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FROM INSTRUMENTAL TO CONSTITUTIVE: TECHNOLOGY AND RADICAL EMBODIMENT

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ABSTRACT

4E cognitive science is not a unitary framework. Embodiment, embedment, extendedness, and enactment are said in different and often incompatible ways. In this paper, I explore the field of 4E cognitive science by grouping its different approaches in three main categories: embodied cognitive science, the hypothesis of the extended mind, and radical embodiment. Then I defend that, while embodied cognitive science and the hypothesis of the extended mind still hold an instrumental use of technology alike to classic computational cognitive science, radical embodiment purports an embodied use of technology that entails a fully new characterization of its relation to cognitive systems. In the last part of the paper, I evaluate some consequences of the understanding of such a relation for the coupling-constitution debate and the political status of technology.
Key Words: 4E cognitive science, technology, radical embodiment.

1. INTRODUCTION

There are two computers on my table right now. One of them is a big desktop computer and the other one is a small laptop. I also have a phone, some notebooks, two books, and a mug. I wear clothes and I am sitting on a moderately comfortable chair while I am writing these words. Far from being special, the situation a I just described is a pretty common one. Most of us are constantly surrounded by many different kinds of technology. Some of them may be considered old forms of technology, like pens, clothes, or mugs, while others are better understood as new technologies, like computers, smartphones, or virtual reality devices. Anyway, it is just a truism that we live in a technological environment.

The overwhelming amount of technology in our environments have brought the attention of many researchers in different disciplines and we can find works on the history of technology (*e.g.*, McNeil, 1990; Nye, 2006), sociology of technology (*e.g.*, Gunderson, 2016), or philosophy of technology (*e.g.*, Varbeek, 2005), and the same may be said of the psychology of technology, which is the field to which this paper aims to make a contribution. The relation between cognitive systems and technologies is a growing issue within the sciences of the mind (see, *e.g.*, Kool & Agrawal, 2016) and in this paper I explore that relation from the point of view of 4E cognitive science.

One caveat is needed at this point. For the sake of clarity and simplicity, I will use "4E cognitive science" to refer to those approaches to cognition that take themselves to be embodied, embedded, extended, *or* enactive. I am aware that, in some literature, only those approaches that clearly encompass all these four characteristics are taken to be 4E. I will not be that strict in this paper and will take approaches that identify themselves with

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only 1, 2, or 3 of the characteristics as instances of 4E cognitive science although I will make the necessary distinctions among them.[1]

The main thesis I will defend is that, given the different frameworks in 4E cognitive science, the relation between technology and cognitive systems is not consistently understood. Concretely, technology is understood as an *instrument* or a prosthesis by researchers that adhere to embodied cognitive science and the hypothesis of the extended mind, but as a *fully embodied resource* by those who identify themselves with radical embodiment. Such an equivocal understanding (*i.e.*, not 1-understanding:1-framework mapping) of the relation between technology and cognitive systems in 4E cognitive science is due, I contend, to some conflicting assumptions within the field. Besides, it leads to consequences that cut across different debates and disciplines.

In the rest of the paper, I unpack the main thesis and some of its consequences. In section 2, I offer a succinct review of the theoretical assumptions of the different frameworks that compose 4E cognitive science. In section 3, I show how the different frameworks hold different understandings of the relation between technology and cognitive systems in terms of embodiment. Finally, in section 4, I evaluate two consequences of the thesis of the paper: the inadequacy of the coupling-constitution fallacy in terms of radical embodiment and the possible consequences of embracing radical embodiment for the political status of technology.

2. VOICES FROM 4E COGNITIVE SCIENCE

It is not especially surprising that a young scientific field as 4E cognitive science lacks a unitary framework. Claims regarding the relevance of the body and the environment to cognitive processes and mental events are common in the cognitive sciences at least since the early 1990s. They had their origin in different reactions to the (still) dominant cognitivist paradigm based on computation. These reactions, such as ecological psychology (Gibson, 1966, 1979) and enactivism (Varela, Thomson, & Rosch, 1991), reject the identification of the mind with the brain and provide theoretical and methodological frameworks to study it in terms of the integration of brain, body, and environment.[2]

Soon after the prequels of 4E cognitive science started gaining relevance in the sciences of the mind, the dominant computational approach began to integrate some of their tenets in different fashions. This is the key to the theoretical pluralism in the 4E field and the equivocality of concepts like embodiment, embedment, and extendedness: psychologists, neuroscientists, roboticists, and philosophers working on classic cognitive science, ecological psychology, phenomenology, analytic philosophy, and so on, started defining embodied cognition or the extended mind in slightly different ways.

For example, on the one hand, some philosophers started supporting the hypothesis of the extended mind (HEM hereafter; see Clark & Chalmers, 1998): the idea that cognitive processes can be constituted by elements outside the neural system. On the other hand, a more interdisciplinary group of people –including some supporters of HEM– started favoring what later would be called embodied cognitive science (ECS hereafter; see Shapiro, 2014): the idea that cognitive processes heavily depend on bodily and environmental elements. It is easy to note the resemblance of both proposals. Both HEM and ECS were originated within the classic, computational approach to cognition although their supporters share the common conviction that cognitive processes and events are either dependent upon or constituted by extracranial elements. In addition to HEM and ECS, there are other forms of embodiment, embedment, and extendedness based on ecological psychology and enactivism that resist from being integrated into the dominant computational cognitive science and that have gained relevance in the last decades. These forms of embodiment, embedment, and extendedness are compatible neither with the HEM nor with ECS and can be labelled as radical embodiment (RE hereafter). In the following, the main features of ECS, HEM, and RE are sketched.

2.1. ECS, HEM, and RE

The core feature of ECS is its defense of the fundamental role the body plays in psychological events (Clark, 1997; Shapiro, 2014).[3] The different ways to understand that role can be classified into three categories: *neural embodiment*, *weak embodiment*, and *strong embodiment*. First, neural embodiment can be understood as the position which defends that basic bodily activities and higher-order cognitive activities share the same neural substrates. The idea is that the same brain areas that support the reception of sensory stimulation and motor control –taking to be fundamental bodily activities– participate in other, allegedly more complex, cognitive activities like language or rational thinking (*e.g.*, Gallese and Lakoff, 2005; Fitzgibbon *et al*., 2014; Gangitano *et al*., 2014; Leonetti *et al*. 2015). Second, weak embodiment is the way Shaun Gallagher (2017) labels the kind of embodied theories that depict the influence of the body in cognitive events in terms of its role in representations (Glenberg, 2010; Goldman, 2012, 2014; Prinz, 2002, 2005). One chief example of such a kind of embodiment are the B-formatted representations, which "represent states of the subject's own body, indeed, represent them from an internal perspective." (Goldman, 2012, p. 73; see also Goldman and Vignemont, 2009). Finally, the main tenet of strong embodiment is that the body is a fundamental constituent of cognition or, in other words, that cognitive processes are the way they are because the body is the way it is. Strong embodiment entails a more substantial role of the body in cognition than the one purported by neural and weak embodiment. In terms of strong embodiment, the body cannot be reduced to the sensorimotor cortex or to an input for some representations, but it is *as a whole* a fundamental contributor to cognitive processes (*e.g.*, Shapiro, 2014).

HEM is built upon functionalist premises. The core idea of functionalism is that mental events are defined in terms of the function they accomplish and, therefore, can be defined without referring to its conditions of implementation. Functionalism reached the dominance of the sciences of the mind with the cognitive revolution and the widespread use of the computational metaphor to understand the mind-brain relation –*i.e.*, computationalism is a form of functionalism. HEM appeared within that computational context as a way to bring functionalism to its last consequences by including both bodily and environmental elements in cognitive processes. Put simply, HEM contends that non-neural, bodily and non-bodily elements can play the same functional role than neural elements in cognitive processes. Thus, as far as cognitive processes are defined in terms of their functions, there is no reason to exclude the extra-cranial elements that fulfill those functions from the explanation of those processes. Clark and Chalmers (1998), the main early proponents of HEM, support this conclusion on functionalism, but also in what they refer to as the *parity principle*: "… as we confront some task, a part of the world functions as a process which, *were it done in the head*, we would have no hesitation in recognizing as part of the cognitive process, then that part of the world *is* part of the cognitive process." (p. 8; emphasis in the text).[4]

Finally, RE encompasses different but likely compatible (see Baggs & Chemero, 2019) approaches to cognition –*e.g.*, ecological psychology (Gibson, 1966, 1979; Warren, 2006; Chemero, 2009) or enactivism (Varela, Thompson, & Rosch, 1991; Di Paolo, Buhrmann, & Barandiaran, 2017)– that were developed against functionalism and brain-centrism. According to ecological psychology, for example, psychological events are ecological events, meaning that they belong to the organism-environment system as such. In other words, cognitive systems are not brains or even complete organisms, but organism-environment systems. On the other hand, according to enactivism, cognitive events depend on the organism's *enaction* of the world. Namely, that the actions of the organism in the environment are the fundamental way in which it is able to make sense of its world. Both theses (the ecological and the enactivist) make of RE a framework in which the organism-environment system –and not the brain!– is the primary unit of analysis of cognitive processes. In this sense, both corporeal and extra-corporeal (*e.g.*, environmental, social) elements are taken to be a *constitutive* part of the cognitive system as far as the whole organism-environment system is the cognitive unit.

3. FROM INSTRUMENTAL TO CONSTITUTIVE

Technological devices are among the extra-cranial elements that can participate in cognitive processes or can be part of cognitive systems. For example, bicycles, guitars, smartphones, or computers are technological devices. But prostheses, cochlear implants, or human-computer interfaces that help people with neural problems to communicate are also technological devices. Two of the most important questions within the cognitive sciences with regard to technology are its ontological and epistemological status with respect to cognitive systems and the way different frameworks in cognitive science account for those statuses. In a more concrete, embodied sense, these questions amount to asking what the status of technology is for ECS, HEM, and RE, and what (if any) their notions of embodiment of technology are. My thesis is that there are fundamental differences in the account of technology and its embodiment between ECS and HEM, on the one hand, and RE, on the other. While the two formers hold an *instrumental use of technology*, the latter embraces an *embodied use of technology*. In this section, I explore the main aspects of these two ways to understand technology, but first I provide a small note on embodiment of objects, tools, and technology.

3.1. A Primer on Embodiment of Technology

Generally speaking, objects are those nameable, identifiable, stable things that are animate or inanimate and can persist through time. Tools are a specific kind of object employed to alter or interact with other objects (Holmes and Spence, 2005). And the embodiment of objects and tools is defined as the way in which those objects and tools has become "part of us" in a similar way that our arms or our feet are parts of us.[5]

The way objects and tools are incorporated into cognitive systems, in the sense of being embodied by these systems, is usually depicted in terms of changes in the *body image* or the *body schema* (Gallagher and Meltzoff, 1996; Gallagher, 2013; Iriki *et al*., 1996; Maravita and Iriki, 2004). The body image is usually understood in terms of one's perceptions, beliefs, and attitudes towards one's own body, and the body schema in terms of one's motor capacities that work without conscious appraisal. An object or a tool is usually said to be embodied when it becomes part of the body image, the body schema, or both, in terms of *ownership*, *i.e.*, as part of one's own body, *agency*, *i.e.*, as part of one's own actions, and *space*, *i.e.*, as part of one's peri-personal space, for instance (de Vignemont, 2011). The dichotomy between body image and body schema is quite standard in the literature but it is by no means uncontested. There are approaches that understand embodiment of objects and tools in terms of the body schema but not so much in terms of the body image. These approaches –usually part of RE– tend to avoid the appeal to the concept of body representations to understand the way objects and tools can be embodied and take cognitive systems to be a kind of complex, self-organized system in which many components, including objects and tools, interact with each other to give rise to a given cognitive ability (Anderson *et al*., 2012; Cavagna *et al*., 2010; Chemero, 2009; Van Orden *et al*., 2003).

The general framework of embodiment of tools and objects is relevant for the embodiment of technology. In a very basic sense, technology can be understood as the set of artifacts (objects, tools, etc.) that human beings have crafted and used all along their history and evolution to deal with they necessities in their environments. For sure, this definition will not satisfy some scholars who are interested in the subtleties of the notion of 'technology' (*e.g.*, Nye, 2006; Varbeek, 2005). However, I think it is concrete and operational enough as to be a good guiding notion for the embodiment of technology. As in the case of objects and tools simpliciter, the question about the embodiment of technology is a question about whether given technological devices become parts of the body image, the body schema, or both. A more concrete instantiation of this question given the distinction between ECS, HEM, and RE offered above is: do the three different paradigms of embodiment provide the same or different senses of embodiment of technology? In the following, I answer this question by noting that ECS and HEM do not hold a substantive notion of embodiment with regard to technology, while RE does.

3.2 The Instrumental Use of Technology

A kind of lurking brain-centrism in both ECS and HEM makes them tend to take *technology as an instrument*; that is, as an *addendum* to the primary, central engine of the psychological life: the brain. It is true that both ECS and HEM allow for a constitutive role of extra-cranial-cum-extra-bodily elements in cognitive processes and systems, but always in a *vicarious* sense: those elements can be understood as constitutive of cognitive systems as far as they perform the same function something in the brain is already performing or could be performing, or as far as they complement, expand, or enable some brain functions. In the specific case of technology (also of objects and tools), it is a constitutive part of cognitive processes or systems if it is functionally integrated into an already determined psychological event. It is never the case that a given technological device–or a given part of the body or of the environment, as a general case–is a constitutive part of a cognitive system on its own sake; that is, because it allows for the performance of a given cognitive process that could be impossible without the device. Actually, such a situation would be against HEM's parity principle, as the new cognitive process could not "be done in the head". At the same time, ECS would not recognize technology as a component of the cognitive system as it is not, *stricto sensu*, a part of the body. To say it concisely, *technology is always a prosthesis* for ECS and HEM.

The instrumental use of the technology typical of ECS and HEM consists in considering technological devices in a purely instrumental fashion when it comes to evaluating their role in cognitive systems and in the realization of cognitive processes. In other words, technological devices are taken to be resources used by the otherwise primary source of cognition, the brain. Ultimately, such an instrumental use of technology aligns ECS and HEM with contemporary versions of the classic, computational approach to the cognitive sciences.

An example of a contemporary form of ECS that holds such an instrumental use of technology is predictive processing (Friston, 2010; Clark, 2015). As a form of ECS according to some authors, predictive processing claims in favor of the importance of the body and the environment, and therefore of technology, in cognition. However, when it comes to its concrete instantiation, the "magic" of cognition *always* occurs in the brain: cognitive processes are realized by a brain-based Bayesian mechanism that aims to reduce the matching error between sensory inputs and top-down priors (*e.g.*, action-oriented representations) in order to successfully deal with the environment. Consider an example of Bayesian visual perception in an organism with a healthy visual system. In visual perception, some guesses about visual sensory inputs are delivered in a top-down fashion within the brain-based Bayesian system. These guesses match the current visual input and the possible error of matching is corrected following some rule. Such a correction will make the next top-down guess more accurate and, eventually, the system will end up having a guess that is a good enough representation of the visual sensory input and, hence, a good enough representation of the environment. Consider now the same event if the organism does not have a healthy visual system and must use glasses. The explanation of the perceptual process would be the exact same one. The whole Bayesian cognitive process would be the same and the glasses would be just an instrument to correct the sensory input. The situation would be similar if the organism received the visual input from a virtual reality device and not from the real environment. Again, the explanation of the cognitive process would remain the same with just a reference to the virtual reality device as a peripheral element.

Thanks to these examples, it is easy to see how predictive processing embraces an instrumental use of technology. The brain-based Bayesian system that realizes what is taken to be the central aspect of the cognitive process is located in the brain. The cognitive system, which is a probabilistic matching system, is primarily –if not completely– implemented in the brain (see Hohwy, 2016). Given this, the body and the environment (including technology!), although both are claimed to be proper parts of the cognitive system by some proponents of predictive processing, remain in a secondary position regarding the role they play in cognitive events.

3.3. The Embodied Use of Technology

Unlike ECS and HEM (and classic cognitive science in general), RE does not take technology to be an instrument or a prosthesis, but a *fully* constitutive element of cognitive life. This is what I label as the *embodied use of technology*. There are two basic aspects –one theoretical and one empirical– of this use of technology. On the hand, as I have anticipated in the previous section, RE takes *cognitive processes to be agent-environment system's events*. Perception, for example, is an ecological/enactive event. This means that perception is not something that occurs in the brain or even in a given organism. Perception is a feature, or a process, of the whole agent-environment system. Thus, the technological elements of the brain-body-environment system constitute perception. For example, wearing glasses or having a prosthetic leg *does not enhance* perception but literally change the behavioral conditions that enable perception and, in this sense, constitute it.[6]

On the other hand, as a matter of empirical research, some proponents of RE have developed ways to understand the constitutive role of technology in cognitive systems. Within the framework of ecological dynamics (see Chemero, 2009), for example, some researchers have defended the thesis that cognitive systems are *interaction-dominant systems –i.e.*, systems in which the interaction between their parts is more important than the proper activity of each part. Following this thesis, they have found in analyses of the complexity of systems –put simply, analyses of their fractal structure by detecting whether their temporal variability exhibits a phenomenon known as *pink noise* (see Van Orden, Holden, and Turvey, 2003)– a way to identify whether they are interaction-dominant system or not. Dotov, Nie, and Chemero (2010) performed this kind of analysis on systems composed by human beings and some hand-tools (the technological devices) and found pink noise in their couplings; that is, they found that couplings between human beings and hand-tools are interaction-dominant systems. In this sense, and following the thesis of cognitive systems as interaction-dominant systems, the whole system (human being + hand-tool) may be taken as a unitary cognitive system. Empirical results of this kind support the idea in RE that technology is not only an aid to cognitive systems but a constitutive part of them.

As in the case of the instrumental use of technology, the embodied use of technology may be better illustrated by taking a closer look at a contemporary form of RE. Ecological psychology is such a form of RE as it takes body, environment, and their lawful relation as the starting point to explain cognitive processes. To do so, ecological psychology rests on two fundamental ideas: (i) the structure of environmental information and (ii) the active character of cognitive events. Regarding (i), what ecological psychologists defend is that environmental information is possible due to the structure of the energy fields that surround organisms. Organisms are surrounded by light, waves, chemicals, etc., and the differential structure of those energetic fields through the environment carries information about the environment itself.[7] Perception *is* the detection of this environmental information, so whatever aspect of the brain-body-environment system that allows for a differential detection of such information is taken to be part of the perceptual process and the perceptual system. In this sense, technological devices such as glasses or virtual/augmented reality tools are not just peripheral elements to the cognitive system but some of its fundamental components. When glasses give access to new environmental information, for example, they allow for *detecting* new information and even for new *forms of detecting* it –*e.g.*, new patterns of exploration as the organism that wears the glasses does not need to approach to things in the environment as close as before. Thus, glasses allow for *qualitatively new forms of perception*.[8] They are part of a new, better perceptual system as far as they do not just improve a given perceptual ability but change the very conditions of possibility of perception as such.

The active character of cognitive processes, (ii), is closely related to the access to the structure of environmental information, (i), and illustrates the same embodied use of technology. If we think about the role of the body in RE, for example, is not just a tool used by the brain to gather information. The body is active and, by being so, is a basic component of all cognitive processes. One example of this fact can be found again when considering perception: the active body adds some fundamental features to the intrinsic character perception that are impossible to explain if the body is taken to be just a tool of a pre-given cognitive system (*e.g.*, a brain-based Bayesian system). For instance, we can only access to some environmental information if we move the way we do: we only have access to some forms of optic flow if we are able to walk or if we are able to jump. In this sense, when ecological psychologists claim that the eyes are in a movable head, attached to a movable body, etc., they are not describing a tool. Rather, they are pointing out that the way our body is shaped the way our cognitive processes are.[9] If we move our focus away from the body and place it on technological devices the same rationale applies. If by *using* technology we are actively changing our access to environmental information, technology must be taken as a constitutive part of the cognitive system. Thus, from the active character of cognitive processes we get the same conclusion that we got from the structure of environmental information: technological devices play a role in structuring environmental information and the active access to it. Thus, they must be considered constitutive parts of cognitive systems in a substantive, non-vicarious sense. In other words, the use of technology must be understood as embodied and not as instrumental.

4. CONSEQUENCES OF RADICAL EMBODIMENT

The arguments proposed until now support the idea that RE is fundamentally different from ECS and HEM in its understanding of the relationship between technology and cognitive systems. ECS and HEM still hold some remnants of brain-centrism and, because of that, are better characterized as aligned with an instrumental use of technology. On the contrary, RE takes the organism-environment system as the basic cognitive unit, which entails an embodied use of technology. However, beyond the general confrontation between ECS and HEM, on the one hand, and RE, on the other, these different views regarding the status of technology in cognition have consequences for concrete debates both within and outside the cognitive sciences. I will say a few words regarding two of these debates.

4.1. Coupling-constitution Debate

In the context of an overall critique of embodied approaches to the cognitive sciences, Fred Adams and Kennet Aizawa (2001, 2010) proposed the *coupling-constitution fallacy*:

> The fact that object or process X is coupled to object or process Y does not entail that X is part of Y. *e.g.*, The neurons leading into a neuromuscular junction are coupled to the muscles they innervate, but the neurons are not a part of the muscles they innervate (Adams & Aizawa, 2010, p. 68).

The general idea is that those approaches that claim in favor of the constitutive role of extra-cranial elements in cognitive processes just confound events of coupling with events of constitution: different objects and processes may be coupled, but that does not entail they are constituted by the other one in any sense.

There have been many reactions to the coupling-constitution fallacy. Some authors have argued that the instances Adams and Aizawa use do not really support their claim –*e.g.*, neurons and muscles connected in specific neuromuscular junctions actually constitute the motor system (Piredda 2017)–, some others have challenged the theoretical underpinnings of the fallacy (see Clark, 2006; Ross & Ladyman, 2010; Kirchhoff, 2013), and others have elaborated empirical models against the fallacy (see Froese, Gershenson, & Rosenblueth, 2013). I am not going to try to provide a general challenge to the fallacy, but I will briefly show how it does not apply to RE, in general, and consequently to its treatment of technology.

The coupling-constitution fallacy only applies, I contend, if the primacy of the brain as a cognitive unit is previously accepted.[10] Actually, the fallacy literally does not make sense within the theoretical boundaries of RE. As noted before, one of the fundamental tenets of RE is that the primary cognitive unit is not the brain but the organism-environment system. Given this, how can we understand the coupling-constitution distinction that allows for the fallacy? In other words, what could be coupled to the organism-environment system for the fallacy to be possible? In the classic delivery of the fallacy, the coupling-constitution distinction was made in terms of the inside-the-brain/outside-the-brain distinction because the brain was assumed to be the basic cognitive unit or system. However, as in RE the basic cognitive unit or system is the organism-environment system, it seems the key distinction should be inside-the-organism-environment-system/outside-the-organism-environment system. Sadly, the meaning of 'outside the organism-environment system' is not obvious. Does it mean the physical world? The microscopic world? The really faraway world? The former seems to be an intrinsic part of the organism-environment system just described in different terms. And the two latter seem to be just out of the scale of what it is normally taken as an environment (Gibson, 1979). It seems, therefore, that there is no way to even meaningfully state the coupling-constitution fallacy within the theoretical coordinates of RE.

As the coupling-constitution fallacy seems not to apply to RE in general, it should be obvious that it does not apply to technology-related instances. Actually, when Adams and Aizawa (2001) refer to technology, they do it already assuming the brain as a cognitive unit:

> Microscopes, telescopes, mass spectrometers, IR spectrometers, stethoscopes, and high-speed photography convert environmental energy into a form usable by our sensory apparatus. In all these cases, common sense has it that *our cognitive faculties, restricted to the confines of our brains*, can be aided in any manner of ways, by cleverly designed non-cognitive tools. (p. 44; emphasis added).

Again, my argument is that they need the brain-centric assumption for the fallacy to hold and as such an assumption is rejected in RE, the fallacy does not apply. In other words, by taking a brain-centric position from the beginning, Adams and Aizawa beg the question regarding what constitutes a cognitive system. RE shows that cognitive systems can be characterized in a different way that is immune to the alleged fallacy.

4.2. The Political Status of Technology

The new characterization of the relationship between technology and cognitive systems in RE might have some political implications. Technology may be a *fully* constitutive part of a cognitive system when used and this could entail that technology may be a *fully* constitutive part of the individual/self as soon as it is supposed to be at least partially constituted by its cognitive events. In such a situation, the general question would be how to make political and legal sense of the status of technology as a constituent of the individual/self. If technology substantially constitutes cognitive systems and consequently individuals/selves, an attack to concrete technological devices used at a time might literally count as an attack to the individual that is constituted by them. Of course, like in the case of the body, there would probably be degrees of importance/punishment. For example, it is not the same to take off a lock of hair from a person than to take one eye off from her. In the same sense, it is not the same to destroy someone's iPad than to destroy someone's prosthetic leg. Anyway, the status of technology in the framework of RE opens new political questions. I do not aim to answer these questions in a few lines, but I will offer an observation that could serve as a starting point of thinking.

If RE is right and technological devices constitute cognitive systems and consequently individuals when used, individuality must be understood as a dynamic process, so the political interventions on it must be context sensitive. When the individual self is taken to be a dynamically soft-assembled, self-organized system that includes elements from the brain, the body, and the environment, our political interventions must reflect the changes in the dynamics given different situations. For example, the individual self of a blind person includes her cane –a technological device– when she is using it. In Merleau-Ponty's words, the blind person does not perceive the cane, but the world at the end of the cane. In this sense, while the blind person is using the cane, it is as part of herself as her legs or her arms are so. Thus, the cane must be protected as much as her body at least during the situations in which she is using it. In other situations, however, as the cane is not part of the soft-assembled, self-organized system –because it is not being used– it can be taken as a mere object. Such is the way in which, depending on the context, our political interventions must be context sensitive.

The case of the blind person and the cane may be a very restricted one because it entails the lack or the loss of a biological cognitive ability (sight) to count the cane as part of the cognitive system. However, the idea may be generalized to other technological devices that do not require the lack or loss of a biological ability in order to be part of a cognitive system. If technology substantially constitutes the cognitive system in a given situation –both as part of the environment or a part of the body– I see no reason to consider it differently from the case of the cane for a blind person if not as a matter of degree –as said before, it is probably less hurtful to destroy the keyboard I am using to write this paper that to destroy the cane of a blind person.

Another aspect of the potential political relevance of the embodied use of technology typical of RE is the generation or withdrawal of political rights due to the use, abuse, or misuse of technologies. Heras-Escribano's (2019) proposal on what can be called the *affordance perspective on politics* is a productive way to approach aspect of the embodiment of technology. From an explicit RE point of view, Heras-Escribano (2019) claims that "the encouragement or the prohibition to take certain affordances is at the basis of political control and regulation of behavior in public spaces." (p. 180). Following the ecological tradition (Gibson, 1979; Chemero, 2009), Heras-Escribano takes affordances to be opportunities for interaction with one's environment and, as far as these opportunities of interaction may be encouraged or prohibited by political institutions, they are relevant for political organization.

To support his claim, Heras-Escribano (2019) provides two examples. The first one is the apartheid in South Africa (1948-1991). Due to racist politics, many affordances were prohibited for black people during the apartheid. From simple interactions with their environment, like passing through a door (*e.g.*, if the door was of public bathroom restricted to white people), to more complex and long-term prohibitions, like getting a house or a job. According to Heras-Escribano, this a clear example of the relevance of prohibiting affordances for political organization. The second example is the political action of Rosa Parks when she was told to leave her sit in a bus to a white person and she refused to do so. In that situation, Rosa Parks was requested to abandon her interaction with her environment–*i.e.*, to stop taking the affordance (sit-ability) of the sit–but she did not do it. In that moment, she was generating a new affordance for black people: the free sit-ability of bus sits. Such a new affordance was eventually political institutionalized and black people did not encounter that restriction anymore.[11]

This idea of the political relevance of some concepts of RE opens further questions about the political implications of the embodiment of technology as, for example, it can play any role in the encouragement or the prohibition of affordances. In some sense, the answer to this question is complementary to the previous reflections on the political significance of the embodiment of technology as it is understood in RE. Those reflections were focusing on the possible political (and legal) consequences of taking technological devices as proper parts of out body. In this case, however, the focus switches to whether the embodiment of technology opens spaces for new political (and legal) events both in individual and social terms. Does the embodiment of technology trigger changes in the political organization of societies? And, if so, in what way?

There are some trivial considerations regarding the relationship between technology and politics: it is obvious that technological changes sometimes entail profound political (and legal) changes. The examples are numerous and varied: changes in property laws due to technological improvements (like houses!) or technological ownership, changes in locomotion laws dues to cars, changes in privacy laws due to the internet, etc. However, these examples do not have to particularly do with the embodiment of technology. They refer to general relations between the presence of technology in our societies and their organization. Regarding the specific question on whether the embodiment of technology may generate new or prohibit old opportunities for interaction with our environment, the key is whether these technologies purport a qualitatively different set of interactions (*i.e.*, affordances) with the environment. If it does so, it is to expect that new affordances are created and that some of them may eventually be the subject of political regulation. The set of examples is not as vast as in the case of general relations between technology and politics, but we can still find some examples, as when different forms of prosthetic technologies affect to the position of individuals regarding some laws. For instance, cochlear implants affect the position of several individuals with regard the societal groups based on functional diversity and, therefore, generate new affordances for some of them (*e.g.*, the possibility of applying for some public jobs that require hearing). In this example, the embodiment of technology entails political implications that can be understood in the categories proposed by RE.

Summing up, the re-description of the status of technology with respect to cognitive systems and its embodiment in terms of in RE is so profound that it might lead to counter-intuitive political positions such as considering the attack to technology as an attack to persons and not to objects or even to ideas regarding the political encouragement and prohibition of different affordances that have to do with such embodiment. However counter-intuitive it seems to be, I do not take it as an argument against RE and its understanding of technology, but as an instance of the power of RE to understand brain-body-environment systems in novel ways, including their political organization.

5. CONCLUSIONS

In this paper I have analyzed some aspects of the take on technology that can be found in 4E approaches to cognition. After briefly introducing the three main paradigms within 4E cognition –ECS, HEM, and RE– I have made three fundamental claims. First, that RE holds a qualitatively distinct take on technology when compared to ECS and HEM. While the latter hold an instrumental use of technology, RE holds and embodied use of technology. My second claim has been that a consequence of such qualitatively distinct take on technology is the completely ineffectiveness of the argument based on the coupling-constitution fallacy with regard to RE. And my third claim has been that the RE position on the embodiment of technology has political implications as well. These three claims taken together point out, I think, substantial differences in the ways 4E approaches to cognition regard technology that are worth further exploration.

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NOTES

1 This semantic decision might be a little confusing for some readers, but I think there are reasons why my strategy is better than referring to the whole field as "embodied cognition" or "situated cognition", as not all the positions in the field are embodied or situated in a relevant sense.

2 Among them, the Gibsonian proposal of ecological psychology is probably both the pioneer and most complete understanding of the role of body and environment for cognition and its consequences for the sciences of the mind (see Chemero, 2009; Raja, Biener, and Chemero, 2017; Raja 2019).

3 Usually, ECS not only proposes that cognition is embodied, but also embedded or situated (Robbins & Aydede, 2009). However, in this paper, I restrict the analysis of ECS to embodiment for reasons of space–also, most–if not all–of the claims regarding embodiment I make here are straightforwardly applicable to embedment and situatedness.

4 Some authors have claimed that either functionalism, or the parity principle, or both are insufficient or irrelevant for HEM (see, *e.g.*, Rupert, 2004; Sprevak, 2009; Walter, 2010a, 2010b).

5 For a general review of this topic, see Schettler, Raja, and Anderson (2019).

6 Other ways to express this idea is that technological devices change the way we explore the environment, change the way we detect information, change the way we enact the world, change the way we perceive affordances, etc. All these claims point to the same idea of the embodied use of technology.

7 Such an ecological notion of information as a kind of given structure is a radicalization or a re-elaboration of Gestalts' rejection of the bundle hypothesis (Koffka 1923, Wertheimer 1923). According to Gestalt psychologists as well as to Gibsonians, what we see is not a bundle of meaningless sensations but complete meaningful structures.

8 Notice, again, that this is contrary to HEM's parity principle.

9 This conception of environmental information experienced by organisms in virtue of their body, skills, and actions can be directly traced back to Heidegger's (1927) notion of purposive practice as the primitive relation between the Dasein and the world, and also to Merleau-Ponty's idea of body schema (1945/2012).

10 Notice that it could apply–and, in fact, I think it does–to ECS and HEM.

11 It is important to point out that the encouragement (or generation) and prohibition of affordances speaks to their social and normative character. Of course, in terms of the physical environment the sit-ability of a sit or the pass-ability of a door are there with and without political norms. However, as we live in a social world, their social (or normative) availability can be politically mediated.