

Piaget's Legacy: Cognition as Adaptive Activity

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Abstract · In the visual arts, “representation” usually means a copy or reproduction of some original. In that context it is clear that the original is always something the representer has seen, something that is the product of ordinary visual perception. With the introduction of the term in philosophical writings, the spurious question has arisen whether or not representations could reproduce, replicate, or correspond to things-in-themselves. The question was long ago given a negative answer on logical grounds by neurophysiology. Most arguments on the topic could have been avoided if one had followed Mark Baldwin, the pioneer of cognitive psychology, and had used the term “presentation” which has the added advantage of being a viable translation of the German “Vorstellung”.

If you look up the word “representation” in a large dictionary, you will find that it has at least five or six meanings, some of which are not compatible with each other. In ordinary English, “representation” usually means a deliberate graphic arrangement of sensory material, such that it is likely to be interpreted in terms of a generally available concept.

Here are some examples: A famous painting by van Gogh is a reliable representation of sunflowers. Or: Henri Matisse had a special talent for making squiggles that most viewers recognize as wonderfully stylized representations of specific fruits or flowers.

In the United States, a vertical wave line, or in Europe a capital Z, have been adopted as a conventional traffic signs because they can be interpreted as representing a curving road. Such representations do not have to be visual. Certain sounds can be used to represent a given event. For example, in the course of a stage play, a flash of light followed by a rumbling noise will be interpreted as a thunderstorm.

The Problem of Psychological Representation

But all these are not the kind of representation that concerns us here. The British philosopher John Locke used the term to indicate that words *stand for* (or “represent”) ideas (Locke, 1690, Bk. iii, Chpt. ii, §2); occasionally he used it also for the mental image of an idea, either fictitious (e.g. “the unspeakable joys of heaven”, Bk. ii, Chpt. xxi, §37) or “made up of ever so many particulars” (Bk. ii, Chpt. xxvi, §1). It was presumably this second meaning that led translators of Kant’s *Critique of Pure Reason* to use “representation” for the German word “Vorstellung”. This was unfortunate because the ordinary- language meaning had practically superseded the Locke’s more abstract second meaning.

The German word *Vorstellung* indicates a range of things that take place spontaneously in someone’s head and do not require an original. In contrast, the English “representation” normally refers to *sensory material* that more or less reliably evokes a common experience. That is to say, it is used to call forth in the beholder specific remembered situations, events, or objects (as for instance, the flowers and fruits in Matisse’s drawings). The term, therefore, indicates a perceptual cause whose effect is expected to be an image in the mind of the perceiver. In short, “representation” in English inevitably suggests reference to an original—in much the same way as does “copy”, “replica”, and “reproduction”.¹

In contemporary psychology—and in the study of intelligence, be it natural or artificial—the term representation is used for mental images that are supposed to reflect, or correspond to things that lie beyond our experiential interface.

¹ Note that *représentation* in French and *rappresentazione* in Italian function in the same way.

Jerry Fodor, for instance, explained in his interview with Baumgartner and Payr (1995, p.88): “mental states that represent states of the world” *constitute a representational capacity*.

In another interview in the same collection, James McClelland says: “I agree with Newell: the mind is a physical device that performs operations on physical objects, which are not the things themselves but representations of those things” (Baumgartner & Payr, 1995, p.134).

Other English speakers in the field of cognitive science have also explicitly or implicitly subscribed to the view that representations represent real things. It does not matter whether they define “to represent” as *to depict* or *to stand for*, because in both cases there is no way of checking any such relation to “real” things.

It is rather ironical that German-speaking authors, anxious to tie in with Anglo-Saxon cognitive science, are now aiding and abetting the confusion by translating the English word in their own writings as “*Repräsentation*” rather than as *Vorstellung*, from which it derived by mistranslation.

I want to emphasize that computer scientists use the term “representation” quite legitimately when they refer to the way they have coded something in a computer. In their case, the coded instructions, the program, or whatever they have fed into the machine, is expected to generate results that can in some sense be considered replicas of something in the scientists’ own heads.

The same goes for neurophysiologists who speak of observable phenomena in the brain as “representing” certain activities and results of the mind. Occasionally, however, they too, slip into the misleading use of the term exemplified by the quotations from Fodor and McClelland. That is to say, they falsely suggest that states of the brain reflect states of an external “real” world.

The Impossible Correspondence

This use of representation is misguided, because it entails the belief that certain ideas we abstract from our experience *correspond* to a reality that lies beyond experience. It would be interesting to study the reasons why this belief manages to survive in the face of a long history of incontrovertible refutation. It has survived in spite of the fact that it was shown to be illusory by Xenophanes at the time of the Pre-Socratics; and it survived in spite of all the sceptics

since, who have amply demonstrated the logical impasse that makes it illicit to claim a representational relation between mental images or structures and any independent external reality.

The main argument of the sceptics is simple and irrefutable. To know whether anything we derive from experience corresponds to, or “represents” an aspect of an external world, we should have to be able to compare it to the real thing. But this we cannot do, because we can compare experiences only to more experiences.

Some early theologians of the Christian era added another solid argument: Reason, they said, operates with concepts that we have derived from experience; in our experiential field we never meet anything that is omniscient, omnipotent, and ever-present; consequently, we cannot rationally conceive of God, because the knowledge, the power, and the eternity we should ascribe to Him go beyond what is conceivable to us (cf. Meyendorff, 1974).

Unlike the church that persecuted them, they did not see this as a calamity, because they understood that faith does not require a rational grounding.

The argument that our concepts, which we abstract from experience, cannot grasp anything that lies beyond our experiential interface, applies not only to the divine but also to any ontological reality posited as independent of the human experienter.

In our present age, where science is supposed to be the arbiter of all fundamental questions of knowledge, it is even more surprising that a correspondence theory is still propagated by philosophers. The notion of ontological correspondence is quite incompatible with contemporary scientific models. I am not referring to some of the relevant arguments that have been drawn from relativity theory and quantum mechanics; I am referring to an established finding in neurophysiology that would seem to be more pertinent to A.I.

About a hundred and fifty years ago, Johannes Müller observed that all the neural impulses or signals that the so-called sense organs send to the cortex of the brain are qualitatively the same. As Heinz von Foerster, who three decades stressed the epistemological importance of this fact, puts it: these neural signals vary in frequency and intensity and tell us “how much”, but they never tell us “what” (Foerster, 1973). In other words, they are quantitative. They contain no information whatever about the character of the event that is supposed to have caused them.

According to the neurophysiologist's model of the nervous system, it therefore appears that the discrimination of sensory modalities—seeing, hearing, touching, etc.—must be the result of the system's own computation. From this perspective, then, whatever sensory structures, patterns, or images a living system compiles are its own construction, and the notion that they *represent* something that was there beforehand, has no empirical foundation.²

Presentations and Re-Presentations

I therefore suggest that it would be wiser to scrap the term “representation” in these contexts and to follow Mark Baldwin's example and speak of “presentations”. This would be much closer to the Kantian term “Vorstellung”.

These “presentations” are pieces of experience that we have combined in order to form more and less complex structures, in our attempt to order and systematize the world in which we find ourselves living. It is the only world we know—and it's a world that only we ourselves perceive and conceive.

Insofar as we remember these structures, we can recall them—and then they are Re-Presentations. I write this with a hyphen, to indicate that they are pieces of experience we have had and are now reviewing. They are not pieces of an external reality.

Almost fifty years ago, my friend and teacher Silvio Ceccato made a remark which, I think, is germane to today's topic because it throws light on the distinction between perception and re-presentation.

The most obvious instances of re-presentations happen in our dreams, when there is no perceptual activity at all. These re-presentations, Ceccato said, start from a concept and manifest only such sensory characteristics as are needed in the particular story of the dream.

You may, for example, dream that you are in a room, but all you *see* of the room is a door (perhaps because you expect someone to come in through it). You have no idea of the size of the room, and there are no windows, curtains, pictures, no ceiling or furniture, or anything else that usually characterizes a

room. These items may come in later—as the plot of the dream develops—but at this point, they are irrelevant in your dream-presentation of a room.

In contrast, your perception of a room starts from sensory impressions that you proceed to coordinate, and they then allow you to consider them compatible with your concept of “room”.

One can therefore say: in perception, sensory signals call up a concept, in re-presentation, on the other hand, a concept calls up sensory impressions. In neither case is the experience *caused* by what philosophers want to call “reality”.

The Space of Experiential Reality

If one accepts these premises—and I can see no way of avoiding it—one is faced with a formidable question: How does it come about that we are able to generate the relatively stable experiential world of everyday living? In other words, these premises make it necessary to show that we *can* construct our experiential world without ever discovering anything about the properties and structure of an external, ontological reality.

A radical interpretation of Piaget's Genetic Epistemology provides an answer to that question. Before going further, however, I want to stress that an inherent principle of Piaget's constructivist approach implies that no solution of a practical problem can claim to be the only one. But at present, Piaget's is the only coherent theory or model I know, and I will give you a brief sketch of some of its features.

Piaget's primary principle is that knowing is an *adaptive* function. To appreciate this statement, one has to be quite clear about the biological notion of adaptation. It is *not*—as one is often led to believe—an activity of organisms or species. It is the result of natural selection and refers to the ability to live and reproduce in the present environment. We can visualize it with the help of a metaphor: the environment “selects” in the manner of a screen used to grade gravel: the screen admits what falls through and discards what does not. Similarly anything that passes through the constraints set by the present environment is adapted, or, as evolutionary biologists sometimes say, everything that survives is *viable* in the given environment. But just as having slipped through, does not tell the pebbles anything about the screen, so, to have survived does not tell the biological organisms anything about the

² Because statements like this are often misinterpreted as “a denial of reality”, I want to point out that I am not saying sensory signals have *no* cause; I am merely asserting that we cannot *know* such causes.

constraints they have not met, i.e., the constraints that eliminated those that could not survive.

The concept of adaptation was first applied to cognition, by William James, Georg Simmel, Hans Vaihinger, and others, around the turn of the century. It then became the main stay in Piaget's "Genetic Epistemology". Today it is also a key concept in Evolutionary Epistemology. However, as far as I have understood the proponents of this school, they share the traditional illusion that adaptation brings our knowledge closer to a postulated ontological reality.

Konrad Lorenz, for instance, maintained that the great success of our concepts of space and time warrants the belief that they reflect something of the structure of an observer-independent world. He wrote:

Adaptation to a given condition of the environment is equivalent to the acquisition of information *about* that given condition. (Lorenz, 1979, p.167)

As I have tried to show with the metaphor of the screen, viability entails neither "information" about the environment nor correspondence with it. The fact that certain concepts and certain theories "work" for us, in that they do what we expect them to do, means no more than that they are compatible with the constraints we experience. In other words, reality leaves sufficient room for them to work in our experiential world.

This has the important corollary that our successful concepts and theories can never be claimed to be the only ones that work ~ and therefore they cannot be claimed to be ontologically "true".

Piaget held that all knowledge springs from action, and he proposed a highly sophisticated developmental model of how concepts & theories may be constructed. Although he did this at least a decade before cybernetics was launched as a discipline by Norbert Wiener, Piaget's model anticipated the principles of self-regulation and of the negative feedback-loop.³

There is not enough time here to go into details, but I want to present at least two examples.

³ Judging by the twenty interviews with "eminent cognitive scientists" that Baumgartner and Payr published in their recent book, Piaget seems to be *persona non grata* in this new branch of science. The index does not contain his name, and the only mention of it I could find is a rather summary dismissal.

Piaget's Scheme Theory

The model of Piaget's action scheme, which constitutes the foundation of his learning theory, is a complex of three elements: A recognized situation, an activity that has been associated with this situation, and an expected result.

The recognition of a situation involves *assimilation*; that is to say, the situation must manifest certain characteristics which the organism has abstracted in the course of prior experience. (If it also has other characteristics, these are disregarded.) The recognition then triggers the associated activity. If the expected result does not occur, the organism's equilibrium is disturbed and an *accommodation* may occur, which may eventually lead to the formation of a new action scheme.

The fact that accommodation does *not* take place unless something unexpected happens, is important for any learning theory, and it relates Piaget's scheme theory to the notion of the feedback-loop in control theory. There, too, certain activities are triggered when a perceived condition is not compatible with a given reference value.⁴

Social Interaction

The experiential environment in which the human organism normally grows up is composed of things and people. The differentiation of these two categories is gradual, and only gradually are different schemes developed for coping with "inanimate" things and coping with people. Eventually the second kind provides far more opportunities for accommodation and learning than the first. Piaget has reiterated this innumerable times, but his critics nevertheless contend that he did not consider social interaction.

In fact, the experiential reality we construct for ourselves is to a large extent the result of our social interactions. Insofar as we are able to construct a viable *modus vivendi*, it is preponderantly due to accommodations in the course of social adaptation.

In order to live in a society, a sufficient number of our ideas—our concepts and schemes of action—

⁴ Gary Drescher, in his 1991 book, takes into consideration the role of results expected of an activity, but gives the usual, misleading definition of Piaget's concept of accommodation as a simple inverse of assimilation (p.23).

have to be compatible with those of others. And this compatibility confers on them a viability that goes beyond the merely individual. The same goes for the acquisition and use of language. Communication with others requires that the meanings we attribute to words prove compatible with those of other speakers.

Compatibility, however, does not entail the kind of "match" that is implied when people speak of "shared ideas" or "shared knowledge". Compatibility, to repeat it once more, means no more and no less than to fit within constraints. Consequently, it seems to me that one of the most demanding tasks of A.I. would be the plausible simulation of an organism's experience of social constraints.

To end this brief survey of the perspective I have been working at for a few decades, I want to repeat that constructivism makes no claim to ontological truth. In fact, it confirms that no model or theory can claim to be ontologically true. Models and theories can be gauged only by how well they do what they promise to do—which is to say, they have to be tested in practice.

I am still pursuing this way of thinking, because I believe that it may eventually make people aware of

the fact that we cannot shirk the tremendous responsibility that lies upon our shoulders; for we are individually responsible for what we think and what we do, and thus for the experiential world we construct.

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