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Conceptual Article

Brain development as 21st-century skills: What is the play doing to my brain?

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As business worlds and societal expectations change rapidly in the 21st century, new skills are required. People are increasingly expected to exhibit critical thinking skills, problem-solving skills, communication skills, collaboration skills, creativity skills, and adaptability skills. Education in the 21st century is expected to develop and support these skills. In order to acquire these skills, brain development is essential. Brain processes information from many sources, interprets senses, and controls and regulates mental processes such as thinking, remembering, and making decisions. Play is, on the other hand, the child's most important tool for understanding the world, making sense of it, discovering himself and the world, dreaming, having fun, and learning. The purpose of this study is to discuss how play contributes to brain growth, which is crucial for developing 21st-century skills in the human body. The relationship between play and 21st-century skills is discussed in this context. Considering motor, language, social, and emotional development within the context of brain development, the effects of play were discussed. Finally, the relationship between video games, which quickly enter children's lives and occupy a significant amount of their time, and brain development was addressed. As a result, play has a significant impact on children's development throughout their lives. There are, however, insufficient studies that examine its effects on brain development because of ethical concerns. The rapid development of technology necessitates examining the effects of play on brain development. The effects of video plays on human behavior and child development are particularly important to understand. Play in video games, however, is insufficiently studied for their impact on brain development.

Keywords: 21st-century skills, brain development, play, brain, video games

1. 21st Century Skills, Play and Brain Development

Access to information is almost unlimited and easy in today's world. It is no longer enough to have knowledge alone in the 21st century. According to Harari (2018), knowledge is the last thing to be taught in schools. The expectations of education are changing in this context. It is no longer enough for educational institutions to simply provide children with information. Among the 21st-century skills, education should equip children with critical thinking, problem-solving, communication, collaboration, creativity, and adaptability (National Research Council, 2012). Furthermore, children should be able to understand and use information, differentiate between important and unimportant information, and relate that information to the world (Harari, 2018). In the 21st century, individuals need to acquire more skills and competencies. The acquisition of these skills is undoubtedly influenced by brain development. Education in the early years is one of the best ways to support brain development and 21st-century skills. This period is crucial for the development of the brain, which is vital to human education (Medina, 2014). Among other things, the brain processes information from many sources, interprets the senses, and controls and regulates mental processes such as thinking, remembering, and making decisions (Carey, 2015). In order for children to acquire all skills, brain development is extremely important (Schlegel, 2011).

The brain develops at its fastest rate during early childhood. An enriched environment and appropriate education can maximize brain development during this period. Studies have shown that early childhood education can enhance the brain's ability to undergo structural or

physiological changes as well as support cognitive development (Diamond et al., 2007; Diamond & Whittington, 2015).

The development of the child's brain is greatly influenced by play during this time. After birth, babies, children, adults, and animals begin to play using built-in neural mechanisms. Animal babies tend to initiate early play from birth. Since infants have a relatively long period of motor immaturity and helplessness, parents must act as scaffolding to initiate play and provide structure and direction (Angier, 1992). As a result of creating connections between nerve cells, play stimulates the brain and helps it develop (Anderson-McNamee & Bailey, 2010). The development of young children's brains and their cognitive abilities is hidden in the veil of play (Sylwester, 1995).

The variety and complexity of the play rapidly increase as neurons begin making physical connections at an astonishing rate. The neural structures of play programs and the resulting, increasingly complex neural structures make play more complicated (Frost et al., 2008). Angier (1992) highlights that animals play best when their brain cells form extensive synaptic connections, a complex network of neural connections allowing electrical signals to be sent from one brain region to another. Playing games (and using these competencies in general) requires the development of structures in the prefrontal regions of the brain (Rothbart et al., 1995). The situation improves as the brain develops through play. The importance of play in brain development cannot be overstated.

In demanding outdoor conditions, children playing in the park will be the closest observers will get to seeing brain growth in action. The way toddlers move, their interactions with other toddlers, the materials they choose to play with, trial and error, moments of exploration, their "out of control" facial expressions, their joy and frustration, early problem-solving leaps, and flight of imagination - it's an ever-evolving symphony of neural structures (Frost et al., 2008).

According to neuroscientists, play is essential to developing a child's brain and mind. It has also been shown that exposure to symbols used in the play promotes brain development. As with the brain, Sutton-Smith (1997) emphasizes that play also starts in a high-potential state. Play enables the brain to realize its potential, according to the researcher, so that potential variability in the brain and behavior will be recorded more than would have been recorded without play. Experts highlight important differences in brain development over the first three years based on the kinds of experiences kids can have. Moreover, the availability of play activities affects not only the development process but also the size of the brain (Brazelton & Greenspan, 2000; Nash, 1997). In the first three years of a child's life, their development and learning depend on both their genetic makeup and their experiences or upbringing. However, other researchers contend that play is reflected in primate brain development from infancy to adulthood (Bekoff, 2001; Smith, 2005).

There may be cultural differences between the plays of girls and boys. While boys enjoy miniature war figures, jousting plays, physical contact, and chasing, girls enjoy jumping rope, hopscotch, dolls, and kitchen utensils. Play involves socially and culturally mediated problem-solving, task analysis, negotiation, and discourse among children (Frost, 1992). Plays that require mental skills and develop children's brains support their brain development. Their brain development increases as their plays become more complex, and their brain development increases as their plays become more complex.

The importance of innate childhood play to healthy learning and continuous improvement cannot be overstated. In the front of the brain, the prefrontal cortex is developed through physical activity, including play. The prefrontal cortex controls the executive functions that make us human. As a result, it serves as the CEO of many brain functions, such as sequencing, planning, rehearsal, evaluation, decision-making, working memory, and comprehension (Ratey, 2008), which all have significant effects on early childhood curriculum (Meltzer, 2010).

The relationship between play and brain development is so intertwined that there can be no clear separation between them. While plays support brain development, they become more complex and detailed as the brain grows. Brain development progresses parallel to play development, and play development progresses parallel to brain development.

The rapidly expanding body of research on the brain indicates that play plays a much more important role than scientists previously believed in health, development, and social interaction. Several early studies used animals because experiments threatening human health could not be conducted on humans (Pellis & Pellis, 2013) provide a comprehensive overview of contemporary animal research on a play). Scientists have been restricted from working in this field due to ethical concerns. This is why scientists use animal behavior to make inferences about human behavior. Nevertheless, with the advancement of technology, studies have begun/will gradually show the negative effects of the lack of play on brain development. It would be helpful to know how play affects the mechanisms of the human brain through research on play and the brain. It should not be forgotten, however, that animal play has accumulated a large amount of information, and some connections have been found between human and animal play (Panksepp, 2010).

2. Brain and Motor Development

Various studies have shown that motor development and physical activities support brain development. According to Kioumortzoglou et al. (1998), basketball players demonstrated superior hand-eye coordination and selective attention. Compared to volleyball players, water polo players showed faster visual response times and better spatial orientation skills. Furthermore, aerobic exercise has been shown to improve a wide range of cognitive abilities, including dual-task performance (Colcombe & Kramer, 2003).

Playing freely in early childhood involves more than physical activity and motor skills; it also involves roleplay, construction, imitation, and use of objects for different purposes. Therefore, free play may be more beneficial for cognitive development than organized physical activity (Burdette & Whitaker, 2005). Additionally to the cognitive effects found by others, Burdette and Whitaker (2005) found improvements in social skills such as attention, intimacy, and emotional affect as a result of free play. By developing motor skills, children are able to interact physically with others. As well as improving communication skills, children can work with friends when playing games. Communication and cooperation are encouraged through team sports.

3. Brain and Language Development

In early childhood, language emerges from play experiences (Hirsh-Pasek et al., 2009). Current studies have shown that whole-child approaches, which emphasize active learning through play and process rather than product, promote language development (Frost, 2010). In free and unstructured play, children actively use their language, and play supports their language development. The number of words a baby hears each day is the most significant predictor of future intelligence, academic performance, and social skills (Blakeslee, 1997). Therefore, as well as supporting language development, plays also support brain development. Developing language skills is essential for 21st-century skills such as communication and collaboration. Communicating effectively with others and expressing oneself effectively are 21st-century skills because today's societies require them. It is through plays that children unable to play on the streets due to safety concerns and who are connected to screens thanks to rapidly developing technology in the current century are able to develop their motor skills, but one of the 21st-century skills is also social development.

4. Brain and Social Development

In order for a child to develop healthy, he or she must interact with other people and socialize with them. Before high-tech neuroimaging studies became available, Vygotsky (1966/1976) emphasized the importance of socializing young children with older children and adults. According to him, play, and consequently higher mental functions, emerge from their interactions. IQ, school grades, and classroom behavior are not the best predictors of adult adjustment, but the child's social skills with others (Hartup, 1992). Through their play, children not only learn basic social skills, but also make sense of their world (see: social development) and learn to adapt to it. Through play, the child learns cooperation, sharing, and problem-solving skills. During this process, play helps the

child cope with an increasingly complex world and social environment. The play provides essential contributions to the child's brain development as well as supporting their social skills. Developing social skills also influences brain development, while brain development impacts social skills.

A mirror neuron is a type of neurophysiological system that is activated through imitation and observation during learning. Mirror neurons respond to both the actions of one individual and those of another individual. A number of cognitive processes are involved in the understanding of actions, including the mirror neuron system, social cognition and social interaction, observational learning, theory of mind, and empathetic comprehension (Chong et al., 2008). Mirror neurons help us understand and imitate the actions of others. When young children can imitate, they learn through observation without direct instruction (Frey & Gerry, 2006). Children are supported while learning and developing their brains with this skill they bring from birth.

5. Brain and Emotional Development

Emotions are controlled by brain connections that are formed before birth. Hugs and supportive words from parents reflect a child's feelings after birth. In this way, the brain's chemical and electrical signals are amplified and the calming circuit is set up (Begley, 1996). In recent years, new neuroimaging technologies have shed light on what has been a source of profound mystery throughout human history: how exactly this complex mass of cells (the brain) functions. As a result of this flood of neurobiological data, we have better understanding of the brain's emotional centers (Goleman, 1995). Physiological activities in the brain tissues are entirely responsible for the thoughts, sensations, joys, and pains we experience (Pinker, 2007). There is a counterpart to our emotions in our brains. Our emotions and brains develop in tandem, so their development is mutually dependent. Emotions are better understood and expressed as our brains develop. Our reactions to our emotions are more accurate when we choose our reactions. However, it is also true in the opposite direction. Gaining expertise and experience in our emotions also helps our brain develop. Play helps us express emotions, to give correct reactions, to discover what we feel when faced with events, i.e., to discover our emotions. Emotional development is greatly facilitated by play (see play and emotion development). As a result, if we support our emotional development through play, we will also support our brain development.

Play promotes wholesome growth and accelerates learning in all contexts. The education also covers affective learning. A neurological drive to explore triggers play. Exploration play stimulates cerebral activity, resulting in the formation of complex neural networks. Role-playing promotes brain development by integrating emotions and cognition into executive function, sensorimotor activity, and verbal expression. Role-playing induces synaptic connections (Szalavitz & Perry, 2011).

Through play, we also learn how to cope with stress, anxiety, and sadness. The development of the brain is also affected by stress. Excessive or sustained trauma floods the brain's circuits with neurochemicals, such as cortisol, and the more often they are stimulated, the easier it is for the circuits to respond. In fact, repeated stress alters the structure of the brain (Begley, 1997). Studies have shown that Children who lost their loved ones to a devastating hurricane still sleep without their clothes and blankets a year later. Additionally, children's paintings still reflect this experience (Frost, 2005). Stress and anxiety will negatively affect the brain structure of children. Through play and adult affection and support, we can minimize this stress and anxiety, and ensure that the brain is not negatively affected. According to Landreth (1991), the play gives a concrete form and expression to the inner world of children. Through symbolic representation, the play helps transform unmanageable situations (such as a hurricane) into manageable ones.

The act of playing allows children to express themselves. As adults develop their brain structures and experience life, they are able to express their experiences. Play, however, is children's language of self-expression. An important part of brain development is play, which helps children resolve conflicts, reduce anxiety, and reduce stress.

6. Brain Development and Video Games

There has been increased interest and concern regarding how video games affect children's development, how they influence human brains and behaviors, and how they contribute to society in general as a result of their popularity. Psychologists, educators, politicians, parents, doctors, and anyone who wants to know how it affects them are curious and perhaps anxious about this. Only a few studies examine the biological effects of video games on brain activity despite the growing popularity of this broad audience.

Positron emission tomography (PET) was used by Haier et al. (1992) to track changes in regional glucose metabolism in patients who had just acquired a thorough visuospatial/motor task. His study found that playing video games reduced brain glucose metabolism overall; this led him to hypothesize that the subjects' brain circuits or neurons per circuit were used less once the task was completed. According to Green and Bavelier (2006), playing action video games increases a player's visual attention and spatial distribution ability. An additional PET study was conducted by Koepp et al. (1998). The findings of both studies indicate that decreased glucose metabolism or increased dopamine release are related to improved playing performance. In order to assess cognitive and deep brain activity spatial resolution, traditional cerebral functional imaging is advantageous. Pediatric studies, however, require a high degree of patient restraint during measurements. However, Feng et al. (2007) concluded that children who play video games may also have enhanced mental rotation abilities. According to a meta-analysis of action video game data covering the period 2000-2015, habitual action video game players tend to have a cognitive advantage of about half a standard deviation. It appears, however, that not all video game genres have equal effects on cognition, with action video games enhancing top-down attention and spatial cognition in particular (Bediou et al., 2018). In their systematic review, Palaus et al. (2017) noted that video game play influences neural pathways when engaging in the 'Flow' experience. Through the reward system, this experience involves the overall activation of somatosensory networks and plays a significant role in skill-difficulty balance. Video game play, however, can have adverse effects, particularly on cognitive skills and attention, as well as on brain development. While the study emphasizes the importance of investigating the neural foundations of video game effects, it focuses on the cognitive and behavioral effects of video game play rather than its neural correlates. Video game playing has primarily beneficial effects on attention and motor skills. These studies have an important limitation in that they were conducted on people who played these games and there was no information about their brain structure before they started playing. There are, however, insufficient studies showing video games have positive effects. Additionally, there is a need for studies that investigate the harmful effects of video games. It should be noted, however, that ethical considerations will limit the scope of these studies.

It is particularly common for families and educators to worry that children are spending too much time in front of the screen and playing video games will harm their brain development. There is, however, insufficient evidence to support or refute this fear. Video games are believed to negatively affect children's brain development if they reduce their physical activities, if they prefer to play video games rather than play games / spend time with their peers or take part in sports, and if they spend a long time watching these videos. Despite the fact that video games support brain development at a limited level and in certain dimensions, as discussed in this section, social relations, interaction with peers, and physical activity contribute significantly. Deficiencies in these dimensions will hinder the development of the child's brain.

7. Conclusion

Human life is based on the brain, the most important organ. The development of the brain continues after birth. Environment plays a role in children's brain development as it does in all other developmental areas. Furthermore, brain development affects other areas of development, such as social, emotional, language and body development.

Participating in play willingly, willingly, and wholeheartedly affects both the child's developmental areas and the brain's development. Due to ethical concerns, brain development studies are not at the desired level. The majority of these studies are conducted on animals, and inferences are made about humans from these studies. Due to rapid advancements in technology and science, scientists should examine the effects of play on brain development in human studies. One of the most important aspects of human development is understanding and supporting brain development.

In addition, as technology has advanced and been published, video games have become a part of human life from a very young age. Several professions are interested and concerned by this entry. An essential factor to consider is how video games affect/will affect child development and human behavior. Brain development is perhaps the most important aspect of human life, and studies investigating video games' effects on brain development are minimal and lacking.

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References

Anderson-McNamee, J. K., & Bailey, S. J. (2010). The importance of play in early childhood development. *Montana State University Extention*, *4*(10), 1-4.

Angier, N. (1992, October 22). The purpose of playful frolics: Training for adulthood. *New York Times*, pp. B5–B6.

Bediou, B., Adams, D. M., Mayer, R. E., Tipton, E., Green, C. S., & Bavelier, D. (2018). Meta-analysis of action video game impact on perceptual, attentional, and cognitive skills. *Psychological Bulletin, 144*(1), 77–110. https://doi.org/10.1037/bul0000130

Begley, S. (1996, February 29). Your child's brain. *Newsweek*, pp. 55–58.

Begley, S. (1997, Spring-Summer). How to build a baby's brain. *Newsweek Special Edition*, pp. 28–32.

Bekoff, M. (2001). *Social play behaviour: Cooperation, fairness, trust, ve the evolution of morality. Journal of Consciousness Studies, 8*(2), 81-90.

Blakeslee, S. (1997, April 17). Studies show talking with infants shapes the basis of their ability to think. *New York Times*, p. A14.

Brazelton, T. B., & Greenspan, S. I. (2000). *The irreducible needs of children: What every child must have to grow and learn*. Perseus.

Burdette, H. L., & Whitaker, R. C. (2005). Resurrecting free play in young children: Looking beyond fitness and fatness to attention, affiliation, and affect. *Archives of Pediatric and Adolescent Medicine*, *159,* 46–50. https://doi.org/10.1001/archpedi.159.1.46

Carey, B. (2015). *How we learn: The surprising truth about when, where, and why it happens.* Random House.

Chong, T., Cunningham, R., Williams, M., Kanwisher, N., & Mattingly, J. (2008). MRI adaption reveals mirror neurons in human inferior parietal cortex. *Current Biology*, *18*(20), 1576–1580. https://doi.org/10.1016/j.cub.2008.08.068

Colcombe, S. J., & Kramer, A. F. (2003). Fitness effects on the cognitive function of older adults: A meta-analytic study. *Psychological Science, 14*, 125–130. https://doi.org/10.1111/1467-9280.t01-1-01430

Diamond, A., Barnett, W. S., Thomas, J., & Munro, S. (2007). Preschool program improves cognitive control. *Science, 318*(5855), 1387-1388. https://doi.org/10.1126/science.1151148

Diamond, A., & Whitington, V. (2015). Studying early brain development: Educators' reports about their learning and its applications to early childhood policies and practices. *Australasian Journal of Early Childhood*, *40*(3), 11-19. https://doi.org/10.1177/183693911504000303

Feng, J., Spence, I., & Pratt, J. (2007). Playing an action video game reduces gender differences in spatial cognition. *Psychological Science, 18*, 850–855. https://doi.org/10.1177/183693911504000303

Frey, S., & Gerry, V. (2006). Modulation of neural activity during observational learning of actions and their sequential orders. *Journal of Neuroscience, 26*(51), 13194–13201. https://doi.org/10.1523/JNEUROSCI.3914-06.2006

Frost, J. L. (1992). *Play and playscapes.* Delmar. https://doi.org/10.4324/9780203868652

Frost, J. L. (2005). Lessons from disasters: Play, work and the creative arts. *Childhood Education, 82,* 2–8. https://doi.org/10.1080/00094056.2005.10521332

Frost, J. L. (2010). *A history of children's play and play environments: Toward a contemporary child-saving movement.* Routledge.

Frost, J. L., Wortham, S. C., & Reifel, R. S. (2008). *Play and child development* (pp. 140-141). Pearson.

Goleman, D. (1995*). Emotional intelligence*. Bantam

Green, C. S., & Bavelier, D. (2006). Effect of action video games on the spatial distribution of visuospatial attention. *Journal of experimental psychology: Human Perception and Performance, 32*(6), 1465-1478. https://doi.org/10.1037/0096-1523.32.6.1465

Haier R. J., Siegel, B. V., MacLachlan, A., Soderling, E., Lottenberg, S., & Buchsbaum, M. S. (1992). Regional glucose metabolic changes after learning a complex visuospatial/motor task: a positron emission tomographic study. *Brain Research*, *570,* 134–43. https://doi.org/10.1016/0006-8993(92)90573-R

Harari, Y. N. (2018). *21 Lessons for the 21st Century:'Truly mind-expanding... Ultra-topical'Guardian*. Random House.

Hartup, W. W. (1992). *Having friends, making friends, and keeping friends: relationships as educational contexts* (ED345854). ERIC.

Hirsh-Pasek, K., & Golinkoff, R. M. (2003). *Einstein never used flash cards.* Rodale.

Kioumourtzoglou, E., Derri, V., Tzetzls, G., Theodorakis, Y., et al. (1998). Cognitive, perceptual and motor abilities in skilled basketball performance. *Perceptual and Motor Skills, 86*, 771–786. https://doi.org/10.2466/pms.1998.86.3.771

Koepp, M. J., Gunn, R. N., Lawrence, A. D., Cunningham, V. J., Dagher, A., Jones, T., Brooks, D. J., Bench, C. J., & Grasby, P. M. (1998). Evidence for striatal dopamine release during a video game. *Nature*, *393*, 266–268. https://doi.org/10.1038/30498

Landreth, G. L. (1991). *Play therapy: Theart of the relationship*. Accelerated Development Inc.

Medina, J. (2014). *Brain rules for baby, Updated and expanded: How to raise a smart and happy child from zero to five*. Pear Press.

Meltzer, L. (2007). *Executive function in education.* The Guilford Press.

Nash, J. M. (1997). *Global paradox.* Avon.

National Research Council. (2012). *Education for life and work: Developing transferable knowledge and skills in the 21st century*. National Academies Press.

Palaus, M., Marron, E. M., Viejo-Sobera, R., & Redolar-Ripoll, D. (2017). Neural basis of video gaming: A systematic review. *Frontiers in Human Neuroscien*ce, *11*, 248. https://doi.org/10.3389/fnhum.2017.00248

Panksepp, J. (2022). Affective neuroscience of the emotional BrainMind: evolutionary perspectives and implications for understanding depression. *Dialogues in clinical neuroscience*, *12*(4), 533-545. https://doi.org/10.31887/DCNS.2010.12.4/jpanksepp

Pellis, S., & Pellis, V. (2013). *The playful brain: venturing to the limits of neuroscience*. Simon and Schuster.

Pinker, S. (2007). The mystery of consciousness. *Time*, *169*(5), 58-70.

Ratey, J. J., & Hagerman, E. (2008). *Spark: The revolutionary new science of exercise and the brain*. Little, Brown & Co.

Rothbart, M. K., Posner, M. I., & Hershey, K. L. (1995). Temperament, attention, and developmental psychopathology. In D. Cicchetti & D. J. Cohen (Eds). *Developmental psychopathology* (pp. 315-340). Wiley.

Schlegel, S. (2011). Mind in the making: the seven essential life skills every child needs. *Journal of Developmental & Behavioral Pediatrics*, *32*(5), 401. https://doi.org/10.1097/DBP.0b013e31821f8d89

Smith, A. (2005*). The brain's behind it: New knowledge about the brain and learning.* Crown House.

Sutton-Smith, B. (1997). *The ambiguity of play.* Harvard University Press.

Sylwester, R. (1995). *A celebration of neurons: An educator's guide to the human brain*. Association for Supervision and Curriculum Development.

Szalavitz, M., & Perry, B. D. (2011). *Born for love.* Harper Collins Publishers.