Opinion

Mental states in animals: cognitive ethology

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This article addresses the question of mental states in animals as viewed in 'cognitive ethology'. In effect, this field of research aims at studying naturally occurring behaviours such as food caching, individual recognition, imitation, tool use and communication in wild animals, in order to seek for evidence of mental experiences, self-awareness and intentionality. Cognitive ethologists use some philosophical concepts (e.g., the 'intentional stance') to carry out their programme of the investigation of natural behaviours. A comparison between cognitive ethology and other approaches to the investigation of cognitive processes in animals (e.g., experimental animal psychology) helps to point out the strengths and weaknesses of cognitive ethology. Moreover, laboratory attempts to analyse experimentally intentional behaviours such as deception, the relationship between seeing and knowing, as well as the ability of animals to monitor their own states of knowing, suggest that cognitive ethology could benefit significantly from the conceptual frameworks and methods of animal cognitive psychology. Both disciplines could, in fact, contribute to the understanding of which cognitive abilities are evolutionary adaptations.

The term 'cognitive ethology' (CE) was coined by Griffin in *The Question of Animal Awareness*[1] and later developed in other publications[2–4]. Although Griffin's 1976 book was first a strong (and certainly salutary) reaction against the inhibitions imposed by strict behaviourism in the study of animals, the book was essentially perceived as an extension of ethology, with the ambitious goal of exploring the conscious mental experiences of animals. Thus, by relying on achievements such as bees' 'language', described by Von Frisch[5], or trained gestural communication in chimpanzees[6], Griffin concluded that these intraspecific and interspecific communications constituted a 'window' on to animal minds.

Briefly, CE is concerned with claims about the evolutionary and comparative study of non-human animal cognitive processes, consciousness, beliefs, information processing and rationality in animals[7]. Cognitive abilities have, *a priori*, a better chance to express themselves in the natural environment of the species under study and, consequently, CE relies mainly on field studies.

Several topics have thus been investigated by cognitive ethologists. Two of them will be presented briefly here. The first topic concerns intraspecific exchanges, namely the play intention in canids, and the second topic is related to interspecific exchanges, namely antipredator strategies in birds. Behaviours analysed by the cognitive ethological approaches often pertain to activities already investigated by more traditional ethologists; However, the novelty of CE is that it advances a purposive or intentional interpretation for activities which are a mixture of some fixed genetically transmitted elements with more flexible behaviours[8].

Cognitive ethologists use conceptual frameworks provided by philosophers (such as the 'intentional stance')[9], for realizing their cognitive analyses. As an illustration, Dennett has offered a scale for evaluating the underlying complexity of social exchanges between animals[9] (see Fig. 1); in the case of social play, several levels of intentionality are thus postulated. The following categorization has been drawn from Bekoff[10]: '0 order' intentionality describes, for example, the situation in which dog X performs a bow movement; 'first-order' intentionality applies to the situation in which dog X *wants* Y to play with him; 'second-order' intentionality applies to a case where X *wants* Y to *believe* that Y should play with him; finally, 'third-order' intentionality qualifies the situation in which X *wants* Y to *believe* that X *wants* Y to play. Based on the analysis of bow behaviours, Bekoff[10] suggests that play-soliciting behaviours among dogs might express first- or perhaps second-order intentional behaviour. Alarm calls of vervet monkeys to different classes of predators[11] have similarly been used to assess the complexity and level of communication in these non-human primates[12] (for a critical evaluation of the use of the intentional stance in CE, see the commentaries that follow Ref. 13).

Ristau[8] reports characteristic behaviours of a shorebird, the piping plover (*Charadrius melodus*), when confronted

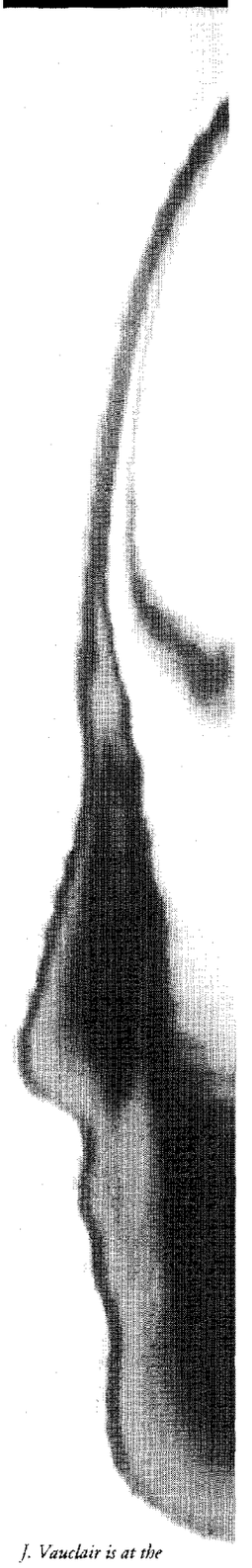

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Fig. 1 A possible example of 'second-order' intentionality in baboons. A young baboon (A) looks at a female (T) while she eats rhizomes that A is looking for. Suddenly, A screams loudly, thus attracting his mother's attention: the mother B chases T away and the young baboon has free access to the food. The interpretation of the young baboon's behaviour (who has previously enacted this sequence with other individuals) would be that *he made his mother believe* that the female had been aggressive to him, thus leading her to intervene and enable him to reach for the desired food (drawn by B.L. Deputte; adapted from Ref. 45).

with intruders perceived as potential predators: several distraction displays have been documented to lure such predators away from either the nest or young birds. The most impressive of such protective behaviours is the 'broken-wing display'. This behaviour can take progressive forms ranging from a fanning tail to an awkward walk and outstretched arched wings that flutter and drag along the ground. From her analysis of piping plovers' behaviours, Ristau claims[8] that the conditions (adjustments to the intruder's behaviour) in which intense distraction displays are used are indicative of the purposive nature (first-order intentional analysis) of the behaviour of these birds. In other terms, according to the cognitive ethologist, the plover, by performing its anti-predator activity, aims to lead the intruder away from the nest or from the young.

All ecologically relevant behaviours are potential research areas for CE. Bekoff provides a list of some of these naturally occurring behaviours which comprise food-caching, individual recognition, imitation, tool use and communication[10].

Cognitive ethology and the comparative study of cognition

It must be said that the definition and scope of CE presented above is extensive enough to encompass other research areas, such as comparative psychology and comparative cognition at large[14]. In effect, the topics of information processing, of problem solving and thought processes, to name a few, are at the heart of the experimental approach of comparative cognition[15]. Notwithstanding the convergence in general objectives, two main obstacles have so far prevented a collaboration between the cognitive ethologist and the cognitive animal psychologist. First, it is very surprising that the high reliance of CE on thought processes is conceptualized without reference to cognitive concepts, such as representation or memory[14] (but see Ref. 7), even though such concepts have amply demonstrated their usefulness and heuristic value in the comparative study of both wild and laboratory animals[14,16,17].

The second barrier comes from the central role assigned to consciousness in CE by some cognitive ethologists[4]. Although this concept has no precise meaning in CE[18], since it is envisioned[3] as being synonymous with mental state, thinking or mind, it is nevertheless at the core of the phenomena that have to be elucidated. In strong contrast with the position adopted in CE, most psychologists in the field of animal cognition assume that the cognitive processes of animals are unconscious. Thus, Terrace writes: 'Just as the modern rationale for using cognitive human terms is not based upon arguments that appeal to consciousness or to introspective reports, the rationale for the study of cognitive processes in animals requires no reference to animal consciousness'[16]. As a consequence, and in sharp contrast to the position taken by some cognitive ethologists (most notably Griffin[1]), comparative psychologists agree that even if one accepts that representations presuppose conscious experience, it is not the subjective quality of the experience itself that is under investigation. In fact, comparative psychologists presume that such a subjective quality is impossible to assess. In effect, without at least a system of mutual understanding, it would be difficult for us, to paraphrase Nagel[19], to envision what it is like to be a bat. Fortunately, the principal aim of a scientific study of the minds of other animals is not to find out what it is like to be a certain type of animal, but rather to clarify how mental states cause observable behaviours[20].

Among the criteria retained by cognitive ethologists for asserting the existence of mental activities in animals are: (1) the complexity of their actions; (2) their adaptive abilities; (3) the flexibility in the sequences of their actions and (4) the anticipation of the result of their actions[3]. The choice of such diverse indices has the disadvantage of providing no specific research strategy to study 'the ambassadors of thinking' in animals. The conceptual imprecision in CE has, thus, led some scholars to question the validity of attributing mental experiences to animals, when it could be only a matter of mental representation[14,21].

For example, Ullman[22] has suggested that CE and its proponents might commit two sophisms: the first fallacy being to identifying self-awareness with self-recognition. Ape species (orangutans, gorillas and chimpanzees; see references within Ref. 23) recognize their own reflections in a mirror; this was first shown by Gallup[24] who later speculated[25] that self-recognition could lead to self-awareness and the ability to make inferences about the mental states of others. Self-recognition might, in fact, only express an ability of the animal to represent its own body, or else the ability to use novel, displaced visual feedback about its physical state and behaviour[26]. As alternative theoretical hypotheses could possibly account for mirror recognition in apes (and other animals), further demonstration is required before concluding that these animals have human-like self-awareness and mental experiences.The second sophism in CE's position on animal thinking is related to the idea that they

plan future activities with conscious intentions[22]. It appears that anticipatory activities are at the heart of most adaptive behaviours, and do not imply the intervention of intentional or conscious processes, as adaptation begins with the detection of regularities among environmental events. It is likely that an organism will quickly detect and anticipate these regularities, as observed by Von Frisch[5] in his studies on insects. This author trained bees to fly towards a food source which changed its location from trial to trial; the bees displayed a kind of anticipatory behaviour. Some bees anticipated these changes (as if they understood that the experimenter always placed the food beyond the last visited location), and flew immediately to a new location where food might be found. Here again, the ability to anticipate could be confused with planning and conscious intention.

The question of intentionality is, indeed, dominant in CE. Interestingly, this issue has also become a controversial topic within animal cognitive psychology, particularly with the advent of research into 'the theory of mind'. In this field, investigators search for evidence that an individual can impute intentions, desires or beliefs to himself or to conspecifics[27]. Such an inquiry has led scientists to propose both a working definition for intentionality and an agenda for carrying out experiments (more specifically among non-human primates) to address this issue. Thus, for Woodruff and Premack[28], intentionality can be inferred when the sender of a message controls the content of the message and understands its consequences on the receiver. With such an operational framework, these authors have, for example, conducted experiments on deception in chimpanzees (*Pan troglodytes*), in a communicative setup, involving manipulation of information between a chimpanzee and a human experimenter. Results show that the trained chimpanzees can both understand and produce false information, suggesting to the authors, a real capacity for deception in the chimpanzee.

The above experiments have been criticized on a number of grounds, and it is questionable whether they demonstrate an ability for true deception in the chimpanzee. For example, one may wonder whether the chimpanzees have really attributed sets of mental states or whether they have merely reacted to differences in behaviour[29]. As Heyes commented[30], the basic problem with this kind of research is to know whether the animals are acting on the basis of reasoning about observables (the 'RO interpretation') or mental states (the 'RAM interpretation'). As a step towards choosing between one of these interpretations, certain control experiments must be performed, an endeavour that is not systematically undertaken.

Other suggestions related to the presence of mental attributions in apes (or their absence in monkeys) are provided by experiments that manipulate the understanding of causal connections between visual perception and knowledge formation. Such experiments have assessed in chimpanzees[31] and rhesus monkeys (*Macaca mulatta*)[32,33] how an individual can understand the consequences of the visual experiences of others. Briefly, the results obtained indicate that some chimpanzees, unlike some rhesus monkeys, do understand the seeing–knowing relationship. Recent investigations with chimpanzees[34] indicate that these primates, although they can respond to shifts in the orientation of a gaze performed by a experimenter (see also Ref. 35), do not appear to appreciate how the eyes connect the experimenter's internal states of attention to the world. Altogether, the above findings point to at least two discrepancies: (1) possible differences between monkeys and apes in their respective ability to understand the perception–knowledge relationship, and (2) possible differences between humans and chimpanzees (as seen in the gaze-following experiments) because of the difficulty for the non-human primate to represent the subjective attention of the other mind.

Whereas the theory of mind explores whether animals can understand and appropriately respond to the mental states of conspecifics, attention can also be directed to the ways that animals monitor and respond to their own states of knowing. This capacity to check for subjective ongoing cognition (that is, subjective states) has recently been investigated in animals within the context of uncertainty monitoring[36–38]. Uncertainty can, for example, be experimentally studied in a discrimination problem. Typically, in this type of experiment, the subject is presented with two primary discrimination responses. The size of the stimulus differences is then progressively reduced, so that the subject is confronted with difficult identifications of the stimulus, close to perceptual limits. At this point, the subject is given a way to escape (a third response, the uncertain response). This uncertain response permits the subject to escape into an easier trial but at a cost (for example, delaying a food reward). It is thus expected that subjects would initially try the primary discrimination response and then the escape response when an error was likely to occur. The uncertainty paradigm has been used successfully for testing dolphins (*Tursiops truncatus*) in acoustical discrimination tasks[36] and rhesus monkeys in a visual discrimination task[37]. Both species showed an ability to sparingly escape from the most difficult trials near threshold, an ability that was identical to that of human participants tested in the same experimental setup. Therefore, dolphins and monkeys demonstrated both the capacity for self-knowledge and metacognitive reactions to subjective uncertainty[38]. Further studies should examine if the monitoring of their own behaviours is also present in other animals species (comparable abilities might also exist in rats)[39]. Such directions of research should ultimately help cognitive psychologists to establish the relationships between body self-awareness, cognitive self-awareness and awareness of others' mental states.

Concluding remarks

CE has undoubtedly contributed to the wave of interest in exploring the complexity of the social life of animals and their 'mental experiences'. However, this field currently lacks research methodology and experimental paradigms to fulfil its ambitious programme. Yet, these methods actually exist and they derive from human cognitive psychology and the experimental analysis of behaviour[14]. Both methods and concepts of the psychological approach can be used with success by those biologists interested in the synthetic or ecological approach to animal behaviour[40,41]. The successful study of cognitive mechanisms involving naturally

Table 1. Cognitive ethology versus comparative psychology in cognition programmes

	Cognitive ethology	Comparative cognition
Goal	The study of natural behaviours in natural settings from an evolutionary and ecological perspective	The study of the generality and continuity of cognitive processes across species
Scope	To investigate minds, including thought processes, rationality and consciousness	To investigate information processing in memory, problem solving and non-verbal thought
Methods	The use of anectodes and empirical data gained with ethological techniques with many different species	Use of the methods and paradigms of experimental psychology (e.g., reaction times), mostly in laboratory settings
Main issue	To discover the invariants of cognitive processes that pertain to the evolution of human cognition	To test Darwin's gradualist hypothesis concerning the continuity between human minds and the minds of other animals

important behaviours has already been carried out (for example, foraging, memory in food-storing birds, song perception and recognition[1,2], antipredator behaviour[8] and social play[9,13]). According to Yoerg and Kamil[14], it is now time to think about animal behaviour in a more integrative way using complementary approaches including psychological information processing theories and methods, ethology and behavioural ecology (see Table 1). It can be expected that these integrated comparative approaches will enable us to reconstruct how our own cognitive features evolved.

There is a longstanding opposition between ethologists and psychologists about the respective virtues of field versus laboratory experiments. The former claim that field observations offer the best opportunity to see the true complexity and intricacies of social exchanges at work, including intentionality and attributions of beliefs[7,10,15], whereas the latter, in line with the tradition of experimental psychology and the necessity of performing control experiments and manipulating experimental variables, believe in laboratory work[15,17].

Two points can be raised in the debate. First, social phenomena cannot easily be transferred into the laboratory and social intelligence often manifests itself in successful solutions to unusual problems[16]. Use of anecdotes and qualitative observations might thus constitute a first step to document significant social events that could help design experiments for later control of variables in the laboratory. Second, as noted by Heyes and Dickinson[17], the credo of cognitive ethologists, according to which animals are less likely to provide evidence of intentional states in the laboratory than in the field, needs to be demonstrated. The argument that behaviours appearing in artificial environments are the result of a long history of training is not inconsistent with the attribution of intentionality. Moreover, we have no evidence, so far, to prove that mental states are formed on the basis of a minimal experience (after all, behaviours of animals in free-living conditions also have a history).

The merge between laboratory and field studies might help significantly in recognizing the importance and role of animal cognition within cognitive sciences. In particular, as proposed by Prato Previde *et al.*[20], through the study of cognitive processes in an ethological perspective, research on animals may shed light on the coupling between a cognitive system and its environment, thus introducing into cognitive science an ecological component that is truly needed.

Finally, cognitive ethology raises the important issue of animal welfare and animal rights. Inevitably, repeated quests to determine whether animals feel, think and have mental experiences fuel the debate over animal rights issues. Most of the time these questions are addressed by activists belonging to animal rights movements (see Ref. 48 for a significant example where activists propose that apes should be given full human rights). It is, however, astonishing that those scientists who study the cognitive capacities of non-humans (cognitive ethologists or cognitive psychologists) have rarely entered the debate (but see Refs 49,50), where their data and interpretations would be very helpful.

Outstanding questions

- CE could help place the analysis of cognition within an evolutionary framework[51,52] and thereby help us to understand the biological framework in which cognitive processes have evolved.
- Cognitive ethologists claim[7] that the consideration of individual behaviour is often neglected in favour of the study of the behaviour of the species. The study of a few individuals could verify the existence of strong intraspecific variations and reduce generalizations about the cognitive skills of the whole species.
- The expression of cognitive abilities by animals in their environment and their sensory world needs to be investigated. This growing field of 'sensory ecology'[53] should aim at 'taking the animals' point of view' by studying their information processing in conditions as close as possible to those in which they live.

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