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Discoverability: affordances and eco-cognitive situatedness

Towards an ecology of human creativity

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Recent studies in the field of "EEEE" cognition (extended, embodied, embedded, and enacted) have demonstrated that the role of what I called environmental situatedness can be a useful way to understand human cognition and its evolutionary dimension. This means that rather than storing detailed representations of the environment and its variables in their memory, humans actively modify it by obtaining information and resources that are either already available, extracted from the environment, or created from scratch. In other words, resources and information are not only provided; they are actively sought after and even created. We may think of human cognition as a chance-seeker mechanism in this way. Thus, chances are not only information, they are also "affordances," that is, environmental anchors that help us make better use of outside resources. Certainly, discoverability depends on having the right affordances available. Even still, abduction is significant because it clarifies all those hypothetical conclusions[1] that are controlled by activities that consist of deft environmental manipulations to find new affordances as well as the creation of artificial external items that provide new affordances or signals.

[1]Inference is often understood in terms of logic or psychology. Conversely, as I shall elucidate later in this chapter, I approach the concept of inference (and hence the hypothetical abductive inference) from a Peircean standpoint, which means that it is not always related to rationality. All thinking is in signs, which can be icons, indices, or symbols, according to Peirce's philosophical and semiotic point of view. Additionally, all inference is a type of sign activity, where the word sign includes "feeling, image, conception, and other representation" (Peirce, 1866–1913, 5.283), or, to put it in Kantian terms, all synthetic forms of cognition. In this sense, the term "inference" refers to cognitive activity engaged in manipulative and model-based cognition as well as conscious processes. This concept of inference's broad meaning is also connected to my eco-cognitive model of abduction. In this model, cognition is understood in relation to an embodied subject who interacts with his surroundings, meaning that he receives and perceives information but also manipulates it, either directly or by using the creation of artificial entities. In this sense, the term "inference" does not only refer to conscious processes but also deals with cognitive activities involved in model-based and manipulative cognition (Magnani, 2009).

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1 The nature of eco-cognitive situatedness determines the type of abduction at play

1.1 Data as suitable affordances that prompt abductive cognition: "ecological validity"

According to Gibson (1979), "affordance" is defined as what the surroundings furnish, offer, or produce. A chair, for example, provides the ability to sit, breathe in the air, swim in water, climb stairs, and more. The concept of agent-environment mutuality is referred to by affordances, which transcend the boundary between the subjective and objective. In addition to giving precise examples, Gibson also included a list of definitions (Wells, 2002) that can lead to possible misunderstandings:

1. affordances are chances for action;
2. affordances are the values and meanings of entities which can be directly perceived;
3. affordances are ecological events;
4. affordances point toward the mutuality of perceiver and environment.

The link between affordances and abduction (that is reasoning to hypotheses) is the subject of our concern in this subsection. Both human and non-human animals may "modify" or "create" affordances by adjusting their cognitive niches,[2] which can either facilitate or hinder particular abductive outcomes. Even the most fundamental and ingrained perceptual affordances accessible to our ancestors were likely considerably different from those we have now. It is also evident that human, biological bodies themselves develop and of course, children and all other animals exhibit a variety of affordances as well.

In his studies, Gibson essentially defined "direct" perception as the absence of an agent's internal inferential mediation or processing. In this sense, affordances—and the direct, uncomplicated way in which an organism takes them in—express the complementary nature of an organism and its environment (Wells, 2002). It is noteworthy to highlight that Gibsonian affordance as originally defined by Donald Norman is modified to include mental/internal processing: "I believe that affordances result from the mental

[2]The cognitive human acts that convert the natural world into a cognitive one are known as representational delegations to the external environment that are configured as elements of *cognitive niches* (some of which may be seen as pregnances; see Magnani, 2022, Lexicon of Discoverability). According to research conducted in the field of biosciences of evolution by Odling-Smee, Laland, and Feldman (Odling-Smee et al., 2003; Laland & Sterelny, 2006; Laland & Brown, 2006), humans have created enormous cognitive niches that are characterized by informational, cognitive, and ultimately computational processes.

interpretation of things, based on our past knowledge and experience applied to our perception of the things about us" (Norman, 1988, p. 14). It is possible for an event or location to offer distinct affordances to distinct organisms, while also providing many affordances to the same creature. According to Donald Norman, affordances indicate a variety of possibilities. Since artifacts are complicated entities and their affordances typically need extensive supporting data, it is more beneficial to examine them from this angle. For instance, understanding a door's complete range of affordances necessitates knowing intricate details like, say, the pull's specific direction of operation (Scarantino, 2003, pp. 953–954). Of course, among the many opportunities provided by affordances are some that are somewhat likely to provide a substantial foundation for human discovery, such as in the field of science.

As I have indicated previously, going beyond Gibsonian direct perception, higher representational and mental processes related to thinking and learning are frequently required in order to become attuned to invariants and disturbances present in the environment. For instance, when creating an artifact with the intention of accurately and beneficially displaying its entire range of affordances, we must distinguish between two levels: (1) the creation of the object's utility and (2) the defining of the potential (and accurate) perceptual cues that characterize the affordances that the artifact can offer. They are quite simple for the user/agent to complete (Gaver, 1991; Warren, 1995; McGrenere & Ho, 2000): "In general, when the apparent affordances of an artifact match its intended use, the artifact is easy to operate. When apparent affordances suggest different actions than those for which the object is designed, errors are common and signs are necessary" (Gaver, 1991, p. 80). In this last case affordances are apparent because they are simply "not seen". Information, as we know, frequently includes higher cognitive faculties and goes beyond what can be obtained by direct perception, arbitrating the perceivability of affordances in this way.

Like in manipulative abduction[3] and other less skilled and creative cases, where the resources are not just inner (neurally-specified) and embodied but also hybridly entwined with the environment, online thinking represents a true case of distributed cognition. In this case, we are dealing with an abductive/adaptive process produced in the dynamical inner/outer coupling

[3]To give a clear example, the idea of manipulative abduction captures a significant portion of scientific thinking in which the role of action and external models (such as for example diagrams and artifacts) and devices is central, and in which the characteristics of this action are implicit and difficult to elicit. It also considers the external dimension of abductive reasoning from an eco-cognitive perspective. Action can supply knowledge that would not otherwise be available, allowing the agent to initiate and carry out an appropriate abductive process of hypothesis development and/or selection. We have to further say that manipulative abduction occurs when we are "thinking through doing" and not only, in a pragmatic sense, about doing (Magnani, 2009, chapter one).

where internal elements are "directly *causally* locked onto the contributing external elements" (Wheeler, 2004, p. 705).

According to Brunswik's hypothesis, an organism must *infer* information about what is happening in its ecological niche from the cues that are accessible, which are supplied by proximal stimuli, rather than being able to directly sense distant stimuli. The ecological validity of this "vicarious" inference, according to Brunswik, is, of course, compromised by the very changeable diagnostic nature of the accessible signals as well as their inherent incompleteness, unreliability, ambiguity, and equivocality. Implicitly expressing an abductive attitude commensurate with Peirce, Brunswik says: "[...] ordinarily organisms must behave as if in a semierratic ecology" (Brunswik, 1955, p. 209), considering the inherent "ambiguity in the causal texture of the environment" (Brunswik, 1943, p. 255). He continues by saying that in this sense, both the cues and the mediated inference are "probabilistic," much as in an abduction scenario where it is always the case that: "Both the object-cue and the means-end relationship are relations between probable partial causes and probable causal effects" (Brunswik, 1943, p. 255).

Accordingly, the Brunswikian notion of *ecological validity* may be understood in terms of the inference's abductive plausibility in light of the relevant information and cues; in other words, ecological validity and the concepts of discoverablity and diagnosticability are congruent. The degree of adaptation between an organism's behavior and the environment's structure is measured by the quality of the inferential abductive performance or the fitness of the behavior based on the specific chosen inference. The scenario is similar to what I have described in the instance of the so-called "visual abduction" when the cues are the subject of an easy and quick perceptual evaluation (Magnani, 2009, chapter two).[4] In contrast, in the other scenarios, organisms more or less correctly inferentially make a "hypothesis/judgment" on the environment's distal structure. Again, this viewpoint makes Gibson's intuition easier to understand: "Perceiving is the simplest and best kind of knowing" (Vicente, 2003, p. 261).

However, there are further types. Using instruments to learn expands perception into the domain of the very small and the very far away; using language to learn makes knowledge explicit rather than implicit (Gibson, 1979, p. 263). An illustration of this would be a forecast of wind behavior, which is often probabilistic and reliant on the current wind speed recorded at a ground station and shown on a computer screen as the "cue." It is noteworthy to mention that in this particular instance, the day-after action of dressing appropriately for the weather is made possible by the proximate perception.

[4]In this last instance, we may state that the proximal and distal structures are mapped one to one (Vicente, 2003, p. 261).

Studies grounded in the Brunswikian tradition have highlighted the fundamentally ecological nature of the cognitive engineering endeavor within the context of systems made up of human interaction, humans, mediating technologies, and tasks environments. Numerous findings have demonstrated in a variety of fascinating ways how technology gadgets support humans in fulfilling their environmental adaptability by improving the creation of hypotheses, judgment, and, ultimately, decision-making. Sometimes the technology itself is unable to make the best decision about a particular scenario, and other times the interaction between the user and the technology introduces a gap in the proximal/distal connection (Kirlik, 2006b).

Understanding perception and other cognitive processes as methods of locating important information using extra-neural active processes associated with the body and social environment brings back the concepts of cognitive activity and its "situatedness", which I have recently discussed in my studies (Magnani, 2022). It is a way of getting more sensory data, compensating for their equivocality, and reaching cognitive feedback, and/or a way of manipulating them, and also of exploiting cognitive delegations to the environment and to artifacts. Thus, brains do not need to store information since they do not need to create intricate internal representations of their surroundings.

1.2 The plasticity of environmental situatedness. Affordances, diagnosticability, and creative abduction

As I said before, Gibson was certain that "The hypothesis that things have affordances, and that we perceive or learn to perceive them, is very promising, radical, but not yet elaborated" (Gibson, 1979, p. 403). To delve further into this matter, we may argue that the very fact that a chair allows one to sit implies that we are able to identify certain cues (stiffness, rigidity, and flatness) that make it simple for someone to state, "I can sit down." Assume that the same individual now possesses item O. Here, the individual is limited to perceiving its flatness. For example, he or she has no idea if it is sturdy and stiff. Nevertheless, he or she chooses to sit down on it and manages to do so. The issue of direct and indirect visual perception arises once more. We are able to identify and stabilize the new affordances because of the action impact.

My point is that we need to make a distinction between the two situations. In the first, the indicators we identify—flatness, robustness, and rigidity—are very diagnostic for determining whether or not we can sit down on it. In the second, on the other hand, we ultimately decide to sit down but lack specific information about it. How many flat objects are there that are not suitable for sitting on? Although a nail head appears flat, sitting on it is not recommended. This illustration makes two crucial points very clearer: first off, creating affordances is a (semiotic) inferential process (see Windsor, 2004); second, it emphasizes the connection that exists in the eco-cognitive interplay between an organism's environment and the knowledge that defines it. In the last instance, information is obtained by a straightforward action; in other instances, it requires an action and intricate manipulations.

"Highly diagnostic" relates specifically to the abductive framework. In the first chapter of my book on abduction (Magnani, 2009), I defined abduction as the process of *inferring* certain facts, rules, and hypotheses that make certain sentences tenable, and that *explain* or *discover* some (ultimately novel) phenomena or observation. From Peirce's philosophical perspective, I have said repeatedly that all thinking is in signs, which can be icons, indices, or symbols. Additionally, all inference is a type of sign activity, where the term sign encompasses "feeling, image, conception, and other representation" (Peirce, 1866—1913, 5.283), and, in Kantian words, all synthetic forms of cognition. In other words, a significant portion of the cognitive process is "model-based" and, as a result, non-sentential. Naturally, when model-based reasoning is integrated into abductive processes, it takes on a unique and creative significance that allows us to identify a *model-based abduction.* When doctors uses diagnostic reasoning, for example, if they see several symptoms (signs or clues) in several ways, such as fever, chest discomfort, and cough, they may conclude that the patient has pneumonia.

As I already said, the original Gibsonian concept of affordance focuses mostly on situations where the "perceptual" cues and indicators that we are able to recognize prompt or indicate one course of action over another. They already exist and are typical examples of how an organism adapts to a particular ecological niche. On the other hand, affordances may be linked to the variable (degree of) abducibility of a configuration of signs if we accept that environments and organisms have to exploit both instinctual and cognitive plastic endowments. For example, a chair facilitates sitting in the sense that sitting is a sign activity in which we perceive certain physical properties (flatness, rigidity, etc.), and as such, we can typically "infer" (abduce, in the Peircean sense) that a possible way to cope with a chair is sitting on it. Put another way, because affordances are pre-existing in the perceptual and cognitive endowments of both human and non-human animals, it is, for the most part, a spontaneous abduction to locate them.

In my opinion, explaining affordances in this way could help to make sense of some of Gibson's puzzling themes, particularly the assertion that humans directly perceive affordances and that object's value and meaning are immediately apparent. Organisms possess a standard set of affordances (such as those derived from their hardwired sensory system),[5] but they can

[5]The word "wired" is prone to misunderstandings. I generally agree that there are two types of cognitive aspects: "hardwired" and "pre-wired". I mean by the former word the parts of cognition that are predetermined and cannot be changed. On the other

also expand and alter the range of what is available to them by using the appropriate cognitive abductive skills. I also emphasize how crucial it is to remember that as environments change, so do the perceptual capacities enhanced by new or higher-level cognitive skills—that is, those capacities beyond those granted by merely instinctual levels. Although affordances are typically stabilized, this does not mean that they cannot be altered or replaced, nor that new ones cannot be formed.

Because affordance perception is abductive, it primarily depends on a cognitively-related, ongoing process of hypothesis-making. That A affords B to C can be also considered from a semiotic perspective as follows: A signifies B to C. A is a sign, B the object signified, and C the interpretant. Cognitive skills related to a particular domain (such as knowledge contents and inferential capacities, but also appropriate pre-wired sensory endowments) allow the interpretant to make certain abductive inferences from signs (such as perceiving affordances) that are not possible for those without those apparatuses. To ordinary people a cough and chest pain are not diagnostic, because they do not know what the symptoms of pneumonia or other diseases related to cough and chest pain are. Thus, they cannot make any abductive inference of this kind and so perform subsequent appropriate medical actions.

2 Discoverability and diagnosticability through affordance creation

Think of a large stone and a chair, for example. Both of these items do, in fact, allow for sitting. The distinction lies in the fact that affordances in the instance of a stone are essentially presumptive: we typically "infer" (in the Peircean sense) that a stone may be beneficial for sitting when we come across one. On the other hand, chairs' are *manufactured* in some way from scratch. In the instance of a chair, we have fully created an entity that exhibits a range of affordances. Using the abductive paradigm we presented above, this affordance creation process may be better understood.

When an entity allows us to do a specific action, it implies that it incorporates the signs that allow us to "infer"—through a variety of acquired and instinctive cognitive endowments—that we may engage with it in a particular way. As mentioned previously, when it comes to stones, humans take advantage of an already-established configuration or structure of meaningful sign data that has been shaped by past evolutionary experiences with the human body (and, to some extent, by "material cultural" evolution, such as

hand, the latter term describes those skills that are built prior to the experience, but that are modifiable in later individual development and through the process of attunement to relevant environmental cues. This distinction helps to highlight the significance of development and how it relates to plasticity. Genes and inbuilt components do not predetermine every facet of cognition. See further Barrett & Kurzban (2006).

when hominids used a stone or chair to sit in front of a primitive altar). In the case of a chair, this configuration is invented. If this viewpoint is valid, we may contend that creating "artificial" affordances entails configuring signs in the outside world specifically to create new, accurate inferences of affordability. By doing this, we carry out deft manipulations and acts that, I conjecture, might provide new (and sometimes "unexpected") affordances. Therefore, affordance creation also entails making new ways of inferring them feasible: a process that is fundamentally tied to improving discoverability and diagnosticability.[6]

2.1 Manipulating external representations and artifacts to create chances

It is now evident that the development of culture, artifacts, and technologies across time may be seen as an ongoing process of creating new affordances on top of or even starting from scratch. Humans and the environments they have created and inhabited have coevolved from cave art to contemporary computing. In fact, when compared to the prospects and chances offered by other tools and technology, what a computer may afford encompasses an astounding diversity of possibilities. More specifically, a computer may mimetically duplicate a significant portion of the most sophisticated operations that the human brain-mind systems can do, acting as a Practical Universal Turing Machine (see Turing, 1992 and Magnani, 2021) (Magnani, 2006). For example, computers are even more powerful than humans in several ways, such as memory and certain areas of mathematical thinking. From a semiotic standpoint, computers bring into existence new artifacts that offer and create new affordances—that is, they present "signs" in the Peircean sense for exploring, expanding, and manipulating our own brain cognitive processing. In this way, they help to "extend the mind beyond the brain." Building affordances, as was previously said, is primarily an abductive semiotic activity in which cues are placed strategically across the environment to promote a certain interaction above others.

To understand this better, think of basic diagrammatic demonstrations of rudimentary geometry—something we have all learned to perform in middle school—as the archetypal example of manipulative abduction. Additionally, they are instances of how affordances from the field of elementary geometry can be constructed so that, in the case of current learners, they can aid

[6] I have demonstrated an analogous problem in (Magnani, 2007): a lot of objects operate as "moral mediators." This phenomenon occurs when manipulations of artifacts and interactions among agents at a local level, such as in the case of the internet's effect on privacy or the derivatives in the global economic crisis, lead to macroscopic and increasingly prevalent global moral consequences on collective responsibilities. For instance, individuals' manipulations on the internet may have unnoticed effects on other people's privacy.

in reaching the conclusion of a proof, and, in the case of ancient pre-Euclidean geometers, they provided the necessary discoverability to yield new geometrical results.

In these situations, new visual affordances are revealed through the so-called diagrammatic *constructions*, which result from the straightforward modification and complication of appropriately externally shown diagrams. In order to readily arrive at generalized results—which, in the case of an axiomatic organization of elementary geometry, are termed theorems – the process involves building and modifying initial suitably depicted external diagrams. If the process is viewed as a broad inference leading to a result through a problem-solving exercise, it involves a distributed interaction between a continuous externalization through cognitive acts, its manipulation, and re-internalization that recognizes what has been learned from the outside, picking up the result and reinternalizing it. New affordances in the action materialize and lead to the outcome.

From an epistemological perspective, the situation shown above is a classic case of the manipulative abduction I mentioned before. Reframed in terms of affordances, this is a cognitive manipulation (completely abductive, the goal is to find an incontrovertible geometrical hypothesis – new or already known) in which an agent organizes epistemic actions that structure the environment in a way that unearths new affordances as opportunities that favor new outcomes when confronted with merely "internal" representational geometrical "thoughts," from which alone it is difficult or impossible to extract new meaningful features of a mathematical concept. As previously stated, affordance detection is hypothesis-driven; it is not claimed that everyone can do so. Only someone who has studied geometry can deduce the affordances within the manipulated construction built upon the original diagram. Thus, affordances that are deemed "artificial" are closely linked to the culture and knowledge that are accessible inside particular cognitive niches of humans, as well as to the appropriate individuals engaged in the process of epistemic inquiry.

The construction of a diagram offers nested affordances:

1. it is a straightforward image that virtually everyone, including many animals, can perceive and comprehend as a perceptual image that offers potential colors and shapes based on the perceptual hardwired endowments of the organism in front of it, such as cats and uneducated people (strict Gibsonian case);

2. it is an image that, with all of its technical characteristics, can be viewed and comprehended as a geometrical diagram (in this instance, a higher level of cognitive ability is required in the creature in question);

3. it is an artifact that can provide new affordances to be absorbed and perhaps added to the existing library of geometrical knowledge through even more inventive cognitive manipulations. Consider a young student who is required to "demonstrate" a simple geometry theorem, such as the sum of a triangle's interior angles. Since this theorem has previously been found (demonstrated) historically and is documented in all Euclidean geometry manuals, the youngster does not need to prove it for the first time. With the exception of the scenario in which he repeats the proof by rote, he may accomplish this demonstration, however, by employing the sequence of suitably extracted affordances, which are predicated on the sensible application of fundamental geometric ideas that he is already familiar with. We may also argue that the youngster employed a heuristic, which is a sophisticated method of investigation. Naturally, this heuristic is a real "demonstration" and plainly does not result in discovery when seen through the lens of an existing geometry handbook (as an abstract and static system of knowledge). It is, instead, a sort of "rediscovery". It is a re-discovery from the perspective of the child-subject as well, as he finds a property that was first granted to him. Rather, the inferences made at the time of the initial historical discovery (perhaps Greek) of that triangular attribute and the evaluation of the corresponding theorem produced a sort of creative achievement (a creative manipulative abduction, as I have stated). Furthermore, as both kinds of reasoning rely on "hybrid" forms of representation that include significant non-verbal cues (like geometric diagrams), they are primarily model-based as well.[7]

Because animals, infants, and adults all have different perceptual endowments, they can all perceive "the brink of a cliff as *fall-off-able* according to a common perceptual process" (Scarantino, 2003, p. 960) which explains why affordances can be grasped simultaneously by all three cognitive differences: "This is much the same as we would describe a piano as having an affordance of music playability. Nested within this affordance, the piano keys have the affordance of depressability" (McGrenere & Ho, 2000, p. 340). It is also possible to add that the piano provides chance—discoverability—in the cognitive interplay artifact/agent, offering fresh affordances of new good melodies, not previously generated in a merely internal/mental way, in the musician's mind, but found over there, in the hybrid interplay with the musical artifact. Of course, depending on their qualities, degrees of affordance, and other characteristics, the diagram and the piano, as well as other

[7] Of course, the agent can alter the artifacts' characteristics in a more or less inventive manner in order to increase the visibility or exploitability of the affordances that are already there or to create new ones that are provided as choices. An instance of this would be if a user alters a computational interface by creating an alias for an extended command string. Instead of writing a lengthy string of characters, he or she can utilize the tool more easily by hitting a single key or many keys at once (McGrenere & Ho, 2000).

artifacts, present different limited conditions for affordances. The example above can be explained in terms of variables and proximal/distal distinctions according to Kirlik's perspective. The agent creates a diagram in which he or she can operate on the surface by utilizing the constraints that ensure that latent variables inherent to the materiality of the artifact at hand "take care of themselves, so to speak" (Kirlik, 2006a, p. 221).

Because different aspects are released from the agent and assigned to the external representation, which provides a proximal perceptual and manipulative environment with all the resources required to successfully carry out the creative task of finding new answers to a certain geometrical question, the need for having a rich internal model of a depicted geometrical diagram is weakened. Since the outcome is readily apparent, it may be taken up and internally reinterpreted. The manipulation of the figure, which is a model in the dynamics of geometrical thinking, demonstrates a situation in which cognition and perception are fully integrated.

From a semiotic point of view, we do not initially possess the cognitive capacities necessary to internally infer the solution of the problem. By modifying the externalized configuration, or the external diagram, we are able to create a new perceptual sign configuration with attributes that were not present in either the original external or internal representation. We are able to solve the problem thanks to a new set of affordances that are created by this altered sign arrangement. As we have said, it is also a means of "demonstrating" a new theorem in the Euclidean sense. This example provides an epistemological illustration of the nature of the cognitive interplay between external representations and internal neuronal semiotic configurations that enable representational thought about an initial problem (along with the aid of various embodied "cognitive" kinesthetic and motor abilities): additionally, also for Peirce, more than a century before the new ideas provided by the studies on distributed reasoning, the two aspects are pragmatically intertwined.

The "hypothetical" nature of affordances serves as a reminder that it is not necessarily the case that just anybody can detect it, affordances are only potentialities for organisms. First of all, the ability to perceive affordances stems from an abductive process in which we infer potential strategies for interacting with an entity based on the signs and clues that are at our disposal. I have to repeat, a portion of affordances is relatively constant, pre-specified or neurally encoded in the perceptual system. These affordances are referred to as "invariants," using a word from physics that Gibson also uses to describe affordances with a strong cognitive valence Because of our cognitive-biological configuration, which makes it easy for humans to acquire the corresponding cognitive ability as a "current" and "reliable" ability, perceiving the affordances of a chair is in fact rooted and "stabilized" in our cultural evolution (Scarantino, 2003, p. 959).

We stated that the majority of the distinctions that we can recognize are, in a sense, *intra-species*. Since intra-species variations appear to be heavily implicated, there is something unusual in the high-level cognitive performance on a geometrical concept and its figure. For example, only someone who has studied geometry can infer (and so "perceive") the affordances "inside" the newly constructed, altered structure that is based on an original geometrical problem. This relates to the "expertise" issue I mentioned earlier. Firstly, there is a close relationship between manufactured affordances and culture and social contexts. Second, affordances have to do with education. Certain affordances, like those of a geometrical construction, may be taught and acquired once they are created; in fact, perceiving them is not an innate ability. Recognizing this fact, of course, emphasizes even more the dynamic character of affordances in organisms' plastic cognitive life, beyond their evolutionary character.

In sum, the ability to execute clever manipulations is related to the process of generating external representations. According to Donald (2001) and myself (2009, chapter three), humans are always involved in cognitive mimetic and creative processes that include representing their ideas, solutions, and thoughts into appropriate external structures and products. By doing this, individuals produce outward representations of certain internal, adequately stored propositional and model-based representations that are already available within their brains. Sometimes, these external counterparts can be creatively employed to find space for new concepts and new ways of inferring that cannot be exhibited by the mere "internal" representation alone. Initially, these external counterparts merely mirror ideas or thoughts already present in the mind (Magnani, 2006). When humans construct these external representations (which, I repeat, might be viewed as essentially mimetic but can also become "creative"), they alter the environment in a way that uncovers new cognitive opportunities and improves *discoverability* and *diagnosticability*.

By doing this, new affordances are created and made collectively available. In a broader sense, we might restate from this angle as well: abduction also involves the ongoing process of modifying the surroundings to provide affordances, or fresh opportunities for action.[8]

[8]Analysis of the so-called "adaptive problem solving" has been offered by an intriguing research on the function of models, which came from a 5-year empirical ethnographic study of two systems biology laboratories and their partnerships with experimental biologists (MacLeod & Nersessian, 2016).

3 Conclusion

I have argued in this chapter that discoverability naturally depends on the availability of suitable affordances. Individuals constantly distribute and assign cognitive functions to their surroundings in an effort to reduce their limits. They provide representations, models, and other kinds of mediating structures that are supposed to support discoverability and act as cognitive help. Regarding the utilization of cognitive resources integrated into the surroundings, I have emphasized the importance of affordances and the goal of enhancing the recently developed framework known as EEEE-cognition (extended, embodied, embedded, enacted). From this angle, I have gone on to explain human cognition and its evolutionary aspect in terms of environmental situatedness, where bodies and external, artifactual entities and gadgets play significant roles. Accordingly, fresh opportunities for discovery—to use my own terminology—become not only information but also "affordances," or contextual anchors that enable us to make the most use of outside cognitive resources. Insofar as it exemplifies those hypothetical conclusions that are driven by activities consisting of astute manipulations of the surroundings to both identify novel affordances and generate artifactual external objects that provide "novel" affordances/cues, abduction has remained in operation.

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