Video Game Engagement and Social Development in Children

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Video games have rapidly emerged as a prevalent facet of children's daily experiences globally. Their appeal to children can be attributed to features such as engaging content, immediate feedback, user interactivity, broad media accessibility, and applicability across a diverse age spectrum.

child electronic game social behavior

1. Video Game Engagement and Children's Social Development

"Social development" refers to the unique psychological characteristics of an individual that are formed on a physiological basis as they participate in social life and interactions. This term encompasses adherence to societal norms, emotional stability, social awareness, familial bonds, and peer relationships [1]. Positive social development during childhood is correlated with favorable social adjustment, effective interpersonal interactions, academic success, and cognitive capacity in subsequent stages of life [2][3]. Thus, understanding the determinants influencing children's social development is imperative. Extensive research underscores video games' substantial influence on children's social development [4][5].

The impact of video games on children's social development is a topic of debate. Several studies have suggested that video games foster positive outcomes in children's social growth. For example, Yilmaz and Griffiths posited that the diverse interactions facilitated by pro-social video games bolster the development of children's peer relationships [6]. Concurrently, other scholars have emphasized the role of video games in enhancing social interaction and collaborative efforts [7]. Many of these games feature multiplayer functionality, fostering improved communication and cooperative skills among children [8]. In consonance with this view, Raventós and Belli indicated that gaming environments enable players to forge friendships and establish shared interests, catalyzing the genesis of novel social bonds [9]. Furthermore, certain video games are geared towards bolstering problem-solving abilities, analytical reasoning, and innovative cognition, all crucial for comprehensive social development [10].

Nonetheless, academic voices are concerned about the ramifications of heightened video game engagement on children's social development [11]. Davis et al. asserted that children deeply immersed in video games often exhibit increased aggressive behaviors and notable social inadequacies [12]. The General Learning Model postulates that individuals deeply engrossed in video games might develop an addiction-like relationship with the medium,

consequently impeding their social development [13]. This model suggests that children heavily involved with video games may consistently internalize the game's content and mechanics, leading to cognitive and emotional disturbances, including hostility and indifference [14][15]. Further, Gentile et al., through a biennial longitudinal study, discerned that augmented social challenges and impulsivity were byproducts of children's heightened video game engagement [16]. Thus, excessive video game engagement may negatively correlate with children's social development.

Undoubtedly, the pandemic's influence on individual social development warrants scholarly attention. To contain COVID-19, numerous governmental interventions, such as self-quarantine and social distancing, have been put into place [17][18]. However, the pandemic's far-reaching implications for all demographics, including children, cannot be overlooked. Countries like Germany, China, and Bangladesh have reported increased psychological stress related to health concerns and economic instability [19][20][21], which inevitably has a downstream impact on children's social development [22]. Additionally, the overwhelming influx of pandemic-related news has heightened anxiety, particularly among children [23]. Nevertheless, contrasting views exist; Allen et al. found minimal changes in children's emotional well-being pre- and post-pandemic when assessed using Rumble's Quest [24].

In this complex landscape, infants and young children born or raised during COVID-19 are of specific concern. Lockdown measures have curtailed their opportunities for conventional social interaction and development [25]. In this restricted environment, their engagement with video games becomes a salient point of inquiry. While some research suggests that video games can offer virtual interactions that teach pro-social behaviors like sharing and cooperation [26], others argue that excessive gaming could discourage real-world social engagement, thus impeding social development [27]. In light of this intricate and multifaceted context, it could be hypothesized that the surge in video game engagement, especially induced by the pandemic, may adversely affect children's social development.

2. The Mediating Role of Executive Function

Executive function denotes a higher-order cognitive capacity, facilitating the cohesive and analytical regulation of an individual's cognitive processes and behaviors. This capacity encompasses vital facets such as inhibition, working memory, and cognitive flexibility [28]. These components collectively constitute pivotal constituents within the scaffolding of intricate proficiencies and aptitudes in human development [29][30]. Inhibition is a sophisticated cognitive process that empowers individuals to quell predominant reactions and counteract extraneous interference [31]. Working memory pertains to an individual's proficiency in continuously retaining, manipulating, and modifying the contents held in short-term memory [32]. Cognitive flexibility is the disposition to engage in creative ideation, adopt diverse perspectives, and promptly and adaptively respond to altered contexts [28]. The underpinning of executive function is closely intertwined with the prefrontal cortical region of the cerebral apparatus, proffering a substrate for the governance and impetus of human cognition and comportment. A robust executive function is a prerequisite for ensuring the progression of an individual's mental well-being [33].

As children age and accumulate experience, their executive functions undergo rapid development. Inhibition, for instance, manifests as early as infancy, with its first significant leap occurring in the preschool years and continuing to improve throughout childhood [34]. Research indicated that infants could delay eating times, and the ability to delay eating increases with age. Specifically, 50% of two-year-olds could delay eating for 20 s, 85% of three-year-olds could inhibit the impulse to eat for one minute, and four-year-olds could delay eating for up to five minutes [35]. Luria's tapping test revealed that children between the ages of four and four and a half showed marked improvements in inhibition, with most advances occurring before age six. Older children demonstrated faster response times and higher accuracy rates [36]. Concerning working memory, continuous improvements are observed from infancy through preschool. Perlman found that prefrontal cortex activation during a working memory task increased with age in children aged three to seven [37]. Best posited that individual working memory followed a linear trajectory from ages 4 to 14, stabilizing after 16 [34]. In a parallel vein, Ahmed utilized nationally representative data to exhibit nonlinear growth patterns in working memory performance from ages 3 to 19, with the most rapid growth occurring during childhood [38]. Research on cognitive flexibility suggests that this skill begins to emerge in children around the age of two and gradually develops between the ages of three and five [34]. Buttelmann et al.'s study supports this notion and indicates that cognitive flexibility develops rapidly in preschool and continues to increase into adolescence [39]. By age 12, children's cognitive flexibility levels approximate those of adults [40].

The relation between video games and executive function is a complex and debated topic in psychology. Some studies argued that video games might have positive effects on specific aspects of executive function. For instance, Whitlock et al. discovered that engagement with the massively multiplayer role-playing game "World of Warcraft" enhanced Stroop performance [41]. Similarly, Liu et al. found that video gaming significantly elevated children's inhibition abilities; children who had undergone video game training outperformed their non-trained counterparts on the Go/No-Go task [31]. Even if they no longer engage in gaming, individuals who were gamers before adolescence displayed superior working memory performance, heightened attentional focus, and enhanced information acquisition capabilities [42]. A meta-analysis by Glass et al. revealed that gaming conditions emphasizing the maintenance and rapid switching between multiple information and action sources substantially increased cognitive flexibility [43]. Further research indicates that complex puzzle-based video games, which necessitate strategic planning and reframing, can even augment the thickness of the player's right dorsolateral prefrontal cortex, right hippocampal formation, and bilateral cerebellar cortex [44][45], thereby significantly elevating executive function levels.

Conversely, studies have elucidated that inappropriate exposure to video games could yield detrimental repercussions for children's executive function [46]. Cognitive engagement in video gameplay is the mechanism of acute effects on executive function [47]. A study by Yang et al. unveiled an adverse correlation between the presence of action-oriented content in video games and a facet of executive function related to inhibition in children [48]. Correspondingly, scholarly exploration has indicated that participating in violent video games can modulate prefrontal cortical activity while engaging in cognitive inhibition [49]. Moreover, an escalating degree of addiction to video games corresponds to deteriorating performance in working memory tasks [50]. A systematic review offered empirical evidence that pathological and/or excessive utilization of video games engenders detrimental outcomes

for cognitive processes, encompassing inhibition and decision-making [51]. Similarly, research showed that individuals exposed to video games for 3 h per day showed reduced inhibitory control compared with those exposed to video games for a limited amount of time per day. Those overexposed to video games had smaller gray matter volumes and thinner cortex in the ventral medial prefrontal cortex, along with shallower dorsolateral frontal sulci [52]. Hence, it can be logically inferred that excessive engagement with video games may harm children's executive function, highlighting a critical area for further investigation and potential intervention.

Empirical evidence illustrates that heightened levels of executive function play a significant role in children's social development [53]. A study by Hughes and Ensor found that executive function skills, such as inhibitory control and working memory, were positively associated with theory of mind (ToM) abilities, which involve understanding others' thoughts and feelings [54]. Similarly, Ming et al. found that higher levels of executive function were associated with greater social competence in children [55]. In contrast, children with poorer executive function also experienced increased isolation and less engagement with peers on the playground [56]. Ego Depletion Theory posits that the performance of volitional activities—such as controlling processes, forming choices, initiating behaviors, and overcoming reactions—requires the expenditure of cognitive resources [57]. When a child's executive function is debilitated, the tasks of self-control and regulation necessitate an atypical abundance of resources. A subsequent depletion of these resources may lead to an escalation in the child's aggressive behavior. Empirical studies have further validated that executive function is a significant predictor of aggression levels in children, with children exhibiting deficits in this area being more inclined to demonstrate aggression in social interactions [58]. Given this evidence, it is plausible to hypothesize that engagement with video games is associated with children's social development via the mechanism of executive function.

3. The Moderating Role of Age

Video game engagement exhibits a close relation with executive function, and investigating variables that may moderate the association between video game engagement and executive function holds significant value for enhancing children's cognitive development. Among these moderating variables, age has been identified as an essential factor that may influence this relation [34]. Ecological Systems Theory emphasizes the importance of considering the systems and contexts that influence child development, including the role of age. Children's age is a temporal system interacting with other ecological systems to shape their development [59]. Research has shown that children's age relates to their video game engagement and its relation to executive function [60].

Recent evidence demonstrates a developmental trend in video game exposure, where older children engage in playing video games more frequently than their younger counterparts. A study illustrated that children's exposure to video games was infrequent before age two, with average playtime recorded at approximately 20 min per day for children aged 2–3 years. This duration of exposure exhibited a progressive increase with age, with those between 5–8 years playing video games for an average of 40 min daily and those between 8–12 years for approximately 80 min a day [60]. Concordantly, Gentile found that older students were more prone to report excessive video game playing [61]. These convergent findings support the notion that older children engage more in video games than

younger children, highlighting the importance of investigating potential implications for cognitive development and executive function.

In addition to the amount of time of video game exposure, children's game genre preferences change throughout their lifespan. The categorization of video games varies across studies due to differing research objectives and target populations. Traditional classifications encompass various game types, from strategy and puzzle games to action/adventure and simulation games [62]. However, these categories often blur, leading researchers to develop customized typologies [63]. For example, Yu and Chan grouped games into four types based on player impact: conventional, exergames, cognitive training, and VR/simulation games [64]. Eichenbaum et al. tailored their classification to the needs of school-age children, identifying five game types: role-playing, action, strategy, music, and puzzles [65]. In the present study, a unique eight-type classification is adopted, specifically designed to align with the age characteristics of young children and the popularity of games. The categories are puzzle games, action games, simulation games, art games, sports games, adventure games, role-playing games, and other games. Video games are dedicated to meeting the needs of individuals, which change throughout the developmental stages as they grow in their abilities. For instance, the cognitive skills required for navigating game challenges are age-dependent; game genres that engage younger children may lose their appeal to adolescents [66]. Research has found that brain games that include exploration and decision-making elements are more popular with preschoolers [65][67]. Conversely, action-adventure games tend to captivate school-age children [68]. Some research has concluded that action games require players to focus on fast-paced, complex goals and that such a requirement may be too demanding for younger children [65].

Childhood is the optimal time to examine whether and how screen time exposure (such as video gaming) affects executive function development [34][66]. Assessments grounded in cognitive and neurophysiological methodologies reveal that executive function, though initially emerging during the foundational years of life, exhibits a marked trend of continual strengthening and maturation throughout childhood and adolescence [34]. The development of executive function is a dynamic process influenced by both biological maturation and environmental factors [34]. Video game engagement, particularly during the sensitive and formative stages of childhood, introduces a multifaceted environmental factor that can interact with the biological maturation of executive function. As children grow older, their likelihood of engaging with video games tends to increase, introducing a variable that may exert both positive and negative influences on the development of executive function. On the one hand, select video games can pose cognitive challenges that stimulate problem-solving capabilities, potentially contributing to executive function development [67]. Concurrently, specific games—especially those equipped with educational components or engineered for collaborative gameplay—have been associated with enhancements in cognitive performance and the cultivation of social skills [69][70]. On the other hand, excessive exposure to video games, especially those lacking educational value, may be detrimental, hindering the natural progression of executive function [51]. Consequently, a child's age can function as a moderating variable within the connection between video game engagement and executive function, signifying that age could potentially intensify this specific association.

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