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Computer games as a subject of psychological research – negative and positive aspects of gaming¹

Abstract

Computer games are an interactive form of entertainment that is popular with younger and younger players. Therefore researchers are actively seeking information on the consequences of pursuing this type of pastime. At the beginning, the researchers' attention was focused mainly on the negative aspects of gaming. Nowadays, more and more benefits related to this activity are being indicated. In 2014, Granic, Lobel and Engels published an article on the benefits of playing computer games. The researchers focused on four areas: cognitive, motivational, emotional, and social. They wanted to inspire new research on mental health benefits of gaming by pointing to various research reports they selected. This paper aims to present the research directions explored in recent years by researchers who strive to describe the positive and negative consequences of gaming. I present the main directions and examples of research in these areas, highlighting the ambiguity of the current results. Problematic areas related to gaming include aggression and violence, addiction, weakening of social relations, experiencing undesirable emotions, sexualization, racial prejudice, and racial discrimination. The indicated opportunities and benefits are the strengthening of cognitive, motor, emotional, and social competences.

Keywords: computer games, video games, player, negative and positive aspects, advantages and disadvantages

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The provision of entertainment is the primary function of computer games (Ritterfeld & Weber 2006; Halim, Fazal-ur-Rehman & Baig, 2010), and their audience is made up of users of all ages. Increasingly younger children are turning to computer games. In the UK, children aged 3–4 years spend around 6 hours and 12 minutes per week on gaming, while adolescents aged 12–15 years spend around 13 hours 45 minutes on this activity (Ofcom 2018). Sălceanu (2014) established that half of the Romanian parents surveyed allowed their children to spend 1–2 hours a day playing games, while 28% of these parents agreed to 3–4 hours. Almost one in three teenagers in Poland plays computer games four times a week or more frequently (Bójko, Dzielska, Mazur & Oblacińska, 2019). Given the fact that computer games are an important form of leisure activity for increasingly younger individuals, researchers are actively seeking information on the consequences of pursuing this type of pastime. In the late 1980s and early 1990s, their focus was on the detrimental consequences of gaming, especially in the context of children and adolescents. Nowadays, the positive aspects of gaming are being highlighted more and more often (Granic, Lobel & Engels, 2014). This paper aims to demonstrate both the negative and positive aspects of the activity of gaming.

Negative phenomena associated with gaming

Aggression and violence

One of the most frequently described negative phenomena is the occurrence of aggression and violence in some computer games. These games are regularly called violent games by researchers (e.g., Barlett et al., 2009; Arriaga, Monteiro & Esteves, 2011; Burkhardt & Lenhard, 2022), but the term might be unclear. It refers to the violent content of these games, specifically to the fact that the players are exposed to that content (and, as a result, engage in violent acts themselves). The results of a series of studies confirm the hypothesis that playing computer games which feature violence is associated with the presence of aggression in players. Violent games aggravate violent behavior (Greitemeyer & Mügge, 2014) while increasing physiological arousal and aggression-related thoughts and emotions (Anderson & Bushman, 2001). Enthusiasts of violent computer games are prone to inflicting heavier punishment (Bartholow & Anderson, 2002) and display higher levels of hostility (Arriaga, Esteves, Carneiro & Monteiro, 2006) and higher levels of emotional desensitization (Arriaga, Monteiro & Esteves, 2011). Bluemke, Friedrich and Zumbach (2010) found that those who played a violent game for five minutes exhibited higher levels of aggressiveness than those who played a peaceful game for the same period of time. The researchers emphasized that both types of games elicited similar levels of arousal, although they varied in content. Therefore, in

their view, it was the element of violence that was the explanatory factor for these changes. Burkhardt and Lenhard (2022) conducted a meta-analysis of 30 effect sizes from 21 studies and discovered a positive effect of violent video games on aggressive behavior. Similar conclusions were reached by Addo, Fang, Kulbo et al. (2021), who collected data from over 3,000 young adults. Other studies suggest that not only playing but also watching someone else play can lead to an increase in aggressive thoughts and behaviors. The researchers, however, have opposing views on which of these two activities produces the greater effect. Cooper and Mackie (1986) and Silvern and Williamson (1987) identified comparable increases in aggression in both players and observers. In contrast, Zhang, Cao and Tian (2021) indicated that it was active gaming that gave rise to greater levels of aggression. Mathur and VanderWeele (2019) found that most studies confirmed a statistically significant relationship between gaming violence and violent player behavior, but the effects were usually small.

Therefore, the correlation between violent games and aggressive behaviors, thoughts, and emotions is quite problematic. Firstly, not all scientific findings support the hypothesis under analysis. For instance, Winkel, Novak, and Hopson (1987) and Hawk and Ridge (2021) stated that game content did not affect the aggressive behavior of study participants, while Fleming and Rickwood (2001) failed to identify a connection between playing violent games and the players' aggressive mood. Tear and Nielsen (2013) also failed to support the hypothesis that playing violent games diminished prosocial behavior. The researchers focused on three games which in a pilot study received similar ratings in terms of interest, frustration, and arousal. The games varied only in their content: one game contained violence, one displayed prosocial behavior, and the third game featured neither. No differences in prosocial behavior, however, were noted by the researchers when the experimenter accidentally dropped a pen. Secondly, some researchers point to the potential role of other factors. Having analyzed more than 400 scientific articles, Bushman and Huesmann (2006) concluded that the short-term effects that were observed in studies on violence in the media resulted from encoded scripts, schemas, or beliefs, rather than from direct exposure to the media. Zheng and Zhang (2016) additionally pointed to the crucial role of gender and trait aggressiveness. The strength of interdependence between violent games and aggressiveness is also related to the identification process – the stronger it is, the more the player identifies with a violent character (Konijn, Nije Bijvank & Bushman, 2007). More recent research also does not confirm a direct effect of games on aggression. Ferguson and Wang (2019) determined that a player would need to play 27 hours a day to produce significant changes in aggression. The lack of such a relationship was also indicated by Przybylski and Weinstein (2019), who analyzed data from over a thousand British adolescents.

Although the number of results available is large, their interpretation and generalization is hampered by the fact that very different games are used in the studies. Combs (2010) found, however, that the genre of the game was directly related to violent acts and words, the number of weapons, and total violent content. Aleissa, Alenezi, Saleheen et al. (2022) analyzed the relationship between the type of computer games played and aggressive behavior in adolescents. Adolescents who preferred action games had higher levels of verbal and physical aggression. Playing adventure games was associated with higher physical aggression, anger, hostility, and verbal aggression scores. Adolescents who chose simulation games had higher levels of verbal aggressiveness, and those who played sports games had higher levels of anger and physical aggression. Strategy/puzzle games were associated with higher levels of anger, hostility, and verbal aggression. Although this study showed some relationships between the type of games and aggressive behavior in players, it did not answer the question about the impact of game types on the aggression level of the study participants. In another study, Dickmeis and Roe (2019) showed that self-reported physical aggression correlated positively with fighting and online shooter games (both characterized as high-violence and high-competitiveness) and negatively with simulation games (characterized as low-violence and low-competitiveness). Therefore, it seems reasonable to assume that the game genre should be an important variable considered by researchers of the relationship between aggression in the game and aggressive behavior of players.

A particular type of aggression that players are exposed to is aggression from other players in multiplayer games. For example, Fortim and de Moura Grando (2013) found that 16% of female players in their study experienced some sort of aggressive sexual behavior. Similarly, Callou, Bezerra, dos Santos Moreira et al. (2021) found that women experienced verbal aggression, insults, and humiliation in games. This data comes from interviews with 13 female players. Due to the small number of respondents, it is not possible to generalize these conclusions, but they can be the basis for generating new hypotheses. Additionally, there is not much data on how players (mainly women) react to different types of aggression. This is a gap that should be filled by further research. However, it should be emphasized that aggression or violence on part of another player is a different phenomenon than the violent content of the game (as aggression by players can be independent of the game content).

To sum up, the results regarding the impact of aggression in computer games on player aggression are ambiguous. Many studies have been carried out in this area, which demonstrate both the existence and non-existence of such an effect. Several meta-analyses have been conducted, but sometimes they take into account completely different studies, so it is difficult to compare their conclusions. It seems that the answer to the question about the impact of aggression in computer

games on the player's aggression requires further, even more thorough research, for example, taking into account the game genre or choosing even more precise criteria for meta-analysis.

Addiction to computer games

Another negative phenomenon associated with playing computer games is the excessively frequent indulgence in this activity. The DSM-5 (APA 2013) diagnosis of the Internet gaming disorder (IGD) qualifies it as a disorder that deserves further analysis. This means that this phenomenon necessitates further theoretical and empirical research. At present, DSM-5 describes the following symptoms: preoccupation with video games, withdrawal symptoms when gaming is not possible, increased level of tolerance (there is a need to spend increasingly more time playing games to satisfy the gaming urge), inability to or unsuccessful attempts to quit gaming, loss of interest in other activities, continuing to play games despite negative consequences, deceiving others about the amount of time spent on gaming, using gaming to cope with low moods, entertaining the risk of damaging one's relationship or the risk of losing one's job due to gaming. The World Health Organization, which has developed the latest International Statistical Classification of Diseases and Health Problems – ICD 11 (World Health Organization 2018), also defines the gaming disorder. It is characterized as a pattern of persistent or recurrent behavior linked to playing online and offline games where the player has impaired control over gaming (for example, its frequency and intensity), gives higher priority to gaming rather than to other interests and daily activities, and continues to play or escalates gaming despite the occurrence of negative consequences. Although DSM-5 does not yet include the gaming disorder in the main section of the manual, and the WHO introduced this disorder only several years ago, the results of the research conducted so far support the premise that the problem of addiction also applies to computer players.

Some researchers determined that the gaming disorder was a serious issue. For example, Grüsser, Thalemann and Griffiths (2006) collected data from over seven thousand players and discovered that over ten percent of their respondents met three or more criteria for addiction. Symptoms of video game addiction were also highlighted by Chappell, Eatough, Davies and Griffiths (2006) as well as by Van Den Eijnden, Koning, Doornwaard Van Gorp and Ter Bogt (2018). The first team of researchers noted withdrawal symptoms and mood changes, while the second team identified decreased psychosocial wellbeing and deteriorating academic performance in adolescents. However, it is difficult to compare these results, especially since researchers adopted different game addiction operationalizations and methodologies (online questionnaire; interpretative phenomenological analysis: IPA; IGD scale). Researchers are also looking for factors

that are associated with addiction. By way of example, Green, Delfabbro, and King (2020) noted that poor self-concept among players was a risk factor, especially for games that facilitated role-playing and identity formation. Wang, Ho, Chan and Tse (2015) focused on the role of personality, linking gaming addiction with low conscientiousness and low openness to experience.

Some researchers link the gaming disorder with loot boxes, the keys to which players collect or (more often) purchase (though without money being directly involved; Yokomitsu et al., 2021). These are boxes with valuable, but unknown, random items that enhance gameplay (Macey & Hamari, 2022). Due to the payment for keys and the randomness of items, some researchers identify loot boxes as a form of gambling (King, 2018; Macey & Hamari, 2022). This use of simulated (non-financial) gambling elements is called gambification. The term means the introduction of gambling mechanics to the digital world, including computer games (Hing, Russell, King et al., 2023). While researchers do not deny the possibility that gambification can lead to positive effects (e.g., promoting certain behaviors), they tend to focus on the negative consequences (Macey & Hamari, 2022). It should also be noted that through loot boxes game developers generate profits from released (often) free games (King, 2018).

It should be emphasized, however, that despite efforts to describe computer game addiction and the gaming disorder, many issues remain imprecise. Aarseth et al. (2017) argued that the gaming disorder included in the ICD-11 should be removed until the basic matters were resolved, such as: low quality of gaming disorder research, poor operationalization referring too much to the substance use and gambling criteria, or the lack of consistent criteria for the disorder. Similarly, Kuss, Griffiths and Pontes (2017) pointed to the weaknesses of the Internet gaming disorder criteria described in the DSM-5 (e.g., the possibility to diagnose IGD based on offline games), but they maintained that problematic gaming existed and could be considered as an example of disordered gaming (Griffiths, Kuss, Lopez-Fernandez & Pontes, 2017). Despite the growing number of studies on gaming addiction, van Rooij, Ferguson, Colder Carras et al. (2018) emphasized that there were still too few of them to talk about a formal diagnosis. The researchers agreed that there were people whose life problems were related to gaming, but this was not enough to talk about a formal gaming disorder. According to them, further research evidence was needed. Due to the controversy surrounding the gaming disorder, the research presented above should be interpreted with caution.

To sum up, the problem of addiction to computer games is extremely complex. Not all researchers agree that the gaming disorder really exists, and those who study it define and measure it in different ways. These researchers who study the gaming disorder indicate that players experience negative effects from excessive gaming and require clinical intervention.

Weakening of social relations

Impaired social relations are also considered to be the adverse consequences of gaming. Both players and those around them point to this particular aspect. The players' perspective became the topic of a paper published by Kowert, Domahidi, Festl and Quandt (2014). The researchers established that those who often played online games had a smaller circle of friends and the relations they had with these friends were of worse quality. The perspective of individuals who form social relationships with players was analyzed by Van Schie and Wiegman (1997). Their studies confirmed that children who played computer games frequently were rated as socially inactive by their peers. The reduction in the number of relationships and the deterioration of social relations are particularly evident in computer game addicts (Zamani, Kheradmand, Cheshmi, Abedi & Hedayati, 2010).

The number of studies on the negative impact of computer games on social relations is small. Given the importance of social relationships in life, research in this area should be developed.

Experiencing undesirable emotions

Experiencing undesirable emotions is yet another detrimental aspect of gaming. Computer games provide players with a wide range of feelings. Bringula, Lugtu and Aviles (2015) established that these included happiness, excitement, and delight, but also anxiety, irritation, and stress. Such a wide range of emotions can be elicited by both a variety of in-game experiences (Van Reekum, Johnstone, Banse et al., 2004) and the game design itself, such as the colors used (Joosten, Van Lankveld & Spronck, 2010). Anger and fear are mentioned by players as some of the undesirable emotions experienced. They are related to a diversity of factors. One such factor is the duration and frequency of gaming. The longer and the more often people play, the greater the anger (Demirok, Ozdamli, Hursen et al., 2012) and fear (Shokouhi-Moghaddam, Khezri-Moghadam, Javanmard et al., 2013), as well as anxiety and stress (Bringula, Lugtu & Aviles, 2015) they feel. Another factor linked to playing computer games is their content, and primarily their violent storylines. Baldaro, Tuozi, Codispoti et al. (2004) observed a significant increase in anxiety in respondents who played a violent game. The researchers, however, pointed to a vital limitation of their research, which was the varying levels of intellectual stimulation, competitiveness, or excitement in the game. There is also a sense of hostility in enthusiasts of violent games, as confirmed by Arriaga, Esteves, Carneira and Monteiro (2006) and by Hasan, Bègue, Scharkow and Bushman (2013). Such feelings of hostility during a game may be more powerful than during face-to-face contact with another person (Williams & Clippinger, 2002). Frustration is yet another feeling experienced by players. It results from having to wait for the game

to load, the need to pause the game mid-play, or from losing and having to start from the beginning (Colwell, 2007).

Several studies have shown that players may experience undesirable emotions, and their source may be both the design of the game and its content or gameplay-related factors. In order to confirm or deny such a relationship, it is necessary to conduct more research that will be free of existing limitations, such as different levels of intellectual stimulation in games.

Avatar sexualization

One of the negative phenomena linked to the creation of one's own character in a game is the sexualization of avatars. The Task Force on the Sexualization of Girls of the American Psychological Association (2010) points to four phenomena when defining sexualization: treating sexual attractiveness as the sole determinant of a person's worth; equating physical attractiveness with being sexy; taking away an individual's ability to make decisions and treating them only as an object that can be sexually exploited; sexuality being inappropriately imposed upon an individual.

The sexualization of avatars and its consequences have been discussed in numerous research papers. In Behm-Morawitz and Mastro's (2009) study, both female and male students played a game with either a sexualized or non-sexualized protagonist. Based on the data obtained, the researchers put forward a hypothesis that playing a sexualized female character affected people's beliefs about women in the real world. Moreover, female study participants playing such an avatar had a lower sense of self-efficacy. An even higher degree of sexualization – hypersexualism – was the subject of a study conducted by Reinhard (2009). The researcher tested the reactions of men and women to female avatars represented in a hypersexualized manner. Such avatars had large breasts, a narrow waist, and long legs. Only female participants in the study (not the male participants) were more engaged in the game when they used hypersexualized avatars.

One of the identified consequences of sexualization may be self-objectification – perceiving oneself through the lens of physical appearance while ignoring personality traits (Fredrickson & Roberts, 1997). Vandenbosch, Driesmans, Trekels, and Eggermont (2017) put forward a conjecture that adolescents who chose a sexualized avatar manifested a higher level of self-objectification than those whose characters were not sexualized. The researchers established that sexualized avatars displayed a link with self-objectification in both young girls and boys, regardless of whether they used a male or female character. Similar results were obtained by Fox, Bailenson and Tricase (2013). In their study, virtual

reality goggles were used to immerse women in a virtual world. Women choosing sexualized avatars presented more body-related thoughts than women who used non-sexualized avatars. In the opinion of the authors, these results supported the hypothesis that sexualized avatars led to objectification. Moreover, women who were presented with sexualized avatars, especially ones with faces, showed greater acceptance of myths related to rape, such as the one which lays the blame for rape on women. As it was unfeasible to generalize these results because of the very specific and complex technique used, too different from the virtual worlds available to average users, other researchers made an attempt to replicate these results in a less immersive virtual environment – *Second Life* (Fox, Ralston, Cooper & Jones, 2015). In this study contact with a sexualized avatar was indeed associated with the feeling of self-objectification, irrespective of whether the character was watched or controlled. Additionally the authors confirmed the impact of self-objectification on the correlation between avatar sexualization and the acceptance of a rape myth. Comparable conclusions were reached by Beck, Boys, Rose, and Beck (2012) as well as by Driesmans, Vandenbosch and Eggermont (2015). The first team established that exposure to female sexual objectification and violence against women led to increased acceptance of rape myths in men. The second team noted that teenagers who played a sexualized character showed greater tolerance of sexual harassment and greater acceptance of rape myths.

Another damaging effect of sexualization is the experience of unwanted behavior online. Behm-Morawitz and Schipper (2016) searched for a link connecting avatar gender with sexualization and cyber-harassment. They noted that female avatar owners were more likely to experience sexual harassment than male avatar owners. No differences were identified between women with more and less sexualized avatars in relation to cyber-harassment on the whole; however, its specific form – sexual harassment – was found to be considerably more frequent in the case of female avatar owners. The latter were also more likely to receive obscene comments. No correlations were found for male avatars. A link between sexualized avatars and sexual harassment was also demonstrated by Burnay, Bushman and Larøio (2019). After the game was over, subjects were presented with two jokes each – two sexist jokes first, followed by one sexist joke and one non-sexist joke – and they were asked to specify which one they would send to their partner. Men using a sexualized avatar sent more sexist text messages to women.

In conclusion, sexualization is still present in computer games, even if it is less marked today than it was several decades ago. Both male and female players experience it. Sexualization leads to such negative effects as self-objectification and acceptance of the rape myth.

Racial prejudice and racial discrimination

Racial prejudice is an antipathetic attitude towards people belonging to a particular racial group, based upon a faulty and inflexible generalization (Allport, 1954). Racial prejudice may lead to racial discrimination, which stands for the unequal treatment of people because of the racial group they belong to (Pettigrew & Taylor, 2000). Yang, Gibson, Lueke, Huesmann and Bushman (2014) conducted two experiments in which they tested the effects of playing a White or Black avatar in a violent game on players' racial stereotypes and aggression. The researchers concluded that playing a Black avatar causes greater aggression than playing a White avatar. Moreover, this also reinforces stereotypes that Black people are aggressive. The relationship between racial prejudice and discrimination and computer games is not often analyzed by researchers, and it requires additional attention.

Positive aspects of playing computer games

Cognitive processes

Computer games can serve to improve human cognitive functioning. With a view of determining their potential, scientists analyze various aspects of games and the gaming process itself. One such aspect is the type of games. According to Zelinski and Reyes (2009), shooter games improve visual attention and response speed, while strategy and role-playing games train working memory and long-term memory retrieval. Another type of games – action games – was described by Bediou, Adams, Mayer et al. (2018). The researchers performed a meta-analysis of the results presented between 2000 and 2015. They demonstrated the impact of action games on attention processes, spatial cognition, and player's perception (although for the latter, these are only preliminary results). However, the researchers pointed out that further analyses were necessary – ones that would involve more subjects, more experimental studies, and longer training times. Another team of scientists analyzed simulation games. Pillay, Brownlee and Wilss (1999) carried out a test of a flight simulator in the game entitled *Pilot Wings*. They concluded that completing all the tasks required players to activate complex cognitive processes such as inductive reasoning, data analysis, problem-solving, and interpretation of explicit and implicit information. A slightly different approach was presented by Barlett, Vowels, Shanteau, Crow and Miller (2009). They did not look at the type of the game but its content. They established that both violent and non-violent games increased cognitive competence in the subjects. At the same time, they emphasized that the games differed in terms of the amount of action, the required level of focus, and their appeal.

Another perspective on data analysis concerns the positioning of respondents on the player/non-player continuum. Researchers compare the results of those who say they play computer games (with some frequency) with the results of those who say they do not play games at all. By way of example, Boot, Kramer, Simons, Fabiani and Gratton (2008) demonstrated differences between players and non-players in their attention and perception skills, their memory, task-switching, and mental rotation ability. Players achieved better results in all these areas. A similar pattern was observed by Colzato, van den Wildenberg, Zmigrod and Hommel (2013) with respect to working memory. It was the computer game players who were faster and more accurate in monitoring and updating information.

Another method of data analysis is linked to the number of cognitive abilities subject to research. Many of the studies discussed above focused on the correlation of computer games and various cognitive abilities. In contrast, the results of studies concerning single abilities will be presented below, these abilities being attention, mental rotation, thinking and reasoning, mathematical skills, and reading and writing. Learning processes and motivation will also be considered.

Attention

Attention is one of the fundamental cognitive competences. Dye, Green and Bavelier (2009) indicated that players had enhanced attention skills, allowing them to react faster during gameplay and enabling them to better allocate their attention for other tasks. However, differences between cognitive abilities in this particular area in players and non-players were also present outside the context of computer games. Donohue, Woldorff and Mitroff (2010) determined that players were better than non-players in processing information arriving simultaneously in different modalities, such as visual and auditory. The advantage of the players was evident both in the correctness of their answers and in their faster reaction time. By way of illustration, Green and Bavelier (2006) demonstrated that players achieved better results than non-players in tasks employing flankers (Eriksen & Eriksen, 1974). The tasks required the respondents to indicate which shape appeared in one of six circles visible on the screen. The procedure required ignoring shapes that appeared elsewhere. Players achieved better scores when the figures were presented both centrally and peripherally. In a study by Castel, Pratt, and Drummond (2005), players and non-players achieved similar results in regard to inhibitory processes, but their reaction times were different. Although both groups achieved similar correctness rates, the players had faster reaction times. The advantage of players over non-players in their attention skills was also demonstrated by Yuji (1996). The children participating in the study had to decide whether the second image was the same as the first by pressing an appropriate button. Children who played

computer games made fewer mistakes and had quicker reaction times than non-playing children.

Such promising results concerning the attention mechanism in players constitute a starting point for training suggested by researchers. On the one hand, this type of training develops attention processes in a healthy population. A training program of this type was developed by Larose, Gagnon, Ferland and Pépin (1989). This twelve-hour program, developed for children with attention difficulties, was based on playing computer games. The scientists confirmed its effectiveness – they noted an improvement in searching through a visual field in members of the experimental group (compared to the control group). At the same time, similar tools are used in the clinical field. The findings of Green and Bavelier (2007) and Achtman, Green, and Bavelier (2008) support the argument for the role of computer games in visual rehabilitation.

Mental rotation

Another aspect that is of interest to researchers is mental rotation (Shepard & Metzler, 1971). The ability to create a mental representation of a specific object and manipulate it in space is related to the graphics used in games: in 2D or 3D form. Gecu and Cagiltay (2015) determined that players of 3D games were more successful at making mental rotations than 2D game players and non-players. However, both types of games were found to improve this particular skill. Cherney (2008) established that both 2D and 3D games could be an effective training tool when learning how to make mental rotations. In her study, participants played a 3D racing game or a 2D version of *Tetris*. The control group was assigned with solving paper versions of puzzles such as sudoku. Members of the experimental group improved their effectiveness of mental rotations when compared to the control group. Also, De Lisi and Wolford (2002) corroborated the role of computer games in improving this specific ability in children. The young respondents participated in eleven sessions that lasted 30 minutes each, which they described as enjoyable.

Thinking and reasoning

Thinking and reasoning is yet another process that is the subject of research of cognitive psychologists. One study showed that players and non-players assumed diverse problem-solving strategies. The former were more likely to use thinking by analogy, while the latter chose the trial-and-error method (Hong & Liu, 2003). Moreover, the results of many studies support the hypothesis that playing computer games improves the respondents' competences in different styles of

thinking. Chakravarti and Chakravarti (2015) noted greater improvements in logical thinking and critical analysis skills in those subjects who played computer games (compared to those who did not). Another type of thinking – computational thinking – became the focus of studies carried out by Zhao and Shute (2019). The researchers used the game *Penguin Go*, whose story is based on the breeding behavior of emperor penguins. The players were tasked with guiding a penguin through a particular area by programming its subsequent steps. The program was developed based on a selection of specific commands, such as “move forward”, “turn around”, “waddle”, and deciding on the correct order of these commands. In order to achieve the objective of the game, the study participants had to use their skills linked to algorithmic thinking, conditional logic, and debugging. The researchers observed that the game had a positive effect on the study participants’ computational thinking. Bottino, Ferlino, Ott and Tavella (2007) focused on the relationship between playing computer games and strategic thinking. The participants in the study, aged 7–8 and 9–10, were divided into three groups: with excellent, average, and poor academic achievements. Each group was assigned computer games with the appropriate cognitive load. The researchers noted that pupils from classes participating in the experiment scored better in strategic thinking than those from the remaining classes.

Analyzing the positive consequences of playing computer games, researchers focused the most on the improvement of cognitive skills. Their results are very promising, although researchers are aware of the limitations of their research. It seems that the relationship between computer games and the improvement of cognitive functions is one of the best documented positive consequences of gaming.

Mathematical skills, reading and writing

Knowledge of mathematics is one of the core competences acquired by children in school. Mathematical education can be more attractive and also more effective thanks to computer games. This premise was confirmed by Kebritchi, Hirumi and Bai (2010). Teenagers assigned to an experimental group participated in lessons that were enhanced with mathematical computer games. In the control group, lessons were conducted in a conventional manner. The researchers observed a significant improvement in the performance of students from the experimental group (compared to the control group). In post-study interviews, students explained that they found the games appealing because of the combination of mathematics, problem-solving, and shooting. The potential for exploration and the adventurous character of the game were defined as positive aspects of this form of learning. Teachers, in turn, emphasized that the process of moving away

from the traditional “paper-pencil” form of education changed the way students viewed mathematics.

Computer games are also considered a tool that can make it possible to equalize educational opportunities. The first group that can benefit from this form of education are children of low socioeconomic status. Aunio and Mononenn (2018) used games to improve numeracy (and reading in the other group). 33 children were assigned to an intervention group and two control groups. Children with low socioeconomic status improved their counting ability, but the differences between groups were not statistically significant. The second group which can benefit from this type of support are children with difficulties in learning maths. Räsänen, Salminen, Wilson, Aunio and Dehaene (2009) compared the performance of children who found it difficult to learn how to count and took part in training using computer games with the performance of children who had average results in mathematics. It was established that students in the first group ultimately performed better than those in the second group.

The learning of reading and writing is yet another vital area of education. As in the case of mathematics, computer games can support conventional forms of education also in this regard. Schmitt, Hurwitz, Duel and Linebarger (2018) carried out a literacy assessment in two groups of preschool children. Some of these children played computer games which aimed to improve their reading and writing abilities. During that time, the other half played computer games that focused on problem-solving skills. The researchers determined that children from the first group scored better on lowercase letter identification, letter-sound awareness, letter-sound fluency, letter sequencing, alliteration and phonics (linking letters to sounds), vocabulary, and overall literacy. The potential of computer games can also be used at higher levels of education. Franceschini, Bertoni, Ronconi et al. (2015) posited that by improving cognitive processes (including auditory, visual, and visuospatial attention) through action games, it was possible to improve reading skills in children with dyslexia.

In summary, several studies have explored the potential role of computer games in learning math, reading and writing. Firm conclusions cannot be drawn because the number of these studies is too small, and because too few children participated in most studies. However, a hypothesis indicating the potential of computer games in acquiring these skills can be put forward.

Learning processes and motivation

Learning processes and motivation should also be listed as another area of interest to researchers. O’Neil, Wainess, and Baker (2005) emphasized that although the potential role of games in education was undeniable, the available empirical evidence

supporting this thesis was still insufficient. At the same time, the use of computer games in the educational process might lead to more effective learning than in the case of traditional lessons. The two studies conducted in this area were linked to history and geography lessons. Huizenga, Admiraal, Akkerman, and ten Dam (2007) used the game entitled *Frequency 1550* to teach children about medieval Amsterdam. The researchers divided twenty elementary school classrooms into two groups. The first group played a game and the second group learned the history of the city in a conventional way. The game-playing students achieved higher grades in tests than the control group. A similar research premise was employed by Tüzün, Yılmaz-Soylu, Karakuş, İnal and Kızılkaya (2009) when testing the acquisition of knowledge about continents. Students played a computer game for a period of three weeks. Their task was to return children lost in Turkey to their countries of origin. The game included information on seven continents and twenty countries. The researchers noted an increase in the knowledge of children after the study was completed; however, they emphasized that the study was conducted on a small sample ($n = 17$).

Computer games can also be used as a tool to motivate pupils. On the one hand, researchers highlight the motivation of pupils to attend classes. Rosas, Nussbaum, Cumsille et al. (2003) demonstrated that computer games could be used as a motivator to encourage better attendance and punctuality. They based their conclusions on the results of over 1,200 students. On the other hand, computer games provide a tool that can motivate pupils to study. Tüzün, Yılmaz-Soylu, Karakuş, et al. (2009) noted that the use of computer games in education increased intrinsic motivation and decreased extrinsic motivation in school kids. Papastergiou (2009) decided to test the motivation of pupils to learn by means of a game. Two applications were developed for the project. The *LearnMem1* application was a game in which students encountered rooms arranged in the shape of a labyrinth, and in *LearnMem2* the player gained the same knowledge, but it was presented in thematic blocks and practised using an interactive quiz. Pupils agreed that the application with the game gave them greater motivation to learn than the one without the game.

In conclusion, some researchers discuss the use of computer games to strengthen motivation and improve learning in students. Preliminary conclusions point to the positive role of games in this respect, but it needs to be investigated in a more thorough way (for example by increasing the number of study participants).

Motor skills

Another aspect on which computer game researchers like to focus is motor skills. The first area of research concerns a healthy population of players and non-players. Borecki, Tolstych, and Pokorski (2012) compared motor skills in 30 players of *Counter*

Strike (where they take on the role of soldiers on the battlefield) and 30 individuals who never played computer games. Players were shown to have much more accurate hand movements than non-players. They performed motor tasks faster and made fewer errors. The second area of research involves clinical populations (people who have some degree of mental or physical conditions). Some researchers focus on stimulating motor development in those children in whom it has been observed to be delayed or impaired. Page, Barrington, Edwards, and Barnett (2017) and Hickman, Popescu, Manzanares et al. (2017) carried out a review of the literature on this topic. The first team of researchers noted that the use of computer games led to significant improvements in most of the studies described. The conclusions made by the other team also attested to the effectiveness of this training method. The researchers underlined, however, that the samples under analysis were limited, and additionally there was a problem with therapy individualization. Patients with Parkinson's disease are another example of a clinical population. In this case, gaming consoles are used more often than computers. This results from the fact that they are fitted with a motion sensor, making it possible to recognize the patient's movements. This function was used by Grunert, Krause, Feig et al. (2019), who developed a game centered around basketball. The player is required to accurately throw the ball into the basket, which forces the player to maintain a specific body posture. Thanks to motion sensors, the body posture is registered, and the player receives feedback on whether it is correct. The game was tested in a pilot study by 15 patients, who assessed it as a positive support tool in rehabilitation.

In summary, the results of research on the positive impact of games on motor skills are promising, but the methodology of further research should be substantially improved (primarily through a larger number of study participants) in order to enable more precise and accurate conclusions.

Emotional competence

Emotional competence is next on the list of phenomena connected to gaming. In one study players tended to turn to games after having experienced a stressful situation, and the relief felt was a vital element of the gaming experience (Reinecke, 2009). The correlation between computer games and emotional competence was observed at both the neural and behavioral levels. Pallavicini, Ferrari and Mantovani (2018) performed a meta-analysis of data in this area. The researchers identified five research articles which concluded that playing computer games induced changes in the brain related to facial expression processing (Bailey & West, 2013), influenced positive emotional responses (Naugle, Naugle & Wikstrom, 2014), and could support stress management training (Bouchard, Bernier, Boivin,

Morin & Robillard, 2012; Dennis & O'Toole, 2014; Dennis-Tiwary, Egan, Babkirk & Denefrio, 2016).

In conclusion, a few studies have been devoted to the relationship between computer games and emotional competence. They show that games have the potential to improve this competence in players, but further research is needed in this area.

Social competence

The study of the relationship between games and social competence encompasses an entire tradition of researching prosocial behaviors. Many such analyses support a hypothesis about the correlation between prosocial games and prosocial behaviors. Greitemeyer and Osswald (2010) conducted four experiments in which subjects played a game with prosocial, violent, or neutral behaviors. It was confirmed that players from the first group (playing the prosocial game) were more willing to help the experimenter pick up his scattered pencils, keener to participate in another (unpaid) experiment, and more likely to help the experimenter who was being harassed. Between 36 and 54 subjects participated in these studies. Greitemeyer and Mügge (2014) came to similar conclusions. The researchers analyzed 98 studies and found that prosocial games influenced people to take prosocial actions. According to Saleem, Anderson and Gentile (2012), prosocial games are not only linked to prosocial behaviors but also to a decreased likelihood of aggressive behavior. However, according to Ferguson and Garza (2011), the occurrence of prosocial behaviors only takes place online. Their deduction is based on their observations of over a thousand adolescent players eagerly helping other players in a game but being less willing to help within their communities.

In MMORPGs (massively multiplayer online role-playing games), players learn how to meet people and how to build relationships and satisfying collaborations with those they meet (Ducheneaut & Moore, 2005). Seniors use such games as places where they can seek and maintain social connections (Zhang & Kaufman, 2016). Trepte, Reinecke and Juechems (2012) used an online survey and demonstrated that online games could be a source of strong social ties if they are continued in both online and offline worlds. However, this task is challenging when it comes to seniors (Zhang & Kaufman, 2017). Based on online survey data from over four hundred MMORPG players, Utz, Jonas, and Tonkens (2012) found that time spent playing games was positively correlated with the number and quality of online relationships, but it was negatively correlated with the number and quality of offline relationships.

Computer games can also be used to shape social competence in people who display its shortage. Based on testimonies posted by players on the blog created in

2011 by Ashly Burch, Lorentz (2014) emphasized that computer games provided a space suitable for social experimentation. This is particularly important for children on the autism spectrum (Piper, O'Brien, Morris & Winograd, 2006). Thanks to computer games, they can learn such primary skills as recognizing faces (Tanaka, Wolf, Klaiman, et al., 2010) and people (Rias & Dehkordi, 2013), or maintaining eye contact (Bartolome, Zorrilla & Zapirain, 2013). However, these conclusions are based on small populations [e.g., 6 people in the study by Rias & Dehkordi (2013)] or predictions (Bartolome, Zorrilla & Zapirain, 2013).

In conclusion, the researchers argue that computer games can develop social skills. They pay particular attention to multiplayer games. Many of the presented results have been obtained through online surveys. It is therefore necessary to plan further research using actual computer games to assess their effectiveness in developing social competences. Researchers also see the potential of computer games in developing social skills in children with autism spectrum disorders, but there is too little research in this area and the data come from only a few children.

Conclusion

Computer games are an increasingly popular form of entertainment. Initially, researches focused mainly on the negative consequences of gaming. The most frequently quoted effect was the increase in aggression and violence levels in players. There is evidence which links aggressive thoughts and behaviors to the experience in playing violent games. Nonetheless, the majority of studies on aggression are correlational in character, so they do not provide a basis for causal inference. Another detrimental consequence – addiction to computer games – has begun to receive more attention only in recent years. This results from the fact that an increasing number of players are showing symptoms of addiction. Still, this disorder requires a more detailed analysis in order to provide its suitable framework definition. The sexualization of avatars is yet another negative phenomenon connected to gaming. It can lead to self-objectification or exposure to sexual harassment. Less attention has been paid to reduced emotional and social competence, also a feature typical for players of computer games. However, preliminary research shows that players experience unwanted emotions and display worsening quantity and quality of relations with other people

Despite numerous criticisms directed towards computer games, researchers are increasingly discussing them in a positive light. Players seem to have a certain advantage over non-players in terms of primarily cognitive, but also motor, emotional, and social functioning, and the process of playing itself is associated with the improvement of these competences. However, the studies so far have

not clearly demonstrated whether people with higher abilities (e.g., motor skills) become players more willingly or whether they develop these abilities through games. For example, if people who are more emotionally competent play more games than people less emotionally competent, the influence of computer games on this competence may be overestimated. More research is needed to evaluate the impact of computer games on various competencies, not just the differences between players and non-players.

Research on the positive influence of computer games on players is conducted on healthy and clinical populations. The promising results of the research are the basis for the development of diverse programs and training projects, for example, ones aimed at improving cognitive processes, enhancing motor skills in patients with Parkinson's disease, or developing social skills in children on the autism spectrum. It should be highlighted, however, that in light of current research it is the potential of computer games that is discussed rather than their proven role. Most of the studies described are correlational in character and were conducted on small populations. Much richer data comes from research on the negative effects of computer games. This can be explained by the fact that researchers have been analyzing them much longer than positive consequences.

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