activate the functions related to the analysis and the transformation of images together with motor skills. Thus, visual working memory per se, is not often required for such tasks, since drawing games normally provide the sample that is accessible at any moment of time. Or, children draw freely. Educational games are aimed at the development of particular skills that are not necessarily related to the EF. Besides, the absence of connections between the digital game type and the EF development could be also caused by the insufficient number of children in some groups. In fact, there were just a few educational and drawing game players and non-players. This fact could explain the absence of the statistical differences between the groups. Thus, the obtained results reflect the need in the search for the most favourable conditions and ways of the EF skills' development in preschoolers by means of various digital games, including those normally used for mere entertainment. The question of the correlation between game preferences and other cognitive processes also arises in this context.

The lack of control of the screen time the children spent playing this or that type of the digital game appeared to be an important limitation for this study. However, it is necessary to emphasize that the homogeneity of the environment the sample came from, allows assuming of an approximately equal time the examinees spent playing games [59]. Secondly, a recent meta-analysis [25] demonstrated the absence of any significant correlation between the total screen time and the EF skills. This fact also speaks in favour of a bigger impact of the type of the game than the screen time, on the development of the EF skills. Another limitation is related to the insufficient control of the characteristics of the compared groups. When the pairs of groups were selected for the analysis, the following factors were taken in to consideration: if they played a certain type of digital game, or not; gender and age composition, and the number of other types of digital games the children played. However, other types of the games played by the participants were not controlled. Furthermore, there weren't enough preschoolers playing one particular type of game to perform a reliable statistical analysis. The sample didn't include the children who didn't play any digital games, either. The analysis of the interviews revealed that some games were not easy to categorize definitively, since they possessed the features of two or more types. Last but not least, this study was also limited in the sense that its results only allow the conclusion about the correlation between the preferred digital game and the EF development, but not about any cause-and-effect connections. On the one hand, playing a certain type of digital games can indeed determine a higher level of EF development. On the other hand, a certain level of development of different EF components can also determine children's game preferences.

Further research could be potentially focused on the sample extension to provide the data for a more reliable statistical analysis of the players and non-players of certain games. More research parameters should be controlled, too. Besides, the amplification of the diagnostic toolkit will allow gathering more complete and systemic date about the digital preferences of present-day preschoolers.

Conclusion

This study suggested a classification of digital games based on the children's reports about their preferences. This classification was designed considering the mechanism and the most actively engaged mental functions of the players. Digital game preferences of present-day preschoolers were defined, as well as their correlation to the EF skills. The suggested classification and the obtained data can be of avail to the end of further research aimed at the definition of the most favourable conditions of digital devises' use. It can also benefit to the preschoolers' parents and kindergarten educators, since the adult's participation is fundamental for the EF skills' development by means of digital games. Adults should choose the game together with children, take part in it, and discuss it. The results obtained in this study can be also applied by adults to purposefully select the most efficient games for children's development and preparation for school.

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