THE LIMIT OF ARTIFICIAL INTELLIGENCE: THE MOTOR CONTROL

IL LIMITE DELL'INTELLIGENZA ARTIFICIALE: IL CONTROLLO MOTORIO

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Double Blind Peer Review

Citazione
Lovecchio N. (2024). The limit of artificial intelligence: the motor control, *Giornale Italiano di Educazione alla Salute, Sport e Didattica Inclusiva*, 8(2), Edizioni Universitarie Romane.

Doi:
https://doi.org/10.32043/gsd.v8i3.1074

gsdjournal.it
ISSN: 2532-3296
ISBN 978-88-7730-494-0

ABSTRACT
Our lives are steeped in AI: from remote sleep control to car sensor. Considering the benefits that AI can offer in computing and public health activities, how will AI impact PE? Will humans be replaced in everything? Will we still be able to learn? In educational context the AI promotes learning models based only on knowledge transfer and robust assessing routine. But are test scores accurate indicators of learning? Even if the PE take advantage in video and storage system the AI will not replace the area of brain that are implicated in the cues synthesis and in motor control.

Le nostre vite sono invase dall'AI: dal controllo remoto del sonno ai sensorI dell'auto. Considerando i vantaggi che l'IA può offrire nell'informatica e nelle attività di salute pubblica, quale sarà l'impatto dell'IA sull'educazione fisica? Gli esseri umani saranno sostituiti in tutto? Saremo ancora in grado di imparare? Nel contesto educativo, l'IA promuove modelli di apprendimento basati solo sul trasferimento di conoscenze e su una robusta routine di valutazione. Ma i punteggi dei test sono indicatori accurati dell'apprendimento? Anche se l'educazione fisica si avvantaggia dei sistemi video e di memorizzazione, l'IA non sostituirà l'area del cervello coinvolta nella sintesi dei segnali e nel controllo motorio.

KEYWORDS
Motor control, Physical education, public health, storage, big data
Controllo motorio, Educazione Fisica, Salute pubblica, memorizzazione, archivi

Received 01/04/2024
Accepted 12/06/2024
Published 24/06/2024

Introduction

Despite the great hype of artificial intelligence (AI) and especially the great use that young people are making of it; more adults still do not have the perception about the influence of AI on our ordinary lives (Tuomi, 2019).

Our daily lives are now steeped in AI: from smart watch readouts that indicate sleep quality to suggestions for TV entertainment based on previous choices, from cars with sensors that can park autonomously to instant text translation, from solving mathematical expressions to producing text according to specific keywords (Luckin, 2016).

In fact, AI is nothing more than the technological advancement that replaced manual labor (even writing with a pen!) with superior, fast and accurate processing capabilities (Kumar et al., 2023; Chien et al., 2020). It is possible, therefore, to consider the AI as a software that performs a task that, normally, a human would have performed.

Before delving into the advantages and disadvantages of AI and its impact on the physical-education and human motion dimensions; it is useful to understand what AI is.

AI (umbrella term) is a discipline of science and technology that enables software to be programmed to become *intelligent:* meaning to be able to perform tasks that consistently and traditionally require human cognition (Aiken & Epstein, 2000). Nowadays, many specific technologies and applications that refer to AI point to specific software that are capable of learning and thinking: forming a variety of human-like functions by learning from experience and adapting to new inputs and variables (Kaplan & Haenlein, 2020).

In fact, it is the transposition of human intelligence into machines (thus artificial) to do things that are normally performed by relying on humans: for example, researching the shortest path to a place or listing the most important historical facts of a chosen century.

From a computer science perspective, AI is complex and extensive software able to accumulate information (i.e., Big Data) and allocate it with logical criteria so that it can be re-used in subsequent queries.

There are two main types of AI based on its ability to operate: weak AI and strong AI (O'Hare, 1990):

- weak AI: processes one task and cannot perform others. As common in our daily lives as voice assistants that provide us with information.
- strong AI: can understand and learn any intellectual task like a human brain. From chess software to word processors.

At the conceptual level, systems analysts and software developers are already envisioning a Super AI (Müller & Bostrom, 2016) that could perform tasks better than humans: for example; defining, calculating, designing and modulating *in itinere* to an underground tunnel.
Certainly, AI has many benefits that include efficiency through automation of tasks, analysis of data for decision-making, assistance in medical diagnosis (Ali et al., 2023), and advancement in the production of autonomous vehicles but there are also disadvantages involving security risks from hacking, disappearance of some job tasks (e.g., librarian), privacy issues, lack of stimulation of human creativity, loss of empathy and ethical issues (Tuomi, 2019).
Considering the benefits that AI can offer into the area of huge storage, performing and computing public health activities, how will AI impact physical education? Will humans be replaced in everything? How will be the educational activity? Will we still be able to learn?

1. Artificial intelligence in health care

AI has rapidly spread to many fields including healthcare (Minz & Mahobiya, 2017; Strachna & Asan, 2020). For example, new-generation-software can recognize artifacts in X-rays or make comparisons with hundreds of case histories in few seconds to help physicians during diagnosis decisions (Sasubilli et al., 2020). Automated decision-making processes; patient monitoring with programmed threshold levels; remote monitoring of elderly, telemedicine (Wootton, 2001); and information storage are the frontiers of AI-based medicine (Deepak et al., 2019). In addition, maximizing the use of resources and trans-local education by sharing databases from around the world has been an important resource since 1996 when there was the first online version of Pubmed (Kruse et al., 2018).
In fact, AI is very effective in analyzing big data to find similar case histories to speed up diagnosis and treatment decisions and, thus, reducing the cost of clinical trials in terms of hours used to produce new drugs.

Patients	**Health care system**	**Pharmaceutical industry**
Monitoring	Improved workflows	Time saving
Early Diagnosis	Cost reduction	Optimization of resources
Simplification of processes	Data Integration	Global training
Quick clinical report	Multimodal processes	Big data sharing
	Sharing clinical case histories	Remote surgery
	Telemedicine	

Tab 1. Benefits of AI in the clinical medical field. Based on Ali et al., 2023

2 Artificial intelligence in education

The most obvious benefit of the use of AI in the educational/school domain regards the intelligent tutoring systems (ITS), which in objective fields (such as mathematics and physics) made possible the control and the detailed supervision of student behavior and learning (Porayska-Pomsta, 2015). Thus, the science of informatic moved to a higher use of AI to create machine learning environments with interfaces for 'learners' without the need of a teacher presence (i.e. Apps for learning a foreign language).

Additionally, the potential of AI has also been spent in the area of special educational needs automating the diagnoses of dyslexia in an early way (Hopcan et al., 2023): the Swedish company *Lexplore* has developed a system that rapidly analyzes the eye movements of readers. The system relying on a set of metric data instantly compares the outcomes of the person offering fast and cheap screening. The diagnosis of autism spectrum disorder and attention deficit or hyperactivity disorder through child-robot interaction also seems to benefit the speed of these new forms of diagnostics.

However, it is necessary to point out that ITS systems have been developed according to a cognitivist philosophy and thus based on an instructional/directive pedagogical approach where learning is not *performed* as a guide-disciple relationships or a common achievement reached together (Dennett, 1990). In fact, during class conducted in an online environment, a teacher can teach to many students, but it is difficult to know what students learn. Analysts, in this regard, suggest that AI could be used to objectively assess learning by scoring test results that would be compared with a number of clusters previously labeled by humans (Mislevy, 2018). But are test scores accurate indicators of learning? To assess learning, it is more appropriate to measure individual development rather than average performance in standardized tests?

If AI adapts and promotes learning models based only on knowledge transfer we believe that it should be employed and developed differently because as Vygotsky said the development of many cognitive abilities (which define advanced forms of thinking) is based on social interaction (Tzuriel & Tzuriel, 2021).

The extreme use of AI could reduce the importance of some human cognitive abilities. For example, dyslexia could become of low-impact because AI is able to convert verbal forms into texts such as dyscalculia could takes advantage from graphical recognizers tools and mathematical Apps. In this way, we will create people dependent on computational machines. From a pedagogical point of view, it might be more beneficial to use AI to help people to develop corollary skills to circumvent difficulties in reading and counting instead of using AI as a total substitute of personal cognitive abilities.

3 Artificial intelligence in physical education classes

Although AI has been widely used in school settings, there are not yet many examples in the gymnasium setting: more precisely, no significant teaching and motor learning experiences have yet been documented (Lee & Lee, 2021). Certainly, there are virtuous examples where teachers use videos to explain and engage students in musical routines or to review accurate technical gestures (i.e. high jump Fosbury flop). But we are confident that just watching (even endlessly repeated) without teacher input enables students to better understand and apply instruction (Lee & Jin, 2016).

Some Apps (i.e. newstream) have succeeded in minimizing clutter and maximizing the functions of smart phone cameras to perform kinematic analysis that can give information on segment velocities, joint angles and arrangements between body parts so that they can be compared either with golden standard patterns or with their own outcomes during training. But are we sure that the content of physical education is the refinement of sports gesture with automatic classification algorithms? Are we sure that technical gesture improvement should take place with a screen that eliminates the tension of being watched by an external person (i.e., coach or teacher)? As it happens in a competition setting where there is an audience and other players in the challenge (Zago et al., 2022; Vandoni et al., 2022). Certainly, some platforms allow a 3D study of anatomy in a fascinating way, but the real innovation of AI applied to sports and PE is the virtual reality (VR). VR can simulate and bring experiences and interactions with objects (Craig, 2013). But sports or an action in a challenge with one's classmates is not virtual: it requires contextual physical interaction in the dimensions of space and time. Except if we want to improve the compliance toward the sport done electronically: E-sports (Russo et al., 2021).

PE is quintessentially an experimental teaching: a teaching activity that integrates knowledge and skill through practice. Although it has the status of theoretical teaching, PE is a discipline that promotes personal practical skill, creativity and exploratory ability: AI at this time is not yet able to replace these experiences.

In addition, a teacher can (and should always consider) take into account the physical condition of individual students, their background of practice, psychological dimensions, at the present moment (hic et nunc) but above all to convey criteria (through practice) for maturing decision-making ability to solve problems (Giuriato & Lovecchio, 2020). In fact, sport is a constant and fast problem solving (Giuriato & Lovecchio, 2018). Fortunately, technical gestures, actions and sports in general have very fast decision-making and executive speeds that cannot wait for AI consultation to figure out what to do and how to do it!

4 Artificial intelligence not adequate for motor learning

With respect to the last reflection, a very recent review (Zhou et al., 2023) confirmed that AI in the context of PE class and sports is limited to university subjects: procedure for PE in middle school there have been only three papers and in high school only one.

In fact, reports on the functions of AI on PE (called AIPE) only covered aspects pertaining to evaluation in sports, automation of processes, assisting management, data collection using tests, and then predicting performance based on data sets (Zhou et al., 2023).

While useful features for trainers and managers to store large amounts of data (and allocated according to adaptable grids and criteria) there are no AI experiences yet to help subjects in motor learning. Certainly, VR systems (Mavropoulou et al., 2019) using *mixed spaces* allow simulations of movement through the combination of signals from kinetic devices. But motor learning in this way occurs only by feedback (Zhang, 2022) from outcomes of a gesture that are seen on a screen. How realize an *itinere c*orrection? How do we substitute the imitation of a mate whose moves he self in an dynamic environment of people and variables? Where is proprioception guaranteed when it changes with the weight of the objects?

Many inertial sensors or gyroscopes make it possible to describe a gesture (Liu & Jiang, 2022) and then compare it to examples stored in software but how to propose a number that can explain gesture interpretation (i.e. Bernstein theory)? How to maintain the richness of performance styles versus the technique described by a set of matrices?

5 Artificial intelligence does not affect brain and muscle

While fascinating, VR and its possibilities are not without concern (Lovecchio et al., 2023): it renders incomplete the integration of the exteroceptive and proprioceptive information that the brain manage at the level of the basal nuclei, motor cortex and premotor cortex.

For example, the mid-brain processes visual and sound stimuli to generate somatic responses (Hülsdünker et al., 2018): how then to make the view, through a visor, of a warm and bright desert with the cold sensation in a room?
The cerebellum is a fine modulator of movements based on proprioceptive cues and memories (Lovecchio et al., 2017): how do proprioceptive cues from a static subject sitting on the couch not moving his or her legs integrate with a memory of a shot in the tennis court while VR shows a smash by the opponents? How will be the performance later in a real-world context?
The medulla oblongata, at the neurovegetative level, integrates visceral and somatic sensations, but how can be a linear synthesis between a visceral sensation of fear (an aspect that an image in VR can induce) and the quiet state of relaxed musculature in a chair?
The bulb fires sensory information to the thalamus to supplement the autonomic functions of heart rate, blood pressure, and digestion (Cadegiani & Kater, 2019): a vision in VR might trigger a hypothalamic-pituitary-adrenal reflex such that the heart rate pick-up but how would circulation be managed in a 'sedentary' body? These things happen in nightmares at night but are short-period-events...what are the long-term effects of inconsistencies repeated several times over days?
Last but not least, what disruption is created at the brain level when the putanem and caudate nucleus (which control the alternation of arm and leg movements) are not assisted by the proprioceptive information of a seated person who nevertheless 'is walking on a crevasse' by the effects of AI?
The nucleus pallidus controls and corrects the muscle tone of appendicular muscles in voluntary movements: but what modulation if the image involves a heavy object while neuromuscular spindles and GTOs register the minimal weight of a console?
Finally, how can fine motor control, involving deep coherence between external and internal cues, take place (see the diagram re-proposed by (Lovecchio et al., 2023) if external vision reports some inputs while actual grasping registers others?

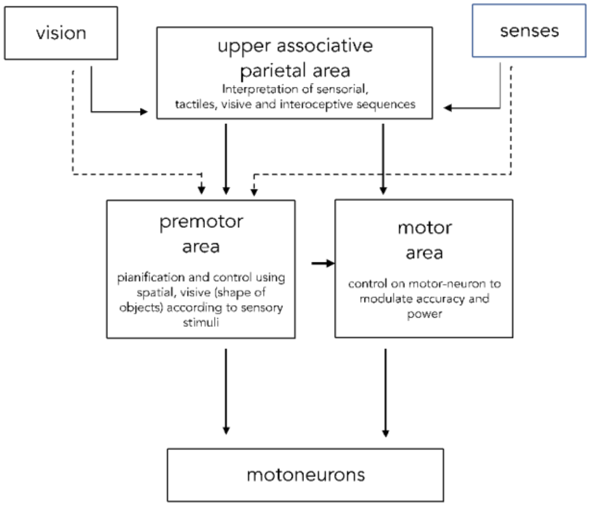

Fig. 1: Information flows within the brain to define spikes on motoneurons in response to a stimulus. From: Lovecchio et al., 2023).

Conclusion

The personal belief is that we need to reduce AI-related motor activities as much as possible and encourage real practice: especially with regards to growing children.

Considering the different theories related to motor learning; that of Adams (who assumed movement as a long chain of individual contractions that generate an internal signal as stimulus information for the next one; (Adams, 1978), the Schmidt's schema theory (which highlights the value of sequential phases of motor performance with the comparison between actual and expected results and thus allows the creation of an "internal reference of correctness"; Schmidt, 1988 (Schmidt, 1975) or that of general motor programs (within a category of movements the motor learning is improved by modulating timing, phasing and strength; Magill & Anderson, 2010) it cannot be denied that neuronal integration in our brain always requires congruity of cues: between environment and internal. AI will increase the accuracy in storage and in organization of data (parameters), will create high definition visual stimuli and non-real targets to induce movements but it will not be able to teach a gesture as person or by-pass the learner's brain.

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