Measuring consciousness in animals

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What is consciousness? As often the case with abstract concepts, most dictionaries provide vague definitions. The Oxford English Dictionary defines it tautologically as "The state of fact of being conscious, as a concomitant of all thoughts, feelings, and volitions," and also as "The totality of the impressions, thoughts, and feelings, which make up a person's conscious being." The Dictionnaire Larousse defines *Conscience* as "The perception, knowledge more or less clear that one can have on self existence and of that of the external world" (our translation). In the following, consciousness will be defined axiomatically as: *An abstract private model of reality—with four dimensions: quality, intensity, hedonicity, and durati*on. The human mind is thus able to call up a broad range of apprehended, recollected, or even totally imagined realities. The result is increasingly complex mental activity: thoughts, feelings, and emotions assume a life of their own within a space that is relatively independent of simple stimulus-response pathways. When this space includes a representation of oneself and how this self interacts with reality, we have the beginnings of self-consciousness.

Consciousness was long considered a human privilege, all other animals being merely machine-like beings [1]. This view was challenged when Darwin [2] pointed out that other mammals could express emotion. The question then faded into the background, largely because of the excesses of psychoanalysis and the efforts of the behaviorist school to make behavior the only object of study, to the exclusion of underlying thought processes [*3*]. Recently, there has been renewal of interest in animal consciousness and a growing acceptance that humans are not the only thinkers. Indeed we do not have direct access to other humans consciouness and we accept indirect evidence for the existence of human consciousness in other people, *i.e*., the verbal and behavioral signs that they provide. We postulate that the same verbal and behavioral signs mean consciousness for ourselves and must be a property all humans share. It is legitimate to question why should similar indirect evidence be rejected when it comes to animals? Although less direct than that provided through verbal communication, such evidence is available [4-8].

In this presentation we shall report the experimental signs of emotion and sensory pleasure that we obtained in animals. However the observer must be prudent and remain permanently aware that the evidence is always indirect [9]. For example many fish complex behaviors such as cheating, altruism, species recognition, individual recognition [10] that we would be tempted to consider signs of consciosness, can be explained on the basis of reflexes. Also, the complex foraging and social communication behavior of bees is often considered intelligent and 'conscious;' however there is evidence that it is purely reflexive [11], in the same way as a computer can be artificially intelligent.

We may accept that self-consciousness is a human property[1] -but we remain with the question of which among the animals are conscious? And which are not? At what point in evolution did the nervous systems cease to operate on a reflexive basis only -when did consciousness arouse [12]? Could/would it be in apes? Mammals? Vertebrates? Invertebrates? Our recordings of emotional fever and tachycardia, and behavioral mimics of sensory pleasure provided signs of consciousness in Mammals, Birds, and Reptiles but not in Amphibians and Fish. Thus, it may be hypothesized that the emergence took place in Vertebrates between Lissamphibia and Amniota, *i.e*., among the amniotes, common ancestors of present-day Mammalia, Chelonia, Lepidosauria, and Archosauria. That conclusion will be supported from several additional lines of 'shareable' experimental evidence obtained from the litterature such as, sleep structure, and play behavior.

References

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1 *And possibly of some apes.*