Being inside: Putting representation, body and world together again

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Briefly I will consider the semantic and referential aspects in the notion of information processing system, such as it has been used in cognitive sciences. Then I will analyse concisely the notion of information processing system in psychology, surveying the evolution of Ulric Neisser's ideas about this point. Contrary to these classical theses I will sketch the antirepresentationalism defended by Timothy van Gelder, and also by Rodney Brooks. I will point out several mistakes in antirepresentationalism and, finally, I will conclude that body and world are inside the mind-brain via representation.

I. Information processing in cognitive sciences

Within the interdisciplinary field of cognitive sciences (which includes artificial intelligence and cognitive psychology) the notion of information processing system (IPS) has been the common basic assumption. This notion was worked out by Allen Newell (1927-1992) and Herbert Simon (1916-2001) in their book *Human Problem Solving* (1972) and later was developed by Newell in his paper "Physical Symbol Systems" (1980). It is worth mentioning that the notion of IPS is equivalent to the notion of physical symbol system (PSS), such as it can be easily seen comparing figure 2.1 in *Human Problem Solving* and figure 2 in "Physical Symbol Systems". This notion constitutes a generic idea embracing both the species of artificial cognitive systems and the species of natural cognitive systems (human or animal). However my concern, in this paper, is with human cognitive systems.

Usually an IPS or PSS has been understood as (basically) a syntactic mechanism, but in fact it includes several semantic and referential aspects. Although in the Turing machine concept the semantic aspects are not excluded, because the manipulated signs can be representational symbols, in the case

of a PSS the semantic and interpretational aspects are more explicit. A PSS consists of a memory, a set of (ten) operators[1], a control, inputs and outputs. The behavior of the system is governed by the control, and the behavior of the control (or processor) consists of the continual interpretation of whatever expression is active; particularly the control interprets data and programs, and also the result. Furthermore the assign operator establishes a basic relationship between a symbol and the entity to which it is assigned. Even the concept of designation is the most fundamental to a PSS, being the concept which gives symbols their symbolic character, i. e., which lets them stand for some entity; Newell says that we call this concept designation, though we might have used any of several other terms, e. g., reference, denotation, naming, standing for, aboutness, or even symbolization or meaning. Personally I would choose representation. Anyway, according to Newell, the symbolic aspect lies in that having X (the symbol) is tantamount to having Y (the thing designated) for the purposes of a process P[2].

II. Information processing in psychology

Before the consolidation of cognitive sciences in 1977, with the launching of the review *Cognitive Science*, a non technical notion of IPS can be found in several (cognitive) psychologists. The most important highlights were the paper by George Miller "The magical number seven, plus or minus two" (1956), the book written by Jerome Bruner, Jacqueline Goodnow and George Austin *A Study of Thinking* (also 1956) and four years later George Miller, Eugene Galanter and Karl Pribram´s *Plans and the Structure of Behavior*, which can be regarded as the manifesto of cognitive psychology. In any case in those years the human beings were understood as information processing systems.

However I think that the most interesting case is posterior to these beginnings, namely the evolution of Ulric Neisser´s ideas about human beings as IPS. In his book *Cognitive Psychology* (1967), which has constituted the first textbook of cognitive psychology, the human mind is depicted as comparable with a computer program[3]. Neisser says that the task of a psychologist trying

1 These ten operators are the following: assign, copy, write, read and input (in connection with receptors) and do, exit-if, continue-if, quote and behave (in connection with motor).

2 A. Newell, "Physical Symbol Systems", p. 156.

3 Neisser warns that we must be careful not to confuse the program with the computer that it controls. For Neisser the "program analogy" (which may be a better term than "computer analogy") has several advantages over earlier conceptions. The first and most important is the philosophical reassurance which it provides; although a program is nothing but a flow of symbols, it has reality enough to control the operations of very tangible machinery that executes very

to understand human cognition is analogous to that of a man trying to discover how a computer has been programmed. And at the same time Neisser believes that physiology and biochemistry have little to say in psychology. Hence human beings seem to be not situated creatures.

Nevertheless Ulric Neisser has changed his mind in his *Cognition and Reality* (1976). This book is dedicated to James Jerome Gibson (1904-1979), the main defender of ecological psychology[4], with whom Neisser coincided at Cornell University. I esteem that the ecological approach is wrong since it disregards human brain and the information processing in the brain. Anyway Neisser in *Cognition and Reality*, in part under Gibson´s influence, proposes the integration of mind and environment. According to him cognitive psychologists should make more effort in understanding the cognition in the world beyond the confines of the laboratory[5]. On other hand Neisser stresses the importance of perception, which is the basic cognitive activity out of which all others must emerge, and it is also the place where cognition and reality meet. Because of it Neisser claims that perception constitutes the interaction point between the internal schemes and the accesible information (environment)[6].

III. Antirepresentationalism

In recent times the notion of information processing system, and particularly the notion of representation, have been challenged in favor of the notion of natural and artificial systems without representations. Hence the human agents seem to be basically coupled in the world agents instead of representers of the world.

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physical operations. And the second advantage of the "program analogy" is that, like other analogies, is a fruitful source of hypotheses; such notions as "parallel processing", "feature extraction", "analysis-by-synthesis" and "executive routine" have been borrowed from programmers. (Cf. U. Neisser, *Cognitive Psychology*, pp. 8-9).

4 Ecological psychology, generally speaking, is the approach claiming that psychology is a branch of ecology, the interdisciplinary study about living systems and their environments and about the interactions between the ones and the others.

5 Neisser points out that a psychology lacking in ecological validity, indifferent to culture, even missing some of the main features of perception and memory as they occur in ordinary life, could become a narrow and uninteresting specialized field. (Cf. U. Neisser, *Cognition and Reality*, p. 7).

6 The interaction between inner schemes and environment is emphasized in the case of visual perception: "The cognitive structures crucial for vision are the anticipatory schemata that prepare the perceiver to accept certain kinds of information rather than others and thus control the activity of looking. Because we can see only what we know how to look for, it is these schemata (together with the information actually available) that determine what will be perceived. Perception is indeed a constructive process" (Neisser, o. c. p. 20).

Once more John Haugeland has well coined the situation speaking about "Mind embodied and embedded" (1995). I solely will consider the case of Timothy van Gelder, the clearest one for natural cognitive agents, and the case of Rodney Brooks, whose ideas about artificial agents are useful for my arguments.

On the one hand, van Gelder intended to shake the establishment publishing his paper "What might cognition be, if not computation?" (1995). To him the Watt´s governor (a non representational device) is preferable to the Turing machine as a landmark for models of cognition. Andy Clark and Josefa Toribio, in their paper "Doing without representing?" (1994), have summarized very well van Gelder´s claims, when his paper was still in press. To begin I will follow their exposition[7].

Van Gelder seeks to convince us that the image of cognition as computation is no longer the only game in town. Instead, there is cause to take very seriously an alternative notion viz., that cognition is state-space evolution in certain kinds of non-computational dynamical system. This turns out to build in some degree of anti-representationalism since it transpires that computational solutions are distinguished, at least in part, by their reliance on internal representations. According to van Gelder cognition itself might be the behavior of dynamical systems relevantly similar to Watt´s centrifugal governor. In fact this governor was designed by James Watt (1736-1819) in the late 18th century as a solution to the problem of keeping constant the speed of a flywheel to which machinery is connected. The speed of the flywheel varies according to the steam fluctuations that take place in the engine workload and the boiler. In order to control the speed of the flywheel, we have to control the amount of steam entering the pistons from the boiler via a valve, the so-called throttle valve. What this governor does is to close the throttle valve as the flywheel speed increases – so the flow of steam is restricted – and to open it as the flywheel speed decreases – letting more steam flow -. In this way the speed of the flywheel is kept constant[8]. The

7 Cf.: Clark and Toribio, "Doing without representing?", pp. 416-417.

8 Van Gelder himself details the mechanism of Watt´s governor: "It consisted of a vertical spindle geared into the main flywheel so that it rotated at a speed directly dependent upon that of the flywheel itself [...]. Attached to the spindle by hinges were two arms, and on the end of each arm was a metal ball. As the spindle turned, centrifugal force drove the balls outward and hence upward. By a clever arrangement, this arm motion was linked directly to the throttle valve. The result was that as the speed of the main wheel increased, the arms raised, closing the valve and restricting the flow of steam; as the speed decreased, the arms fell, opening the valve and allowing more steam to flow" ("What might cognition be, if not computation?", p. 349). We can add that the process is the following: 1) speed increasing in the machine, 2) rotation increasing in the flywheel, 3) closing of the throttle valve, 4) speed decreasing in the machine, 5) rotation decreasing in the flywheel, 6) opening of the throttle valve, and 7) again speed increasing in the machine. Obviously this feedback loop is potentially continuous.

importance of the way in which the governing problem was solved, van Gelder states, is that the task is performed without any representation of the speed of the flywheel or the throttle valve adjustments.

In his "The dynamical hypothesis in cognitive science" (1998), van Gelder has compared the computational hypothesis (CH), saying that cognitive agents are basically digital computers (and referred to the physical symbol system hypothesis seen above), with the dynamical hypothesis (DH), saying that cognitive agents are dynamical systems. According to van Gelder this dynamical hypothesis has two major components: first, the *nature* hypothesis that specifies that cognitive agents *are* dynamical systems, and second, the *knowledge* hypothesis that says that we can and should *understand* cognition dynamically. In any case the proper domain of the DH is *natural* cognitive agents, that is, evolved, biological agents such as people and other animals. This point is important for me because, in this paper, I am concerned with human cognitive systems.

Van Gelder insists that dynamical systems are not inherently representational and that dynamics forms a powerful framework for developing models of cognition that sidestep representation altogether. Summarizing his points of view, van Gelder offers the following compact formulation of the DH: "For every kind of cognitive performance exhibited by a natural cognitive agent, there is some quantitative system instantiated by the agent at the highest relevant level of causal organization, so that performances of that kind are behaviors of that system; in addition, causal organization can and should be understood by producing dynamical models, using the theoretical resources of dynamics, and adopting a broadly dynamical perspective"[9].

In "What might cognition be, if not computation?", van Gelder has written that in order to describe the functioning of Watt´s governor we need a more powerful conceptual framework than mere talk of representation. That framework is the mathematical language of dynamics, and, in that language, the quantities are said to be coupled. The real problem with describing the governor as a representational device, van Gelder goes on, is that the relation of representing – something standing in for some other state of affairs – is too simple to capture the actual interaction between the governor and the engine[10].

On the other hand, Rodney Brooks has published "Intelligence without representation" (1991), which has had a new expanded version in 1997 with the same title. While van Gelder is mainly interested in natural agents Brooks puts forward his ideas in artificial intelligence, particularly in the building of autonomous mobile robots. Anyway Brooks defends that representation is the

9 Van Gelder, "The dynamical hypothesis in cognitive science", p. 622.

10 Cf.: Van Gelder, "What might cognition be, if not computation?", p. 353.

wrong unit of abstraction in building the bulkiest parts of intelligent systems[11]. Hence I can make use of his ideas to exemplify anti-representationalism.

Brooks concludes that when we examine very simple level intelligence we find that explicit representations and models of the world simply get in the way; it turns out to be better to let the world itself serve as its own model. Brooks´ key ideas are situatedness, embodiment, intelligence (understood as determined by the dynamics of interaction with the world), and emergence, and these key ideas have led him to the new style of artificial intelligence that he is calling "behavior-based robotics". In fact when Brooks describes the robots of our future life in *Flesh and Machines* (2002) he speaks (incidentally) about dumb and simple robots[12].

IV. Some mistakes in antirepresentationalism

I find several serious mistakes in antirepresentationalism.

First of all there is a confusion between *knowledge* and *motor ability*, or between properly cognitive systems and mere motor systems. In the case of Brooks the situation is very clear, because he speaks repeatedly of "behavior-based robots", while traditionally artificial intelligence is concerned with "kowledge-based systems". Furthermore Brooks is proud of having eliminated cognition box establishing a direct conection between perception and action[13]. But actually his robots exhibit effectiveness without intelligence; a mechanism can be very effective without being intelligent, for example our digestive system; Brooks´ robots are not very different from washing machines or dishwashers. Perhaps by propagandistic reasons he has spoken about a new approach in artificial intelligence, but in fact he is working with new and clever methods in simple (not intelligent) robotics[14]. According to Brooks intelligence would be something more apparent than real, because "intelligence is in the eye of the observer"; intelligence emerges from the interaction of the components of the system, in the case of traditional artificial intelligence from the modules defined as information-processing modules, and in the case of behavior-based

11 Cf.: Brooks, "Intelligence without representation", *Artificial Intelligence*, 47 (1991), p. 140.

12 Cf.: Brooks, *Flesh and Machines*, p. 121.

13 Cf.: Brooks, o. c. p. 36.

14 Already in 1991, David Kirsh criticized Brook´s orientation in artificial intelligence. In his "Today the earwig, tomorrow man?" stresses that, although we can frequently exchange representation for control, we need representations in a theory of perception, in a theory of learning and in a theory of control, so that we must rely on symbolic representations at least sometimes.

artificial intelligence from modules defined as behavior-producing modules[15]. Other scientist, Ronald Arkin, give us the following definition: "an intelligent robot is a machine able to extract information from its environment and use knowledge about its world to move safely in a meaningful and purposive manner"[16]. I think that it is important this relationship between intelligence and knowledge (not merely information). Furthermore Arkin, in a realistic manner, establishes a robot control system spectrum from reactive (reflexive) to deliberative (purely symbolic) robots; on one side we find robots which are representation-free, with real-time response, low-level intelligence and simple computation, while on the other side we have representation-dependent robots, with slower response, high-level intelligence (cognitive) and variable latency; from one end to the other the speed of response decreases, whereas predictive capabilities and dependence on accurate, complete world models increase[17]. We must realize that actually the main development in robotics has not been in the field of true intelligent robots, but the distinction between dumb robots (without real knowledge) and intelligent robots (with true knowledge) should be maintain.

In the case of van Gelder the central issue is whether human agents are like Watt´s governors but the correct answer, I think, is negative. In his "Dynamics and cognition" (1997), loosely based in his "What might cognition be, if not computation?", van Gelder specifies that a system is a set of variables (things, aspects, features, and the like) which change over time, such that the way any one variable *changes* at a given time depends on the *states* of other variables in the system at that time. Taken together, the states of all the variables make up the state of the system as a whole. In particular dynamical systems are sets of coupled magnitudes; in them variables are quantitative, their changes are interdependent in "real" time, and the tools for their description are differential equations. Above all the most genuine facet in dynamical systems is that they exhibit high degrees of coupling; every variable is changing all the time, and all pairs of variables are, either directly or indirectly, mutually determining the shapes of each other´s changes. For example, in the solar system (which is, like the Watt´s governor, a dynamical system) the position and momentum of every massive body is constantly changing, and every variable influences every other one. According to van Gelder the fundamental mode of interaction with the environment is not to represent it, or even to exchange inputs and outputs with it; rather the relation is better understood via the technical notion

15 Cf.: Brooks, "Intelligence without representation", 1997, pp. 418-419.

16 Arkin, *Behavior-Based Robotics*, p. 2.

17 Cf. : Arkin, o. c. p. 20.

of coupling[18]. From my point of view we can accept that the human brain is a dynamical system, but its cognitive functioning needs representations and it is not sufficient a mere coupling with the environment. We need representations in order to have properly knowledge instead of having mere motor ability.

Secondly antirepresentationalism implies an undesirable return to behaviorism, since the disappearance of explicit representations and of models of the body and the world depicts a direct relationship bearing stmuli to responses (without mind). Certainly the relation of human agents with their environment belongs frequently to the kind of simple reactions; changes in muscles and glandes (the favorite field of research for behaviorists) are produced very often without representations, but in these cases we should not speak of knowledge. When Donald Norman was interviewed by Bernard Baars in the book *The cognitive Revolution in Psychology* (1986) pointed out that in the early 1960s the word "mind" was not allowed and the study of information processing didn´t really exist, and added that "mind" is a respectable word today[19].

We can easily see that we could return to the old times previous to cognitive psychology. Van Gelder believes that various pervasive and pernicious misconceptions inherent in the Cartesian picture (basically the idea that mind is an inner realm of representations and processes) are very often retained even when substance dualism is rejected; he points out that if we begin with a thoroughly post-Cartesian approach, the dynamical account of cognition will be immediately attractive. This post-Cartesian conception rejects the model of mind as an atemporal representer, and, like the dynamical approach to cognition, emphasizes instead ongoing, real-time interaction of situated agents with a changing world[20]. But in my opinion the condition of being a situated agent in the world is not contradictory to the condition of being a representer of the world; on the contrary since the higher form of being in the world is the human form of being a representer instead of a mere coupled agent, like a Watt´s governor. It is true that human minds are (normally) coupled with their bodies and their ecological niche, but they have also the very special and important ability of decoupling from the current situations (decouplability)[21]. Precisely this ability is responsible for the general knowledge, which we can suppose typical of human beings.

And thirdly the antirepresentationalist stance is as naïve as its metaphysical basis, namely naïve realism. According to this position our ordinary perception

18 Cf.: Van Gelder, "Dynamics and Cognition", pp. 433-439.

19 Cf.: Baars, *The Cognitive Revolution in Psychology*, p. 382.

20 Cf. : Van Gelder, "Dynamics and Cognition", pp. 446-448.

21 Just the normal way of decoupling is by using symbols (mental or physical) entailing less or more generality.

of the things in the world is direct, without any construction by the mind, in such a way that the things in the world are known (more or less) exactly as they are in themselves. The refusal of representations by Brooks and van Gelder commits them to naïve realism. I do not say that any of them is for naïve realism, but I do say that both coherently should be for. On the one hand Brooks defends repeteadly that his autonomous mobile robots (*Allen*, *Herbert*, or *Genghis*) use the world as their own best model[22]. On the other hand van Gelder puts forward that cognitive systems are taken to consist of sets of coupled quantities evolving in real time; the fundamental mode of interaction with the environment is not to represent it, rather the relation is better understood via the technical notion of coupling[23]. In both cases it seems to be a direct access to the world in accordance with naïve realism but in contrast to representationalism.

In a certain sense human beings have a direct access to the world, just in the *ontological* sense of being in the world; it is trivial that human beings are embodied and situated in the world. Nevertheless from an *epistemological* standpoint humans have characteristically, in the most interesting cases (precisely in the cases of genuine cognition), an indirect access to the world via representations. In other words the perceived world is not the world itself. The main reason supporting this idea is that different cognitive agents can perceive differently the same thing. Let us imagine a football match contemplated by crowds of people; obviously the moves seen by the spectators are different according to (for example) their situation in the football ground or the colours of their team.

V. Conclusions

I esteem that it can be said straightforwardly that to know the world is not to have the world itself but to have representations of it. Therefore in order to be knowers we need to be representers. And certainly the world perceived by each human mind is different from the world perceived by the others minds. Nevertheless we can eschew any epistemological relativism since human beings share a (basically) same equipment of representation and a (basically) same linguistic competence. Roughly speaking although the perceived worlds are diverse among human beings it is meaningful to speak about a shared reality because we share a same kit of representation.

22 Cf.: Brooks, "Intelligence without representation", 1997, p. 416, *Flesh and Machines*, p. 42.

23 Cf. : Van Gelder, "Dynamics and Cognition", p. 439.

Hence, as I have defended in my paper "La realidad desde la mente" (The reality from the mind) (2001), we have to combine ontological realism and epistemological idealism. It means that *there is* the world independent of our minds-brains, but the world *exists* as a construction of our minds-brains via their representations. In other words *what there is out there* is outside our representations (ontological realism), but our representations are about *what there exists*, that is, about a reality built in an important extent by our minds-brains (epistemological idealism), and obviously these representations are inside the minds-brains. Summing up I can say that R is a representation of an item I for an agent A to the degree that A takes account of I in virtue of the manifestation of R[24]. For example, my visual perception of the Málaga cathedral is (assumed as) a representation of the Málaga cathedral for me because I take account of the Málaga cathedral in virtue of the presence (in my mind) of this representation, so that, for instance, I decide to go in this church. Also my concept of cathedral is a representation of certain buildings (in their general and characteristic aspects) for me because I consider these buildings in virtue of the presence (also in my mind) of this representation, so that, for instance, I can connect cathedrals and Christian temples.

It is true (and even a truism) that human agents are embodied and embedded, that is to say, human agents have a specific body and we are situated in an ecological niche (our peculiar world). But is is also true that our mind-brain represents our body and represents our world, at least in the obvious sense that our mind-brain is neither our complete body nor our whole world, and however it is able to put up internal stand-ins of both. Cognitive neuroscience has adopted the talk of representations and information processing. For example, Eric Kandel (Nobel Laureate in 2000) and Irving Kupfermann, in their chapter "Cognitive Neuroscience" (in the book *Essentials of Neural Science and Behavior*, 1995), state that the main aim in cognitive neuroscience is the study of internal representations, and say that the idea of an internal representation implies that every perceptive or motor action corresponds to a pattern of activity characteristic in a specific set of interconnected neurons. And also Stephen Kosslyn and Olivier Koenig, in their *Wet Mind. The new Cognitive Neuroscience* (1995), establish that a complete understanding of the brain will require more than a description of its physical composition, its cells and their connections, various chemical and electrical interactions, and so forth; the brain does something different from any other organ: it processes information; the brain registers input from the senses, interprets the input, and make decisions about how to

24 See my paper "Representación e interpretación" for a related notion of representation.

behave accordingly; thus, we can characterize brain function in terms of how information is processed[25].

Andy Clark, in his book *Being There. Putting Brain, Body, and World Together Again* (1997), has claimed a minimal representationalism where the notion of internal representation itself may be subtly transformed, losing especially the classical connotations, and at the same time he has proposed to put in a whole lot brain, body and world[26]. In my opinion since we have representations of body and world just inside our brain, the real issue in cognitive psychology is to put together again representation, body and world inside the brain.

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25 Cf.: Kosslyn and Koenig, *Wet Mind. The New Cognitive Neuroscience*, pp. 17-18.

26 Cf. : Andy Clark, *Being There. Putting Brain, Body, and World Together Again*, pp. 174 and 222.

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