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## Animal Consciousness

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Questions about animal consciousness – in particular, which animals have consciousness and what (if anything) that consciousness might be like – are *both* scientific and philosophical. They are scientific because answering them will require gathering information using scientific techniques – no amount of arm-chair pondering, conceptual analysis, logic, a priori theory-building, transcendental inference, or introspection will tell us whether a platypus, an iguana, or a squid (to take a few examples) enjoy a life of subjective experience – at some point we will have to learn something about the animals. Just what sorts of science can bear on these questions is a live question, but at the least this will include investigations of the behavior and neurophysiology of a wide taxonomic range of animals, as well as the phylogenetic relationships among taxa. But these questions are deeply philosophical as well, with epistemological, metaphysical, and phenomenological dimensions. Progress will ultimately require interdisciplinary work by philosophers willing to engage with the empirical details of animal biology, as well as scientists who are sensitive to the philosophical complexities of the issue.

### Motivations

There are many reasons for philosophical interest in nonhuman animal (hereafter “animal”) consciousness. First, if philosophy often begins with questions about the place of humans in nature, one way humans have attempted to locate themselves is by comparison and contrast with those things in nature most similar to themselves, that is, other animals. At least in the West, the traditional – and perhaps still intuitive to many people – way of thinking about consciousness is as primarily an innate endowment of humans. However, within a modern biological worldview, while humans may be unique in certain (perhaps quite important) respects, we are only one species of animal among many – one tip of one branch of the phylogenetic tree of life – and enjoy no particular special status. From an evolutionary perspective, salient questions include: Is consciousness a late evolved, narrowly distributed trait, or an older more broadly shared trait? And, did it evolve only once, or a number of times independently? From this viewpoint, the question “are (nonhuman) animals conscious?” is rather strange, because, for example, it implicitly groups bats together with rabbits (as “non-human” animals) in contrast to humans. In reality, rabbits are more closely related to

humans than they are to bats (Nishihara, Hasegawa, & Okada 2006), so framing the question this way embeds a false presupposition. Of course, it is consistent with an evolutionary perspective that humans are the only conscious animals. This would imply that consciousness was acquired through a recent evolutionary event that occurred since the split of our ancestral lineage from that of our closest nonhuman relatives, chimpanzees and bonobos (see later for discussion of such hypotheses). But such a view requires support; though perhaps intuitive to some, its choice as a default position is arbitrary.

Second, there is a lot at stake morally in the question of whether animals are conscious beings or “mindless automata.” Many billions of animals are slaughtered every year for food, use in research, and other human purposes. Moreover, before their deaths, many – perhaps most – of these animals are subject to conditions of life that, if they are in fact experienced by the animals in anything like the way a human would experience them, amount to cruelty. Arguments that nonhuman animals are not conscious therefore effectively double as apologetics for our treatment of animals. When the question of animal consciousness is under consideration, our guilt or innocence as a civilization for an enormous body of cruelty may hang in the balance. However, some philosophers have argued that consciousness *per se* does not matter for the treatment of animals, and therefore either that (a) even if animals are not conscious, they may deserve moral consideration, or (b) even if animals are conscious, they may not deserve moral consideration. (For more discussion of the ethical issues, see Singer 1990 [1975]; Regan 1983; Rollin 1989; Varner 1998; and Steiner 2008.)

Third, while theories of consciousness are frequently developed without special regard to questions about animal consciousness, the plausibility of such theories has sometimes been assessed against the results of their application to animal consciousness (and, similarly, to human infants). This raises questions about the relative epistemic weight of theoretical considerations (e.g., philosophical arguments for a given theory of consciousness) against particular case judgments or intuitions about whether a given creature is conscious. For example, Searle (1998) argues that our intuitive, commonsense attributions of intentional and emotional states to dogs carry more epistemic weight than philosophically motivated skeptical concerns. In contrast, Carruthers (1989) asserts that his own arguments that nonhuman animals (even dogs) lack consciousness are sufficiently weighty that we are morally obligated to eradicate or ignore our sympathetic feelings toward such creatures. Should our theories of consciousness be constrained by our intuitive attributions of consciousness to animals (or, e.g., babies), or should the former override the latter?

Fourth, the problem of determining whether animals are conscious stretches the limits of knowledge and scientific methodology (beyond the breaking point, according to some). The so-called “cognitive revolution” that took place during the latter half of the twentieth century has led to many innovative experiments by comparative psychologists and ethologists probing the cognitive capacities of animals. Despite this work, the topic of consciousness *per se* in animals has remained controversial, even taboo, among many scientists, while other scientists from a variety of disciplinary backgrounds (e.g., neuroscience, animal behavior, evolutionary biology) have developed novel ways of approaching the subject. The recent Cambridge Declaration on Animal Consciousness indicates that many scientists agree that “the weight of evidence indicates that humans are not unique in possessing the neurological substrates that generate consciousness.” However, other scientists, including Marian Stamp Dawkins, who has been prominent

in the science of animal welfare (Dawkins 1985, 1993), are not ready to endorse the claim, writing that “[t]he mystery of consciousness remains. The explanatory gap is as wide as ever and all the wanting in the world will not take us across it” (Dawkins 2012, pp. 171–2).

Many philosophers and scientists have either argued or assumed that consciousness is inherently private, and hence that one’s own experience is unknowable to others. While language may allow humans to cross this supposed gap by communicating their experience to others, this is allegedly not possible for other animals. Despite the controversy in philosophical and scientific circles, it remains a matter of common sense to most people that some animals do have conscious experiences. Most people, if asked why they think familiar animals such as their pets are conscious, would point to similarities between the behavior of those animals and human behavior – for example, animals seem to visibly express pleasure and displeasure and a variety of emotions, their behavior seems to be motivated by seeking food, comfort, social contact, etc., they seem aware of their surroundings and able to learn from experience. Similarity arguments for animal consciousness thus have roots in common sense observations. But they may also be bolstered by scientific investigations of behavior and the comparative study of brain anatomy and physiology, as well as considerations of evolutionary continuity between species. Neurological similarities between humans and other animals have been taken to suggest commonality of conscious experience; all mammals share the same basic brain anatomy, and much is shared with vertebrates more generally. Even structurally different brains may be neurodynamically similar in ways that enable inferences about animal consciousness to be drawn (Seth, Baars, & Edelman 2005).

Such similarity arguments are, of course, inherently limited in that it is always open to critics to exploit some *disanalogy* between animals and humans to argue that the similarities don’t entail the conclusion that both are sentient. Even when bolstered by evolutionary considerations of continuity between the species, the arguments are vulnerable, for the mere fact that humans have a trait does not entail that our closest relatives must have that trait too. There is no inconsistency with evolutionary continuity to maintain that only humans have the capacity to learn to play chess. Likewise for consciousness. So, while perhaps a combination of behavioral, physiological, and morphological similarities with evolutionary theory amounts to a stronger overall case, a convincing argument will likely also require motivation in terms of a well-developed theory of the structure and function of consciousness as a cognitive process – a route that many recent participants in the debate on animal consciousness have pursued.

## What’s the Issue?

There are two senses of consciousness that cause controversy when applied to animals: *phenomenal consciousness* and *self-consciousness*. The bulk of this article deals primarily with the attribution of phenomenal consciousness in its phenomenal sense to animals, although there will be some discussion of self-consciousness. Two central questions are:

- 1) Can we know which animals beside humans are conscious? (The Distribution Question)
- 2) Can we know what, if anything, the experiences of animals are like? (The Phenomenological Question)

In his seminal paper “What is it like to be a bat?” Thomas Nagel (1974) simply assumes that there *is* something that it is like to be a bat, and focuses his attention on what he argues is the scientifically intractable problem of knowing what it is like. While many side with Nagel concerning the scientific inaccessibility of animal consciousness in this sense, others have proceeded by developing structural and/or functional theories of consciousness, and using these to argue for a particular hypothesis about the distribution of consciousness among animals. The idea of behavioral flexibility is central to discussions of the functional aspects of animal mind and consciousness. Donald Griffin, who made his reputation taking careful physical measurements to prove that bats use echolocation, and who reinvigorated discussions of animal consciousness in a series of books about cognitive ethology (Griffin 1976, 1984, 1992; see Burghardt 1985 for historical perspective), emphasized behavioral flexibility and versatility as the chief source of evidence for consciousness, which he defined as “the subjective state of feeling or thinking about objects and events” (Griffin & Speck 2004, p. 6).

## Representational Theories of Phenomenal Consciousness

Representational theories of consciousness link phenomenal consciousness with the representational content of mental states, subject to some further functional criteria.

First-order representationalist accounts (e.g., Dretske 1995; Tye 2000) hold that if a particular state of the visual system of an organism represents some property of the world in a way that is functionally appropriate (e.g., not involving conceptual representation, and operating as part of a sensory system), then the organism is phenomenally conscious of that property. First-order accounts are generally quite friendly to attributions of consciousness to animals, for it is relatively uncontroversial that animals have internal states that have the requisite functional and representational properties (insofar as mental representation itself is uncontroversial, that is). Such a view underlies Dretske’s (1995) claim that phenomenal consciousness is inseparable from a creature’s capacity to perceive and respond to features of its environment, i.e., one of the uncontroversial senses of consciousness identified above. On Dretske’s view, phenomenal consciousness is therefore very widespread in the animal kingdom. Likewise, Tye (2000) argues, based upon his first-order representational account of phenomenal consciousness, that it extends even to honeybees.

Driven by a variety of allegedly counter-intuitive consequences of first-order theories of consciousness, several philosophers have offered higher-order accounts of phenomenal consciousness. Such accounts invoke mental states directed towards other mental states to explain phenomenal consciousness. Carruthers’ “higher order thought” (HOT) theory is that a mental state is phenomenally conscious for a subject just in case it is available to be thought about directly by that subject (Carruthers 1998a,b, 2000). The term “available” here makes this a “dispositionalist” account. The contrast is an “actualist” account, which requires the actual occurrence of the second-order thought for the subject to be conscious in the relevant sense. According to Carruthers, such higher-order thoughts are not possible unless a creature has a “theory of mind” to provide it with the concepts necessary for thought about mental states. Carruthers’ view is of particular interest in the current context because he has used it explicitly to deny phenomenal consciousness to (almost) all nonhuman animals. Carruthers argues that there is little, if any, scientific support for theory of mind in nonhuman animals, even among

the great apes – with the possible exception of chimpanzees – from which he concludes that there is little support either for the view that any animals possess phenomenological consciousness.

In contrast to Carruthers' higher-order *thought* account of sentience, other theorists such as Lycan (1996) have preferred a higher-order *experience* account (HOE), where consciousness is explained in terms of inner perception of mental states, a view that can be traced back to Aristotle, and also to John Locke. Because such models do not require the ability to conceptualize mental states, proponents of higher-order experience theories have been slightly more inclined than higher-order theorists to allow that such abilities may be found in other animals. Gennaro (2004) argues, however, that a higher-order *thought* theory is compatible with consciousness in nonhuman animals, arguing that Carruthers and others have overstated the requirements for the necessary mental concepts and that reentrant pathways in animal brains provide a structure in which higher- and lower-order representations could actually be combined into a unified conscious state.

## Degrees of Consciousness

A question that seems directly relevant for the question of the phylogenetic distribution and evolution of consciousness is whether possessing it (i.e., being conscious) is binary (i.e., on/off, all-or-nothing), or admits of degrees? Lycan (1996) argues that consciousness can come in a wide spectrum of degrees of richness or fullness of consciousness, and that there is a meaningful sense in which a system with a minimal degree of consciousness is not “really” conscious. Admittedly, this sounds a bit paradoxical, but the point seems to be that it is counter-intuitive for us to consider very low degrees of consciousness, as it is hard to imagine the contents of very simple mental states. Dennett (1995) also argues that consciousness is not binary. He does so in the context of advocating a radically deflationary anti-realism about consciousness overall, on which consciousness is essentially an illusion created by language (1991/1995). On his view, “the very idea of there being a dividing line between those creatures ‘it is like something to be’ and those that are ‘mere automata’ (is) an artifact of our traditional assumptions” (1995, p. 706).

Velmans (2012) distinguishes between “discontinuity theories,” which claim that there was a particular point at which consciousness originated, before which there was no consciousness (this applies both in the universe at large, and also to any particular consciousness individual), and “continuity theories,” which conceptualize the evolution of consciousness in terms of “a gradual transition in consciousness from unrecognizable to recognizable.” He argues that continuity theories are more elegant, as any discontinuity is based on arbitrary criteria, and that discontinuity theories face “the hard problem” in a way that continuity theories don’t. Velmans takes these arguments to weigh in favor of adopting, not just a continuity theory, but a form of panpsychism.

## Evolution and Distribution of Consciousness

A variety of hypotheses have been put forward by scientists and philosophers about which animals are conscious and which are not. These views span a huge range of possibilities, from the narrowest, which is that only humans are conscious, to some

authors arguing that almost all animals, even simple invertebrates, have a basic capacity to experience the world. Some authors have even argued that single-celled organisms (Chalmers 2015) or plants (A. Nagel 1997) are conscious, and some have given arguments for versions of panpsychism, the view that consciousness is a property of fundamental physical entities, much in the same way that mass and charge are (Chalmers 2015). It is worth noting that neither the attribution of consciousness to single-celled organisms, nor to fundamental physical entities, implies that all animals are conscious. In the former case, it may be that the information processing complexity and integration of relatively complex single-celled organisms outstrips that of the simplest multi-cellular animals. In the latter case, while the version of panpsychism developed by Chalmers attributes “microexperience” to “fundamental physical entities,” this does not imply that any particular macroscopic object (like an animal) has “macroexperience” – i.e., “the sort of conscious experience had by human beings” (Chalmers 2013). This view is compatible with the possibility that a given animal has no conscious experience, although it is composed of microphysical entities that possess conscious microexperience.

The question of which lineages (species, or more inclusive groupings such as class or phylum) of animals are conscious inevitably goes hand-in-hand with considerations of the evolutionary origin of consciousness. This is a logical implication of the broadly Darwinian view of life, on which modern organisms have evolved through descent, with modification, from a small number – perhaps one – of very ancient ancestors. If a trait is characteristic of a given species, it either arose in that species, or is derived from an ancestor – in which case, it will be present in other species derived from that ancestor, unless it has been secondarily lost in those species. Did consciousness first arise in humans, or in an earlier, nonhuman ancestor? If the latter, then what was this ancestor? Another possibility is that consciousness may have arisen multiple times, like winged flight, which evolved independently in insects, birds, bats, and pterosaurs.

### **Mammals**

Theoretical and empirical arguments have been put forward to the effect that consciousness is shared across all mammals. Seth, Baars, and Edelman (2005) argue that the neural processes essential to human consciousness – widespread reentrant activity in the thalamo-cortical complex – involve anatomical systems that are shared among all mammals (and perhaps more widely). Panksepp (2004, 2005) takes a similar approach, although focusing on the neurophysiological systems involved in the “core emotions” which he identifies as “seeking,” “fear,” “rage,” “lust,” “care,” “play,” and “panic.” He argues that these are shared by all mammals, and may be widely shared among all vertebrates, and he assumes, although it is hard to prove, that emotions gain their motivational force from the associated conscious experiences. While acknowledging that consciousness may be more widespread than just mammals, these authors argue that in the case of mammals, the weight of evidence based on homology of relevant neurophysiological systems is overwhelming, whereas outside of mammals, the inference is more tenuous because of the biological differences in nonmammalian animals.

### **Other Amniotes (Birds and Reptiles)**

Questions about whether reptiles are conscious (and if so what their mental lives might be like) are especially interesting because birds are more closely related to them than they are to mammals, yet birds display a variety of behaviors that tend to intuitively

suggest intelligence and emotion to human observers much more obviously than the behavior of scaly, so-called “cold-blooded” animals like snakes and turtles. Do birds and mammals share mental features (consciousness, intelligence, emotion, social attachment) that are absent in reptiles? If so this would represent independent, convergent evolution of these phenomena. Alternatively, are these features common to all of these animals, but less obvious in some than others?

Michel Cabanac and colleagues (2009) argue that consciousness is unique to, and shared by all *amniotes* – the clade that includes all descendants of the common ancestor of living birds and mammals, including reptiles such as lizards, snakes, turtles, and extinct animals such as dinosaurs, pterosaurs, and pleisiosaurs (see <http://tolweb.org/Amniota>). On this hypothesis, only these animals, and not amphibians, fish, or any invertebrates, possess consciousness. Cabanac’s argument is based on an explicit structural and functional theory of consciousness as a unified representational space, “an abstract private model of reality with four dimensions: quality, intensity, hedonicity and duration” (2009, p. 268). Possessing this ability to model reality allows animals to simulate possible courses of action, using hedonicity (pleasure or pain) as a “common currency” to evaluate and choose between actions based on expected consequences (which are based on prior experience). Cabanac appeals to experimental evidence from his own lab suggesting that only amniotes show emotional responses.

### **Vertebrates**

Merker (2005) has proposed that consciousness originated early in vertebrate evolution, and is therefore both ancient and widespread. On this proposal, not only mammals and birds, but amphibians and all marine vertebrates are conscious. Merker begins his argument with the phenomenological observation that the contents of conscious experience are object- and goal-oriented, but exclude the fine-grained sensory and motor details represented in peripheral and low-level neural processing. Merker argues that consciousness is an integrated representational platform – what he refers to a “synthesized reality space” – that, for animals with complex bodies with many degrees of freedom of movement and multiple sensory modalities, solves a cluster of critical neural logistics problems. Partly motivated by concerns about their welfare arising due to the increasing importance of fish farming, there has also recently been a lively debate over fish consciousness, particularly concerning whether fish can experience pain, stress, and suffering (Rose 2002; Sneddon, Braithwaite, & Gentle 2003; Allen 2013; Braithwaite 2010).

### **Invertebrates**

The vertebrate lineage represents just one of approximately 34 known phyla – ancient lineages of animals characterized by differences in fundamental anatomical organization and the developmental processes that generate it. Each of these phyla is derived from a relatively simple state (i.e., few tissue types and a minimal central nervous system with limited sensory capacities). Hence, the invertebrates such as cephalopod mollusks (e.g., octopi and squids) and arthropods (e.g., crustaceans, insects, and spiders), that are complex enough to attract the attention of those interested in animal consciousness, evolved their complexity independently from vertebrates, and in the case of cephalopods and arthropods, independently from each other. Given the radical differences between vertebrates and invertebrates with respect to anatomy and physiology, the

strategy of identifying homologous and functionally analogous structures and processes is much more difficult to apply (Seth, Baars, & Edelman 2005; Edelman, Baars, & Seth 2005).

Today, only three of the phyla (vertebrates, arthropods, and mollusks) include animals with complex active bodies. Feinberg and Mallatt (2013) place the origins of consciousness in the Cambrian period, and Trestman (2013a) argues that the evolution of complex active bodies during the Cambrian requires a capacity for integrated, embodied spatial cognition, and that this capacity evolved independently in each of the three phyla in which it is currently found (vertebrates, arthropods, and mollusks). If Merker (2005) is right that consciousness represents a solution to the neural-logistics problems posed by controlling a complex body in space, these three lineages are the best bets for possessing consciousness. This line of reasoning can be bolstered by considering the role of temporal integration of perceptual information in consciousness and in action-selection and object-oriented perception (Trestman 2013b).

One group of invertebrate animals that has received attention in the context of questions about consciousness is the coleoid cephalopods – octopuses, squids, and cuttlefish. Mather (2008) argues that cephalopods exhibit many behavioral indicators of consciousness, including complex learning and spatial memory, as well as apparent play. Merker (2005) and Edelman and colleagues (Edelman, Baars, & Seth 2005), Edelman & Seth 2009) argue that a strong provisional case can be made for consciousness in cephalopods – although these authors emphasize the limitations on our present understanding.

The other phylum that has received particular attention is the arthropods, which includes insects, crustaceans, spiders, and many other less familiar animals. This is an ancient and tremendously diverse group of animals, so any generalizations should be made with caution. Arthropods were among the earliest animals to evolve complex active bodies – and correlatively to evolve brains capable of adaptively controlling complex adaptive bodies (Trestman 2013a), and so if the function of consciousness is to solve problems raised by the control of complex active bodies (cf. Merker 2005), it may have evolved early on in the arthropod lineage, in a common ancestor of all living arthropods.

## Self-consciousness and Metacognition

Systematic study of self-consciousness and theory of mind in nonhuman animals has roots in an approach to the study of self-consciousness pioneered by Gallup (1970), who developed an experimental test of mirror self-recognition that has become widely used as a test of self-awareness. Gallup argues that the performance of chimpanzees in this test indicates that they are self-aware. He also argues that self-awareness – in the sense of being able to think about one's own mental states – is required for having a mind, and therefore that animals that “fail” the mirror test have no minds (1982, 1985). Though there has been controversy over just which animals “pass” the mirror test – the validity of versions of the test modified for use with elephants, dolphins, and magpies has been challenged – as of 2002, Gallup maintained that there was evidence that humans, common chimpanzees, bonobos, and orangutans consistently pass the test, and strong evidence that a wide range of other primates fail consistently fail. He took this to support the claim that self-awareness is unique to great apes (Gallup, Anderson, & Shillito 2002). Combined with his earlier arguments that consciousness requires the



sort of self-awareness measured by the mirror test, this would imply that consciousness is unique to the great apes. Rochat and Zahavi (2011) challenge Gallup's interpretation of chimps' mirror-oriented behavior as indicating a human-like experience of mirror self-recognition, and his claim about the connection between mirror self-recognition and consciousness.

Although it is typically reported that chimpanzees consistently "pass" the mirror-mark test, a survey of the scientific literature by Shumaker and Swartz (2002) indicates that of 163 chimpanzees tested, only 73 showed mark-touching behavior (although there was considerable variation in the age and mirror experience among these animals). Shumaker and Swartz also report mark-touching behavior in five of six tested orang utans and six of 23 gorillas. They suggest that the lower incidence of mark-touching by gorillas may be due to avoidance of socially-significant direct eye contact. For non-human primates outside the great apes, the evidence for mirror self-recognition has been sparse. Gallup himself regards it as a phenomenon restricted to the great apes only. However, the idea that Gallup's protocol uses a stimulus that is not particularly salient to monkeys continues to have some currency. For example, Rajala et al. (2010) have presented quantitative and videographic evidence that rhesus monkeys with surgical implants in their heads use mirrors to inspect the implants, as well as other parts of their bodies that they cannot usually see.

Modified versions of Gallup's experiment have also been conducted with non-primate species. Notoriously, Epstein, Lanza, and Skinner (1981) trained pigeons to peck at a mark on their own bodies that was visible only in a mirror, and they used this to call into question the attribution of "self-awareness" on the basis of the mirror-mark test, preferring an associative learning explanation. Gallup et al. (2002) reject the claimed equivalence, pointing out that chimpanzees were not trained to touch marks before the test was administered. Reiss and Marino (2001) have offered evidence of mirror self-recognition in bottlenose dolphins and the mirror-mark test continues to be an area of active investigation in various species including elephants (Plotnik, Waal, & Reiss 2006) and magpies (Prior, Schwartz, & Güntürkün 2008).

Another intriguing line of research into animals' knowledge of their own mental states considers the performance of animals in situations of cognitive uncertainty. When primates and dolphins are given a "bailout" response allowing them to avoid making difficult discriminations, they choose this option in ways very similar to humans (Smith, Shields, & Washburn 2003). The original experiments have attracted both philosophical criticism of the second-order interpretation (e.g., Carruthers 2008) and methodological criticism by psychologists (reviewed by Crystal & Foote 2009). In the literature on human cognition, awareness of what one knows is called "metacognition" and it is associated with a "feeling of knowing." Smith and colleagues claim that investigating metacognition in animals could provide information about the relation of self-awareness to other-awareness (theory of mind), and that their results already show that "animals have functional features of or parallels to human conscious cognition" (Smith et al. 2003; Smith 2009).

## Animal Pain and Suffering

Proper understanding of neurological studies of animal pain begins with the distinction between nociception and pain. Nociception – the capacity to sense noxious stimuli – is one of the most primitive sensory capacities. Neurons functionally specialized for

nociception have been described in invertebrates such as the medical leech and the marine snail *Aplysia californica* (Walters 1996). Because nociceptors are found in a very wide range of species, and are functionally effective even in decerebrate or spinally transected animals, their presence and activity in a species provides little or no direct evidence for phenomenally conscious pain experiences (Allen 2004; Allen, Grau, & Meagher 2009).

It is generally accepted that the mammalian pain system has both a sensory and an affective pathway, and that these can be dissociated to some degree both pharmacologically (with, e.g., morphine) and surgical lesions. The anterior cingulate cortex (ACC) is a particularly important structure of the mammalian brain in this regard (Price 2000). Allen et al. (2005) and Shriver (2006) argue that this dissociability provides a route to empirical assessment of the affective component of animal consciousness, and Farah (2008) uses it to distinguish suffering from “mere pain” (see also Bermond 2001).

Detailed analysis of other taxonomic groups may, however, indicate important anatomical differences. Rose (2002) argues that because fish lack an ACC they may not be bothered by pain. This is in contrast to Sneddon et al. (2003) who argue that there is adequate behavioral and physiological evidence to support pain attributions to fish. (See also Chandroo, Yue, & Moccia 2004 for a review.) While the ACC is important to mammals, there remains the possibility that other taxa may have functionally similar structures, such as the *corticoidea dorsolateralis* in birds (Atoji & Wild 2005; Dubbeldam 2009). Genetic knockout animals are also providing further clues about the affective aspects of pain (see Shriver 2009 for a review and application of these findings to animal welfare).

There has been a major shift in veterinary practice in regards to animal pain during the past decade. Surgery on animals was once routinely practiced without analgesics or anesthetics. The vast majority of veterinary practitioners now accept the basic premise that veterinarians can be trained to recognize animal pain reliably, and that veterinary patients benefit from the same kinds of pain alleviation treatments that are delivered to humans. It has even been argued that animals possess the neurobiological mechanisms responsible for phantom limb pain and neuropathic pain (pain in the presence of no obvious tissue damage or disease), and that these conditions may therefore be detectable and treatable in nonhuman animals (Mathews 2008).

## Summary

An article such as this perhaps raises more questions than it answers, but the topic would be of little philosophical interest if it were otherwise.

For philosophers, the topic of animal consciousness is no longer only of peripheral interest. There is increasing interest in animal cognition from a range of philosophical perspectives, including ethics, philosophy of mind, and the philosophy of science. Philosophers working in all of these areas are increasingly attentive to the particular details of scientific theory, methods, and results. Many scientists and philosophers believe that the groundwork has been laid for addressing at least some of the questions about animal consciousness in a philosophically sophisticated yet empirically tractable way. Yet there remain critics from both sides: on the one hand are those who still think that subjective

phenomena are beyond the pale of scientific research, and on the other are those who think that science and philosophy have not moved far enough or fast enough to recognize animal consciousness. The arguments on both sides are by no means exhausted.

*See also 6 Rethinking the evolution of consciousness; 8 Panpsychism; 27 Physicalist panpsychism.*

## Note

More details about the issues covered here can be found in the *Stanford Encyclopedia of Philosophy* article from which this entry is abridged by permission of the original copyright holders; Allen & Trestman 2014.

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