On the Evolution of Reality—Some Biological Prerequisites and Evolutionary Stages

SVERRE SJÖLANDER

Institute für Humanbiologie, Universität Wien, Althanstrasse 14, A-1020 Wien, Austria

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The discussion of the evolutionary origins of consciousness has largely been concentrated to the human mind, and it is only in recent years that a comparative ethological view has come into play. Even here, a tendency has been to look mainly at the primates. There is a vast literature that discusses the differences between human consciousness and cognition, compared with that of the other primates, but much less attention has been given to the fact that evolutionary gaps—fulgurations, emergences, new systems—have occurred at many stages in the evolution of cognition. More especially, the complexity of rather simple cognitive systems in lower animals has been underestimated, as well as the necessary prerequisites for a cognition worthy of the name to exist. Of particular interest in the discussion has been the views from evolutionary epistemology and radical constructivism, since they support the ethologically founded view that mind representations do not depict reality, but are adaptations for a successful way of *behaving* in the physical world, that reality in this sense is in the mind, that there are many realities, varying for different species—rich or poor in complexity—but all of them basically of the same nature. Even such human achievements as mathematics or logic may thus be seen as specific cognitive adaptations in our species, not as independent aspects of the physical world.

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1. Introduction

The current discussion on cognition and consciousness draws from many different sources, e.g. philosophy, epistemology, constructivism, psychology, ethology etc. But a recent very interesting addition has been to include evolutionary perspectives. The basic idea behind the evolutionary thinking in this discussion is however astonishingly old. In 1941, Konrad Lorenz had written a largely neglected paper, *Kants Lehre vom Apriorischen im Lichte gegenwärtiger Biologie*, where he suggested an elegant solution to the age-old question, perhaps best posed by Kant, how we may know anything at all about the world around us, what the thing in itself actually is—since the only way we can have knowledge about reality is through the very indirect and notoriously unreliable channels our sense organs provide. Lorenz' suggestion was to apply the evolutionary model proposed by Darwin to cognition and he said that: “we only perceive the world indirectly, i.e. what I see, hear, touch or smell is a world created—

constructed—within my brain, it is by no means a picture of the world as it actually is.” On the contrary, we have every reason to assume that the world in our heads is very different indeed from what actually exists in reality. At the same time, there is an equally undeniable correspondence between the inner and the outer world—in man as in animals. However, as Lorenz pointed out, this correspondence between the inner world and the reality outside of the brain must not be the effect of some determined relationship, a relationship of unknown but necessitated nature—as Kant was forced to assume—but a phenomenon that may be explained as the outcome of evolution, of mutation and selection. After all, we do not need to assume any supernatural forces to explain the evolution of all the astonishing and highly functional adaptations in e.g. morphology, and—as Lorenz claimed—this holds equally true for the inner world in our minds. Thus, the basic function of the inner worlds—representations, in the sense of Roitblat (1982)—is not to tell us the truth about

reality, but to allow us to *act* appropriately. Such representations have been selected, not because they are more *true* than others, or *depict* reality, but since they allow us to *behave in an adaptive way*—kill the antelope with a thrown stone, dig a trap, make a spear, etc. G. G. Simpson (1963) expressed this idea in a very congenial way when he said: “The monkey that had no realistic perception of the branch he was jumping for was soon a dead monkey—and did not belong to our ancestors.”

However, the Lorenz paper, for different reasons, did not spark any discussion at the time, and even his later book on the subject, *Die Rückseite des Spiegels*, published in 1973, essentially failed to get the attention it deserved. The theoretical basis was more extensively formulated by Campbell (1974), but the time did not seem ripe until the 1980s, when the current discussion really picked up speed—not least through evolutionary epistemology (e.g. Vollmer, 1983; Riedl, 1980, 1987; Mohr, 1983; Riedl & Wuketits, 1987), as well as radical constructivism and its successors (e.g. Maturana, 1970; Varela, 1981; Watzlawick, 1981; Schmidt, 1987; von Glasersfeld, 1987, etc). The evolutionary perspective has likewise proven to be fruitful on a more neural level (see. e.g. Edelman, 1993).

2. The Human Bias

So far, the consciousness-cognition debate has had a heavy slant towards our own species—understandably enough. Since we all have first-hand knowledge, we are able to engage in the discussion as to whether the world in our heads is—or is not—a picture of reality, or if reality may be something entirely different, if reality exists at all, if the world as we know it is just a construct among a plethora of possible ones, etc. The discussion in natural science in this respect has interesting parallels to the constructivist approach in a very similar—although older—discussion in literature and art, whether beauty is only in the eyes of the beholder, whether a work of literature exists before it—by reading is created anew in the head of the reader, whether one interpretation of e.g. a painting or a literary work may be said to be more true than another (see e.g. Rentschler *et al.*, 1988). But this still remains a discussion concerning ourselves, our species and—implicit or explicit—about our species-specific cognitive abilities.

3. A Lesson from Animal Behaviour

The human bias has been heavily reflected in the debate, since it has tended to be top-down, to the

extent that the question of how lower animals perceive reality—if at all—was for a long time rather neglected, except by a few authors [e.g. Griffin, (1976), and others]. The gap was then rapidly bridged, however, especially by cognitive ethology (see e.g. Roitblat *et al.*, 1984; Crook, 1983) but the knowledge gathered from the biological behavioural sciences is still not a strong foundation for debate.

For example, in almost all handbooks on animal behaviour, the language of bees gets a deserved amount of attention—how a bee may transmit information to other bees about the kind of flower to visit, the distance, the direction and angle to the sun, etc. From the human point of view, the language metaphor is an easy and understandable way of describing things: the bee *transmits information*, it performs a *symbolic* behaviour, the symbols are *interpreted* by other bees, etc. But obviously this whole description and way of looking at the bee dance is highly anthropomorphic (Griffin, 1984). What the bee actually does is that it merely makes intention movements, a category of movements well known in ethology, i.e. when an animal performs the initial stages of a behaviour (e.g. crouching low and spreading the wings, as birds do when intending to fly off) but without actually performing the whole behavioural sequence. Intention movements may easily become ritualized and used by other individuals as indicators of what another individual is about to do—if he is staring hard, baring the teeth, squaring the shoulders, etc—but this does not mean that the animal performs the intentional movement in order to *tell* somebody something. It will perform the same behaviour when alone, in the same mood or situation. Thus, the bee merely makes a short run towards the flowers, aborts the start attempt, turns back, makes a new run, breaks off, turns back, makes a new run etc and is not informing other bees intentionally. This is especially seen when bees dance on the board outside the hive, since they then make the short runs directly at the nectar source, not angular to gravity, as they do when they dance in the darkness of the hive. There are no symbols here—except for the human observer.

Now, another bee accompanying the abortive starter may by doing this, register the direction in which to fly. In addition, by the intensity of the dance, the distance, and, by the smell of the dancer's body fur, it may determine which flower to search for. It is however clearly questionable to discuss this as a parallel to a language, since the dancer is not trying to pass on information, and does not have the intention (Dennett, 1990) of influencing the behaviour of others. Perhaps most importantly it

does not have any idea of what she is doing and why. The bee just dances, instinctively, automatically—at least, there is no need to assume any more—and this has the desired effect.

One may compare this to a language, or to transmission of information, but such an interpretation is in the brain of the human observer and is, merely a way for *us* to interpret the behaviour of the bee. As such, this way of looking at the dance of the bee may be fairly harmless—as long as we do not assume that the bee has cognitive capacities which exist for the bee to perform the remarkable behaviour. Indeed, Occam's razor needs to be applied with animal cognition.

4. Object Constancy—in Man or Beast?

As for misleading parallels, another example from the insect world is illustrative. Piaget (e.g. 1954, 1967) pointed to the interesting developmental stage in the human child when it acquires object constancy, i.e., when the child is able to understand that a ball put into a paper bag and then taken out again ought to be the same ball. This means that the child is somehow able to retain the existence of an object in the mind, to regard it as existing, even if the object cannot be seen any longer. Piaget rightly assumed that this was a rather advanced stage, not attained until about 3 years of age.

However, a dragon fly larva is able to perform a similar cognitive feat (Etienne, 1977, 1984). If a prey which a dragon fly larva is stalking disappears behind an obstacle, the larva will anticipate its appearance at the other side of the obstacle. It would be absurd to assume that a dragon fly larva has the same ability for object constancy as the child. But an important lesson is that we may—in the myriad of different cognitive systems that the animal kingdom offers—find many phenomena which in humans are explained by a rather complicated cognitive mechanism, but in animals may be the effect of a direct-wired connection evolved for the specific purpose, not as an effect of a general cognitive capacity. However, it will be very tempting to express these things as the *language* of bees, or *object constancy* in dragon flies, since that is an understandable and easy way for us to describe the phenomena.

5. Intermodality—an Evolutionary Breakthrough

The top-down attitude, the anthropomorphic slope, sometimes leads us to overlook the fact that seemingly simple cognitive feats may actually be extremely complex. A snake, catching a prey, may seem to perform a rather simple behaviour, as it

strikes the prey, follows the prey to the place where the effect of the poison overcomes it, finds the head of the prey and swallows it. But a closer look at the behaviour will show that this is not a cognitively coordinated act. The striking of the prey is governed by the eyes (or the heat-sensitive organs). However, the following of the struck prey is governed by smell—smell only!—and the final swallowing by touch (not by sight or by smell). Even if the snake is hanging from a branch, with the prey in the coils of its body, it will still search stochastically around for the prey, as if all the information from the body, which is holding the prey, did not exist. Thus, the snake acts as a multichanneled mechanism, where each behaviour program is governed by a particular sense channel, and where there is no general capacity to translate the information from one channel to the next (Stein & Meredith, 1994; Sjölander, 1995).

From what we can judge from the behaviour, the snake does not seem to live in a single world, which has different aspects, detected by sight, sound, smell, touch etc. Rather it seems to live in several different worlds, where a mouse is not an *object* with different characteristics, but rather many “things”. Sometimes a mouse is a thing that moves, sometimes just a smell, or a touch. We have no reason to assume that the snake has some kind of general, centralized representation of a *mouse*—its behaviour strongly indicates the opposite.

It should be noted that this lack of intermodality, although sometimes strikingly inefficient, in most cases works sufficiently well for the snake to achieve the goal, i.e., eating the prey. As Lorenz said (1973): there are many things in evolution that are not optimal, but—just good enough.

Nevertheless, it is rather surprising to find that we have no indication of the existence of a snake *world*, a snake *reality*. After all reptiles are not that far from us, compared with the majority of living species. It is only in the birds and the mammals that we will find behaviour that leads us to assume that there are *objects* in the animals's reality, objects that may look, sound and smell, i.e. that the cat actually has a representation of a mouse in its head—whatever it may be—and that this representation may be evoked by sight, sounds, smell etc to the extent that the cat, hearing a mouse sound, may go *looking* for a mouse or search for the typical *smell*. This may be seen as a “merging of the senses” (Stein & Meredith, 1994), but may also be an evolutionary breakthrough of an inner representational world where a single centralized reality is constructed, instead of many.

Likewise, a snake will not anticipate that a prey, running behind an obstacle, will appear at the other

side. But the cat can make such an anticipation, and it can even wait for hours outside a hole for a mouse to come out again. One may of course argue that this does not necessarily mean that something is going on in the cat's head, that we must not assume that representations exist in the cat's mind or that something happens in the cat's mind according to rules corresponding with reality [Lorenz, 1941, 1943; Craik, 1943; see also Johnson-Laird (1989), etc]. There is however good reason to assume so, since the cat, or dog, obviously dreams. A dog may bark and make running movements during sleep, but a lizard does not (Rial *et al.*, 1993).

This does not mean that we do not have several examples of intermodality in lower animals—in certain well-defined respects (Stein & Meredith, 1994). But again, this is like object constancy in the dragon fly larva: a specific function for a specific situation, and this is far from a general ability.

6. Many Realities and Many Evolutionary Paths

If we speak of the evolution of reality it would seem that we, as so often in evolution, are not thinking of a specific stage somewhere where it came about, but many different stages, many different realities. Clearly, there are essential breakthroughs (e.g. Stenhouse, 1973; Rensch, 1968; Premack, 1976; Osche, 1979; Bonner, 1980; Anderson, 1984; Rumbaugh & Pate, 1984; Humphrey, 1986; Dennett, 1990; Sjölander, 1995 etc), at many different stages. One may seriously question whether it is helpful to think about reality in e.g. the reptiles. The term does not seem to acquire a meaning until there is a centralized representation, where mice or men exist as categories in the mind (Hartmann, 1964; Riedl, 1987; Huber, 1996), having certain characteristics, and acting as if on a mental stage (e.g. Craik, 1943). Again, this reflects the top-down thinking, since we humans have a fully centralised cognition, with a practically unlimited ability to imagine things, things that may happen, things that have happened etc. It is natural to assume that other animals have a simplified version of this. However, a comparative look at animal cognition does not justify such an assumption. In the mammals and the birds, we certainly have indications that something similar goes on in their minds—else, it would be hard to explain dreaming in dogs—but other animals seem to work in quite different ways.

7. The Mammalian Reality

Consequently, it is tempting to see our form of cognition, our reality, as a *mammalian* speciality,

perhaps tied to new brain structures (e.g. Hubel, 1989). We can also see clear stages in the evolution of mammal cognition. A dog can obviously predict the future, have some notion of what may happen next (else, a dog would not respond to the suggestion of a walk by going to the door and wagging its tail). But it is also obvious that the dog cannot imagine several steps into the future, as the primates can. Likewise, true imitation does not, as far as we know, occur below the primate level. There are clear indications that monkeys may master the remarkable cognitive feat of looking at what somebody else does, and then imitating it (e.g. Visalberghi & Frigaszy, 1990; Heyes, 1993), but the next stage, to know what somebody else knows—does not seem to appear anywhere except in the apes (de Waal, 1982; Premack, 1976; Premack & Premack, 1983).

What we see in the cognition, the reality perception of mammals, is an evolution where the internal representation increasingly frees itself from the here and now, from corresponding to things occurring outside. Instead, it increasingly becomes a stage where the inner world may do something different that just corresponding to what goes on outside. It may instead be mulling over memories, making plans, solving problems, fantasizing. Evolution creates a reality where other beings of the same species exist as independent entities in the mind, with their specific knowledge, characteristics, abilities etc—a cognitive necessity if a complex non-kinship based social network, as in the primates and especially man, may work at all. This evolution has sparked an evolutionary breakthrough as important as any in prehistory (e.g. Stenhouse, 1973; Klix, 1980; Bonner, 1980; Vogel, 1983; Humphrey, 1986; Oeser, 1987; Bischof, 1987; Riedl, 1987, 1992).

8. Is Human Reality More Real?

A general effect of the top-down thinking is to assume that our conception of reality is in some sense more true, more exact, than in other animals. But as the constructivists point out, we have no reason to assume so (e.g. Maturana, 1970; Maturana & Varela, 1980; von Glasersfeld, 1987; Schmidt, 1987). Our reality is more complex, in the sense that it allows us to act in much more complicated ways, over larger spans of time, in anticipatory ways, or even by changing the outside world to suit us and our species better. We do this by applying certain principles of action on the environment, principles gained by experimenting with the same environment. These principles do not exist independent of the human mind, they are constructed by it. This inevitably

means that our perception of the world is no truer than what the snake or even the tick perceives (Uexküll, 1937). Even the expansion of our understanding of the world that science has given us is still only an addition to the world view we have inherited, it is still based on the same cognitive mechanisms.

This does not always seem clear. Although most natural scientists will agree that colours do not exist in the physical reality, or tones, or smells, i.e. that colours, tones and smells are representations created in our heads, provoked or constructed when prodded by the sense organs, there is less understanding that this also holds true for concepts like the three dimensions of Euclid, or for time. And there is even less appreciation that such seemingly human-independent systems as mathematics, or logic, are but constructs in our minds (Diettrich, 1995). Any number of other mathematics, logics, dimensions etc is possible. A beautiful example of the unreflected assumption that systems like mathematics, or geometry, must be general—almost absolute—instead of being merely aspects of the specific human cognition, is the famous message sent to outer space, depicting the earth with geometrical figures and digitalized numbers, as well as a man and a woman. As Diettrich (1995) has pointed out, the assumption that cogniscent beings on other worlds necessarily must have the same mathematics, logic etc is anthropomorphic to an almost absurd degree, since even those seemingly “absolute” categories are specific human constructs.

A behavioral biologist may add that an even more anthropomorphic aspect of the “message” was the fact that the man depicted wore his hair and beard not according to nature, but to the (western) fashion of the infinitely short glimpse in human existence that the late 20th century consists of, and further that he held his hand raised in what the scientist responsible described as “a universal signal of peace”—particularly ludicrous since, already on our own planet, we can see that in the millions of species living there is but a single one that uses or understands this signal.

9. Reality as Adaptation

Lorenz, following Kant, stressed the point that we have no direct way of knowing what reality is, or how it works, but instead pointed out that evolution has provided us with a system which allows us to live and act to survive without knowing the truth about everything. Evolutionary epistemology has taken the point further, stressing that what we know as reality, in this sense, is an

evolutionary product, selected in each species for specific purposes. Like other adaptations, there may be many different realities, many different solutions to the problem of reacting appropriately to whatever it is that surrounds us. Radical constructivism finally teaches us that the reality in our heads may be an entirely autopoietic system (e.g. Varela, 1981), independent and, only structurally coupled—via evolution—to the outer world, no more a true picture of the world that notes are a picture of the music played, and that even seemingly human-independent and eternal systems like mathematics are only creations of the human mind. To say that the world we perceive is only in the head, that reality is something that has evolved, and that any number of other realities are conceivable, may seem a little bit like losing our foothold in the world. But neither evolutionary epistemology nor radical constructivism takes the—rather uninteresting—stance that there may be no world at all outside the mind, the old solipsistic idea. They simply say that something surely exists out there, but what we see as the physical reality actually is a mind construct, made to work in resonance with whatever the physical world outside is. This system has evolved for that specific purpose, as a survival and fitness-increasing mechanism in our species, making it very apt to guide our actions in some respects, and singularly inadequate for other late-invented purposes. We have been selected to live on the surface of our planet, where three dimensions are quite sufficient as a representational system to allow movement and action, and where a small section of the electromagnetic radiation, some of the vibrations in the air and a few of the free-flying—or water solved—molecules are used by our mind to govern what constructs to make. As active beings, we also need a timing device for appreciating the relative speed of objects in our (stone-age) world. The number of factors we can combine and overlook, as well as the time span, is appropriate for the life we have led for millions of years—before the last 10,000 years, a period which is a negligible amount as far as evolution goes, a mere 500 generations.

It is hardly surprising that these systems do not work well neither in the micro-cosmos nor in the macro-cosmos, but only in our human mesocosmos (Mohr, 1983). That modern science has allowed us to transcend these constrictions as far as it has is something we can be justly proud of, but we should not forget the evolutionary origins of reality.

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