Journal of Inclusive Methodology and Technology in Learning and Teaching
ISSN 2785-5104
Anno3 n.4(2023)

EDIZIONI UNIVERSITARIE ROMANE
editoria scientifica dal 1952

CONNECTION HYPOTHESIS BETWEEN ARTIFICIAL INTELLIGENCE, EMBODIED COGNITION AND BODY PERCUSSION

Mariapia Mazzella [1,*] & Antinea Ambretti [2]

[1] Università degli Studi di Cassino e del Lazio Meridionale; Mariapia.Mazzella@unicas.it
[2] Università Pegaso; Antinea.Ambretti@unipegaso.it
* Correspondence: Mariapia.Mazzella@unicas.it

Abstract: This work explores the hypothesis of a connection between Artificial Intelligence (AI), Embodied Cognition and Body Percussion. The fundamental premise is that traditional machine learning methods in AI differ greatly from the ways humans learn. Embodied Cognition emphasizes the essential role of the physical body and its interactions with the environment in the learning process. This revolutionary perspective contradicts traditional cognitive theories that isolate the mind as an information processor far from the body. In this context, the hypothesis is considered that intelligent agents, including virtual robots, should learn in a similar way to humans, actively interacting with the environment and their body. Body Percussion, a musical-motor activity that involves the human body in the creation of rhythms and sounds, emerges as a bridge between Embodied Cognition and AI. This work suggests that the practice of Body Percussion can be an innovative method to develop cognitive and motor skills and promote inclusion in education. It also stresses the importance of considering the body and the environment as key components in designing more advanced AI systems. This study provides food for thought for further research and practical applications in education and robotics.

Keywords: Artificial Intelligence, Embodied Cognition, Body Percussion

1. Introduction

The methods for machine learning differ from how humans learn. Humans learn by seeing, moving, interacting, and speaking with others. Humans learn from sequential experiences, not from mixed and random experiences. 'Embodied intelligence' refers to the concept of intelligence that is closely tied to and emerges from the physical body and its interactions with the environment. This perspective assumes that the body is not merely a vessel for the mind but plays a crucial role in how an intelligent agent perceives, learns, and interacts with the world. Embodied intelligence highlights the role of the body in interacting with the physical environment. The physical body and its sensorimotor abilities are essential for perceiving and navigating the world.

The thesis of embodied artificial intelligence is that embodied agents (or virtual robots) learn in the same way humans do. This is why a deep understanding by experts in cognitive sciences and psychology is fundamental. This means that virtual robots should learn by seeing, moving, speaking, and interacting with the world, just like humans. Assuming that this may one day be possible, one must start from Embodied Cognition, which is a theoretical framework in cognitive sciences suggesting that cognitive processes are deeply interconnected with the body and its interactions with the environment. This perspective clashes with traditional views that cognition is solely a product of information processing by the brain. Embodied cognition presupposes that perception and action are closely linked. Our understanding of the world is influenced by our physical interactions with it. For instance, when you reach out your hand to grasp an object, your perception of that object is shaped by the actions your body takes to interact with it. Embodied Cognition has allowed us to understand that cognition extends into the body: many mental states arise from bodily experience. The new exploratory direction of cognitive sciences - embodied cognitive science - reintegrates cognition into the realm of the body, acknowledging as relevant, indeed essential and irreducible, all cognitive manifestations closely linked to corporeality: emotion, affectivity, intentionality, action (Damasio, 1994; 1999). The classic cognitivist paradigm held that cognition was a computational process based on language that used the syntactic nature of cognitive processes. This was akin to a calculation the mind executed by following rules and logical operators applied to propositions involved in transforming inputs into outputs. Cognitive sciences in the latter half of the 20th century were thus based on the idea that human cognition was symbolic processing independent of the physical support on which it takes place, namely, the body. Today, the neuroscientific and philosophical communities believe that such an approach is inadequate or incorrect in explaining the genesis and development of cognitive processes.

The prevalent opinions in the philosophy of mind and cognitive sciences have hitherto considered the body peripheral in understanding the nature of the mind and cognition, as philosopher Robert A. Wilson (2015) writes: "Traditional views in the philosophy of mind and cognitive sciences describe the mind as an information processor, such that connections with the body and the world are of little theoretical importance. Conversely, growing empirical evidence shows that bodily states and specific systems for perception and action underpin information processing, and embodiment contributes to various aspects and effects of mental phenomena." Many experimental studies demonstrate a dependency between an agent's possession of particular cognitive abilities and the morphological and dynamic characteristics of its

body. This new paradigm is slowly replacing the traditional abstract and mentalistic view of cognition. Since 1998, philosophers Andy Clark and David Chalmers have proposed the concept of "extended mind," which has become part of the ongoing debate in the philosophy of mind. Clark and Chalmers then highlighted the role that some "objects" play in mental processes. For instance, notebooks where humans jot down their appointments or thoughts to retrieve them when needed, or mathematical calculators. Or currently, with the use of smartphones that, with their numerous functions, have become humans privileged "assistants," thus affirming that the mind is not confined to the brain but extends to the objects humans use.

According to Antonio R. Damasio (1994; 1999), 'The mind is primarily for the body, within the body, and with the body. The human brain and body are thus an "indissociable organism, integrated by the action of interacting neural and biochemical regulatory circuits" (p. 24). This organism interacts with the environment as a whole, and the "mind" resulting from various physiological processes depends on the interaction of the entire body-brain organism with the environment. 'The soul breathes through the body, and suffering, whether arising from the skin or from a mental image, occurs in the flesh' (Damasio, 1999). The rise of an embodied view of cognition and the recognition of a dynamic dialogue between organism and environment have prompted the construction of new research pathways, creating the conditions for recognizing the learning, communicative, simulative, and vicarious potential of corporeality in teaching-learning processes (Sibilio and Galdieri, 2022).

The latest research in neurobiology, cognitive sciences, linguistics, and especially artificial intelligence and robotics, is providing scientific evidence in support of the hypothesis that the "mind" should be considered in a broader conception that encompasses not only the brain but the entire body and the environment in which humans find themselves. Cognitive sciences are rapidly evolving, compelled to update themselves by the momentum of neuroscientific research, artificial intelligence, and robotics. Psychologists Fausto Caruana and Anna M. Borghi (2013) have described the evolution of these studies: Over the past twenty years, an immense amount of data has been collected, especially in psychology and neuroscience, rendering the label 'Embodied Cognition' too inclusive, referring generally to the idea that cognition is constrained by bodily and environmental elements, not describable in the abstract and amodal terms [i.e., not corresponding to anything in the objective realm] of classical representational theory. Cognitive processes have been variously labeled as 'embodied,' 'situated,' 'grounded,' or 'enacted.' Although these labels are often employed in a generic and interchangeable manner, they harbour slightly different theoretical positions. The concept of 'grounded' cognition, already in its name, explicitly refers to the ground or soil and not to the body. The application of this concept is broader than those of embodied or situated cognition: its pivot of reflection is the idea that cognitive processes are subject to constraints inherent in the physical world, including but not limited to the constraints of the sensorimotor system. According to Barsalou (2008), the concept of 'grounded' is preferable to that of 'embodied' because the latter might lead to the mistaken assumption that researchers in this field always consider bodily states necessary for cognition, and that these states are the focus of all research. Barsalou (2008) suggests that cognitive processes are instead 'grounded' in multiple ways, including simulations, situated action, and occasionally even bodily states."

2. Materials and Methods

Common among the various approaches falling under the term 'Embodied Cognition' is the idea that the shape and motor capabilities attributable to a body are essential factors in the development and functioning of a cognitive system. In particular, the embodied cognition paradigm emphasizes the role of interaction possibilities with the environment associated with possessing perceptual systems and motor skills. This leads the proponents of this view to assert that defining processes such as perception, reasoning, and language depend, ontologically and epistemologically, on bodily properties beyond the boundaries established by the nervous system.

In contrast to the cognitivist paradigm, embodied cognition denies that cognitive processes are simply reducible to internal algorithmic processes within the system, attributing a significant role in the genesis of cognition to the morphological properties of the body and its interactions with the environment. An activity involving music and movement that can create a link between mind, body, and environment, impacting learning in a way that is no longer purely traditional or computational but based on the principles of Embodied Cognition, is Body Percussion. In Body Percussion, the rhythmic and musical dimension is experienced and internalized through the body, stimulating attentive, emotional, and concentration-related aspects that are beneficial to the overall learning of the individual. It is now evident that using the body as an inclusive mediator is a powerful facilitator that enhances accessibility and participation. The language of music and artistic expressive languages intersect, meeting the language of the body, becoming a means to express and raise awareness of emotions and feelings, manage discomfort, identify creative solutions to overcome conflicting dynamics, and create inclusion.

Attention to physical movement and its central role in musical learning processes can be found in Carl Orff (Piazza, 1984): bodily movement and rhythmic imitation can be seen as a learning tool. Affiliated with this tradition are the Body Music workshops proposed in the United States and around the world by Keith Terry, an American educator, dancer, and percussionist who began experimenting with his own body what he had learned from playing the drums, and in Italy, by young musicians like Ciro Paduano, Stefano Baroni, Salvo Russo, Andrea Pedrotti, and Eliana Danzì.

Keith Terry's artistic and educational activities have paved the way for the development of body music in different application areas, such as teaching mathematics through workshops and the manual 'Rhythm of Math.' Within this thought framework lies research on body music, its development, and the opportunities it can offer as an expressive, educational, therapeutic medium, and more generally, for the psychophysical well-being of every human being in an inclusive perspective.

It is precisely along these lines that this work positions itself, proposing an experiment in schools involving musical-motor activities, particularly the didactic technique of Body Percussion. This approach has been consolidating in recent years, involving students and teachers who, in a perspective of full pedagogical activism, use the body to convey other forms of knowledge. Rhythm, music, and motor activity are used as inclusive elements for disabled individuals, including children with special needs or any student who needs motivation for social interaction and relationship-building, and full awareness of their body as the foundation for constructing personal and social identity."

Body Music (music produced by the body, a combination of vocal and rhythmic/body sounds) is an extremely useful tool for cognitive stimulation, aiming to

develop and consolidate rhythmic awareness on one hand, and body confidence and coordination on the other. It also works on self-esteem, attention, concentration, and executive functions. The goal isn't to learn musical notes, their duration, or reading a musical score, but to stimulate the brain through the benefits of rhythm based on neuroscience findings. The learning method creates a fun, inclusive situation where participants don't feel judged, facilitating the achievement of self-confidence and greater body awareness.

In many aspects, Body Percussion shares basic principles with neuro-education, asserting that all learning must focus on life, within life, and for life, thus including physical, social, and emotional practices to combat stress, poor health, or isolation. Body Music has become an almost essential practice within music-related subjects in formal education, as well as in conservatories. It can play an important role in subjects like physical education, psychomotor skills, or mathematics and language.

Body Percussion, which involves creating rhythms and sounds using the body - hands, feet, and other body parts, can certainly be used to stimulate cross-curricular subjects in education. Cross-curricular topics go beyond traditional subjects like math, science, history, etc., often including themes such as creativity, artistic education, collaboration, and communication.

As an educational practice within educational action, it is a type of play-activity that can bring about positive changes in individuals and mindsets as it involves a procedural and dynamic educational process.

The educational activity proposed here will be a possible experiment to implement educational action through the playful activity of Body Percussion to assess the changes and models put into practice. The goal will be to evaluate the potential of Body Percussion as an innovative method for developing musical-motor skills, cognitive abilities, and as a method of inclusion. Body Percussion serves as a means to make new observations and draw new conclusions. For instance, it can be verified during music classes by applying activities focused on Body Percussion how this method enhances the development of rhythmic-motor coordination, but also positively impacts students' cognitive functions, especially memory and concentration.

In fact, if we consider Body Percussion in relation to memory, we can observe how during practice, each exercise aims to initiate the three main phases. The first is 'acquisition': this involves the learning process, where our brain is encoded through temporary 'neural activation pathways'. 'This means that some neurons, depending on the specific activity we are doing, come into contact with each other and communicate through a process known as "neural synapse." In our case, by performing exercises that require a lot of coordination, the synaptic pathway will form using neurons from the right and left parietal lobes, where all information about gross motor skills is processed. If, at the same time, we have to use rhythmic text while moving, it will also activate the pathway in the left temporal lobe (Broca's area), where language is processed. Initially, these pathways are temporary, so they are part of the short-term memory system." (Romero-Naranjo, 2017. p.173).

The second phase is 'consolidation': this involves concentration, a fundamental cognitive process that allows for the consolidation and retention of information. Finally, the last phase is called 'retrieval', involving the retrieval and processing of short and long-term information, based on different types of memory: muscular, rhythmic, declarative, procedural, analytical, and emotional (Romero-Naranjo, 2017). It's important to highlight that this work can be conducted through empirical re-

search, using direct teaching exercises aimed primarily at working on rhythmic-motor skills that would stimulate memory as a cognitive process.

Therefore, Body Percussion is an example of how embodied cognition can be put into practice. In performing Body Percussion, the body becomes the means through which rhythm and music take shape. Individuals embody rhythm in their movements and directly experience sensations and perceptions related to rhythm through the body. This process of embodiment is central to embodied cognition, emphasizing the fundamental role of the body in experiencing the surrounding world. In Body Percussion, the body is the primary performance instrument. The percussionist uses their body to produce sounds and rhythms, involving tactile, kinesthetic, and auditory-motor sensations. These bodily sensations are central to information processing and rhythm perception, a key aspect of embodied cognition. In Body Percussion, the body actively responds to the surrounding environment to create rhythms and sounds. This direct interaction between the body and the environment underscores the importance of the physical environment in influencing cognition. Embodied Cognition considers the environment as a key factor in shaping thought and action. Experimental studies show a dependency between an agent's possession of specific cognitive abilities and the morphological and dynamic characteristics of their body, suggesting new ways to conceptualize and explore the nature of cognitive systems.

3. Anticipated results

The main objective of the action research to be carried out at the school in Salerno will be to provide not only reflection but also factual data that can highlight whether, through the use of the innovative rhythmic game of Body Percussion, teachers will be able to generate, in their relationship with students, a transformative action promoting health, collective well-being, and inclusion. These activities promote the inclusion of all students, including those with special needs and disabilities. By easily engaging in rhythm and music-making activities with others, these students feel part of an equal group, boosting their self-esteem with positive effects on group dynamics.

Moreover, the teacher, acting as a mediator, can leverage technology by using videos and educational material available online to involve students through the use of Interactive Whiteboards (IWBs). The research will take place in a school in Salerno and will target primary school children and lower secondary school students. It will be structured in various phases, including field observations categorized by reference macro-areas using grids, as well as questionnaires for both teachers and students. The gathered data will undergo checks and final evaluations.

This research proposes a qualitative analysis aiming to apply thematic analysis, particularly suitable due to its flexibility (Braun and Clarke, 2006). It intends to identify thematic cores in the obtained responses, providing an initial analysis based on those cores.

4. Discussion

Of course, as Eliana Danzì (2023) states in her text on Body Percussion, 'a high level of knowledge in this type of activity is crucial to make the communicative dimensions of knowledge, know-how, teaching how to do, and knowing how to be practicable through the structuring of heterogeneous environments where every

student can interact.' The teacher must be an actor and actress alongside the students in a shared experience where the themes revolve around empathic action, mutual respect, the appreciation of differences, interpersonal conflict resolution, and the use of non-violent communication. Now more than ever, there's a need for an educational path and practice that leads to significant changes in everyone's way of being, towards oneself, towards others, and towards the environment we live in, fostering well-being.

Hoping to still dream of a better world today might seem visionary, but the inclusive learning provided by Body Percussion ensures a way of learning where, by playing with creativity and one's own body, it's possible to create a serene and stimulating environment. Experimental studies on the impact of Body Percussion on the development of human cognition and cross-cutting skills can support the advancement of robotics and the design of artificial intelligence-based machines.

5. Conclusions

The theories of Embodied Cognition assert that our cognitive architecture, despite being highly adaptable, is the result of millennia of evolution largely rooted in the Pleistocene era. It was during this time that humans had to develop specific perception-action procedures to survive in the environment, procedures that still hold relevance today. What evolutionary and proactive robotics aim to do now is to program the foundational dispositions of an intelligent system so that it can actively evolve by interacting with its environment and its own morphological body.

Hence, the discussion doesn't end in these few lines. Instead, this work aims to provoke reflection, both to understand the importance of Body Percussion in Italian schools as a catalyst for the development of cognitive and relational functions, as well as inclusion. Moreover, it aims to bridge Embodied Cognition and Artificial Intelligence. Body Percussion can provide a practical ground, offering tangible experiences, to explore and implement principles of embodied learning in artificial systems. This can enhance the ability to understand and interact with the physical world, with potential future implications thanks to studies connected to artificial intelligence systems.

References

Barsalou L. (2008), Grounded Cognition, Annual Review of Psychology, 59, 617–645.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative Research in Psychology, 3 (2), 77-101. http://dx.doi. org/10.1191/1478088706qp063oa

Caruana F., Borghi A. (2013), Embodied Cognition: una nuova psicologia, Giornale Italiano di Psicologia, 1, 23-48, DOI: 10.1421/73973

Clark A., Chalmers D. (1998), *The extended mind*, Oxford University Press, Oxford.

Damasio, A. R. (1994), *L'errore di Cartesio*, Milano, Adelphi.

Damasio A. R. (1999), *Emozione e coscienza*, Milano, Adelphi, Milano.

Danzì E. (2023). La Body Percussion, Carrocci editore, Roma.

Piazza G. (1984). *Orff-Schulwerk. Musica per Bambini. Esercitazioni pratiche*. Milano. Edizioni Suvini Zerboni.

Romero-Naranjo F.J. (2017) *Body Percussion - Programacìon Didactìca*, Vol.1 y 2. Alicante: Ramon Torres Gosalvez.

Sibilio M., Galdieri M. (2022). Il potenziale corporeo nell'azione didattica. In "Educazione degli Adulti: politiche, percorsi, prospettive", Studi in onore di Paolo Federighi. Pag.191-201 Firenze University Press- ISBN:979-12-215-0005-9

Wilson R.A. (2015), *Embodied Cognition*, Stanford Encyclopedia of Philosophy, https://plato.stanford.edu/entries/embodied-cognition/