

# Creating Chances through Cognitive Niche Construction

## The Role of Affordances

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**Abstract** As a matter of fact, humans continuously delegate and distribute cognitive functions to the environment to lessen their limits. They build models, representations, and other various mediating structures, that are considered to aid thought. In doing these, humans are engaged in a process of cognitive niche construction. In this sense, I argue that a cognitive niche emerges from a network of continuous interplays between individuals and the environment, in which people alter and modify the environment by mimetically externalizing fleeting thoughts, private ideas, etc., into external supports. Through mimetic activities humans create *external semiotic anchors* that are the result of a process in which concepts, ideas, and thoughts are projected onto external structures. Once concepts and thoughts are externalized and projected, new *chances* and ways of inferring come up from the blend. For cognitive *niche construction* may also contribute to make available a great portion of knowledge that otherwise would remain simply unexpressed or unreachable.

## 1 Introduction

As a matter of fact, humans continuously delegate and distribute cognitive functions to the environment to lessen their limits. They build models, representations, and other various mediating structures, that are thought to be good to think. The aim of this paper is to shed light on these *designing* activities. In the first part of the paper I will argue that these designing activities are closely related to the process of niche construction. I will point out that in building various mediating structures, such as models or representations, humans alter the environment and thus create *cognitive niches*.

In dealing with the exploitation of cognitive resources and chances embedded in the environment, the notion of *affordance*, originally proposed by Gibson [1] to illustrate the hybrid character of visual perception, can be extremely relevant. The analysis of the concept of affordance also provides an alternative account about the role of external – also artifactual – objects and devices. Artifactual cognitive objects and devices extend, modify, or substitute “natural” affordances actively providing humans and many animals with new opportunities for action [2]. In order to solve various controversies on the concept of affordance, I will take advantage of some useful insights that come from the study on *abduction* [3]. Abduction may fruitfully describe all those human and animal hypothetical inferences that are operated through actions which consist in smart manipulations to both detect new affordances and to create manufactured external objects that offer new affordances.

## 2 Humans as Chance Seekers

### 2.1 Incomplete Information and Human Cognition

Humans usually make decisions and solve problems relying on incomplete information [4]. Having incomplete information means that 1) our deliberations and decisions are never *the best* possible answer, but they are at least *satisficing*; 2) our conclusions are always *withdrawable* (i.e. questionable, or never final). That is, once we get more information about a certain situation we can always revise our previous decisions and think of alternative pathways that we could not “see” before; 3) a great part of our job is devoted to elaborating conjectures or hypotheses in order to obtain more adequate information. Making conjectures is essentially an *act* that in most cases consist in manipulating our problem, and the representation we have of it, so that we may eventually acquire/create more “valuable” knowledge resources. Conjectures can be either the fruit of an abductive selection in a set of pre-stored hypotheses or the creation of new ones, like in scientific discovery. To make conjectures humans often need more evidence/data: in many cases this further cognitive action is the only way to simply make possible (or at least enhance) a thought to “hypotheses” which are hard to successfully perform. In this sense, humans can be considered *chance seekers*, because they are continuously engaged in a process of building up and then extracting latent possibilities to uncover new valuable information and knowledge.

The idea I will try to deepen in the course of this paper is the following: as chance seekers, humans are *ecological engineers*. That is: humans like other creatures do not simply live their environment, but they actively shape and change it looking for suitable chances. In doing so, they construct *cognitive niches* [5,6,7] through which the offerings provided by the environment in terms of cognitive possibilities are appropriately selected and/or manufactured to enhance their fitness as chance seekers. Hence, this ecological approach aims at understanding cognitive systems in terms of their *environmental situatedness* [8,9]. Within this framework, chances are that “information” which is not stored internally in memory or already available in an external reserve but that has to be “extracted” and then *picked up* upon occasion.

As I will show in the following two sections, “the active interrogation of the environment” is also at the root of the evolution of our organism and its cognitive system. I will also describe this ecological activity by using the notion of abduction [3] and its semiotic dimension. (I have already treated the relationships between abduction and chance in [8,10]).

### 2.2 Cognitive Niche Construction and Human Cognition as a Chance-Seeker System

It is well-known that one of the main forces that shape the process of adaptation is natural selection. That is, the evolution of organisms can be viewed as the result of a selective pressure that renders them well-suited to their environments. Adaptation is therefore considered as a sort of *top-down process* that goes from the environment to the living creature [11]. In contrast to that, a small fraction of evolutionary biologists have recently tried to provide an alternative theoretical framework by emphasizing the role of niche construction [12] [13].

According to this view, the environment is a sort of “global market” that provides living creatures with unlimited possibilities. Indeed, not all the possibilities that the environment offers can be exploited by the human and non-human animals that act on it. For instance, the environment provides organisms with water to swim in, air to fly in, flat surfaces to walk on, and so on. However, no creatures are fully able to take advantage of all of them. Therefore, all organisms try to modify their surroundings in order to better exploit those elements that suit them and eliminate or mitigate the effect of the negative ones. This process of *environmental selection* [14] allows living creatures to build and shape the so-called “ecological niches”. An ecological niche can be defined as a “setting of environmental features that are suitable for an animal” [1]. It differs from the notion of habitat in the sense that the niche describes *how* an organism lives its environment, whereas habitat simply describes *where* an organism lives. In any ecological niche, the selective pressure of the *local* environment is drastically modified by organisms in order to lessen the negative impacts of all those elements which they are not suited to. Indeed, this does not mean that natural selection is somehow halted.

My contention is that the notion of niche construction can be also usefully applied to human cognition. More precisely, I claim that cognitive niche construction can be considered as one of the most distinctive traits of human cognition, i.e. humans construct “cognitive niches”.<sup>1</sup> It emerges from a network of continuous interplay between individuals and the environment, in which they more or less tacitly manipulate what is occurring outside at the level of the various structures of the environment in a way that is suited to them. Accordingly, we may argue that the creation of cognitive niches is *the way* cognition evolves, and humans can be considered as ecological cognitive engineers.

Recent studies on distributed cognition seem to support my claim [16,17,18,19]. According to this approach, cognitive activities like, for instance, problem solving or decision-making, cannot only be regarded as internal processes that occur within the isolated brain. Through the process of niche creation humans extend their minds into the material world, exploiting various external resources. For “external resources” I mean everything that is not inside the human brain, and that could be of some help in the process of deciding, thinking about, or using something. Therefore, external resources can be artifacts, tools, objects, and so on. They are property of individuals in so far as those individuals are embedded in given settings or environments [20]. Something important must still be added, and it deals with the notion of representation: the traditional notion of representation as a kind of abstract mental structure is old-fashioned and misleading [21]. If some cognitive performances can be viewed as the result of a smart interplay between humans and the environment, the representation of a problem is partly internal but it also depends on the smart interplay between the individual and the environment.

As I have already said, an alternative definition of the ecological niche that I find appealing in treating our problem has been provided by Gibson [1]: he pointed out that a

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<sup>1</sup>If we also recognize in animals, like many ethologists do, a kind of nonlinguistic thinking activity basically model-based (i.e. devoid of the cognitive functions provided by human language), their ecological niches can be called “cognitive”, when for example complicate animal artifacts like landmarks of caches for food are fruit of “flexible” and learned thinking activities which indeed cannot be entirely connected with innate endowments [15].

niche can be seen as a set of *affordances*. My contention is that the notion of affordance may help provide sound answers to the various questions that come up with the problem of ecological niches. The notion of affordance is fundamental for two reasons. First of all, it defines the nature of the relationship between an agent and its environment, and the mutuality between them. Second, this notion may provide a general framework to illustrate humans as chance seekers.

### 3 Affordances as Eco-Cognitive Interactional Chances

As I have illustrated in the first part of this paper, humans and some animals manipulate and distribute cognitive meanings after having delegated them to suitable environmental supports. The activity of cognitive niche construction reveals something important about the human and animal cognitive system. As already mentioned, human cognition can be better understood in terms of its environmental situatedness. This means humans do not retain in their memory an explicit and complete representation of the environment and its variables, but they actively manipulate it by picking up information and resources upon occasion. Information and resources are not only given, but they are actively sought and even manufactured. In this sense, I consider human cognition as a chance-seeker system. In my terminology, chances are not simply information, but they are “affordances”, namely, *environmental anchors* that allow us to better exploit external resources.

One of the most disturbing problems with the notion of affordance is that any examples provide different, and sometimes ambiguous insights on it. This fact makes very hard to give a conceptual account of it. That is to say, when making examples everybody grasps the meaning, but as soon as one tries to conceptualize it the clear idea one got from it immediately disappears. Therefore, I hope to go back to examples from abstraction without losing the intuitive simplicity that such examples provide to the intuitive notion.

Gibson defines “affordance” as what the environment offers, provides, or furnishes. For instance, a chair affords an opportunity for sitting, air breathing, water swimming, stairs climbing, and so on. Gibson did not only provide clear examples, but also a list of definitions that may contribute to generating possible misunderstanding: 1) affordances are opportunities for action; 2) affordances are the values and meaning of things which can be directly perceived; 3) affordances are ecological facts; 4) affordances imply the mutuality of perceiver and environment.

I contend that the Gibsonian ecological perspective originally achieves two important results. First of all, human and animal agencies are somehow hybrid, in the sense that they strongly rely on the environment and on what it offers. Secondly, Gibson provides a general framework about how organisms directly perceive objects and their affordances, as behavioral and cognitive chances. His hypothesis is highly stimulating: “[...] the perceiving of an affordance is not a process of perceiving a value-free physical object [...] it is a process of perceiving a value-rich ecological object”, and then, “physics may be value free, but ecology is not” [1, p. 140]. These two issues are related, although some authors seem to have disregarded their complementary nature.

We can find that a very important aspect that is also disregarded in literature is the dynamic one, related to designing affordances with respect to their evolutionary framework: human and non-human animals can “modify” or “create” affordances by manipulating their cognitive niches. Moreover, it is obvious to note that human, biological bodies themselves evolve: and so we can guess that even the more basic and wired perceptive affordances available to our ancestors were very different from the present ones. Of course different affordances can be detected in children, and in the whole realm of animals.

Moreover, organisms need to become *attuned* to the relevant offered features and much of the cognitive tools built to reach this target are a result of evolution and of merely wired and embodied perceptual capacities like imagistic, empathetic, trial and error, and analogical devices. These capabilities, that in our epistemological perspective have to be considered “cognitive” even if instinctual, can be seen as devices of organisms that provide potential implicit abductive powers: they can provide an overall appraisal of the situation at hand and so orient action, and can be seen as forms of pseudo-explanation of what is occurring over there, as emerging in that material contact with the environment granted in the perceptual interplay. It is through this embodied process that affordances can arise as chances both in wild and artificially modified niches. Indeed, humans and animals make available – create – new affordances through the manipulation of the environment and the construction of artifacts; moreover these artifacts are often fruit of high-level – not merely reflex-based, instinctual – cognitive plastic endowments.

### 3.1 Affordances and Abduction

Let us consider the case of a chair that affords sitting. Now, my point is that we should distinguish between two cases: in the first one, the cues we come up with (flatness, robustness, rigidity) are *highly diagnostic* chances to know whether or not we can sit down on it, whereas in the second case we eventually decide to sit down, but we do not have any precise clue about. How many things are there that are flat, but one cannot sit down on? A nail head is flat, but it is not useful for sitting. This example introduces two important elements: firstly, finding/constructing affordances deals with a (semiotic) inferential activity; secondly, it distinguishes between an affordance and the information that specify it that only arise in the *eco-cognitive interaction* between environment and organisms. I maintain that the notion of abduction can clarify this puzzling problem.

The term “highly diagnostic” explicitly refers to the abductive framework. Abduction is a process of *inferring* certain facts and/or laws and hypotheses that render some sentences plausible, that *explain* or *discover* some (eventually new) phenomenon or observation. The distinction between theoretical and manipulative abduction extends the application of that concept beyond a sentential dimension. From Peirce’s philosophical point of view, all thinking is in signs, and signs can be icons, indices or symbols. Moreover, all inference is a form of sign activity, where the word sign includes “feeling, image, conception, and other representation” [22, 5.283], and, in Kantian words, all synthetic forms of cognition. That is, a considerable part of the thinking activity is “model-based”. Of course model-based reasoning acquires its peculiar creative relevance when embedded in abductive processes, so that we can individuate a *model-based*

*abduction*, a considerable part of the “performances that involve sign activities are abductions” (*cit.*). [22, 5.283]. In the case of diagnostic reasoning, a physician detects various symptoms (that are signs or clues), for instance, cough, chest pain, and fever, *then* he/she may infer that it is a case of pneumonia.

The original Gibsonian notion of affordance deals with those situations in which the “perceptual” signs and clues we can detect prompt or suggest a certain action rather than others.<sup>2</sup> They are already available and belong to the normality of the adaptation of an organism to a given ecological niche. Nevertheless, if we acknowledge that environments and organisms’ instinctual and cognitive plastic endowments change, we may argue that affordances can be related to the variable (degree of) *abductivity* of a configuration of signs: *a chair affords sitting* in the sense that the action of sitting is a result of a sign activity in which we perceive some physical properties (flatness, rigidity, etc.), and therefore we can ordinarily “infer” (in Peircean sense) that a possible way to cope with a chair is sitting on it. So to say, in most cases it is a spontaneous abduction to find affordances because this chance is already present in the perceptual and cognitive endowments of human and non-human animals.

I maintain that describing affordances that way may clarify some puzzling themes proposed by Gibson, especially the claim concerning the fact that we directly perceive affordances and that the value and meaning of a thing is clear on first glance. As I have just said, organisms have at their disposal a standard endowment of affordances (for instance through their wired sensory system, which is the only cognitive system “available” in the case of simple organisms), but at the same time they can extend and modify the range of what can afford them through the appropriate cognitive abductive skills (more or less sophisticated). As maintained by several authors (for example cf. [23,3]), what we see is a result of an embodied cognitive abductive process. For example, people are adept at imposing order on various, even ambiguous, stimuli [3, p. 107]. Roughly speaking, we may say that what we *see* is what our visual apparatus can, so to say, “explain”. It is worth noting that this process happens almost simultaneously without any further mediation. Perceiving affordances has something in common with it. Visual perception is indeed a more automatic and “instinctual” activity, I have already said that Peirce claimed to be essentially abductive, even if not propositional. Indeed he considers inferential any cognitive activity whatever, not only conscious abstract thought: he also includes perceptual knowledge and subconscious cognitive activity.

We also have to remember that environments change and so the perceptive capacities when enriched through new or higher-level cognitive skills, which go beyond the ones granted by the merely instinctual levels. This dynamics explains the fact that if affordances are usually stabilized this does not mean they cannot be modified and changed and that new ones can be formed. First of all, affordances appear durable in human and animal behavior, like a kind of habit, as Peirce would say [22, 2.170]. For instance,

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<sup>2</sup>In the original Gibsonian view the notion of affordance is strictly referred to proximal and immediate perceptual chances, which do not involve higher cognitive functions such as memory and schemata, but which are merely “picked up” by a stationary or moving observer. In this paper I maintain that perceiving affordances also involves evolutionary changes and the role of more sophisticated and plastic cognitive capacities. In an analogous perspective Norman [2] and Zhang and Patel [19] expand the notion into a framework for design and for distributed cognition.

that a chair affords sitting is a fair example of what I am talking about. This deals with what we may call *stabilized affordances*. That is, affordances that we have experienced as highly successful. Once evolutionarily formed, or created/discovered through cognition, they are stored in embodied or explicit cognitive libraries and retrieved upon occasion. Not only can they be a suitable source of new chances, through analogy. We may have very different objects that equally afford sitting. For instance, a chair has four legs, a back, and it also stands on its own. The affordances exhibited by a traditional chair may be an analogical source and transferred to different new artifacts that present the affordance of a chair for sitting down (and that to some extent can still be described as a chair). Consider, for instance, the variety of objects that afford sitting without having four legs or even a back. Let us consider a stool: it does not have even a back or, in some cases, it has only one leg or just a pedestal, but it affords sitting as well as a chair.

Second, affordances are also subjected to changes and modifications. Some of them can be discarded, because new artifacts are invented with more powerful ones. Consider, for instance, the case of blackboards. Progressively, teachers and instructors have partly replaced them with new affordances brought about by various tools, for example, slide presentations. In some cases, the affordances of blackboards have been totally re-directed or re-used to more specific purposes. For instance, one may say that a logical theorem is still easier to be explained and understood by using a blackboard, because of its affordances that give a temporal, sequential, and at the same time global perceptual depiction to the matter. In this perspective we acknowledge that artifacts like computational programs are tools for thoughts as is language: tools for exploring, expanding, and manipulating our own minds. The *information artifacts* [24] or *cognitive artifacts* [25] which represent the external multiple tools - communication, context shifting, computational devices expressly constructed to the aim of creating opportunities and risks, like KeyGraph, etc. - recently analyzed by the researchers in the field of chance discovery [26], are artifacts as *chance seeking prostheses* offered to humans to enhance their cognitive capabilities.

## 4 Conclusion

In this paper I have argued that cognitive niche construction is one of the most distinctive traits of human cognition. Humans and many other organisms continuously manipulate the environment in order to exploit its offerings. In doing this, they are engaged in a process of altering or even creating external structures to lessen and overcome their limits. New ways of coping with the environment, through both evolution and cultural evolution, namely affordances, are thus created. In dealing with cognitive niche construction, I have argued that abduction can fruitfully shed light on various aspects of building affordances.

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