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Impact of Children's Digital Device Usage on Their Cognitive Function: A Comprehensive Literature Analysis

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Abstract: This paper comprehensively reviews and analyzes relevant literature on the use of digital devices and children's cognitive development, exploring the impact of children's digital device usage on their cognitive function. The analysis reveals that prolonged use of digital devices can have negative effects on children's cognitive development, such as attention issues, delayed language development, and decreased learning abilities. However, appropriate and targeted use of digital devices can positively enhance children's cognitive development, including improving attention, expanding language skills, and enhancing learning and memory. Based on the research findings, the paper provides the following recommendations: improving the digital environment to ensure children's healthy growth, creating a positive family environment, and enhancing training on the use of digital devices, as well as establishing guidelines for children's digital device usage.

Keywords: digital devices, children's cognition, cognitive function, smartphone addiction

1. Introduction

1.1. Current Status of Children's Digital Device Usage

With the advancement of technology, digital devices have become indispensable in people's daily lives and learning, permeating various aspects, including children's daily routines. The prevalence of these digital devices among children has increased significantly with technological advancements. According to surveys, the smartphone and tablet ownership rates among 1-3-year-old children in Shanghai, China, have reached 96.5% and 89.4%, respectively [1]. In the UK, many children start using devices such as tablets at the age of two [2].

This phenomenon primarily stems from the attractiveness of digital devices to children, as they provide a diverse range of content and entertainment, enabling children to watch videos, play games, listen to music or stories, and even engage in learning and creative activities. Particularly, with the outbreak of the COVID-19 pandemic in 2020, the opportunities for children to learn online increased significantly, leading to more children engaging with and using digital products for educational purposes.

However, as the prevalence of digital devices continues to rise, the negative impact they have on children's development is becoming increasingly prominent, such as harming vision and disrupting academic performance [3]. Research indicates that inappropriate use of digital devices can indeed

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have various adverse effects on children, including excessive dependence on digital products, lack of concentration and obsessive symptoms, stress, self-absorption, inferiority, and decreased academic performance [4].

1.2. Children's Cognitive Abilities

Children's cognitive function forms the basis for their understanding and interpretation of the world, including the following aspects:

Perceptual abilities: These form the basis for understanding the world, with sensations being unprocessed information from various sensory organs, and perceptions being organized, giving meaning to the sensed information [5].

Attention: It is the ability to select and concentrate on specific information. For children, their attention mainly manifests as unintentional attention, which gradually develops into intentional attention [5].

Memory: Memory is the storage and reproduction of past experiences. The basic processes of memory include encoding, storage, and retrieval or recognition [5].

Thinking abilities: Thinking abilities are a significant manifestation of cognitive abilities, representing the higher stages of cognitive activity. Problem-solving and reasoning abilities are essential components of thinking abilities [5].

As the time and frequency of children's use of digital devices increase, scholars have become increasingly concerned about the impact of digital device usage on children's cognitive abilities. Therefore, it is crucial to understand the effects of digital device usage on children's cognitive function and to establish relevant rules and policies for children's digital device usage. This paper synthesizes existing research to arrive at conclusions on this topic.

2. Research on the Impact of Children's Digital Device Usage on Cognitive Function

Through searches in various academic databases and specialized journals in the field of child development, the author screened the literature based on predetermined inclusion and exclusion criteria. The following review text was compiled based on the analysis and integration of the results:

2.1. Main Findings and Perspectives of Relevant Domestic and International Studies

2.1.1. Impact of Children's Digital Device Usage on Attention

Several studies indicate that prolonged use of digital devices may have a negative impact on children's attention [6]. One study found that over two hours of daily digital device usage is associated with an increased risk of attention problems in preschool children. Additionally, excessive use of digital devices, such as smartphones and tablets, is related to distractions in young children.

However, some research suggests that the use of digital devices may also have a positive impact on children's attention. Some educational applications have been found to help children improve their focus and cognitive control. This suggests that the appropriate selection and use of digital device content and applications may be beneficial for the development of children's attention [6].

2.1.2. Impact of Children's Digital Device Usage on Language Development

Research has shown that excessive use of digital devices by children may be associated with delayed language development. For instance, frequent television viewing and digital device usage are related to less verbal interaction and smaller vocabulary development in children [7].

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Additionally, for preschool children, the use of smartphones and tablets may diminish their oral language abilities [8]. However, some research indicates that the targeted and appropriate use of digital devices can promote children's language development. For example, interactive applications and educational games can provide rich vocabulary and speech stimuli, assisting children in expanding their language skills.

2.1.3. Potential Effects of Children's Digital Device Usage on Memory and Learning Abilities

Studies have found that prolonged use of digital devices may impair children's memory and learning abilities. For example, excessive engagement in electronic games and social media might lead to decreased academic performance and reduced learning motivation. Furthermore, frequent screen use is associated with diminished working memory and suboptimal learning outcomes in children [9]. However, some research suggests that the proper use of digital devices can create an environment that enhances learning and memory. For instance, educational applications and online learning resources can offer children personalized, interactive, and multimedia learning experiences, fostering their learning outcomes and memory capabilities [10].

In summary, both domestic and international research extensively discuss the effects of children's digital device usage on attention, language development, and memory and learning abilities. Despite some disparities in research findings, the majority of studies suggest that the targeted and appropriate use of digital devices may benefit children's cognitive development. Therefore, parents and educators need to pay attention to content selection, duration of usage, and interactive methods concerning children's use of digital devices, making utmost efforts to promote children's healthy growth and learning development.

2.2. Integrated Analysis and Discussion of Existing Research

From the preceding literature review, it is evident that there are varying research outcomes regarding the impact of children's digital device usage on attention, language development, and memory and learning abilities. On one hand, prolonged excessive use of digital devices may have negative implications for children's cognitive development, such as attention issues, delayed language development, and decreased learning abilities. On the other hand, the targeted and appropriate use of digital devices may positively promote children's cognitive development, including enhancing attention, expanding language abilities, and strengthening learning and memory effects.

These conflicting research findings might be influenced by several factors. Firstly, children's age and developmental stages could result in differences in the impact of digital device usage. Younger children might be more sensitive to the stimuli of digital devices, making them susceptible to the negative effects of excessive usage. As they grow older, children's cognitive abilities and self-control gradually develop, enabling them to better adapt to and benefit from interactive engagements with digital devices.

Secondly, the content and applications utilized significantly impact the effects of digital device usage. Some studies indicate that educational applications and games can provide rich learning and cognitive stimuli, fostering children's development. Conversely, excessive involvement in entertaining content and games might distract children's attention, hindering their learning and development.

Furthermore, the role of the family environment and guardians can significantly influence the impact of children's engagement with digital devices. A supportive family structure and active engagement with parents or caregivers can help guide children in the proper use of digital devices, averting the negative consequences of excessive use. Hence, parents and educators play a critical

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role in children's engagement with digital devices.

3. Policy Implications

Based on the aforementioned research findings, the following recommendations are proposed for children's usage of digital devices:

3.1. Content Regulation: Improving the Digital Environment to Ensure Children's Healthy Growth

One criterion for improving the digital environment is regulating children's exposure to digital media content. Recent studies have shown that viewing violent or adult-oriented television programs or videos has negative impacts on children, whereas the use of highly interactive educational applications can promote children's cognitive development.

Since 2018, digital media, represented by short video platforms, has rapidly emerged and gradually replaced television and computers as the primary channels for video content distribution. According to a report by the China Internet Network Information Center, as of December 2021, the number of short video users in China has reached 934 million, an increase of 60.8 million from December 2020, accounting for 90.5% of the total internet users. It is worth noting that many short video platforms excessively emphasize sensory stimulation and contain vulgar content, making children and adolescents susceptible to addiction to short videos. In order to address this issue, the Chinese government has enacted several laws and regulations to standardize the management of short video platforms. Despite some improvements in the content of short videos, the assessment of their suitability for children remains insufficient.

Therefore, in the future, it is necessary for scientific researchers to conduct in-depth studies on these issues, and relevant regulatory authorities should pay special attention to children's use of digital devices. All parties need to collaborate to establish an effective mechanism for regulating the digital environment to protect children and ensure their healthy growth [4].

3.2. Parental Guidance: Creating a Favorable Family Environment and Strengthening Digital Device Use Training

Active parental engagement in children's cognitive activities, such as early reading and positive parent-child interactions, is a key factor in promoting children's cognitive development. Therefore, educational authorities and childcare institutions can guide parents to create a proactive, sensitive, and highly interactive family environment that aligns with children's developmental characteristics, thereby fostering the cultivation of children's cognitive and non-cognitive abilities [4].

Firstly, educational authorities can encourage and guide parents' participation in children's cognitive activities. For instance, relevant incentive policies can be introduced to commend parents who actively engage in early childhood reading and interactive learning at home. Simultaneously, themed activities such as parent-child reading sessions and interactive family learning can be organized regularly, providing parents with more opportunities to grow together with their children.

Research has shown that kindergartens and schools serve as crucial venues for early childhood reading and interactive learning. Therefore, childcare institutions can regularly host lectures or workshops on fostering children's cognitive abilities. Additionally, these institutions can prioritize children's reading and interactive learning in their curriculum, thereby promoting the development of children's cognitive abilities.

Moreover, parents' active involvement is significant in fostering children's cognitive development. Parents can pay attention to their children's interests and needs in daily life, understand their thoughts and cognitive processes through interaction and communication with

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them. Furthermore, parents can enhance their parenting skills and capabilities by reading books on children's cognitive development and participating in parent-teacher meetings.

Simultaneously, educational authorities and childcare institutions should enhance parental training on the use of digital devices, implemented through various levels of lectures and community activities. This assistance can help parents develop corresponding skills, particularly in the following aspects:

(1) Establishing reasonable rules and restrictions: by setting household rules that clearly define the time, location, and content restrictions for the use of digital devices. For example, specifying no device usage before dinner or limiting daily screen time.

(2) Strengthening parent-child interaction and communication: maintaining a good parent-child relationship and actively participating in children's digital device use. Exploring and discussing the digital world with children, understanding their interests and needs.

(3) Supervising and guiding: monitoring children's activities while using digital devices, ensuring they are exposed to age-appropriate and educationally valuable content. Providing necessary guidance to teach them how to use digital devices appropriately.

(4) Setting screen time and rest time: scheduling children's screen time reasonably, ensuring they have sufficient outdoor activities, physical exercise, and social interaction time. Also, ensuring they have adequate rest time, avoiding prolonged continuous use of digital devices.

(5) Encouraging diversified hobbies: cultivating children's interests in other activities such as reading, drawing, music, and outdoor activities. Providing diverse experiences and learning opportunities to enrich children's life experiences.

(6) The power of role models: as parents, setting an example by demonstrating good habits of digital device use. Creating a positive and healthy digital environment at home and engaging in meaningful activities with children.

(7) Collaboration with schools: closely collaborating with children's schools, understanding the school's digital device use policies and educational resources. Communicating with teachers and education experts, sharing experiences and advice.

3.3. Policy Development: Issuing Guidelines for Children's Use of Digital Devices

Currently, representative policies and guidelines for digital device use include a report from the American Academy of Pediatrics, which suggests limiting the time children of different age groups spend using digital devices, and providing four guiding principles for parents and teachers, including controlling the occasions, frequency, and content of digital device use, as well as parental supervision during viewing. "Notice on Further Strict Management and Effective Prevention of Minors' Addiction to Online Games," released by the National Press and Publication Administration in August 2021, and in October of the same year, six departments including the Office of the Ministry of Education also issued "Notice on Strengthening the Management of Preventing Primary and Secondary School Students from Addiction to Online Games," which proposed guidance on implementing anti-addiction requirements, internet content, campus management, and home-school cooperation [4]. Both notices aim to strengthen the control of minors playing online games, preventing them from becoming excessively addicted to gaming.

Although these laws and documents have some significance, there has yet to be a specific guiding policy document dedicated to children's use of digital devices in China. Therefore, it is particularly important to formulate specific guiding policies for children's use of digital devices. Government departments should formulate digital device usage guidelines that cater to children's needs, based on children's physical and mental development characteristics, along with existing scientific theories and practical experiences. In this regard, the national health department and the education department should collaborate to create a safe, healthy, and beneficial online environment

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for children.

In addition to policy development, government departments should regularly release white papers on children's digital device use through various channels [4]. These white papers should analyze the current situation and issues related to children's use of digital devices in detail, proposing scientific cognitive and intervention strategies to help children's parents, caregivers, kindergarten teachers, etc., establish scientific cognitive, intervention, or educational strategies. These strategies should include how to reasonably control children's use of digital devices, how to make appropriate choices and use of digital devices, and how to prevent online risks, among others.

Simultaneously, government departments can enhance public awareness and attention to children's use of digital devices by conducting promotional education activities and hosting special lectures. This can not only enhance children's safety awareness but also encourage various sectors of society to pay attention to and participate in addressing children's internet safety issues.

4. Conclusion

Based on the aforementioned research findings, the following conclusions can be drawn: excessive use of digital devices has a negative impact on children's cognitive development, including attention issues, delayed language development, and decreased learning abilities. However, the appropriate and targeted use of digital devices can positively promote children's cognitive development, such as enhancing attention, expanding language abilities, and strengthening learning and memory effects. Based on these research findings, it is recommended to take the following measures to improve the digital environment and ensure children's healthy growth: first, create a favorable family environment and strengthen training on the use of digital devices; second, issue guidelines for children's use of digital devices to guide parents and educators in the rational use of digital devices by children.

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