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Editorial Open Access

Embodied Cognition and Ergonomics

Sebastiano Bagnara* **and Simone Pozzi**

Iuav- University of San Marino, Italy

***Corresponding author:** Sebastiano Bagnara, Iuav- University of San Marino, Italy, Tel: +39 0549 996181; E-mail: sebastiano.bagnara@gmail.com

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Editorial

In the years, ergonomics has established a fruitful dialogue with psychology, and with cognitive science, in general. Indeed, these disciplines have been able to provide ergonomics with useful insights on needs, abilities and limitations of human beings. This positioning has been particularly true when the discipline has adopted a research-led approach [1], considering users as subjects to be studied.

In the last twenty years, a new approach has flourished in cognitive sciences: *embodied cognition* [2,3]. According to this approach, traditional cognitive science has largely overlooked the role of the body in cognition, by tracing an artificial neat separation between perception, cognition and action. While cognition has been studied extensively, perception and action have been disregarded as not that relevant to understand what was happening inside the brain. Instead, the approach of embodied cognition seeks to understand the role played by our body in cognition, showing the ways in which the body characteristics affect cognitive activities. This may happen in three different manners: Firstly, body characteristics act as constraints for cognition's form and contents, because humans perceive the world, and act on it, via the body. Body characteristics regulate and pace the rhythm followed by cognition. Secondly, bodily states may affect thinking, as for instance when body postures have an influence on memories, or on the way a situation is assessed. Thirdly, mental representations of bodily states may also play a role in cognition [4].

Synthetically, the approach of embodied cognition recognises that there is no clear-cut separation between body and cognition; rather, body plays a constitutive role in the way cognition takes place, by shaping its functioning and contents.

Ergonomics is well equipped to deal with this level of complexity, as one of its hallmarks is focussing on interactions among components, and on avoiding considering elements in isolation. Ergonomics is systemic by nature; its focus being the study of systems (as opposed to individual elements), context, and complex interactions (in order not to isolate elements), holism, and emergence (in order to capture the various levels of explanation of one phenomena) [5].

Indeed, Marras and Hancock [6] have already suggested that ergonomics should integrate the physical and the cognitive dimensions [6]. For instance, they propose to consider context as including: the physical setting and what can be perceived of it, the physical demand, the cognitive demand, psychosocial dimensions. So, ergonomics has been already focussed on both physical elements and cognitive ones.

However, when it comes to analysing the way humans interact with these elements, ergonomics has tended to propose the body-mind divide: we have physical ergonomics on one side, cognitive ergonomics on the other. Ergonomics has, traditionally, studied the interactions among system elements, and considered both physical interactions and cognitive ones, but it has seldom integrated the methods used to study cognition with the ones used to study physical interactions. The relevant explanatory level is physical OR cognitive, simplifying the analysis by focusing one moment at the time on either one of the two levels.

It is our opinion that the embodied cognition approach might of most help in overcoming the dichotomy between physical and cognitive ergonomics. To illustrate this point, let's consider the two following themes to stimulate the discussion, one concerning human-machine interaction, the second concerning the interaction with immaterial artefacts, like procedures or knowledge.

a) The body as an object of design

The body is a potential target of ergonomics intervention: ergonomists can contribute to the design and evaluation of the systems, and they can also contribute to the design of the involved bodies. The field of augmented cognition via body prostheses seems to be especially relevant here. If tools become internalised, incorporated by their users, the body boundaries become a field for ergonomics intervention. As Kirsh [7] points out "How different can our remote "body parts" be from our own before we cannot assimilate them? Snap-on arms and legs are one thing. But how about two sets of nine-fingered claws that operate in articulate and continuous ways? Are there limits on what can be a prosthetic "body part"?"

Kirsh [7] highlights how often, and how much humans "naturally" internalise tools. But, we still do not know the limits of this process. And, according to embodied cognition approach, we do not know the potential effects on the form and contents of our cognition.

b) The body in ideas

By which tools and techniques, the ergonomists understand the role of embodied cognition in those activities that seem, but are not, to be purely cognitive? For instance, in control tasks, or supervisory monitoring ones, which tools do we have to identify the role of the body, and of the physical reality, in the way humans perform these tasks? Where the body is, physically, in communication flows?

To capture these aspects, we may need to revert to physical ergonomics, or may need to deploy other techniques, for instance drawing from the study of motor movements. Linguistics may also be of some use here, for instance by focusing the analysis on the physical part of the metaphors being used, as a strategy to identify the materiality of speech and cognition [8].

There are many issues that one can foreses if and when the embodied cognition approach would be adopted in ergonomics: one is about the analysis (as suggested, so far), the other about design. Design has been traditionally seen as a means to give body to immaterial ideas. For an embodied cognition perspective, ideas already come with a body, as happens in the just mentioned materiality of metaphors: Can

we use the body part of ideas as leverage for design? Which are the bodily aspects of ideas that can facilitate self-reflection or meta-cognition? We know that people may use external tools to support their internal thought processes and to more easily achieve goals (as well known in Distributed Cognition [9,10]. Can we use the physicality of mental images for the same goal?

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