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CONVERGENCE OF MAN AND MACHINE: ARTIFICIAL INTELLIGENCE IN HUMAN LIFE

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Abstract: In an era where the boundaries between man and machine are becoming increasingly blurred, the article dives into exploring the revolutionary convergence between artificial intelligence (AI) and the human body. Analysing significant developments in the fields of brain-computer interfaces (BCI) and virtual reality (VR), the article highlights how these advanced technologies are redefining how humans interact with the digital, expanding sensory and cognitive experiences beyond traditional physical boundaries. While BCI offers new ways of communication and control, especially for people with disabilities, VR creates immersive worlds that open new frontiers of human experience. However, along with these advances come complex ethical issues, including issues of privacy, autonomy and psychological impact. The article emphasises the importance of an interdisciplinary approach in addressing these challenges, bringing together knowledge from neuroscience, psychology, engineering, philosophy and pedagogy. Looking to the future from an inclusive perspective, the need to move forward with a critical awareness is emphasised, ensuring that the benefits of these technologies are distributed fairly and contribute positively to societal progress and individual well-being, balancing technological innovation with a deep respect for human dignity.

Keywords: Virtual reality; Human body; Artificial intelligence; Technologies; Inclusion.

1. Introduction

Today's era of advanced technology has ushered in an era where the integration of artificial intelligence (AI) with the human body opens up unprecedented horizons, promising to revolutionise not only our physical and cognitive capabilities but also reshape our very understanding of what it means to be human. This article aims to examine the complex interplay between AI and the human body, exploring how these emerging technologies are not only extending the limits of our capabilities, but also redefining our understanding of mind and body. At the heart of this study is Embodied Cognition (Morin 1989; Varela et al., 1992; Lakoff, Johnson 1999; Merleau Ponty, 2002; Shapiro, 2010), which stands as an important theoretical pillar in this area of research. According to this perspective, the human body is not simply a passive shell that houses the brain, but an active agent that influences and shapes our cognitive process. This interdisciplinary approach, combining corporeality, neuro-

science and education, emphasises the importance of the interactions between body, space, mind and emotions in learning (Gomez Paloma, 2017).

The paper will explore the role of the sensory-motor-emotional system in shaping our cognitive processes, highlighting how the integration of these systems influences human thought patterns (Gallese, 2001). Furthermore, the concepts of intersubjectivity and meaning transfer will be examined, where the human body acts as a pre-reflective and pre-verbal medium for communication and social interaction, an idea supported by the studies of Rizzolatti (1996; 2004) and later by Gallese (2007). A further focus will be placed on embodied cognitive processing and body representations, exploring how these influence the performance of cognitive tasks, drawing on research by Goldman (2009) and Caruana & Borghi (2016). Furthermore, the importance of mirror neurons and embodied simulation in facilitating empathy and understanding of others' actions, a concept highlighted by Berthoz & Petit (2006), will be discussed. Finally, the paper will explore how these cognitive and neuroscientific researches intersect with the development of AI, particularly with regard to brain-computer interface, virtual reality and simulation technologies. The ethical implications and potential practical applications of these advanced technologies will be discussed, both in the field of education and in the health of the body, thus providing a complete picture of this fascinating convergence of man and machine.

In the field of scientific research related to the integration of artificial intelligence (AI) with the human body, particularly in the areas of brain-computer interfaces (BCI) and virtual reality (VR), there is an interdisciplinary evolution that maps out a complex and rich understanding. This scenario is explored through a lens that combines neuroscience, psychology, engineering and pedagogy, with significant contributions from several seminal works. Embodied cognitive science (Noë, 2004; Clark, 2008) has emphasized how experience is not confined to the brain, but emerges from the interaction between mind, body and environment: this concept proves crucial to understanding how AI can be integrated with the human body, particularly in the development of BCIs. The works of Damasio (1999) and Pfeifer & Bongard (2006) offer an in-depth analysis of the biological and neural mechanisms underlying these interactions, which are essential for the progress of BCIs. The role of mirror neurons (Rizzolatti, 1996; 2004), has opened up new perspectives in understanding how the brain can connect to external systems, knowledge that is crucial for the advancement of BCI. These studies were complemented by research (Wolpert, Doya & Kawato, 2003), which provided a computational framework for motor control and social interaction, key elements for brain-computer interfaces. In parallel, VR and embodied simulation technologies (Berthoz & Petit, 2006; Iacoboni 2008), have shown how immersive experiences can be created that transcend physical boundaries, the understanding of the cognitive basis of simulation and bodily experience (Barsalou, 2008; Niedenthal, 2007), is fundamental to the development of VR. Also important is the inclusion of ethical and philosophical considerations in the use of AI in the human body (Thagard, 2005; Lakoff & Johnson, 1999; Goldman, 2009; Caruana & Borghi, 2016), emphasizing the need for a responsible, interdisciplinary approach, bringing together expertise from various fields to address the complex challenges that integrating AI with the human body presents. This convergence of disciplines offers a deeper and more robust understanding of the potential and challenges of integrating AI with the human body, laying the foundation for future innovations and raising ethical issues that need continued attention and in-depth analysis.

2. Embodied Cognitive Science: rediscovering body cognition for innovative experiences

Embodied Cognitive Science marks a significant evolution in our understanding of cognition and learning. This interdisciplinary field challenges traditional conceptions that confine cognition to the neural activities of the brain, arguing instead that it is deeply rooted in and shaped by bodily experiences. The human body, in its totality of sensory, motor and emotional interactions, acts not as a mere passive container, but as a crucial actor in the cognitive process (Gomez Paloma, 2017).

The concept of 'embodied education' (Francesconi & Tarozzi, 2012) focuses on individual self-perception and identity, emphasizing the importance of personal relationships in defining our interaction with the world. This approach recognizes two fundamental components: a perceptual and a motor component (Caruana & Borghi,2013) that together influence our ability to process emotions, make decisions and represent ourselves in various life situations. Furthermore, Merleau Ponty (1962) anticipated the shift from an outcome-focused view of human behaviour to an emphasis on the role of the body and personal experience in the formation of knowledge and self-awareness, i.e. the importance of moving from purely objective to situational and relational reasoning. This is reflected in the interaction between bodily conduct and reality, where the body is not only a passive participant but an active and determining element in experience:) such integration between body, environment and situation is essential for cognition and openness to change (Tarozzi, 2008; Cescato, 2015).

The essence of the present is the action of the individual in concrete situations, forming meaningful experiences and strengthening awareness of the impact of one's actions. Education should help develop this active awareness, which is essential for shaping a personal worldview (Francesconi et al., 2012). The importance of maintaining innate awareness tends to fade with growth. Therefore, children should be encouraged to explore freely, activating their kinesthetic-body intelligence and paying attention to everyday situations, avoiding automatic and routine responses (Cescato, 2015).

In conclusion, Embodied Cognitive Science offers a revolutionary holistic view of learning and cognition, considering body, mind and environment as interconnected components of a single complex system. This innovative approach challenges educators and researchers to reinvent learning environments, promoting contexts that stimulate not only intellectually, but also physically and emotionally, integrating the body fully into the educational process. Adopting this paradigm can radically transform the way we teach and learn, emphasising the importance of a truly integrated, body-based education.

3. From sensory-motor-emotional system to cognitive processes: an integrated vision of human cognition

Understanding the role of the sensory-motor-emotional system in cognitive processes (Gallese, 2014) is a milestone in contemporary cognitive science. This holistic approach, which transcends the traditional view of the brain as the sole center of thought, opens new perspectives on the nature of human cognition. The sensory-motor-emotional system is not only a mechanism of response to external stimuli but is an integral component that actively contributes to the formation of our concepts and thoughts.

The interaction between sensory systems, motors and cognition is much deeper than previously guessed. Every physical movement, every sensory perception and every emotional reaction leaves an imprint in our mind, influencing the way we think and perceive the world. For example, our ability to understand spatial concepts such as "above" or "below" is intrinsically linked to our physical experience of space and movement in the world. Research in neuroscience has shown that the areas of the brain involved in physical movement are also active in the processing of these spatial notions (Meraviglia, 2012). Emotions, often neglected in traditional cognitive theories, play a fundamental role in modulating our perception and decision-making. Emotional states such as happiness, sadness, fear or excitement can alter our attention, perception and memory, thus influencing our ability to process and interpret information. For example, a state of anxiety can limit our ability to focus on complex tasks, while joy can enhance creativity and openness to new ideas (Colombetti & Thompson, 2008).

Mirror neurons (Gallese et al., 2006) offer a significant example of how the motor-sensor system is intrinsically linked to our ability to understand others. These neurons, which are activated both when we perform an action and when we observe another person performing the same action, are fundamental to our ability to empathize and understand the intentions of others. This discovery suggests that our understanding of others is deeply rooted in our neural and bodily structures, and is not just an abstract process. Understanding the role of the sensory-motor-emotional system in cognition has significant implications for education since it emphasizes the importance of experiential learning that actively involves the body and emotions of students. This includes the use of teaching methodologies that promote learning through movement, sensory experiences, and emotional expression. The integration of the sensory-motor-emotional system into our understanding of cognitive processes represents a significant step forward in cognitive science. This integrated vision emphasizes that to fully understand the nature of human cognition, we must consider the body and emotions not as peripheral elements, but as central components of our cognitive being, Such an approach not only enriches our understanding of the human mind, but also provides a foundation for more effective and humanistic educational and therapeutic approaches.

4. Intersubjectivity and transfer of meanings: the central role of the body in human communication

Intersubjectivity and the transfer of meanings represent key concepts in the field of human communication and embodied cognition (Ferri et al., 2011). At the heart of these dynamics lies the fundamental role of the human body, not only as an instrument of expression, but as an active and essential mediator in the sharing and understanding of meanings.

The human body actively participates in the transfer of meanings through a variety of channels. Every gesture, facial expression, posture and tone of voice brings with it a load of information that goes far beyond the verbal content of communication. This non-verbal dimension of body language is often intuitive and acts on a pre-reflective plane, communicating emotions, intentions and moods in ways that words alone cannot capture. Intersubjectivity refers to our ability to relate to others, sharing experiences and understanding their views. This empathic connection is fa-

cilitated by our bodily experience. Mirror neurons, for example, illustrate how our brain reacts to the actions and emotions of others in ways that reflect our bodily experience. When we watch someone smile or wrinkle their forehead, mirror neurons activate, allowing us to "feel" those emotions, thus improving our ability to empathize and understand. In social communication (Fortunato et al., 2002), the human body goes far beyond its role as a mere means of physical expression, since in non-verbal communication, including gestures, eye contact, body language and voice tone, is crucial to establishing and maintaining social relationships. These non-verbal elements play a fundamental role in building trust and expressing feelings and moods that may be difficult to verbalize. Understanding the body's role in intersubjectivity and the transfer of meanings has important practical implications, especially in areas such as education and therapy. In education, this approach emphasizes the importance of a learning environment that encourages not only verbal interaction, but also body communication and movement. This can help develop more comprehensive communication skills and foster more immersive and engaging learning. In the therapeutic field, techniques that incorporate body awareness (Guerini, 2018) and non-verbal language can be particularly useful. For example, therapy through movement and dance can be effective in treating emotional and psychological disorders (Mignosi, 2015), harnessing the power of the body to express and work through emotions and trauma that may be difficult to articulate in words.

The human body plays a central and active role in intersubjectivity and the transfer of meanings. Our ability to communicate effectively, understand others, and form meaningful social relationships largely depends on our bodily experience. This bodily perspective enriches not only our understanding of human interactions, but also provides a solid foundation for more integrated and bodily approaches in various fields, from education to therapy. Recognizing and valuing the role of the body in human communication opens the way to more empathic, connected and authentic practices.

5. Mirror neurons and simulation embodied: neurobiological foundations of empathy and social understanding

Mirror neurons and incarnate simulation (Gallese, 2013) represent fundamental concepts in modern neuroscience, offering a detailed understanding of how empathy and understanding of the actions of others are rooted in the neurobiological and bodily structures of the human being. These mechanisms not only illuminate crucial aspects of social cognition, but also open new perspectives on the origin and nature of human empathy.

Mirror neurons, discovered in the premotor cortex of primates and later in humans, are particular brain cells that activate both when an individual performs an action, and when he observes another person performing the same action. This discovery suggested a direct connection between perception and action, providing a neurobiological basis for empathic understanding. These mirror neurons not only activate in response to physical movements, but also in response to emotional facial expressions, suggesting that their role extends far beyond mere motor imitation. This reactivity reflects a cerebral system that allows individuals to "map" internally the actions and emotions observed in others (Rizzolatti & Vozza, 2007), facilitating an intuitive and non-verbal understanding of the mental states of others.

The concept of simulation embodied extends and deepens the understanding provided by mirror neurons. The embodied simulation suggests that the process of understanding others is not limited to one brain mechanism, but involves the entire body. When we observe another person expressing a certain emotion or performing an action, our body simulates that same experience on a subconscious level. This process of simulation is not only a mere internal representation, but a real body resonance with the experience of the other.

The integration of mirror neuron concepts and embodied simulation provides a robust framework for understanding how humans interpret and respond to each other's actions and emotions. This empathic simulation ability is critical in everyday social interactions, as it allows individuals to intuitively understand others without the need for explicit verbal language. This is particularly crucial in situations where words may be inadequate or misleading, allowing for a deeper understanding based on nonverbal signals and an implicit emotional connection.

Mirror neuron and simulation research has significant implications for a variety of fields, from psychology to pedagogy, from therapy to robotics. In the educational and therapeutic field, this understanding can guide the development of strategies that value empathy and interpersonal connection. In addition, embodied simulation offers fascinating perspectives for the development of robots and artificial intelligence that can mimic and respond more naturally and intuitively to human emotions, potentially revolutionizing the way we interact with technology (Brignone et al., 2020).

Thus, mirror neurons and embodied simulation provide us with a deep understanding of how our neurobiological (Mazzotta, 2007) and bodily structure facilitates an intuitive empathic understanding of the actions and emotions of others. These discoveries not only enrich our knowledge of social cognition and empathy, but also pave the way for new and exciting applications in various fields, emphasizing the importance of considering the body and mind as an integrated system (Francesco & Piredda, 2016) and interconnected in our human experience.

6. AI and the Human Body: applications and ethical implications in a connected world

The integration of artificial intelligence (AI) with the human body represents a compelling and complex frontier in science and technology (Stano, 2023). This fusion of embodied cognition and AI paves the way for breakthrough innovations, particularly in brain-computer interfaces, virtual reality, and simulation technologies. However, with these extraordinary opportunities significant ethical issues also emerge that require careful consideration.

Brain-computer interfaces (BCIs) are transforming the way we interact with technology. Through the use of advanced sensors and AI algorithms, these interfaces allow direct communication between the human brain and computer systems. However, with these opportunities delicate ethical issues emerge. Privacy and data security become primary concerns, as BCIs can potentially access personal thoughts and intentions (Ienca, 2019). Moreover, the possibility of inadvertent manipulation or control of human behavior raises significant concerns about individual freedom and autonomy. Virtual reality (VR) and embodied simulation offer immersive modes of interaction with digital environments, extending human sensory and motor experiences. VR applications range from training and education, where users can experience

complex scenarios in safe environments. Despite the benefits, VR also raises ethical questions.

Prolonged use of virtual environments can have psychological effects, including dependence or confusion between virtual and physical reality. Moreover, there are concerns about the potential impact of VR on personal and social identity, especially in relation to representation and interaction in virtual environments that may differ radically from reality (Pieretti, 2020). Simulation technologies, embracing both VR and other advanced AI systems, are rewriting the rules of what is possible in terms of learning, research, and human interaction. These technologies have the potential to create scenarios and environments for training, scientific research and the exploration of new forms of artistic expression. However, simulation brings important ethical dilemmas. Creating realistic, but potentially manipulative, virtual environments raises questions about the veracity and integrity of the experiences provided. Moreover, interaction in these virtual environments poses challenges related to the fair and respectful representation of different cultures, identities and human experiences. The evolution of technologies that integrate AI and the human body (Di Lella, 2023) requires careful navigation in the ethical territory. The opportunities offered by these innovations are immense, but they must be balanced with the consideration of privacy, autonomy, integrity and social impact. An approach that takes into account ethical implications, involving a wide range of stakeholders, including scientists, legislators, ethics and the public, is essential to ensure that these technologies are developed and implemented in a responsible and beneficial way.

7. Concluding reflections

The convergence between artificial intelligence (AI) and the human body marks a fundamental stage in our journey towards the future, a path that is continually redefining the boundaries between the natural and the artificial. Progression in fields such as brain-computer interfaces (BCIs) has opened new avenues in the communication and control of electronic devices, offering unprecedented opportunities. However, these extraordinary opportunities also bring ethical and social challenges. Issues regarding privacy, individual autonomy, and the psychological consequences of these immersive technologies require careful and thorough examination. The future of these technologies, deeply intertwined with our human existence, will require a balance between the desire for innovation and the need to maintain and respect fundamental ethical principles. Collaboration between different disciplines, from neuroscience to philosophy, from engineering to ethics, will be crucial to navigate this complex technological landscape. Progress must be driven not only by enthusiasm for new and innovative, but also by a deep sense of responsibility for the social and individual implications of our technological choices.

As we move towards a future in which the AI and the human body become increasingly integrated, we must proceed with a critical awareness of the challenges and opportunities that lie ahead. This means not only celebrating the incredible possibilities offered by these technologies, but also recognizing and proactively addressing their potential repercussions on society and the individual. Ultimately, the success of this integration will be measured not only in terms of technological progress, but also in our ability to ensure that this progress takes place in a fair, ethical and respectful of human dignity and integrity.

References

Barsalou, L. W. (2008). "*Grounded Cognition*". Annual Review of Psychology.

Berthoz, A., & Petit, J. L. (2006). "*The Physiology and Phenomenology of Action*". Oxford University Press.

Brignone, S., Grimaldi, R., Denicolai, L., & Palmieri, S. (2020). Intelligenza artificiale, robot e rappresentazione della conoscenza. Il Laboratorio di simulazione del comportamento e robotica educativa" Luciano Gallino". *THE LAB'S QUARTERLY*, 2, 143-161.

Caruana, F. & Borghi, A.M. (2013). Embodied Cognition: una nuova psicologia. *Giornale Italiano di Psicologia*, 1, 23-48.

Caruana, F., & Borghi, A. M. (2016). "*Embodied Cognition: A New Approach to Understanding the Mind*". Philosophy Compass.

Casillo, M., Lombardi, M., Lorusso, A., Marongiu, F., Santaniello, D., & Valentino, C. (2022, June). Sentiment analysis and recurrent radial basis function network for bitcoin price prediction. In 2022 *IEEE 21st Mediterranean Electrotechnical Conference (MELECON)* (pp. 1189-1193). IEEE.

Cescato, S. (2015). Vedere il mondo in un granello di sabbia. Il ruolo del momento presente nello studio dell'esperienza educativa. *Encyclopaideia, XIX* (41), 4-20.

Clarizia, F., Colace, F., De Santo, M., Lorusso, A., Marongiu, F., & Santaniello, D. (2022, September). Augmented Reality and Gamification technics for visit enhancement in archaeological parks. In 2022 *IEEE 2nd IoT Vertical and Topical Summit for Tourism* (IoTT) (pp. 1-4). IEEE.

Clark, A. (2008). "*Supersizing the Mind: Embodiment, Action, and Cognitive Extension*". Oxford University Press.

Colombetti, G., & Thompson, E. (2008). Il corpo e il vissuto affettivo: verso un approccio «enattivo» allo studio delle emozioni. *Rivista di estetica*, (37), 77-96.

Damasio, A. (1999). "*The Feeling of What Happens: Body and Emotion in the Making of Consciousness*". Harcourt Brace.

Di Francesco, M., & Piredda, G. (2012). La mente estesa. Un bilancio critico. *Sistemi intelligenti*, 24(1), 11-34.

Di Lella, F. (2023). Intelligenza artificiale e atti di disposizione del proprio corpo. *QUADERNI DI BIOETICA*, 21, 405-418.

Ferri, F., Campione, G. C., & Gentilucci, M. (2011). L'emergere del linguaggio e gestualità. *Sistemi intelligenti*, 23(2), 301-308.

Fortunati, L., Katz, J., & Riccini, R. (2002). *Corpo futuro. Il corpo umano tra tecnologie, comunicazione e moda* (Vol. 1, pp. 1-299). FrancoAngeli.

Francesconi, D., & Tarozzi, M. (2012). Embodied Education. A Convergence of Phenomenological Pedagogy and Embodiment. *Studia Phaenomenologica*, XII, 263-288.

Gallese, V. (2001). "The 'Shared Manifold' Hypothesis: From Mirror Neurons to Empathy". *Journal of Consciousness Studies*.

Gallese, V. (2013). *Corpo non mente: le neuroscienze cognitive e la genesi di soggettività ed intersoggettività*, 8-24.

Gallese, V. (2014). Arte, corpo, cervello: per un'estetica sperimentale. *Micromega*, 2(2014), 49-67.

Gallese, V., Eagle, M. N., & Migone, P. (2006). La simulazione incarnata: i neuroni specchio, le basi neurofisiologiche dell'intersoggettività e alcune implicazioni per la psicoanalisi. *La simulazione incarnata*, 1000-1038.

Goldman, A. (2009). "*Mirror Neurons and the Simulation Theory of Mind-Reading*". Trends in Cognitive Sciences.

Gomez Paloma, F. (2017). *Embodied Cognition: Theories and Applications in Education Science*. Nova Science Publishers, Incorporated.

Iacoboni, M. (2008). "*Mirroring People: The Science of Empathy and How We Connect with Others*". Farrar, Straus and Giroux.

IENCA, M. (2019). Tra cervelli e macchine: riflessioni su neurotecnologie e su neurodiritti. *Notizie di Politeia, XXXV*, 133.

Lakoff, G., & Johnson, M. (1999). "*Philosophy in the Flesh: The Embodied Mind and its Challenge to Western Thought*". Basic Books.

Mazzotta, S. (2007). *I neuroni specchio, l'empatia e la coscienza*. I neuroni specchio, l'empatia e la coscienza, 185-209.

Meraviglia, M. V. (2012). *Sistemi motori: Nuovi paradigmi di apprendimento e comunicazione*. Springer Science & Business Media.

Merleau-Ponty, M. (1962). *Phenomenology of Perception*. London and New York: Routledge and Kegan Paul.

Mignosi, E. (2015). Il corpo e l'arte come risorsa formativa all'Università: un percorso verso la danza-movimento terapia per futuri formatori. *Studi sulla Formazione/Open Journal of Education*, 18(1), 161-185.

Morin, E. (1989). *La conoscenza della conoscenza*. Milano: Feltrinelli.

Niedenthal, P. M. (2007). "*Embodying Emotion*". Science.

Noë, A. (2004). "*Action in Perception*". MIT Press.

Pfeifer, R., & Bongard, J. (2006). "*How the Body Shapes the Way We Think: A New View of Intelligence*". MIT Press.

Pieretti, A. (2020). Oltre l'intelligenza artificiale. *Oltre l'intelligenza artificiale*, 253-270.

Rizzolatti, G. et al. (1996). "*Premotor Cortex and the Recognition of Motor Actions*". Cognitive Brain Research.

Rizzolatti, G. et al. (2004). "*A Unifying View of the Basis of Social Cognition*". Trends in Cognitive Sciences.

Rizzolatti, G., & Sinigaglia, C. (2006). "*Mirrors in the Brain: How Our Minds Share Actions and Emotions*". Oxford University Press.

Rizzolatti, G., & Vozza, L. (2007). *Nella mente degli altri. Neuroni specchio e comportamento sociale* (Vol. 4). Zanichelli Editore IT.

Shapiro, L. (2010). *Embodied Cognition*. London: Routledge.

Stano, S. (2023). I corpi (im) possibili dell'Intelligenza Artificiale. In *Semiotica e Intelligenza Artificiale* (pp. 219-237). Aracne.

Tarozzi, M., & Francesconi, D. (2012). Per un'embodied education fenomenologicamente fondata. *Encyclopaideia, XVII* (37), 11-17.

Thagard, P. (2005). "*Mind: Introduction to Cognitive Science*". MIT Press.

Varela, F.J., Thompson E.T., Rosch E. (1991). *The Embodied Mind: Cognitive Science and Human Experience*. MA: MIT Press.

Wolpert, D. M., Doya, K., & Kawato, M. (2003). "*A Unifying Computational Framework for Motor Control and Social Interaction*". Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences.