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Cognitive and communicative challenges in adolescence: implications in technoaddictive life

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ABSTRACT

Adolescence represents a critical phase marked by substantial neurobiological and psychosocial changes that influence emotional and behavioral growth. This stage is characterized by synaptic reorganization and increased myelination, especially in prefrontal areas, which enhance self-regulation while also heightening susceptibility to impulsive behaviors and addictions, such as excessive Internet use. Internet addiction is increasingly relevant among adolescents, given their developmental inclination toward novelty-seeking and a still-developing capacity for self-control. This dependency often leads to compromised academic performance, family tensions, and interpersonal difficulties, exacerbating communication barriers and generational conflicts. These issues underline how Internet addiction impacts both individual well-being and family dynamics, making it a significant risk factor for the stability of family relationships. Furthermore, the quality of parent-child communication is essential for preventing and managing problematic Internet use. Supportive, open communication that respects adolescent needs can foster understanding, reduce the risk of social isolation, and encourage mindful digital engagement. Ultimately, maintaining effective communication channels can help adults support adolescents in their journey toward identity formation and independence, while also guiding responsible Internet use, essential for healthy psychosocial development.

Background: Adolescence is a transformative phase with significant neurobiological and psychosocial changes. These developmental processes, including synaptic reorganization and prefrontal myelination, are linked to both enhanced self-regulation and increased vulnerability to impulsive behaviors and internet addiction. The objective of this review is to explore the interplay between neurobiological development, psychosocial changes, and the increasing prevalence of Internet addiction during adolescence, by examining the impact of adolescent brain plasticity and behavioral vulnerability on digital dependency.

Method: This narrative review explores the relationship between adolescent neurobiological development and behavioral vulnerability, particularly regarding internet addiction. We analyze the role of family communication in moderating these risks through a review of recent literature on

adolescent brain development, social behavior, and internet addiction.
Results: Findings highlight that the ongoing neurobiological maturation process, coupled with social and environmental factors, can predispose adolescents to internet addiction. Furthermore, family dynamics and the quality of parent-adolescent communication significantly affect the likelihood of compulsive internet use and its associated social risks.
Conclusion: The study underscores the importance of open and supportive communication between parents and adolescents in preventing problematic internet use. Effective family communication serves as a protective factor, fostering better psychosocial outcomes and supporting adolescents' healthy development.

Keywords: Adolescence, neurobiological development, internet addiction.

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Introduction

Adolescence represents one of the most complex and transformative stages of life, characterized by profound changes on a biological, psychological, and social level. During this period, young people face the physical development related to puberty, as well as significant brain reorganization that has substantial effects on behavior and emotions. Although the general size and macroscopic organisation of the brain are comparable between adolescents and adults, significant dynamic changes are observed during adolescence that affect brain structure, functioning and the characteristics of neuromodulatory systems. These changes influence and shape the decision-making processes typical of this developmental phase (Hartley 2015). These neurobiological changes do not occur in isolation but intertwine with the social transformations adolescents experience. Relationships with family, peers, and adult figures of reference undergo significant modifications. At the same time, adolescents begin seeking greater independence and autonomy, experimenting with new roles and social responsibilities. The interaction between neurological development and social context makes adolescence a particularly delicate period, where the ability to communicate effectively with adults and manage peer pressure becomes crucial for psychological well-being (Blakemore & Mills, 2014). Adolescents' emotional and behavioral functioning tends to be hyperactivated, often presenting specific psychopathological risk factors associated with this developmental stage, which typically decrease in early adulthood (Costello et al., 2003). According to Gerber et al. (2009), this behavioral hyperactivation is supported by heightened neurobiological plasticity, enabling adolescents to adapt to profound bodily and emotional changes, acquire relational strategies, and develop greater independence from parents. However, this same plasticity appears to encourage, and partially predict, risk-taking behaviors and sensation-seeking during youth, including internet addiction (Doremus-Fitzwater et al., 2010; Laviola et al., 2003; Spear, 2000). The primary objective of this review is to

examine the complex interplay between neurobiological changes, psychosocial development, and the increasing prevalence of internet addiction during adolescence. This review aims to highlight how the adolescent brain's reorganization contribute to emotional regulation, but also increase vulnerability to impulsive behaviors and addictive patterns, such as excessive internet use. Additionally, the review underscores the critical role of effective communication within families, especially between parents and adolescents, in mitigating the adverse effects of internet addiction and fostering healthier, more balanced digital behaviors.

Neuronal Remodeling in Adolescence

During adolescence, both the body and brain undergo significant hormonal and neurodevelopmental changes aimed at enhancing reproductive capacity and fostering personal independence. These complex processes are heavily influenced by the expansion of neural circuits, which see increased brain activity in specific areas. Furthermore, there is a reorganization of synaptic connections, with the strengthening of some and the reduction of others a phenomenon that helps optimize information transmission (Stampanoni, et al., 2019). Synaptic plasticity shapes brain connectivity: implications for network topology. *International journal of molecular sciences*, *20*(24), 6193.). Another key factor is the increase in myelination, particularly in prefrontal areas, which improves the speed and efficiency of neuronal communication. Simultaneously, subcortical areas, responsible for crucial connective functions, continue their maturation process, allowing for better integration between different brain regions and contributing to the refinement of adolescents' cognitive, emotional, and behavioral abilities (Miguel-Hidalgo, 2013). This reorganization of synaptic connections is a process known as "neuronal remodeling," which involves a series of changes in the structure and function of neurons and their connections. One of the most significant aspects of this phenomenon is the revision

and restructuring of synapses through what is known as "synaptic potentiation and pruning." This process is essential for optimizing brain efficiency, eliminating superfluous connections, and reinforcing those crucial for cognitive functions. This phase of synaptic pruning concludes approximately between ages 23-25 for women and 27-29 for men (Giedd et al., 2015). However, in modern society, these peculiarities can be associated with risky behaviors. Consequently, adolescence is commonly regarded as a period of behavioral vulnerability, with adolescents being more inclined to experiment with substances such as tobacco, drugs, and alcohol, develop internet addiction, drive recklessly, engage in unprotected sexual activity, and face interpersonal conflicts (Arnett, 1999; Chambers et al., 2003; Spear, 2000). Theories regarding vulnerability during adolescence suggest that the brain development process in this stage of life leads to behavioral changes and heightened sensitivity to stress. These changes can make adolescents more susceptible to mental health risks, increasing the likelihood of developing psychological disorders (Hammerslag, 2016). Furthermore, neural development is not the same for everyone, and gender differences play an important role. The brain development of males and females follows slightly different trajectories, influencing both the timing and nature of behavioral and emotional changes (Dahl, R. E., 2004). This may explain why boys and girls show different vulnerabilities to specific psychological disorders during adolescence. For instance, girls may be more predisposed to developing emotional disorders such as anxiety or depression, while boys may exhibit a greater vulnerability to impulsive behaviors or disorders related to impulse control. These gender differences may be the result of the varying ways in which male and female brains develop during adolescence, influencing their susceptibility to different types of stress and psychological risks (Romeo, 2006). In addition, various studies have shown how the excessive use of digital media is associated with a decreased effectiveness of attentional and multi-tasking abilities (Uncapher et al., 2017; Ophir et al., 2009; Ra et al., 2018; Thoma et al., 2020), with an

increased susceptibility to external interference. The literature has also shown the impairment of working memory (Dong & Potenza 2015; Dong & Potenza 2016), with the possible alteration of the activation of associated brain areas. All this shows a negative impact on cognitive performance (Van Der Schuur et al., 2015; Bohle et al., 2019; Firth et al., 2019).

Social Sensitivity and Behavioral Vulnerability in Adolescence

The psychosocial context of adolescents differs significantly from that of both childhood and adulthood. During adolescence, relationships with peers, family, and society undergo significant transformations. In this phase, young individuals begin to develop greater autonomy, assuming more independent control over their decisions, emotions, and behaviors. This process of detachment from parental influence leads them to redefine their role within the family and establish clearer boundaries between themselves and adult figures (Choudhury, 2006). At the same time, the school environment becomes a crucial space for socialization, where adolescents not only confront the norms and expectations of their peers but also begin to internalize the perspectives of others, including classmates, teachers, and other significant social figures. This growing awareness of others' opinions and perceptions fuels the development of their social identity, prompting them to question their role within groups and experiment with new ways of relating to others. Furthermore, the social influences exerted by the school environment and interpersonal relationships can profoundly affect adolescents' behavioral choices and emotional development, shaping their self-esteem and sense of belonging to a group (Adams & Berzonsky, 2008). A recent study published in the "Journal of Neuroscience" (Abrams et al., 2022) identifies adolescence as a "sensitive period" for processing social information, characterized by increased sensitivity to signals from unfamiliar sources compared to familiar ones

(Blakemore & Mills, 2014). This suggests particular attention to social relationships during this phase of development. The findings of the study by Blakemore (2014) showed that, as individuals age, there is an increased focus on unfamiliar voices compared to familiar voices like the mother's. More specifically, younger children demonstrated a preference for the mother's voice over unfamiliar voices, while adolescents showed a preference for unfamiliar voices (NF) over the mothers. This enhances our understanding of key principles regarding adolescent social development. Firstly, a prominent developmental model identifies five distinct phases of social development across the lifespan, each defined by a primary social goal that is pursued vigorously within each stage of development (Nelson et al., 2016). For infants, mothers and caregivers represent the primary social target. During the juvenile phase, which spans from weaning to puberty, the mother/caregiver is considered a central target (with increasing attention to peers), while the adolescent phase, extending from puberty to full maturity, focuses on integration with the peer network (NF) and groups. Adolescence is therefore considered a “sensitive period” for processing social information, marked by heightened sensitivity to social cues (Blakemore & Mills, 2014). The results obtained by Abrams (2022) indicate that the brain mechanisms involved in reward processing and social evaluation show specific preferences for stimuli from both maternal and unfamiliar voices during the various stages of childhood and adolescent development. These findings provide a neurobiological framework for understanding the shifting dynamics of social orientation throughout the lifespan, both in neurotypical individuals and those with psychiatric disorders, such as individuals with autism (Abrams et al., 2013). Based on such studies, it becomes crucial to be aware of how communication difficulties between parents and adolescents are partly influenced by the natural development of the brain.

Technoaddictive life

Goldberg (1996) introduced the term "Internet Addiction Disorder (IAD)" to describe the impact of excessive Internet use on daily life, despite the absence of addictive substances. Adolescents represent a vulnerable population for developing Internet addiction (Leung, 2007), partly due to the variability in the development of cognitive control (Casey, Tottenham, Liston, and Durston, 2005) and limited ability to establish appropriate boundaries (Liu and Potenza, 2007). In recent years, devices such as computers, smartphones, and tablets have become extremely popular among adolescents, many of whom use these tools compulsively. This phenomenon has led to Internet addiction (IA) becoming a growing global concern (Talis, 2022). The Internet has become widely accessible to adolescents, who use it for recreational activities, socialization, educational support, and information seeking (Kormas et al., 2011; Wang et al., 2011). This easy access provides adolescents with opportunities for learning and social connection but also carries significant risks when its use becomes excessive. With the rapid increase in Internet use, Internet addiction has become a significant mental health and social issue among young people. Although official diagnostic criteria do not yet exist, Young (1998, 1999) conceptualized Internet addiction as an excessive, obsessive-compulsive, and uncontrollable engagement with the Internet that can lead to tolerance, psychological distress, and impaired daily functioning. This condition can take various forms, including cybersex addiction, cyber-relationship addiction, online gaming addiction, information overload, and network compulsions. The global spread of Internet addiction has raised considerable concern, especially because adolescence is a critical period of vulnerability to addictive behaviors (Pallanti, Bernardi, & Quercioli, 2006). Adolescents are more at risk than adults of developing compulsive Internet use patterns, as studies indicate that young people often engage more intensively in online activities (Tsitsika et al., 2009). This issue underscores the need for greater awareness and potential interventions to address and

prevent the negative impacts of excessive Internet use among youth. Excessive use is frequently associated with declines in academic performance, affecting school engagement, and with family tensions, as it may reduce communication quality and increase parent-child conflicts. This highlights how Internet addiction can have detrimental consequences, impairing daily functioning by affecting academic achievement and family interactions, particularly relationships with parents (Anderson, 2001; Tsai & Lin, 2001).

Parent-Adolescent Communication

Effective communication is widely recognized as a critical element for the proper functioning of the family. Open and respectful communication with parents allows adolescents to express their thoughts, emotions, and concerns, feeling heard and supported (Jackson, 1998). As highlighted by studies from Barnes and Olson (1985), positive communication between parents and adolescents not only strengthens family bonds but also helps create a more harmonious environment characterized by love, understanding, and greater flexibility in resolving conflicts. In families where communication is strong, parents tend to be more responsive to the needs of their children, offering appropriate support, while adolescents develop greater self-confidence. This type of interaction not only facilitates family cohesion but also enhances the family unit's ability to adapt to new and complex situations, promoting a balance between adolescent autonomy and parental support. The family, as a fundamental social unit, is susceptible to global transformations, including the evolution of technology and communication. The Internet and media have also impacted parent-child dynamics, becoming widely accessible to children and youth in modern families. Over time, parents have sought to maintain a delicate balance between the educational and social benefits of social media use and its potential

negative effects on children's attitudes, behaviors, and safety (Jamali, 2019; Clark, 2011). For adolescents, peer relationships take precedence over family bonds, with friendships and group activities becoming central (Brown & Larson, 2009; Cotterell, 2013). This shift supports their personal development, and with the rise of digital technologies, the ways adolescents socialize have evolved. Numerous studies highlight a close relationship between the quality of parent-adolescent relationships and adolescents' Internet use (Assunção et al., 2017; Chang et al., 2015; Liu & Zhang, 2012; McMahon & Curtin, 2013). Adolescents who maintain positive, high-quality family relationships are less likely to engage in compulsive Internet use, experience lower levels of social isolation, and tend to use the Internet more responsibly (Ang et al., 2012). According to Günnar (2016), problematic Internet use, common among youth, is linked to family difficulties and feelings of loneliness. As a result, it is the responsibility of adults to create the conditions and seize opportunities to keep communication channels open. Gordon (1994) identified 12 behaviors that indicate a lack of listening and should be avoided, such as giving orders, preaching, criticizing, and minimizing. These behaviors are examples of communication styles that do not contribute to improving communication and often make it more difficult than it already is. A significant aspect relates to the role of tone of voice as a valuable tool we have, and its modulation can prove advantageous in any relational context. In fact, showing an assertive and supportive attitude toward the adolescent would allow them to feel understood and respected in their needs. This, inevitably, would encourage a positive response from the adolescent toward the parent and greater attention to their requests without the shield of the mobile phone.

Conclusion

Adolescence represents a period of profound neurobiological and psychosocial changes that significantly influence emotional and behavioral development. Synaptic reorganization and increased myelination, especially in prefrontal areas, underpin the growing capacity for self-regulation; however, these changes can also heighten adolescents' susceptibility to impulsive behaviors and addictions, as evidenced by excessive Internet use. Internet addiction has emerged as a relevant issue, particularly among youth, due to their specific vulnerability during this developmental stage. The combination of a natural inclination toward novelty-seeking and an incompletely developed capacity for control can indeed foster patterns of compulsive and problematic Internet use. This dependency often results in compromised academic performance, family tensions, and interpersonal difficulties, reducing communication quality and increasing generational conflicts. Such dynamics highlight how Internet addiction not only interferes with adolescents' individual well-being but also poses a significant risk factor for family relationship stability. Finally, it is clear that the quality of parent-child communication plays a crucial role in preventing and managing problematic Internet use. Open, supportive communication that respects adolescents' needs can facilitate dialogue and enhance mutual understanding, reducing the risk of social isolation and promoting a balanced, mindful use of digital technologies. In this regard, it is essential for adults to maintain an effective communication channel, supporting adolescents in their journey toward identity formation and independence, while also monitoring and guiding Internet use to prevent potential misuse and foster healthy psychosocial development.

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