

VGs' impact on Pediatric Age

Subjects: Behavioral Sciences

Contributor: Daniela Smirni

A growing number of children and adolescents play video games (VGs) for long amounts of time. The current outbreak of the Coronavirus pandemic has significantly reduced outdoor activities and direct interpersonal relationships. Therefore, a higher use of VGs can become the response to stress and fear of illness.

Keywords: children ; adolescents ; playing video games ; addiction behavior ; cognitive skills ; COVID-19 lockdown

1. Introduction

The current systematic review focuses on some crucial outstanding issues within the debate on the effects of VGs on cognition and behavior in order to provide suggestions for parents, pediatricians, health providers and educators dealing with pediatric ages, especially in the complex pandemic period. Namely, it analyzes the most debated and educationally relevant problems on the relationship between video games, cognition and behavior: 1. video games' effects on cognitive function; 2. video games' effects on attention and addictive behaviors; 3. video games and prosocial or aggressive behavior. Therefore, the current analysis may be accounted as an original contribution to the practical dimension in the educational and rehabilitation field for parents and educators.

Early common predominant opinions mainly focused on VGs according to dichotomous thinking, as enjoyable entertainment or harmful tools ^[1]. The recent literature instead provided evidence on the impact of VGs on the brain and its functional modifications while playing ^{[2][3][4][5][6]}, showing that video games involve different cortical and subcortical structures, with cognitive and emotional competence, such as frontal and prefrontal regions, the posterior and superior parietal lobe, the anterior and posterior cingulate cortices, limbic areas, the amygdala, the entorhinal cortex and basal nuclei ^{[7][8][9][10]}.

Similarly, Lee et al. ^[4], found a thinner cortex and a smaller gray matter volume in critical areas for evaluating reward values, error processing and adjusting behavior, namely, the anterior cingulate cortex, the orbitofrontal cortex and the frontoparietal areas, in young male adults with internet gaming disorders, compared to age-matched healthy male controls. A neuroimaging study examined in individuals affected by gaming disorders the differences during the playing of a violence-related vs. a non-violence-related version of the same VG ^[5]. While functional connectivity of the reward-related network and the behavioral inhibition system was altered, the orbitofrontal cortex and anterior cingulate cerebral area were overstimulated, similarly to smart drug addiction ^{[4][11]}.

Recently, Kwak et al. ^[6] longitudinally compared 14 adolescents with internet gaming disorder to 12 professional internet gaming students who practiced for about ten hours a day, within a defined support system that included practice, physical exercise, lectures on team strategy, rest and mealtimes. After one year, both groups showed increased brain activity within the attention system of the parietal lobe. However, professional gamers improved problematic behaviors, impulsivity, aggression, depression and anxiety, while adolescents with internet gaming disorder showed no behavioral improvement and a dysfunctional brain activity within the impulse control network in the left orbitofrontal cortex.

2. Effect of Video Games on Cognitive Functions

Any modern VG requires an extensive repertoire of attentional, perceptual and executive abilities, such as a deep perceptual analysis of complex unfamiliar environments, detecting relevant or irrelevant stimuli, interference control, speed of information processing, planning and decision making, cognitive flexibility and working memory.

Literature data in the last years have proven that VGs may improve a variety of cognitive domains ^{[7][12]} as, for example, even just 10 hours of VG could improve spatial attention and mental rotation ^{[13][14]}. A large variety of design studies reported in habitual players better performance in multiple cognitive domains, including selective attention ^{[15][9][13][16]}, speed of processing ^{[9][16]}, executive functions ^{[17][18]} and working memory ^[19]. Similarly, a large body of intervention

studies have shown improvements in the same cognitive domains in non-players following training in action VGs [14][20][21][22][23][24][25]. Recently, Benoit et al. [26] examined in 14 professional VG players and 16 casual VG players various cognitive abilities, such as processing speed, attention, memory, executive functions, manual dexterity and tracking multiple objects in three dimensions [27]. Professional players showed a very large advantage in visual-spatial short-term memory and visual attention, and less in selective and sustained attention and auditory working memory. Moreover, they showed better speed thresholds in tracking multiple objects in three dimensions overall, though the rate of improvement did not differ in the two groups. In two previous meta-analyses, Bediou et al. [28] focused on the long-term effects of action VGs on various cognitive domains using both cross-sectional and intervention studies. Overall, the results documented a positive impact of action video gaming on cognition. In cross-sectional studies, a main effect of about half a standard deviation was found. The habitual action game players showed better performance than non-players. Likewise, intervention studies showed about a third of a standard deviation advantage in cognition domains in action VG trainees. Perception, spatial cognition and top-down attention were the three cognitive domains with the most robust impact [28].

Homer et al. [29] examined the effectiveness of a custom-designed VG ('alien game') in a group of 82 healthy adolescents (age range 14–18 years; average = 15.5 years) trained to play for 20 min per week for 6 consecutive weeks. Such a digital game was devised to target, in a fun way, the specific executive ability of shifting, as the ability to shift between tasks or mental sets, hypothesizing that after playing the 'alien game' over a period of several weeks, adolescents would show significant improvements in the targeted ability. Pre- and post-test measures of another executive ability, inhibition, as the ability to control a prepotent response, were also recorded in order to examine the extent to which training would transfer from one executive ability to another. Significant advantages both in shifting and in inhibition abilities were found, providing evidence that VGs can be effective tools for training executive abilities [30][31].

Similarly, Oei and Patterson [32] examined the effect of action and non-action VGs on executive functions. Fifty-two non-VG gamers played one of four different games for 20 h. Pre- and post-training tests of executive function were administered. The group that trained on the physics-based puzzle game, demanding high level planning, problem solving, reframing, strategizing and new strategies from level to level, improved in several aspects of executive function. In a previous study, the same authors [33] instructed 75 non-gamers, (average age 21.07 ± 2.12) to play for 20 h, one hour a day/five days a week over four weeks. They compared effects of action and non-action games to examine whether non-action games also improve cognition. Four tests pre- and post-training were administered. The results showed that cognitive improvements were not limited to training with action games and that different games improved different aspects of cognition. Action VGs have even been used to treat dyslexic children [34][35]. Only 12 h of action VGs, for nine sessions of 80 min per day, significantly improved reading and attentional skills [36].

Moreover, several meta-analytic studies provide evidence that action VG training may become an efficient way to improve the cognitive performance of healthy adults. Wang et al. [37], in a meta-analysis, found that healthy adults achieve moderate benefits from action VG training in overall cognitive ability and moderate to small benefits in specific cognitive domains. In contrast, young adults gain more benefits than older adults in both overall cognition and specific cognitive domains.

In summation, the studies on VG effects, by different methodologies, document both in adults and in children significant positive outcomes in different cognitive domains. Such performance improvements may be paralleled by functional brain remodelling [1].

3. Video Games Effect on Attention and Addictive Behaviors

Attentional problems are accounted as a crucial area of focus on outcomes of intensive game-play practices in children and adolescents. However, literature on the topic appears inconsistent. While some research has found mixed results [38] or a positive effect [39][40][41], or no relationship between VG practice and attention, other studies have linked VG playing with greater attention problems, such as impulsiveness, self-control, executive functioning, and cognitive control [41][42][43].

Gentile et al. [44], examining longitudinally, over 3 years, a large sample of child and adolescent VG players aged 8–17 (mean = 11.2 ± 2.1), suggested a bidirectional causality: children who spend more time playing VGs have more attention problems; in turn, subjects who have more attention problems spend more time playing VGs. Therefore, children and adolescents with attention problems are more attracted to VGs (excitement hypothesis), and, in turn, they find it less engaging to focus on activities requiring more control and sustained attention, such as educational activities, homework or household chores (displacement hypothesis). According to such hypotheses, and to the operant conditioning model [45][46], VGs, providing strong motivational cues, become more rewarding for impulsive children and teenagers [39] who, in such contexts, experience a sense of value and feelings of mastery that they do not experience in their daily relationships [47].

Actually, any modern VG is a highly engaging activity with a variety of attractive cues, such as, for example, violence, rapid movement, fast pacing and flashing lights [48][49]. According to the attractive hypothesis [44], it may provide a strong motivation and support for attention and even become addictive, especially in subjects with problems maintaining attention in usual, monotonous and poorly engaging tasks. Therefore, paradoxically, a greater VG exposure may improve visual attention skills involved in such engaging play [13], but it may impair the ability to selectively focus on a target for lasting time, without external exciting cues.

Probably, in line with the bidirectional causality framework [44], such rewarding conditions could become the psychological context for the structuring of addictive behaviors, such as a sense of euphoria while playing, feeling depressed away from the game, an uncontrollable and persistent craving to play, neglect of family and friends, problems with school or jobs, alteration of sleeping routines, irregular meals and poor hygiene [1]. The most psychologically fragile subjects may be most attracted to an engaging and rewarding activity, ensuring an effective compensation to their fragility [1]. However, the topic of video game addiction continues to present today many outstanding issues. There is a large consensus that 'pathological use' is more debilitating than 'excessive use' of VGs alone [50][51][52]. Addictive behavior appears associated with an actual lowering in academic, social, occupational, developmental and behavioral dimensions, while excessive use may simply be an excessive amount of time gaming. According to Griffiths' suggestions, 'healthy excessive enthusiasms add to life, whereas addiction takes away from it' [53]. However, it is sometimes difficult to identify the clear line between unproblematic overuse of gaming and the pathological and compulsive overuse that compromises one's lifestyle and psychosocial adjustment [54][55][56]. Therefore, there may be a risk of stigmatizing an enjoyable practice, which, for a minority of excessive users, may be associated with addiction-related behaviors [57][58]. Przybylski and colleagues, in four survey studies with large international cohorts (N = 18,932), found that the percentage of the general population who could qualify for internet gaming disorders was extremely small (less than one percent) [59].

In such a discussion of the pathological nature of VGs, another outstanding question is whether pathological play is a major problem, or if it is the phenomenological manifestation of another pathological condition. Several studies have suggested that video game play can become harmful enough to be categorized as a psychiatric disorder, or it could be a symptom of an underlying psychopathological condition, such as depression or anxiety. Moreover, the functional impairments observed in individuals with game addictions are also thought to be similar to the impairments observed in other addictions. Neuroimaging studies have shown that the brain reward pathways which are activated during video game playing are also activated during cue-induced cravings of drug, alcohol or other type of substances abuse [60][61][62].

Some longitudinal studies [1][63][64] proved that pathological addictive behaviors, such as depression, are likely to be outcomes of pathological gaming rather than predictors of it [65][66]. Lam and Peng [67], in a prospective study with a randomly generated cohort of 881 healthy adolescents aged between 13 and 16 years, found that the pathological use of the internet results in later depression. Similarly, Liao et al. [68], in a 2-year longitudinal study involving 3034 children and adolescents aged 8 to 14 years, found that pathological video gaming has potentially serious mental health consequences, in particular of depression.

In summary, attention problems and addictive behaviors in the context of VGs should be addressed in a circular and bidirectional way in which each variable can influence the others.

4. Video Games Effect and Prosocial and Aggressive Behaviors

The positive impact of video games also concerns the social and relational dimension, as occurs in the VG training of prosocial or educational skills. Several studies have reported that playing prosocial VGs, even for a short time, increases prosocial cognition [69], positive affect [70] and helping behaviors [71][69][70][72][73][74], whereas it decreases antisocial thoughts and the hostile expectation bias, such as the tendency to perceive any provocative actions of other people as hostile even when they are accidental [71][75]. Such findings have been found in correlational, longitudinal and experimental investigations [70][74][76].

In four different experiments [71], playing VGs with prosocial content was positively related to increased prosocial behavior, even though participants played the VGs for a relatively short time, suggesting that VGs with prosocial content could be used to improve social interactions, increase prosocial behavior, reduce aggression and encourage tolerance.

Following experimental, correlational, longitudinal and meta-analytic studies provided further evidence that playing a prosocial VG results in greater interpersonal empathy, cooperation and sharing and subsequently in prosocial behavior [76][77][78][79].

Such literature's data are consistent with the General Learning Model [80][81], according to which the positive or negative content of the game impacts on the player's cognition, emotions and physiological arousal, which, in turn, leads to positive or negative learning and behavioral responses [82][83][84][85]. Therefore, repeated prosocial behavioral scripts can be translated into long-term effects in cognitive, emotional and affective constructs related to prosocial actions, cognition, feelings, and physiological arousal, such as perceptual and expectation schemata, beliefs, scripts, attitudes and stereotypes, empathy and personality structure [72][80].

In the same conceptual framework, educational video games have been found to positively affect behaviors in a wide range of domains [82], school subjects [86] and health conditions [87][88]. In randomized clinical trials, for example, diabetic or asthmatic children and adolescents improved their self-care and reduced their emergency clinical utilization after playing health education and disease management VGs. After six months of playing, diabetic patients decreased their emergency visits by 77 percent [89]. Therefore, well-designed games can provide powerful interactive experiences that can foster young children's learning, skill building, self-care and healthy development [90].

Violence in VGs is a matter of intense debate, both in public opinion and in the scientific context [91][92]. A vast majority of common opinions, parents and educators consider the violence of VGs as the most negatively impacting feature to emotional and relational development of youth and children. Actually, studies agree on the negative impact of violent video games on aggressive behavior. Several meta-analyses have examined violent VGs [93][94][95][96] and, although they vary greatly in terms of how many studies they include, they seem to agree with each other. The most comprehensive [95] showed that violent VGs, gradually and unconsciously, as a result of repeated exposure to justified and fun violence, would increase aggressive thoughts, affect and behavior, physiological persistent alertness, and would desensitize players to violence and to the pain and suffering of others, supporting a perceptual and cognitive bias to attribute hostile intentions to others.

Similarly, experimental, correlational and longitudinal studies supported the causal relationship between violent VGs and aggression, in the short- and long-term, both in a laboratory and in a real-life context. A greater amount of violent VGs, or even a brief exposure, were significantly associated with more positive attitudes toward violence [97], higher trait hostility [98] and with increased aggressive behaviors [99], physical fights [100] and aggressive thoughts [101] and affect [102]. In a two-year longitudinal study, children and adolescents who played a lot of violent VGs showed over time more aggressive behaviors, including fights and delinquency [103]. Saleem, Anderson and Gentile [70] examined the effects of short-term exposure to prosocial, neutral and violent VGs in a sample of 191 children of 9–14 years old. Results indicated that while playing prosocial games increased helpful and decreased hurtful behaviour, the violent games had the opposite effect.

In summation, the overall literature data support the opinion that violent video games, over time, affect the brain and activate a greater availability to aggressive behavior patterns, although some researchers have pointed out that the negative effects of violent VGs are small and may be a publication bias [1][104].

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