

# Affordances as Possible Actions: Elements for a Semiotic Approach

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## Abstract

As far as semiotic theories are concerned, new digital texts and objects emphasize the need to refocus on the intimate connection between user and interface, considered as a space where deploying and manipulating contents through repeated contacts with a sensitive area (Fontanille & Zinna, 2004; Zinna 2004). In this case, the concept of «affordance» becomes of central importance.

Originally developed in the framework of Gestalt theory, the term «affordance» was subsequently reworked and made famous through the ecological approach to perception conceived by James Gibson (1966, 1979). However, the concept has successively been integrated into a more binary conception of cognition (Norman, 1988, 1998, 1999, 2007; Zhang & Patel, 2006), which seems to be responsible for the loss of much of its heuristic power. In this paper, I intend to go back to the genesis of the notion (Koffka, 1935, Visetti & Rosenthal, 1999) and propose a semiotic and dynamic reinterpretation of this concept, where affordances can be seen as dispositions to act and patterns of expectation (De Souza, 2005; Eco, 1997, 2007; Paolucci, 2007; Peirce, 1931-58; Quéré, 1999). Using Graphic User Interfaces as my object of study and developing an ecological approach to cognition, where the environment and the subject cannot be considered on the basis of binary distinction (Clark 1997, 2006, 2008; Noë 2004, 2009), I will show how semiotic activity takes place in a not infinitely brief present-time (Rosenthal, 2004, 2005), which is necessary for the development of a microgenetic activity of perception and cognition that will be intrinsically cultural. In this context, affordances may be explained as responses to a conceivable practical action made possible by habits that subjects consider on the basis of their inclusion in a system of practices and knowledge which foreshadow a specific and located horizon of action.

## 1. BETWEEN TECHNOLOGY, ECOLOGY AND COGNITION: THE RETURN OF AFFORDANCES <sup>[1]</sup>

What happens when we begin using a computer? How does the interface communicate, how does it show the actions that will be put at our disposal and what are the points on which the user can act? If exploring the way an object communicates its functions can be considered a classical approach, the development of new objects and forms of digital narrative involves more complex interaction practices. This increasing complexity, combined with the need of a more intuitive interaction, led in recent years, to a new centrality of the concept of «affordance», seen as a manifestation of a readiness for action. These last developments make it necessary to refocus semiotic theories on the intimate connections established between user and interface, intended as a space where it is possible to deploy and manipulate contents through repeated contacts with a sensitive area (Fontanille & Zinna, 2004; Morgagni, 2008; Zinna, 2004).

Together with the concept of «ambient optic array», the concept of «affordance» has been developed by and is one of the theoretical pillars of the ecological approach to visual perception developed by James Gibson (Gibson, 1966 & 1979). It is however important to note that in both cases the American psychologist keeps developing themes that were already central in the tradition of Gestalt psychology (Ash, 1982 and 1998, Koffka 1935, Köhler, 1929 and 1969), trying to clearly mark the differences with the theoretical approach he proposes. Today, since affordances have been integrated and have become very popular in the context of a binary conception of cognition (Norman, 1988, 1998, 1999 and 2007), I think that a renewed reflection about this tradition and these concepts has become inevitable. I will try to quickly go through Gibson's position, drawing a parallel with the one exposed in the Gestaltist approaches. I will then show how a reinterpretation of this concept in the context of an ecological approach to cognition, crossing a Gestalt microgenetic perspective (Rosenthal, 2004 and 2005; Visetti & Rosenthal, 1999 and 2003) with an interpretative semiotic approach (Eco, 2007; Paolucci, 2007; Peirce, 1931-1958; Stjernfelt, 2007), can allow us to overcome the main theoretical impasses of the Gibsonian concept of affordance, and in particular of the impoverished version of this concept developed by some cognitive approaches.

## 2 FROM AUFFORDERUNGSSCHARAKTERS TO AFFORDANCES: FROM PHENOMENOLOGICAL DUALISM TO THE ECOLOGY OF PERCEPTION

In *The Ecological Approach to Visual Perception*, Gibson starts from the Gestalt assumption that the meaning or value of things is constituted by an *immediate perception*, as would be, for example, the recognition of their colour. To clarify this position, he mentions Kurt Koffka, arguing that: «*Each thing says what it is [...] a fruit says 'Eat me'; Water says 'Drink me';*

[1] The author would like to thank Nadège Lechevrel for the constructive critiques and discussions of previous versions of this paper.

*thunder says 'Fear me', and woman says 'Love me'»* (Koffka, 1935: 7). According to Koffka, those values are essential and visible results of the experience itself, because this kind of sense could not be explained as a pale context of memory images or as an unconscious set of response tendencies. To resume, using his famous example of the mailbox, he says that it's the box in itself which «invite» us to introduce mail and, more generally, that the things in themselves tell us what we can do with them, thanks to what he calls a *demand character*. Then, Koffka calls us back to the concept of *Aufforderungscharakter* used by Kurt Lewin (Lewin, 1926) and translated as «valence» (for the history of the English translation of this term, cf. Marrow, 1969: 56). This concept implies the existence of vectors that can attract or repel the subject from the object of observation. Koffka questions himself about the role they can play and how they can correctly be explained. As a member of the Gestalt school, he could obviously not reduce them to an exclusive and physical monist existence, so he seems to accept the conclusion of the necessity of a dual position. He therefore considers them as the result of a phenomenological dynamics, following which the valence of an object shall be established on the basis of the experience and of the necessity a subject can have of it, thus accepting some kind of variation dependent on the needs of the subject himself. As a consequence, a mailbox will not have this valence; it will not invite us to mail a letter if the subject does not find himself in the necessary condition of feeling the need to do it.

The concept of affordance developed by Gibson, however, is not sensitive to subject's changing needs. It is invariant, always available to the perception that may put or not the subject in the necessary condition for this recognition activity. For Gibson, the affordances of an object are not constructed by the needs of a subject and by his perceptive action, but are just offered by the object, they are a constituent part of this one. Gibson explains that this statement has to be considered in the context of an ecological approach and not in the context of the classical physical theory: everything here derives from the interactional environment to which subject and object belong.

Gibson doesn't accept Koffka's dualist position, following which it is the phenomenal mailbox and not the physical one which gives us the opportunity to send a letter. He prefers to affirm the existence of a single mailbox, a real mailbox that can *afford* letter mailing to a letter writing human being living in a community with a postal system. This would be understood in the exact moment in which the mailbox is recognized as such, beyond its actual presence in the visual field. To resume, we can say that the Gestalt theory explains the «*direct and immediate*» experience of valences, assuming that ego as well is an object of experience, and that, in the dynamic relation of the subject's experience, some tensions arise between his phenomenal ego and the object. Gibson rejects this explanation and proposes an easier way to show why the values of things seem to be perceived «*immediately and directly*». According to him, this perception is obvious because the affordances of things are specified in stimulus information itself, and so in the ambient optic array. They *seem* to be perceived directly, he said, because they *are* perceived directly.

If the Gestalt theory has seen the light as a reaction to the elementarist psychology that considers the value of things as something that is perceived indirectly, for Gibson it fails to explain how these components are to be considered part of the objects and how they are understood by subjects. For this reason, he dismisses its phenomenological foundations, transform-

ing it, with a clear background of behaviourism, in a kind of externalist realism that permits to say that Gestalt psychologists, while criticizing the classical theories of perception, «*never managed to go beyond them*» (Gibson, 1979: 140).

### 3 ON SOME SOCIO-CULTURAL LIMITS OF THE ECOLOGICAL APPROACH TO VISUAL COGNITION

According to Gibson, the environment contains a medium and some substances that form objects and subjects, and allow them to «*afford*» different interactions. Gibson uses the term «*affordance*» to represent any possible interaction offered by an environment to the subjects living in it: «*The affordances of the environment are what it offers the animal, what it provides or furnishes, either for good or ill*». In this way, the air will *afford* vision and breathing, the land will *afford* walking, a stone will *afford* gripping and so on, in a relationship exclusively depending on the physical characteristics of objects connected with the physical characteristics of subjects of perception. Water, for example, has a «*holding on*» affordance for a finite number of animals (a lot of insects), that are able to maintain the relationship between their weight and the contact surface below the breaking point of equilibrium; for all other animals water will have the «*not holding on*» affordance. However, in special occasions, water may provide an affordance such as «*walk in*» and so on. With the concept of environmental niche, Gibson suggests that species live in an environment which is an interplay of affordances, complementary to their bodily characteristics and which cannot be modified without a complete reorganization of the entire environmental niche. Men are the clearest example: they change or create affordances to make their environment more livable. So, affordances depend on the environmental niche in which the animal lives: they are not to be conceived as subjective creations, but as physical properties of this environment on the subject, regardless his expectations or his actual needs. Water supports the «*holding on*» and «*walk in*» affordances, also in the absence of a subject actually performing the action. Moreover, Gibson believes that affordances are meaningful to the subject and, for this reason (and only in this limited sense), they should be understood as subjective. Affordances would thus go beyond the classic subjective / objective<sup>[2]</sup> dichotomy and the limits it poses.

In Gibson's theory, the link between visual perception and the concept of affordance is constitutive. To be able to guide and supervise the behaviour of subjects, affordances must have a strong meaning and should be continuously perceived. It is important to explain this perception. For Gibson, perceiving affordances is something direct, i.e. they are seized on the perceptual field thanks to the recognition of specific invariants. They are not the result of an inference or a mental representation, but the simple recognition of information being part of the ambient optic array. In this context, analysing the concept of information used by Gibson becomes necessary because, as shown by the Carello & Turvey (Turvey & Carello, 1985) and

[2] «An affordance cuts across the dichotomy of subjective-objective and helps us to understand its inadequacy» (Gibson, 1979: 129).

the Coulter & Sharrock critics (Sharrock & Coulter, 1998), the ecological approach to visual perception seems to pass over the double mediation of sensations and cognitive processes only thanks to the reduction of the gestaltist direct perception to a simple recognition of some eco(logical) structures already existent in the environment. In a world where all animals live governed by fundamental elements called substances, media and surfaces<sup>[3]</sup>, no difference can be made between the affordances of social objects and human behaviour and those of the natural environment. This lack of differentiation, however, seems not to modify the problem of the support, the detection and the concepts that will be necessary to get information from the environment. As noted by Louis Quéré (Quéré, 1999), echoing peircean terminology, even a purely factual statement, an index, will not signify anything in the absence of a third term, an interpretant that is not to be intended as an agent giving meaning, but as a habit, a mind's law.

Two fundamental and complementary problems arise at this point of our dissertation if we will not accept Gibson's argument without discussing it. On the one hand, it is necessary to recognize the role of practices and the continuing changes they cause in the socio-cultural sphere complementary to the natural environment. On the other hand, the affordances of a socio-cultural environment seem to require the mediation of interpretants to be accessed. So, to speak of affordances as an immediate information perception in the framework of an ecological approach ask to specify in greater detail both the content of this ecological environment and the notion of objectivity we can apply to the affordances we find in it.

For the moment, we will limit ourselves to summarize the three main points that have emerged from the comparison between Gibson's theory of affordances and his Gestaltist sources:

1. Affordances have not to be seen as full properties of the object, but as actions that the object may afford in the context of a larger environment, which includes the subjects of perception. The value of an object depends on the actions made available in an ecological framework including both the object and the subject of the interaction.

2. This first point has an obvious Gestaltist source but, at the same time, Gibson deeply criticizes this theory, saying that it is dualistic and does not provide explications about the human competence of identifying and detecting these actions.

3. Gibson's use of the terms «*directly*» and «*immediately*» is obviously derived from the synonymous use typical of Gestalt theory. However, despite his rejection of the phenomenological dualism and his systematic use of the term «*directly*» referring to the information transfer known as affordance, he never explains how all this can be integrated in a theory considered innovative because it rejected any notion of aprioristic meaning in a perception that, in the human case, cannot not be limited to the natural environment, but it is also constituted by a fundamental socio-cultural milieu.

[3] In Gibson's theory the matter composing the environment can be divided in three different categories: media, substances and surfaces. The media is the matter in which animals move; all the matter which is not included in it represent the substances forming the objects and the surfaces are the boundaries between substances and media.

#### 4. RE-READING AFFORDANCES IN A BINARY CONCEPTION OF COGNITION

Technological evolution and the consequent renewed interest in practices put this notion again in the spotlight. Donald Norman, for example proposes a renewed conception of the affordance notion from a psychological and cognitive point of view, giving it a really different meaning if compared to the original Gibson's notion. In *The Psychology of Everyday Things* (Norman, 1988), he applies the concept of affordance to object design, proposing in particular a new Human Computer Interaction approach that has experienced a great success and has been one of the key terms of the contemporary discussion in both design and cognitive science.

For Norman, the concept of affordance refers to the detected and present properties of objects, and in particular to some fundamental properties, which illustrate their possible uses. Affordances can then be used to make interaction easier for users by transmitting, during an exclusively perceptual contact, the instructions they need for the interaction. Here we assist to a revival of the concept of affordance, not involving its insertion in an ecological environment like the one developed by Gibson.

In Norman's theory, a second distinction is made between perceived and real affordances, distinction that would not have reason to exist in the original Gibson's theory. During the design process, perceived affordances are more important than real affordances, because they show the user what is the action to do to correctly interact with the object (Norman, 1998: 123). In this theory, everyday situations are determined by a combination of internal cultural knowledge and informational external constraints. We see a clear distinction between cultural conventions, which are learned and embedded in memory processes, and affordances, viewed as natural potentials and limits of action, belonging to the sphere of external cognition (Norman, 1988: 55). In these two psychological spheres (psychology of everyday things and psychology of cognitive processes), affordances are everything that can be collected as information without the need of specific understanding and cognitive processes (Norman, 1998: 42).

We can see how a position like that, which considers affordances as belonging to one of the two categories structuring mental representations, not only renounces to the idea of direct and ecological perception, but it also establishes a strict dualism between cognition and perceptual activity. If Gibson considered affordances as transcending the distinction between objective and subjective, thus designing a unique system where the activity of perception was the result of a collaborative work between its two poles, Norman<sup>[4]</sup> continues to use the concept in connection with some psychological premises imposing a clear distinction between a world of cultural and social conventions and a world of directly perceived affordances. In contrast with this theoretical position, but remaining in a strictly cognitive domain, many critics show how the interaction with objects seems to require at least an access to semantic resources (Creem & Proffitt, 2001), not to mention that a correct interaction with objects often requires a different motor response from the one which men would normally activate (Klatzky, McCloskey, Doherty, Pellegrino, & Smith, 1987).

[4] This seems true also if Norman, later (Norman, 1999: 123), will ambiguously speak of affordances as «relationship that old between the object and the organism that is acting on an object».

Only recently, in his *The Design of Future Things* (Norman, 2007), Norman, considering the work of Clarisse De Souza (De Souza, 2005), modifies his position, accepting the idea that affordances can be understood as the result of a communication process. In this new perspective, Norman's concept of affordance is completely shaken: from a direct relationship with the external world, he develops a new view based on a communication process involving the intervention of human higher cognitive levels. This change is due to a factor of utmost importance for him, because the practical issues related to the design process are inextricably linked to the visibility of affordances. Affordances cannot be used before the subject recognises them. The ability to discover and learn to use them will be one of the explanations for conceiving easier interactions with objects that have not been experienced yet. The need to build objects with perceptible and visible affordances has always been important, but it is still more important today in an era where objects are becoming digital and automated, he says, because they must communicate and interact effectively with both ourselves and the world. Norman concludes saying that the aim of affordances is to *implicitly* show where and how to go. They just show us a privileged way to optimize our interaction, without even the need for the subject to notice it.

In Norman's theory evolution, we clearly see the need to find a way to go beyond a fixed and aprioristic time frame, an extremely problematic element in the process of understanding the affordances surrounding us. If Gibson does not seem to be able to explain how the *immediacy* of visual perception was able to *directly* make us understand affordances, Norman feels the need to partially abandon his dichotomy between the spheres of human cognition to look for a communication process that can *implicitly* show to men how to intervene in the world. The positions of the two researchers, very different in the beginning, failed at the same point: the need to reintroduce inherent temporality in the emergence of the percept and in the development of human action. These two processes seem intimately interrelated and cannot easily be explained out of a framework that is from its beginning inherently semiotic.

## 5. RETHINKING AFFORDANCES BETWEEN SECOND GENERATION COGNITIVE SCIENCE AND SEMIOTIC APPROACH

I will start from the deadlocks that have been highlighted to propose a definition of affordance as *possible action*. A definition of this kind might allow us to overcome the impasses of the original concept, thanks to a broader approach, which includes the effects of taking into account time and intersubjective values.

I will immediately embrace the thesis of an ecological approach to cognition that does not allow describing the environment and the subject according to a binary distinction. Several cognitive approaches, the so-called «second generation approaches»<sup>[5]</sup> appear to have undertaken

[5] The term «second generation cognitive sciences» refers to the most recent cognitive approaches leaving aside the original binary conception between body and mind in favour of a progressive embodiment of cognitive processes. Instead of thinking cognition as a sum of some internal and abstract processes filling a material and physical body, these new perspectives try to explain these significant dynamics in the interaction between their sensorimotor, conceptual and intersubjectives components.

such a work by progressively extending cognitive processes outside the brain and the body (Clark, 1997 & 2008; Hollan, Hutchins & Kirsh, 2000; 1995 Hutchins, Noë, 2004 and 2009, O'Regan & Noë, 2001; Varela, Thomson & Rosch, 1991). Despite these recent advances and the development of some externalist and at least partially anti-representational theories, the most known contemporary approaches still appear to present the classical problems about perception and the emergence of meanings and values that have already been identified. Actually, they do not seem to be able to give us a convincing restatement (see Lechevrel & Morgagni, submitted) of these problems, something that could highlight the need for a complete embodied semiotics necessary to show us the double dependence existing between our body, especially with regard to our sensorimotor abilities, and the selection of relevant elements made by our cognitive system.

A more structured and convincing approach can be built up on the idea that a sensation, and some sensorimotor qualities linked to it, can be reciprocally involved within the framework of a perception process, implying at the same time some semiotic organization of forms, as suggested by a recent reformulation of the Gestalt theory in a dynamic key (Rosenthal & Visetti, 1999 and 2003) and of the semiotic theory of Charles Sanders Peirce (Paolucci, 2007; Stjernfelt, 2007). The problems of this sensorimotor coupling, the role of the physical environment and the contribution of language and culture can be explained from the perspective of a renewed phenomenological approach, in which all these elements are redistributed in a dynamic loop. This dynamic loop would permit to take into account, from the beginning, all the complex interrelations existing between these elements, showing that no distinction is possible between the phenomenological and the physical level of human perception. In doing so, we can once more make reference to the almost classical example of the mailbox, seeing a single box-sign that can *afford* some actions by simply making them possible for someone, in a complex situation that does not elude the knowledge and the intersubjective practices previously acquired by the subject of perception. Moreover, if we want to develop a comprehensive approach to the domain of cognitive organization and form perception, we have to recognize, at the same time, that any cognitive activity should be deployed in time within the framework of a non immediate present, necessary to the microgenetic development of the activity of perception and cognition (Rosenthal 2004 and 2005). In its dynamic process of categorization, this temporal space opens a horizon of action, composed by provisions for act which forms the plot of an active anticipation of what will build up meaning on the basis of the whole process in progress. In this context, affordances will be just actions made possible by the cognitive activity in itself and could thus be conceived as answers to practical actions, following the pragmatic maxim of CS Peirce:

Consider what effects that might conceivably have practical bearings you conceive the objects of your conception to have. Then, your conception of those effects is the whole of your conception of the object.

I will restate this in other words, since oftentimes one can thus eliminate some unsuspected source of perplexity to the reader. This time it shall be in the indicative mood, as follows: The entire intellectual purport of any symbol consists in the total of all general modes of rational conduct which, conditionally upon all the possible different circumstances and desires, would ensue upon the acceptance of the symbol.

(‘Issues of Pragmaticism’, CP 5.438, 1905)



The meaning will be established by answers to pragmatic actions made possible by the *habits* people may develop on the basis of a diagram, which represents a network of temporary relations based on past experiences. Not knowing the postal service, mailboxes do not say anything about the affordances they can make available for us, while our social and previous experience make us possible to receive such actions as conceivable by giving us access to this particular kind of affordance. This will potentially be possible until the mailbox, the postal service or another player acting in this social context announces that these affordances are no longer available, leading us to produce a new abduction that will take us to a new diagrammatic reasoning, with the possibility to develop a different conclusion and thereafter generate new possible actions. This is the fundamental difference, as well remembered by Claudio Vandi (Vandi, 2009), between James' pragmatism, often mentioned in ethnomethodological approaches, and Peirce's pragmaticism. The first states that any truth has to be built on a practical action, while the second affirms that the meaning is acquired thanks to the development of a *habit*, a predisposition to act that can interrupt the continuous reorganization of the network diagram. This interruption is in principle, and it is important to remember it, independent from the practical success of the action that can be accomplished.

## 6. GRAPHICAL INTERFACES, COGNITIVE ECOLOGY AND POSSIBLE ACTIONS

In the context we have outlined, perception, cognition and practices are developed in a parallel and complementary way, always considering both the affordances of traditional and materials objects and the affordances of digital objects such as computer interfaces. In this last case, the access points to activate, the icons to identify and to select, the path to run through to accomplish a goal seem to show us in a particularly striking way the process just described. Despite the stability and the invariance of the support on which they are presented, interfaces allow the establishment of extremely changing and varied interactions, where perception binds itself with practical usages, as showed for example by some current research in semiotics, usability or in the field of the situated cognition (Bar, 2004; Fusaroli & Morgagni, 2009; Greeno, Moore & Smith, 1993; Kirsh, 2009; Queen, 2006; Vandi, 2009). Computer icons, but more generally each interactive graphic element of an interface, can be used in a multitude of different ways, and can «afford» some actions by their colour, their form, their accompanying or embedded text, or even (which is the most common case) a complex interplay between all these and many more others elements. In any case, all these properties remain potential, and cannot be selected, used and even perceived out of a set of immediately semiotic practices formed in parallel with the object's primary perception. The affordances of objects should therefore be intended as potential actions triggered by a particular elaboration of a diagrammatic reasoning, that allow their selection as expressive qualities, as Firstnesses of the object in question. What in our immediate perception appears to be an organized opposition, a constituted meaning, is not necessarily a prove of a direct transmission of information, or, to express it in Peircean terms, just a Firstness. It always emerges from the bottom of a previous Thirdness. Each element belonging to the world fits into a system of practices and knowledge that always foreshadows a located and specific horizon of action. These practices, taken together with the progressive

development of our perceptual activity, are what permits the emergence of a certain number of meanings, which can certainly be seen as immediate, but that are not for this reason to be considered directly determined by a physical world. By proposing an approach of this type, I tried to show that the affordances of objects are nothing more than the specific manifestation of a process which is actually far more extensive, and that they have therefore to be approached more broadly by a global semiotic theory. To proceed further in the elaboration of this notion it will, on one hand, be necessary to have more empirical supports in cognitive science's empirical experiments trying to put together interpretation and action processes. On the other hand it will also be necessary to better comprehend how objects can be conceived as instruments capable to acquire and redistribute cognitive structures intended as interpretative habits culturally shaped.

## BIBLIOGRAPHY

- Ash, Mitchell (1982): *The emergence of Gestalt Theory: experimental psychology in Germany, 1890-1920*. PhD thesis in History. Cambridge Massachusetts: Harvard University.
- (1998): *Gestalt Psychology in German Culture, 1890-1967*. Cambridge University Press.
- Bar, Moshe (2004): «Visual objects in context», *Nature Reviews: Neuroscience*, n.5: 617-629.
- Clark, Andy (1997): *Being There*. Cambridge Massachusetts: MIT Press.
- (2008): *Supersizing the Mind. Embodiment, Action and Cognitive Extention*. Oxford: Oxford University Press.
- Coulter, Jeff & Sharrock, Wes (1998): «On What we Can See», *Theory and Psychology*, 8 (2): 147-164.
- Creem, Sarah & Proffitt, Dennis (2001): «Grasping Objects by their Handles: A Necessary Interaction between Cognition and Action», *Journal of Experimental Psychology: Human Perception and Performance*, 27 (1): 218-228.
- De Souza, Clarisse (2005): *The Semiotic Engineering of Human Computer Interaction*. Cambridge Massachusetts: MIT Press.
- Eco, Umberto (2007): «La soglia e l'infinito». In Paolucci, Claudio (ed.) *Studi di semiotica interpretativa* (pp. 145-176). Milano: Bompiani
- Fontanille, Jacques & Zinna, Alessandro, eds. (2004): *Les objets au quotidien*, Nouveaux Actes Sémiotiques – recueil. Limoges: PULIM
- Fornel, Michel de & Quéré, Louis, eds. (1999): *La logique des situations*. Paris: Editions de l'EHESS.
- Fusaroli, Riccardo & Morgagni, Simone (2009): «Enacting Computer Icons. The Dynamics of Interpretation between Forms and Diagrams», *Proceedings of The Arco'09 Conference: Interprétation et problématiques du sens*.
- Gibson, J. James (1966): *The senses Considered as Perceptual Systems*. Boston: Houghton Mifflin.
- (1979): *The ecological Approach to Visual Perception*. Boston: Houghton Mifflin.
- Greeno, James, Moore, Joyce & Smith, David (1993): «Transfer of situated learning». In Detterman, Douglas & Sternberg, Robert (eds.), *Transfer on Trial: Intelligence, Cognition and Instruction* (pp. 99-167). Norwood: Ablex.

- Hollan, James, Hutchins Edwin & Kirsh, David (2000): «Distributed Cognition: Toward a New Foundation for Human-Computer Interaction Research», *ACM Transaction on Computer-Human Interaction*, 7 (2): 174-196.
- Hutchins, Edwin (1995): *Cognition in the Wild*. Cambridge Massachusetts: MIT Press.
- Kirsh, David (2009): «Problem Solving and Situated Cognition». In Robbins, Philip & Aydede, Murat (eds.), *The Cambridge Handbook of Situated Cognition* (pp. 264-306). Cambridge: Cambridge University Press.
- Klatzky, Roberta, McCloskey, Brian, Doherty, Sally, Pellegrino, James & Smith (1987): «Knowledge about Hand Movements and Knowledge about Objects», *Journal of Motor Behavior*, 19: 187-213.
- Koffka, Kurt (1935): *Principles of Gestalt Psychology*. New-York: Harcourt Brace.
- Köhler, Wolfgang (1929): *Gestalt psychology*. New York: Liveright.
- (1969): *The task of Gestalt Psychology*. Princeton: Princeton University Press.
- Lechevrel, Nadège & Morgagni, Simone (submitted). Ecology and Cognition: on some new contributions to the epistemological debate over biological metaphors.
- Lewin, Kurt (1926): «Vorbemerkungen über die psychischen Kräfte un Energien und über die Struktur der Seele», *Psychologische Forschungen.*, 7, 294-329.
- Marrow, Alfred (1969): *The Practical Theorist: The Life and Work of Kurt Lewin*. New York: Basic Books.
- Morgagni, Simone (2008): «Montages signifiants: les icônes d'Apple iPhone entre texte et image», *Signes, Discours et Sociétés*, n.2. Available on <http://www.revue-signes.info/document.php?id=715>.
- Noë, Alva (2004): *Action in Perception*. Cambridge Massachusetts: MIT Press.
- (2009): *Out of Our Heads*. New York: Hill and Wang.
- Norman, Donald (1988): *The Psychology of Everyday Things*. New York: Basic Books.
- (1998): *The Invisible Computer*. Cambridge Massachusetts: MIT Press.
- (2004): *Emotional Design. Why we Love (or hate) Everyday Things*. New York: Basic Books.
- (2007): *The Design of Future Things*. New York: Basic Books.
- O'Regan, J. Kevin & Noë, Alva (2001): «A sensorimotor account of vision and visual consciousness», *Behavioral and Brain Sciences*, 24 (5), 939-1011.
- Paolucci, Claudio, ed. (2007): *Studi di semiotica interpretativa*. Milano: Bompiani.
- Peirce, Charles Sanders (1931-58): *Collected Papers of Charles Sanders Peirce*, voll. I-VI edited by C. Hartshorne and P. Weiss, 1931-1935, voll. VII-VIII edited by AW Burks, 1958. Cambridge, Massachusetts, Belknap Press.
- Queen, Matt (2006): «Icon Analysis», Boxes and arrows. Available on: [http://www.boxesandarrows.com/view/icon\\_analysis](http://www.boxesandarrows.com/view/icon_analysis).
- Quéré, Louis (1999): «Action située et perception du sens». In Fornel, Michel de & Quéré, Louis, (eds.), *La logique des situations* (pp. 301-338). Paris: Editions de l'EHESS.
- Robbins, Philip & Aydede, Murat, eds. (2009): *The Cambridge Handbook of Situated Cognition*. Cambridge: Cambridge University Press.
- Rosenthal, Victor (2004): «Perception comme anticipation: vie perceptive et microgenèse». In Sock, Rudolph & Vaxelaire, Béatrice (eds.). *L'anticipation à l'horizon du présent*. Liège: Mardaga.
- (2005): « Formes, sens et développement: quelques aperçus de la microgenèse », *Texto!*, mars 2005.

- Rosenthal, Victor & Visetti, Yves-Marie (1999): «Sens et temps de la Gestalt»: *Intellectica*, 28, 147-229.
- Rosenthal, Victor & Visetti, Yves-Marie (2003): *Köhler*. Paris: Les Belles Lettres.
- Stjernfelt, Frederik (2007): *Diagrammatology*. New York: Springer-Verlag.
- Turvey, Michael & Carello, Claudia (1985): «The Equation of Information and Meaning from the Perspective of Situation Semantics and Gibson's Ecological Realism», *Linguistic and Philosophy*, 8 (1): 81-90.
- Vandi, Claudio (2009): «La strategia di Google: abiti e pratiche», *E/C*, 3-4: 163-172.
- Varela, Francisco, Thompson, Evan & Rosch, Eleanor (1991): *The Embodied Mind*. Cambridge Massachusetts: MIT Press.
- Zinna, Alessandro (2004): *Le interfacce degli oggetti di scrittura*. Roma: Meltemi.