Biosemiotics (2011) 4:83–102
DOI 10.1007/s12304-010-9109-6

ORIGINAL PAPER

What Capabilities for the Animal?

Dominique Lestel

Received: 20 May 2010 / Accepted: 30 August 2010 / Published online: 19 February 2011

Abstract In this essay, I defend a bi-constructivist approach to ethology—a constructivist ethology assuming that each animal adopts constructivist strategies. I put it in opposition to what I call a realist-Cartesian approach, which is currently the dominant approach to ethology and comparative psychology. The starting point of the bi-constructivist approach can be formulated as a shift from the classical Aristotelian question "What is an animal?" to the Spinozean question, which is much less classical but which seems to me to be much stronger: "What are the capacities of the animal?". Is it possible to conceptualize an ethology which insists on interpretation and therefore on invention, innovation and creativity, rather than on causality, the monotony of behavioural routines, and/or genetic or environmental determination? Such an ethology would be based not on the fiction of an absent observer but on fully recognizing the necessity of an observer, who is effectively present in order to get an observation. A *pluralistic ethology* does not dissociate itself from the *marginal epistemologies* of practitioners like animal trainers, hunters, stockbreeders etc., or, moreover, non-western experts. An ethology of this kind is not clamped within the boundaries of purely academic epistemology, obsessed by demarcation lines between the human and the animal. My work on the bi-constructivist approach represents a contribution towards the elaboration of an authentically biosemiotic ethology, one which is significantly different from the mechanical ethology of today.

Keywords Ethology · Bi-constructivist and realistic (Cartesian) approaches

Comparing Both Approaches

Contemporary ethology emphasizes an approach to the animal which could be characterized as realistic and Cartesian. It combines fundamental description of the world with stipulation

D. Lestel (✉)
Ecole normale supérieure, 45, rue d'Ulm, 75005 Paris, France
e-mail: Dominique.Lestel@ens.fr

of the legitimate ways of studying it. It supposes that there is a world which is separated from the subject, and that we can provide a genuine description of the animal by investigating the causal and mechanical procedures determining animal behaviour. The possibility of observations without observers,[1] and the description of an animal as a machine, therefore fundamentally define this approach. However, I propose a bi-constructivist approach which emphasizes the view that we invent the world rather than discover it.[2] The view is expressed in our activities (individual and collective). Understanding the animal fundamentally means that an ethologist develops methods enabling him to assess how the animal *invents* its world. This approach is bi-constructivist in the sense that ethology must set up a model in order to understand how to construct the way the animal constructs its world. Ethology develops as a discipline organized along two axes: the invention of invention, and the interpretation of interpretation. Let us highlight the basic points of difference with the prevailing realist-Cartesian approach:

Realist-Cartesian approach	Bi-constructivist approach
The animal is determined by its genetics	The genetics of the animal represents but one of many constraints.
We need to study the *behaviour* of the animal; it should be done in terms of an ethogram[a]	We need to study the *activity* of the animal and the ethogram is only one of the tools used to reach the goal.
The animal always follows behavioural *routines*	The animal invents and innovates. The animal is a *generator of surprises*
A paradigm of *the mechanical animal.* The behaviour of the animal is always causal and mechanistic. The animal can be explained through chains of causality.	Paradigm of *a hermeneutical animal*. The animal's activities develop according to interpretational procedures. The animal can be understood only by assuming a space of interpretation and meaning.
The animal is in command of species-specific *competences*.	The animal is in command of *capabilities,* which are typical of the species, the group and the given individual, and which reflect the environment, dispositions, and characteristics of the species.
The animal has no history	Each animal represents the crossroads of three lines of history—phylogenetic, cultural and individual—differing in their importance.
The competencies of the animal are defined by its affiliation to a given species.	Animals are individuals which do not always behave as they "should" according to the species-specific schemes developed by scientists.

[a] An ethogram is a catalogue of discrete behaviours typically employed by a species. These behaviours are sufficiently stereotyped that an observer may record the number of such acts, or the amount of time engaged in particular behaviours in a time budget. Rooted in traditions which focus on discrete species-typical innate behaviours, ethograms represent an early stage in the investigation of the behaviours of a species and the contexts in which they occur. Difficulties in compiling ethograms include rarely performed behaviours, graded displays, inter-individual variation and non-stereotyped behaviours, all of which introduce ambiguities into the lexicon-like concept of an ethogram. (Source: Wikipedia)

[1] This strange-sounding expression refers to objectivity as it is understood by contemporary science. It assumes, first, that there exists a reality separated from those who are living in it. Second, it is supposed that superposition of observations is not a sign of social and cultural convergence of the observations, but of an independence acquired by an observer through the observation process. Such independence is proof of the truthfulness of the observations.

[2] This approach is close to what Ernst von Glasersfels tried to develop through many years: direct access to reality does not exist. Access to reality is *always situated* at a certain location and time. The observer always represents a part of the image created. The English philosopher Berkeley and the Neapolitan philosopher Vico are undoubtedly the fathers of constructivism. But it was Jean Piaget who first established a connection between individual construction of knowledge and the Darwinist idea of adaptation. Piaget also imagined a new relation between knowledge and reality: the relation between the two no longer has a representational nature. The portrayal is not understood any longer as an image of reality. My communication cannot be compared to sending a message in Morse code. Others interpret my message according to their experience, not to mine.

These differences are obviously somewhat artificial, but they create an epistemic tension of undeniable heuristic power. I now take each of them and explore them more fully, in order to better capture the real problems and differences.

Genetic Constraints

As concerns the determination of the animal, the prevailing realist-Cartesian ethology always takes the genetic dimension of behaviour as essential. Even the most audacious investigators working within the paradigmatic framework have never challenged this core idea, and have been content simply to add this or that supplementary dimension to the basic disposition as a kind of an *après-coup*—such as, for example, the social component. The role of an ethogram further reinforces this tendency by accentuating the fundamental belief of the objective ethologists that each animal can be comprehended through a finite number of intermediaries and a small number of behavioural unities, mechanically laced together.

The bi-constructivist approach reverses this perspective by championing the view that each animal reigns over a vast space characterized by many degrees of liberty, outnumbering those—more or less rigid—constraints. Some of the rigid constraints are indisputably genetic, but this does not automatically mean that they should bear an exceptional status.

Seen from the realist-Cartesian perspective, behaviour is *imposed* to the animal. Of course, the bi-constructivist perspective also recognizes constraints of different strength, but they represent only limits. In relation to such limits, the animal has a large area of freedom: on the one hand there is what is imposed on the animal, what it *has to do*, whilst on the other there is what is *not allowed*. Such a constructivist perspective is in line with the work of Bas van Frassen (1989), when he proposes an open rationality in the model of democracy. He distinguishes between a closed rationality (which is expressed by rules) and an open rationality (which is not explicitly in contradiction with the rules).

Behaviour Versus Activity

Realist-Cartesian ethology has always been obsessed with the term *behavior*, to the extent that it has not hesitated to characterize itself, in certain historic periods, as *the biology of behaviour* (as in France in the 1980s). The bi-constructivist approach prefers *activity* instead of behaviour. The difference between the two lies in the necessity to interpret, in the second case, what the animal does in terms meaning: it's the animal which gives meaning to what is happening. More exactly: this approach postulates that the behaviour of an animal can be explained by the meaning it tries to give to what happens.[3] Realist-Cartesian ethology (claiming to be objective, sociobiological or cognitive) always refuses to attribute the slightest relevance to

[3] I think that one characterization of a living being is to give a meaning to what happens, but note that this does not mean that there is necessarily only ONE meaning, which we can find and which can be effectively objectified.

any meaning which the animal could use as reference when acting,[4] and believes that an objective description of behaviour is directly accessible through observation if the appropriate methodological rules are followed.

Animal as a Causal System Versus Animal as an Auto-Anticipating Entity

The animal of the realist-Cartesian ethology is a purely causal and deterministic system. This very strong conviction was in particular elaborated in an extreme form by objectivistic ethology, and it led the researchers of this paradigm to publish illegible patterns of causal procedures, like for example the causal procedures of Rober Hinde when explaining the bird songs.

The notion of auto-anticipating systems, as developed by Robert Rosen (1991, 2000) and reopened by Mihai Nadin (e.g. 2003), completely renews the space of relevance of ethology. They emphasize that living systems are distinguished from physical systems because of their ability for anticipation. If I drop a stone, I can calculate the trajectory of the fall; this kind of calculation is impossible if I drop a living and conscious cat, because the animal will anticipate what will happen next, and act accordingly—even though the cat, like the stone, is a physical system. Anticipation is the result of a number of a great variety of processes—either inherent to the system, or learnt. Evolution relates to the past, while anticipation turns to the future. M. Nadin cites von Förster's saying "die Ursache liegt in der Zukuft" ('the cause lies in the future'). Such a provocative phrase has a meaning in connection with the subject of anticipation. In the world of physics we deal with homogenous entities, which are supposed to behave in the same way when they encounter the same causes. A living being, on the other hand, represents an exceptional diversity; and it is creative, which means that no living being behaves exactly as a copy of its predecessors. There is no exact repetition, but rather there is always a small deviation—therefore it is not possible to study anticipation from the perspective of repetition and proof. Anticipation deals with singularity, and anticipatory capacity is fundamentally semiotic in that it lies in interpretative abilities. Prediction and anticipation are moreover two different things. We became very good at *predictions* based on statistics and probabilities, but remain still very sluggish when dealing with *possibilities* which establish anticipations—since we do not consider them to be as important.[5]

Routine Versus Surprise

The realist-Cartesian ethology remains fundamentally mechanical. In the best case it admits a stochastic dimension into the behavioural mechanisms with which it deals.

[4] The question of sexual selection is interesting from this point of view because it is a domain where ethology, particularly sociobiology, largely reintroduced an interpretative dimension. But this dimension became immediately neutralized, because it is understood only as a process of behavioural triggering. The objectivistic ethology was, in addition, interested also in the semiotics of triggers, but was constantly eliminating any interpretative dimension. The semiotics of ethology was always *mechanical semiotics.* I believe that an interesting chapter of a rigorous history of ethology should be devoted to precisely this subject.

[5] For Nadin, L. Zadeh's genius lies not only in his invention of systems of fuzzy logic, but also in his making the first meaningful attempt to give a rational base to probability theory.

The treatment of mistakes by ants proposed by J.-L. Deneubourg (e.g. Halloy et al. 2007) is exemplary from this point of view. An ant which gets lost when it goes to look for an identified source of food makes a mistake, but this may be adaptive since it can lead the ant to find another source of food, perhaps even richer than that it was initially seeking. To take the fruitful metaphor introduced by the American philosopher D. Dennett, the ethologist is in the position of a *retro-engineer* who receives a machine which he does not know. To understand the machine he must reconstruct the intentions underlying its design (Dennett 1990). Such an extremely technical vision of the animal excludes all innovations other than those acquired by (Darwinian) evolution. The bi-constructivist approach, on the other hand, puts *surprise*, novelty, at the very centre of every encounter with the animal. By its very essence, the animal is something what can surprise the observer: a good ethologist has to be prepared to be surprised. Innovation therefore becomes essential for characterizing the animal. Such innovation can be either individual or collective. As a result, the scope of possibilities for a living being is not infinite (it cannot do anything), yet is indefinite (it can do more that it does and it is very difficult to anticipate what it can do in advance).

History

One consequence of this indefinite scope of possibilities is that the animal of a bi-constructivist approach is *the* subject of history: not only of biological history as it unwinds through evolution, but also cultural history, which concerns groups and fixes itself through them and individual history, which concerns each animal individually. In constrast, the animal of realist-Cartesian ethology is almost devoid of history, with the exception of biological history, i.e. evolution.

History, however, "precipitated" very convincingly from a long-lasting study of a group of chimpanzees of Gombe in Tanzania. In the 1970s, the chimpanzees of Gombe divided themselves into two antagonistic groups, Kasekala and Kahama (Goodall 1986). In 1977 the latter was completely and violently annihilated by the first one. It is not my intention to superpose human history onto the history of other animals but to recognize the social dynamics that exists in the societies of both of them and which determine their characteristics. Animal history is not only political: it can also be cognitive. It his respect it is interesting to see a philosopher like Dennett (1996) recognizing that the human spirit is the joint result of phylogenetic and cultural history, without ever asking if this could not be the case also for other animals.

Mechanical Animals Versus Hermeneutic Animals

The animal of realist-Cartesian ethology is a mechanical animal, which means an animal that can be represented in a satisfactory way as a machine: depending on the causes it functions in a more or less deterministic way. In contrast, the animal of the bi-constructivist approach is a hermeneutic animal, constantly interpreting the surrounding world by attempting to comprehend also the interpretations of other living beings which share life with it. As the Danish biologist J. Hoffmeyer says "first of all, the dog is a message for another dog"(see Hoffmeyer 1997, 2009). We

could add that every living being is *potentially* a message for *all* other living beings. This does not mean to deny the existence of causalities in the dynamics of living beings but to realize that they are only necessary, not sufficient, preconditions. The bi-constructivist paradigm can be neutral regarding the interpretations. They are not intended as interpretations made by the animal, but only as descriptions of the animal's behaviour according to the interpretations it makes.

Capacities and Capabilities

The realist-Cartesian approach in ethology studies the capacities of the animal, behavioural and cognitive. The bi-constructivist approach, in contrast, takes into consideration the fact that the possibilities for an animal's action cannot be reduced to mere capacities. They should be understood as applications of such capacities, as influenced by the opportunities encountered by the animal, as well as of its abilities to appropriate them. The realist-Cartesian ethology is constituted around a fundamental opposition which is close to Chomsky's opposition between competence and performance, but which does not go so far in the reductionist direction.

Chomskian competence is meant as a biological capacity specific to the animal and its performance. It represents the individual appropriation of the specific competences of a given species. I propose to replace the notion by that of *capability.*

Competence/performance	Capability
Animals of a given species are characterized by a finite list of competences. This allows an exhaustive determination of the animal. Hence, the investigator can provide an objective characterization of the animal.	Animals of a certain species master capabilities, which are developed and updated through important dispositions and contacts and are established through interplay with the ecosystem (in a broad sense). Such capacities cannot be defined a priori or provided as a finite list; still less can they be exhaustively enumerated by humans. It is not possible to describe them from the outside but only to establish a contact and relations with them, thereby simulaneously transforming them.

The very nature of animal capabilities does not allow for their objective description, because understanding them requires us to work *with* the animal (rather than *on* the animal). By doing so, we establish a relation with the animal and therefore transform its capabilities. The question is therefore not *What are they?* but rather *What can I do with them?* Here again, questions of practice have a superior status to questions of ontology.

Therefore the bi-constructivist approach is especially interested in singular animals, which are neglected by the realist-Cartesian approach—in animals whose competences cannot be reduced to those of a species they belong to. For the realist-Cartesian approach to ethology, the capacities of the species are fundamentally the capacities of the species, which are given once and for every member throughout natural evolution. They cannot be transformed in any other way than through classical Darwinist processes of trial/error, so placing mutation at the heart of limited dynamics.

Two Epistemologies

The two paradigms (realist-Cartesian and bi-constructivist) result in an elaboration of very different epistemologies., i.e. legitimate epistemic approaches, which it is worth describing. I distinguish three levels: 1) phenomena to observe, 2) the conceptualization of such phenomena, and 3) legitimating strategies in the conceptualization of phenomena—in particular through experimental protocols.

Realist-Cartesian epistemology	Bi-constructivist epistemology
Fable of the inexistent observer	All observations require an observer
The paradigm of contagion: all observers can contaminate the behaviour of the animal and it is important to protect the results from this danger.	The paradigm of a structure of contacts and relations: we do not have to explain how to *avoid* the transformation of the animal by the one who is observing it but why it occurs so easily. These are the most interesting mechanisms at play.
Utmost danger dwells in *anthropomorphism.*	A "Popperian" approach is to be followed concerning the *capabilities* of the animal, based on *familiarity* with the animal
Anecdotes must be banished.	The *rare occurrences* represent precious data, which have to be collected with care.
Naïve and realistic empirism. The reality of the animal can be completely disclosed through rigorous observation and judicial experiences. The conceptual dimension of this kind of ethology is neglected.	Stresses the necessity to link observation, experimentation and conceptualization in order to understand the variety of animal's constructive abilities.
The ideal of *transparency* (we can and we have to provide an integral description of the animal).	There will always exist a part of the animal unsurmountable for human understanding.
Universal academic ethology.	It is necessary to leave some room for marginal explications coming from other cultures and/or from professionals working with animals.

Situation and Status of the Observer

The situation and the status of the observer represent without doubt a central point which distinguishes realist-Cartesian epistemology and bi-constructivist epistemology. In the case of the former, since the 17th century the status of the observer has been defined by the physical sciences: the observer should remain as distant as possible from the object of his study, to be able to provide as neutral a description as possible. In contrast, for the bi-constructivist paradigm observation of an animal is an interactive process. The observer and the observed play complementary roles which are even inverted occasionally. The human observer is always observed by the living being that is observed: the relation connecting the observer and the observed is therefore far from simple. Ethology is for example deeply preoccupied with the fundamental issue of the influence of the observer on the behaviour of the animal. As a result the recurrent question arises of *how* to avoid such an influence, even though there is another more interesting question which should be asked: the question of *why* the animal can be influenced so easily. The methodological question has to be understood as an intrinsically theoretical

question. The animal is so sensitive to the observer exactly because it constitutes its being through contact with other agents and the characteristics of its ecosystem. This ecosystem unfolds to the animal thanks to, and through, the animal's own activities.

Contagion Versus Contact and Relation

One of the recurring fears of the realist-Cartesian approach is that the observer contaminates his object of study. Since reality exists independently of all observers, the observer has to create conditions such that he is—at least virtually—absent from the system studied. Here lies the source of the permanent fear, even panic, that the behaviour of the observer will contaminate the *true* behaviour of the animal. Furthermore, mental contagion makes the observer to perceive other things that the true reality—for example when accepting anthropomorphic attitudes. The bi-constructivist approach is free from such fears: it does not take the situation to represent an acute methodological problem, but sees it instead as an inevitable process of self-modification dependent on interaction with other living beings. This process offers creative opportunities rather than being merely misleading. When reality is not independent of the observer, the task is less so to provide a true image but to explore the potentialities of what is given.

Anthropomorphism

This implies that anthropomorphism becomes a main danger in the realist-Cartesian approach to ethology: succumbing to it leads to the distortion of reality. In contrast, anthropomorphism is a methodological resource for the bi-constructivist approach, suitable for cautious use but without the danger of being excluded from science. The limits of the two approaches are thus defined very differently. The realist-Cartesian approach with its engineering logic has its limits in "functional objectivity", while the limit of the bi-constructivist approach is the question of the *familiarity* of the observer with the animal studied.

Anecdotes, Eccentric and Scarce Observations

The approach taken towards anecdote represents a second fundamental difference between the two paradigms. The majority of ethologists continue to deny the relevance of anecdotes, as they consider them to be mere eccentric observations, even though they could conceptualize them by using the term *scarce observations*—as phenomena that occur only from time to time. C. Boehm (1999) reminds us that only a single collective rebellion of subordinates was observed during 35 years of chimpanzee observation in Gombe. Similarly, C. Boesch (1999) describes a case of learning how to crack nuts by means of a stone and a hammer: the only known case so far. We could multiply such examples. The aim is not to deny that eccentric, over-interpreted observations or subjects necessitating a cautious treatment do exist, but to emphasize that not all infrequent observations necessarily fit into the category of methodological error. It belongs to the fundamental characteristics of living beings to generate rare phenomena.

Naïve Empiricism, Realism and Constructivism

The realist-Cartesian paradigm is based on a naïve empiricism and on a realist conception of the world. The reader may be surprised by the adjective "naïve" used to quantify the empiricism of ethologists and therefore it is worth explaining the point. Usually an ethologist is a biologist who typically regards detailed conceptual work as a loss of time; for him, it is sufficient to observe the animal with a maximum of rigour in order to understand it. It is astonishing to realize that ethologists, otherwise always open to critical approaches, themselves accept in their work the ballast of concepts, a heritage of Western philosophical history, which has led to a firm distinction being drawn between humans on one side and animals on the other. Those who favour the bi-constructivist paradigm believe, in contrast, that there are no concepts without a complex cultural history. Therefore it is useful to work with them with prudence. Permanent conceptual innovation is indispensable.

Ideal of Transparency

The realist-Cartesian paradigm pursues the ideal of capturing the animal as something totally transparent and amenable to exhaustive description. The ideal of transparence has as its prerequisite two strong beliefs, although they are rarely explicitly expressed. The first one takes the animal to be a machine; it maintains that it is possible to provide a complete plan of the animal. According to the second belief, greatly inspired by the experimental method of Claude Bernard, such a plan is identifiable with the scientific approach. The bi-constructivist paradigm insists in contrast that it is impossible to eliminate all traces of context and individual distinctiveness in understanding the animal. There are two reasons for this. First of all, the animal is not a machine, and to provide an exhaustive plan is a shallow dream. Second, each organism is the result of historical contingencies, the outcome of a plethora of completely different trajectories. Therefore to provide an exhaustive description of an animal would mean to be able to take into account *all* such histories. Even if a mathematician could trace in advance, and exhaustively, the range of possible transformations of trajectories, such anticipation is not possible with a living being, where the range of possibilities is not infinite but indefinite. Animal anecdotes have the characteristic not of being monadic but rather of being interactive, inseparable, cooperative and irreversible. It is not possible for the ethologist to reverse the history of the animal to some illusory point zero in order to follow some alternative history. Moreover, the necessity of an observer describing the animal inevitably creates new bifurcations of such trajectories. Of course, the realist-Cartesian paradigm might be prepared to admit that it cannot know everything (particularly because the investment required to reach the ultimate relevant information may be too high compared with the real interest in the information concerned) but it will be prepared to ignore since it supposes the additional knowledge gained to be of weak or almost no interest. In contrast, for the bi-constructivist paradigm incidental anecdotes and observational details may reveal essential aspects of the animal, even if to be an animal also means that it cannot be fully revealed the essence of the animal will be revealed only partially.

The Monopoly of Academic Ethology over Non Academic Professional Observations

Realist-Cartesian ethology has to be understood through a double logic: its aim is to establish positive scientific knowledge about the animal on one side and at the same time to eliminate all possible competition from other academic traditions. Different branches of ethology have so far insisted completely on the first aspect but never embarked on the second, which is nevertheless the essential one. A theoretical physicist will only be confronted by scholars or researchers who received the same academic education that he did. This is certainly not the case for the ethologist, who is suddenly confronted by something that can be defined as "competition" from the side of the savage. Hunters, stockbreeders, animal trainers and tamers etc., all claim a certain expertise in understanding the animal. In this respect the experience of the animal trainer and philosopher Vicki Hearne is interesting. To eliminate the participation of such outsiders, we scientists mobilize two weapons of war: anthropomorphisms on one hand and anecdotes on the other. D. Dennett (1996, p.16) remarks that to understand the spirit of the animal assumes that we start from what we know about our own spirit because it is the only thing about which we have any idea. Dennett wants to compare the spirit of the animal and the spirit of the human being but what he really proposes is to compare the animal spirit with *our representations* about the human spirit. It is therefore necessary to keep his position in perspective: because human spirit is the starting point, these portrayals are multiple. They exist in all the cultures and some of them—for example the Chinese, the Japanese, the Mayan—reveal great complexity, very different from the portrayals currently found in Western cultures.

Two characteristics of the animal, significantly underestimated or even completely ignored by the realist-Cartesian ethologists deserve to be developed: the existence of individuality in animals on the one hand and the creative dynamics which can deeply transform the species on the other.

The Singular Animal

A singular animal is an animal with capabilities not found in other members of the same species, or only very rarely. The term singular animal is indispensable when working with a bi-constructivist epistemology (Lestel 2004, 2007). A singular animal is represented by an individual that is able to establish a *different* relation with the world: it is able to form the world in its own, distinctive way. Singular animals have the capabilities of learning and "personal development". Such capabilities evolve through their individual lives, and differ from one to another. They have a considerable influence on what animals eventually become and what distinguishes them noticeably from other congeners.

Watana is a typical example of a singular animal. This young orangutan lived in the Jardin des Plantes and had the distinctive feature of knowing how to nod, while his congeners never, or almost never, displayed such a capability (Herzfeld and Lestel 2005; Lestel and Herzfeld 2005)

The Singular Animal in Terms of its Species

Neither the competences nor the behaviour of singular animals correspond to the characteristics that should be those of their of their species. The singular animal embodies an extra plasticity which allows innovation within the species. Indeed such singular animals destabilize our conceptions of the term species, while inverting the relation between the species and individuality which we spontaneously establish in ethology. This inversion makes the usual epistemological model of ethology waver, since it is more oriented towards biology than towards social science. The question of the singular animal is oriented along three axes. (1) The first is epistemological, asking what kind ethology we should create in order to give a central place to the singular animal instead of denying its existence and relevance. (This view gives a certain credit also to anecdotes that assume certain anthropomorphisms. (2) The second is metaphysical, and pertains to the discovery of what it means to be alive in a world where animals are taken as open windows for various and surprising subjectivity, rather than closed robots exhibiting just the mechanical repetitions of certain ancestral determinisms. (3) Finally there is the methodological axis, to do with understanding how to comprehend the singular animal in order to convert an eccentric subject into a fundamental scientific object for, say, ethology. This aspect also assigns a central place to anecdotes and to anthropomorphic viewpoints.

Epistemology of a Singular Animal

In the realist-Cartesian ethology an animal cannot become a source of *surprise*. Certain species behaviours may be unforeseeable but it is still the behaviour of the species, and therefore all animals belonging to the given species have to adopt such behaviour should they find themselves in the same circumstances. The animal is not expected to be characterized by a particular pattern of behaviour or a capacity that would be absent in all other members of the species. In this sense the singular animal is somewhat disconcerting. First of all, such an animal is create source of suspicions. It generates confusion due to its transgressing two major principles of realist-Cartesian ethology: the *principle of causality* (all members of a given species demonstrate the same behaviour as all other members of the species) and that of *statistical evaluation* (every behaviour has to be statistically evaluated in order to be considered legitimate: otherwise it is considered anecdotal).

The singular animal must be carefully distinguished from animals displaying rare, eccentric or even pathological behaviour. One example of a rare behaviour is given by J. Poole (1996), who directly assisted in the birth of an elephant in the National Park Amboselli in Kenya. Eccentric behaviour does not have any significance for the species and may result in accidents or unexpected developments. For example, a snake called I/M studied by Burghards at the Rockleffer University possessed two heads, which were in competition with each other as agents of predation.

Hyper-rationality of the Singular Animal

We can consider the singular animal as part of the mechanism of blind hyper-rationality of evolution. The singular animal allows marginal plasticity to generate

trajectories leading to innovations. The project of W.S. Cooper (2001) is interesting in this respect. He suggests that the laws of reasoning should be investigated within the framework of a theory of evolution. Reasoning is a particular competence. This competence differs from other adaptations because the laws of logic reflect aspects of the laws of adaptation. The actual emergence of rationality is inseparable from evolutionary biology. The laws of reasoning are based on evolution but they are simultaneously distinct from it. They use evolution as a support in order to transform it profoundly. Darwinian logic does not exclude the phenomena of singular animals; it is normal that certain individuals are abnormal. These animals can be very different from others, without assuming the status of being pathological. In other words the existence of singular animals is not only compatible with but even required by evolution, which places innovation and invention at the heart of the processes of living beings. The singular animal without doubt plays an important role in the dynamics of animal societies, in the evolution and constitution of species and in the nature of the human/animal relation. It is necessary better to understand the creativity and innovation of the animal, a subject with which realist-Cartesian epistemology is not very comfortable.

Animal Creativity

Theoretists like Robert Rosen, when characterizing a living being, put its capacity for auto-anticipation centre-stage. The question I am interested in nevertheless goes further. In some animal species, individuals are not only able to *anticipate* what can happen, but they can also *invent* what can happen. This is a much more interesting capability but at the same time it is much more problematic. It is something that no conceptualization or formalization of complex systems has yet suggested or dealt with in a satisfactory manner. Living systems, the subject of evolutionary theories, involve not just the dynamics of adaptation and learning but also creative and inventive dynamics. It is necessary to realize that this creativity is established on two levels. The first is represented by the creativity of the forms and nature of the organisms themselves, which relates to the question of biodiversity. The second concerns an often neglected aspect of the animal behaviour: the capability to engage in new practices and activities contrasting with those normally carried out by congeners of the same species. Generally, the innovational ability of the animal is much more important than we imagine.

Animal Creativity and Innovation

Nature offers many examples of invention. Jane Goodall had been examining the manipulation by chimpanzees of plants for many years. She describes examples of nest construction, the technique and popularity of which is short-lived (Goodall 1968, p.197), and also the inventive use of sticks as levers in order to open a metal and cement box containing bananas (ibid, 207). T. Nishida (1980) noted the appearance of a surprising communicative behaviour—leaf-clipping—of animals in the M group (in Mahala), when expressing their frustration. Such behaviour was not observed elsewhere. The chimpanzees of the M group also began consuming

cultivated plants—guava, mangos, or lemons—that did not belong to their ordinary diet. There are plenty of other examples of innovative animal behaviour: we can demonstrate their diversity without claiming to provide an exhaustive overview.

Creativity and Innovation Coming from the Interaction with Humans

Trinidad White-Fronted Capuchin (*Cebus albifrons trinitatis*)	Use of leafs to drink from cavities in trees
Capuchin (*Cebus paella*)	Striking stones against each other in order to remove splinters and to use as opening devices
Japanese Macaque (*Macaca fuscata*), Jigokudani Monkey Park	The female Tokai was able to build a stick from a branch of tree, when there was not other stick already available around. Furthermore she threw stones (with varying strength depending on the audience) into a pipe in order knock fruits out of it. She makes her pup move into the pipe to take them.
Chimpanzee, Outamba-kilimi National Park	Use of sticks as footware in order to climb bushes with thorns in Sierra Leone
Gorilla	Use of a branch in order to clean the nose of a congener.
Hamadryas Baboon	Spontaneous development of cooperative tool usage
Rehabilitated Female Orangutans,[a] Sepilok	Use of leaves as dish for eating
Japanese Macaques in Katsuyama	Washing roots in the river before eating them
Orangutan, Zoo in Jardin des Plantes	A female has become a virtuoso in making knots

[a] Orangutans living originally with humans and subsequently released free to the forest in Borneo.

Creative Behaviour Emerging While Cohabiting with Humans

Many different behaviours are developed further by animals living together with humans. Such animal creativity is almost completely unstudied in ethology, partially due to the postulates of the realist-Cartesian paradigm. An animal living with humans is necessarily one that has gone astray. It is not a "true" animal anymore; it is an animal from a circus, a trained animal. This view is difficult to retain, however, because there are animals which show new behaviour while with humans, even if never trained to perform it, even though it takes place only in course of an interaction with humans. Heinrich (1999) is interested in the life styles of ravens, which live in families, where they are perfectly integrated. The creativity of birds becomes apparent particularly in relations which they manage to establish in contact with humans with whom they live. Painting monkeys provide another interesting example, extensively studied by Thierry Lenain (1997). Again, comprehension of the situation cannot be achieved if we do not admit that the animal has capabilities rather than competences. These capabilities are formed together with the environment in an opportunistic but not necessarily risky or blind way.

Creative and Innovative Behaviour is Not Limited to Primates

Innovative behaviour is not limited only to primates. Many birds, sea mammals, and mammals such as elephants are highly creative as well. A wild crow which

was regularly offered food one day altered the way it used to reach it. The bird ignored the possibility of attaining immediate satiety in order to get more food later. This remarkable behaviour was moreover based not on learning through trial and error but on operational analysis of the situation. Karen Pryor has explained how she taught a dolphin (*Steno bredanensis*) named Hou in the great aquarium in Hawaii to invent new forms of gymnastics in order to get food from the trainer. The animal later developed a very complex and abstract concept of originality. K. Pryor (1975) refers also to another dolphin which made a similar progress. However, individual innovation has not generally been observed in insects or reptiles. Hence, the capacity to innovate is distributed unequally among species. It seems that there is a correlation between the ability of a certain species to innovate and its ability to play.

How to Think about Innovation in Non-humans

Innovation is a complex phenomenon, the treatment of which in ethology is in its beginnings. It does not necessarily require the amount of imagination we often attribute to it. Inability to predict what could happen does not necessarily indicate that something new will appear. As in the case of games, innovation creates a phenomenon the analysis of which presents multiple difficulties. The realist-Cartesian approach is simply incapable of recognizing those difficulties in a satisfactory manner, and researchers working in this tradition have a tendency to underestimate them considerably. Simply put, the phenomenon is very difficult to handle in a mechanistic way, and it is difficult to tackle it from the perspective of a discipline that excessively favours such an approach to the world. A car is not capable of innovating[6]; why should the animal be able to do so? The ethologist working in the open air is describing neither cars nor computers. Observed animals sometimes show new behaviours as if they are pre-adapted to the situation they are confronted with, enabling them to transform the situation in their favour. Two important characteristics have to be brought to our attention in order to understand animal creativity—behavioural inaccuracy on one hand and the unpredictability of behaviour on the other. Both relate to fundamental characteristics of the capabilities of animals.

Creativity and Behavioural Inaccuracy

The hypothesis of behavioural inaccuracy was originally proposed in order to explain the behaviour of fly maggots. It suggests that new behavioural structures can cause an emergence of variations, and these result from the inaccuracy of behaviour rather than from the variationss caused by mutations. It is difficult to place this behavioural inaccuracy under the concept of behavioural plasticity. Plasticity here means that some environmental variation can modify or refine an organism's phenotype in an adaptive and often predictable way while the phenotype remains strictly adaptive. Hunting strategies which vary according to the nature of the

[6] But a computer can be partially capable of innovation—at least, when it multiplies the unexplained "bugs". Some of them can become also adaptive to take the evolutionary metaphor.

prey serve as a good example. Behavioural inaccuracy causes unpredictable changes of the phenotype (because they are not organized), which also appear to be hazardous in relation to adaptation. Furthermore they are not correlated with any environmental variables. They represent "noise" in the nervous system. Here is one little-known example in this respect: the spiders of the species weindilgarda (family Theridiosomatida) build webs demonstrating important intra-specific and inter-specific differences (Eberhard 1990). In the case of *W. galapagensis* and *Wendilgarda* sp.c., the same individuals can subsequently make webs of very different pattern. Hence, even established behavioural structures such as spinning a web may vary to a great extent.

Creativity, Unpredictability of the Behaviour and Sexual Selection

The phenomenon of the unpredictability of behaviour is not new and differs substantially from the behavioural inaccuracy. It was firstly discussed in an innovative way in the 1970s. Julian Huxley and Ernst Mayr worked with psychiatrists in order to evaluate schizophrenia from an evolutionary point of view (Huxley et al. 1964). They coined the hypothesis that the behaviour of pathological individuals emphasize the general tendency of certain living beings to adopt unpredictable behaviour. Such an ability can lead to the creation of strategies that will be very efficient socially (Driver and Humphries 1988). It does not follow that such an ability should be also intrinsically cognitive. It is based particularly on mechanisms well known in the evolution of the living, particularly the capacity to develop an ability to react in a hazardous or quasi-hazardous way. From the Darwinian viewpoint, these possibilities represent no heresy. Quite the contrary, to be able to mobilize such unpredictable behaviour, not only to escape predators or catch prey, but also to find sexual partners for reproduction, contributes to the elaboration of winning strategies. Creative behaviour, in other words, would be very attractive for a potential sexual partner. This thesis was put forward by Elen Dissanayake (1992) in order to instil an awareness of artistic and aesthetic creativity in the evolutionary perspective. The exceptional creativity of the human primate should be studied in connection with this phenomenon, as should the intensification of its force enabled by language.

Innovation of Artifacts and Innovation of Procedures

Two very different characteristics of behavioural inaccuracy and unpredictability of behavior can be highlighted. The first brings the necessary and sufficient condition of innovation. The second considers them as but one source among many that could be mobilized by innovating animals. In the first case, such processes remain blind. But we do not explain why certain animals innovate more than others, nor why not every animal abounds with innovations whenever possible. The characterization of an animal's capabilities in terms of mobilizing one of the possible sources is more interesting. An innovation is based on the possibility of an animal modifying the controlled situation. That modification can be done either through the invention of objects or though the invention of procedures. Two very different forms constitute distinct ends of a complex phenomenon: invention of an object and invention of a

procedure. We would say that innovation allows renewed control over the environment, over oneself and over others. Innovation enables first of all the initiation of other relations with oneself and with the environment. Fentress (1992) explains for example that a wolf shows great behavioural creativity but some individuals in contrast show a surprising inability to modify their behaviour. The ability to innovate also varies very much from one species to another. Moreover it is far from homogenous even for the same individual. Fentress does not need more than a few minutes to teach Lupey (a wolf which he works with) to "shake hands" but it is very difficult to teach him to sit down during play time.

The Central Problem of Ethology: Where is the Right Place to Study the Constructivism of the Ethologist and the Constructivism of Animals?

The central problem of ethology can be defined as this: how can human beings come to understand how animals build their worlds? The bi-constructivism explained here (the source of which lies in the work of Gregory Bateson, who tries but does not manage to conceptualize the fact that constructivism is his central problem) is based on two concerns. Firstly animal constructivism—how each animal builds its own reality, when respecting the interrelatedness of the world which surrounds him. And secondly the constructivism of the ethologist—how the ethologist becomes aware of the dispositions of the animal, when creating a significant influence on the dispositions of the animal. Such an approach places interpretation at the centre of human being/animal relations, making ethology fundamentally a biosemiotic discipline.

The Main Consequence of Bi-Constructivism

The ethologist has to be as creative as possible. The more creative he or she becomes, so the more complex and interesting the animal becomes. This does not mean to be *polite* in the sense of Vinciane Despret (2002), but to be creative in a very strong sense. We should not concentrate on areas of best performance, but try to find—together with the animal—where it can be good. The objectivity of the bi-constructivist ethologist involves engaging in a dialogue with the studied animal in order to understand its lifestyle (throughout which we need to determine the nature of the animal). As a consequence it is an objectivity which is created through shared life, not objectivity, and which draws its legitimacy from external truths uninfluenced by any interactions.

The relativistic objection which is often expressed does not hold. Because we think of an animal in an innovative perspective, where it reveals new capabilities and can be at its most efficient, does not mean that we can work with it as we like. A multiplicity of actualizations is not the same thing as a multiplicity of points of view. Such an idea can nevertheless be given two distinctively different formulations.

First the *weak* one: a phenomenon can be complex to such an extent that it appears differently depending on the point of view from which it is observed; but that does not mean that the phenomenon is illusory.

And now, the *strong formulation*: a phenomenon can be complex to such an extent that the way of access of the observer in part determines the very characteristics of the animal, since the very presence of the observer constitutes a part of the phenomenon in question. The idea that the observer is part of the phenomenon and therefore can never be external or neutral is a fundamental characteristic of the bi-constructivist approach. That does not mean looking at the animal from a closed perspective: we have to learn to think in an open perspective. The animal develops through the contacts and relations which it establishes, and therefore experimentation builds a great range of multiple dispositions. The experimenter, in other words, does not explore the species as independently of himself as he believes, but rather makes the capabilities of an animal happen.

A Hermeneutic-Popperian Approach

Fundamentally the bi-constructivist approach is moreover based on a completely logical and hermeneutic-Popperian approach,[7] which stipulates that the observer has to grant maximum abilities to the animal and try subsequently to disprove them when relying on the familiarity acquired through contact with the animal. The latter point is essential. The principal and neglected characteristic of the realist-Cartesian approach is the belief that the animal can be immediately (or quasi-immediately) evaluated by means of simple tests—often with only two possible possibilities—which can be carried out without noticeable difficulty and without the prior acquisition of solid knowledge about the animal. Such an approach leads the researcher to produce affirmations about the animal which are out of line with the views of practitioners, without ever holding a real discussion about (or at least a constructivist confrontation between) the points of view. An important characteristic of the realist-Cartesian approach, which is in particular completely ignored even though it seems to me to be of the highest epistemological importance, can be expressed as a question: how can such a paradigm, which has been constantly mistaken about the capabilities of the animal (behaviourists denying that non-human animals have mental life, even though cognitivists apparently are able to access to it) claim truthfulness so dogmatically? Such a disciplinary history should foster among followers of the realist-Cartesian approach a certain modesty, which they are visibly unable to adopt.

Bi-Constructivism and Biosemiotics

The bi-constructivist approach is fundamentally a biosemiotic approach to ethology.[8] The proposed bi-constructivist approach differs from realist-Cartesian approach of contemporary ethology, as we saw above, but it also unlike the biosemiotic approach

[7] The Popperian approach rests on creating a hypothesis about reality, followed by attempts to disprove it empirically or experimentally. The hermeneutic-Popperian approach applies this idea to the interpretation of living subjects of study.

[8] I have to thank to Kalevi Kull for an enlightening discussion on the subject.

of J. von Uexküll[9] in one essential point, which requires to be explained. The approach of von Uexküll is in reality monadic: the animal is imprisoned in the species in a physiological sense. Umwelts are juxtaposed without really interpenetrating each other.

[1] The realist-Cartesian of the contemporary ethology	[2] The biosemiotic approach of von Uexküll	[3] The bi-constructivist approach
There exists a well established reality. We only need to discover it and provide a causal description—truthful, accurate and without any ambiguities.	The animal interprets its environment through its physiological senses and this interpretation represents a biological interpretation of the species, which does not have any history.	Each animal creates its own world through contacts and relations and the ethologist constructs the connection of the animal to the world, when himself constituting his own connection to the animal through his own contacts and relations.

The bi-constructivist approach is built in contrast on that characteristics of the umwelt which von Uexküll largely neglects: an umwelt of the animal is a realm which can become open to the umwelten of other animals. This represents interspecific interpretation, which is again a domain noticeably neglected by contemporary biosemiotics. Despite the efforts of zoosemiotics, this domain deserves to be examined and requires to be studied from a cultural and historical perspective and not just from a biological perspective. The last point is far from being trivial or unimportant, even if it looks as such. We have indeed a tendency to neglect the profoundly cultural dimension of biosemiotics and to underestimate the capacities of the individual of a species to make their umwelt converge with those of individuals of other species, according to technological and social conventions.

Conclusions

We claim that contemporary ethology essentially follows the realist-Cartesian paradigm, privileging the conviction that animals are more or less complex causal machines and the idea that there exists a reality independent from the observers. It claims to provide a true concept of the animal, and humans are, it is suggested, able to provide an exhaustive description of the animal. We have shown here that the bi-constructivist paradigm recognizes certain characteristics of the animal, for example by assuming that the animal is a creative subject constantly interpreting its environment while it reacts. An observation always requires an observer, which should also be conceptualized in the image given to the animal, but there is always a remaining part of the animal that is inaccessible to human epistemic desires. The bi-constructivist approach suggests in particular why science, trying to understand the living beings, cannot be reduced either to the physics or biology of organismic

[9] I have rather neglected the biosemiotic approach, which is only marginal in ethology. I have neglected it especially because it is marginal and because I prefer to focus my paper on the dominant realist-Cartesian approach and on the bi-constructivist approach.

constituents, but has to be understood in terms of biosemiotics, which is simultaneously biological, cultural and individual.

The advantage of the bi-constructivist paradigm is the ability to provide a dynamic image of the animal based on creativity and innovation. It is not merely a system of functions and behavioural routines. Consequently we need to ask what the animal can do rather than what it is—an ontological question, which in the end is of little importance and which is becoming increasingly trivial. All living beings are characterized through 'a space of possibilities' (inherent to a given species but noticeably different from one member of the species to the other) and through contacts and relations elaborated together with its (biocultural) ecosystem, which enable them to react, feel, and think in particular together with other living beings. Computational models of living systems are neither so robust nor rich as systems of real creatures. When we develop models only according to this approach we loose something, and currently we have only a weak idea of what it might be.

References

Boehm, C. (1999). *Hierarchy in the forest. The evolution of egalitarian behavior*. Cambridge: Harvard University Press.

Boesch, C. (1999). Teaching in wild chimpanzees. *Animal Behaviour, 41*, 530–532.

Burghardt, G. (1991). Cognitive ethology and critical anthropomorphism: A snake with two heads and hognose snakes that play dead. In C. Ristau (Ed.), *Cognitive ethology, the minds of other animals: Essays in honor of Donald R. Griffin* (pp. 53–90). Hillsdale: Lawrence Erlbaum Ass.

Cooper, W. S. (2001). *The evolution of reason, logic as a s branch of biology*. Cambridge: Cambridge University Press.

Dennett, D. (1990). The interpretation of texts, people and other artifacts. *Philosophy and Phenomenological Research, 50*, 177–194.

Dennett, D. (1996). *Kinds of minds: Toward an onderstanding of consciousness.* Basic Books

Despret, V. (2002). *Quand le loup habitera avec l'agneau*. Paris: Les Empêcheurs de Penser en Rond.

Dissanayake, E. (1992). *Homo aestheticus. Where it comes from and why*. Seattle: University of Washington Press.

Driver, M. P., Humphries, N. (1988). *Protean behavior: The biology of unpredictability.* Oxford University Press

Eberhard, W. G. (1990). Imprecision in the behavior of Leptomorphus Sp. (Diptera, Mycetophilidae) and the evolutionary origin of new behavior patterns. *Journal of Insect Behavior, 3*, 3.

Fentress, J. C. (1992). The covalent animal: on bonds and their boundaries in behavioral research. In H. Davis and D. Balfour (Eds.), *The inevitable bond. Examining scientist-animal interactions*. Cambridge University Press, pp. 44–71.

Goodall, J. (1968). Behaviour of free-living chimpanzees of the Gombe Stream area. *Anim. Behav. Monogr. 1*.

Goodall, J. (1986). *The Chimpanzees of Gombe: Patterns of behavior*. Harvard University Press.

Halloy, J., Sempo, G., Caprari, G., et al. (2007). Social integration of robots into groups of cockroaches to control self-organized choices. *Science, 318*, 1155–1158.

Heinrich, B. (1999). *Mind of the raven, investigations and adventures with wold-bird*. New York: Cliff Street Book.

Herzfeld, C., & Lestel, D. (2005). Knot tying in great apes: etho-ethnology of an unusual tool behavior. *Social Science Information, 44*(4), 621–651.

Hoffmeyer, J. (1997). *Signs of meaning in the universe.* Indiana University Press.

Hoffmeyer, J. (2009). *Biosemiotics. An examination into the signs of life and the life of signs*. University of Scranton Press.

Huxley, J., Mayr, E., Osmmond, H., & Hoffer, A. (1964). Schizophrenia as a genetic morphism. *Nature, 204*, 220–221.

Lenain, T. (1997). *Monkey painting*. London: Reaktion Book.

Lestel, D. (2004). *L'animal Singulier*. Paris: Seuil.
Lestel, D. (2007). L'histoire des animaux singuliers. *Bulletin d'histoire et d'épistémologie des science de la vie, 14*(2), 119–136.
Lestel, D., & Herzfeld, C. (2005). Topological ape: Knot tying and untying and the origins of mathematics. In P. Grialou, G. Longo, & M. Okada (Eds.), *Image and reasoning, interdisciplinary conference series on reasoning studies* (Vol. 1, pp. 147–162). Tokyo: Keio University Press.
Nadin, M. (2003). *Anticipation. The end is where we start from.* Lars Müller Publishers.
Nishida, T. (1980). The leaf-clipping display: a newly discovered expressive gesture in wild chimpanzees. *Journal of Human Evolution, 9*, 117–128.
Poole, J. (1996). *Coming of age with elephants. A memoir*. New York: Hyperion.
Pryor, K. (1975). *Lads before the wind*. New York: Harper and Row.
Rosen, R. (1991) *Life itself: A comprehensive inquiry into the nature, origin and fabrication of life.* Columbia University Press.
Rosen, P. (2000). *Essays of life itself*. Columbia University Press.
van Frassen, B. (1989). *Laws and symmetry.* Oxford: Clarendon.