No credible consciousness without critical thinking

In their essay, 'The ubiquity of consciousness', Trewavas and Baluska ask "on what experimental evidence, other than supposition, do we reject consciousness in other organisms?" [1]. The authors use some examples of adaptive behavioural responses of animals and plants to argue that consciousness is everywhere. Their ambition to approach the question of consciousness without bias is brave, but in our opinion not convincing. We argue that this uncritical approach is not useful to elucidate the phenomenon of consciousness.

The question of which types of organism have consciousness is of special interest for researchers in our field, animal welfare. In particular, sentience—the capacity for experiencing pleasure and pain—is of central importance. Evidence from new research in combination with societal discussions is shifting the frontiers between (presumed) sentient and (presumed) non-sentient organisms. As such, it is essential that assumptions about sentience or its absence are made on the basis of critical reasoning and appropriately used terminology.

By describing any kind of adaptive behavioural response as a sign of consciousness, self-awareness and intention, the authors empty these concepts of meaning. To understand consciousness we do not need a wider definition but a clear reasoning about what it is and what evidence we should be looking for in non-human beings. There are various and different sources of evidence, as research on consciousness is spread across many different fields with widely varying research paradigms. To understand consciousness it is helpful to consider opinions on its definition and prevalence from the fields of neurobiology, cognitive psychology, ethology and philosophy.

The first problem is a lack of a clear definition. It is generally considered that there are several levels of consciousness that range from the ability to feel, through knowing that you feel, to self-awareness—knowing that you exist as an individual. It is the first level that has most ethical/practical applications, in particular as it affects how we humans

should treat other living beings. Positions range from authors who do not believe that there is convincing evidence for consciousness in any non-human animal [2] to those who believe that all animals are conscious. Among the latter, Donald Griffin [3] has perhaps been the most influential. This is not a trivial question, as highlighted by the debate on whether fish can feel pain or not [4], which might have far-reaching consequences on animal welfare legislation.

Intermediate positions, especially on higher forms of consciousness, often focus on its function as opposed to the assumption that it is an epiphenomenon. It is not immediately clear what the function of consciousness is because even in humans a large part of behaviour is performed subconsciously. However, there are speculations that consciousness might be a late error-detection system. By comparing what one expects will happen with what is actually happening, an individual will be better able to detect and react to changes in the environment. If this is the function of consciousness, it requires an ability to form expectancies. We should therefore predict that consciousness only exists in animals that have expectancies, that is, which have episodic-like memory [5].

One approach to study expectancies and possibly emotions in animals is the contrast effect. If an animal receives a reward for a certain behaviour, it will perform more of that behaviour. If the reward is doubled, the performance of the animal is increased to a higher level than if it had been given the double reward from the beginning [6]. It demonstrates that it is not the size of the reward that is important, but the size compared to the expected reward, which strongly suggests that the animal has an expectation. All mammalian and avian species tested show this behaviour, but no fishes or reptilian species. This would support the view that only mammalian and avian species "know what they feel".

We believe that such critical reasoning, accompanied by suitable experiments and other studies, is a more fruitful approach than redefining consciousness to encompass all living beings. Consciousness is a complex

phenomenon and using only one criterion would be wrong. Being able to feel, being able to reflect on one's feeling and being able to reflect on one's existence are three different sets of capacities and lacking or having one of them does not automatically mean lacking or having another.

There is, and should be, a conflict between basic science and animal welfare research. In basic science, the lowest level of psychic ability, or consciousness, should be preferred as an explanation for any behaviour. In animal welfare, the animal should be given 'the benefit of the doubt'. The argument for this approach for animal welfare is that we have repeatedly underestimated the consequences for the animal of, for example, various routine surgical procedures such as debudding, tail docking or castration.

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Response to Olsson and Forkman

We welcome the contribution from Olsson and Forkman to the discussion about consciousness, but disagree with its main contention. The nub of their argument is that our use of the Margulis definition of consciousness—that "every organism is conscious ... in the

simplest sense consciousness is an awareness of the outside world"—empties 'consciousness' of any meaning [1]. On the contrary, recognizing that every organism is conscious opens up enormous opportunities for experimental investigation and evidence-based understanding of this crucial biological capability. Awareness can be considered as an ability to respond to certain patterns of stimulation or signalling. By comparison of these data with internal information and assessment, awareness then leads to intelligent behaviour, an ability shared by all classes of organism. Alternatively, awareness can be regarded as resulting from a set of maintained internal images that can be used for comparison with the integrated signal pattern. The image, a network, can be either molecular or nervous, although the distinction is often blurred. Awareness is clearly an adaptive quality that enables organisms to sense and optimize their behaviour within the perceived environment and will be subject to selection.

Olsson and Forkman provide a typical description of consciousness as feelings, reflecting on experience and existence. This description, rooted solely in human experience, is abstract and personal to the individual experiencing it. It provides little in the way of real biological measurement; does one individual have more consciousness than another? It certainly provides for endless, subjective philosophizing. Mankind has qualities that render him unique: a complex language with excellent verbal communication, a large, unusually structured brain, manual dexterity and consequently complex culture. Do we really expect other organisms to be humanly conscious? Since we cannot communicate directly, it is no more than speculation whether other species are conscious by this definition. Even Alex, the communicative parrot with his 100 words, which we described in relative detail, gave no real hint of such experience. But by our definition, he was clearly conscious. The de-construction of this kind of anthropomorphic agenda was ably and classically performed by Nagel [2] when he asked what it was like to be a bat, a mammal, using echolocation—like dolphins—and flying. His conclusions, "No reason to suppose a bat's (or even wasp's) experience is subjectively like anything we can experience or imagine. The less it depends on a specifically human viewpoint, the more objective is our description."

The wasp *Polistes*, an invertebrate, uses learned facial recognition both to recognize itself and other nest mates as individuals, and to attack unrecognized enemies [3]. Wasps in these colonies recognize their position in the nest order and discriminate between the ranks [4]. They must therefore also have self-awareness as an individual distinct from others. All classes of organism are able to recognize members of their own species, to recognize that they themselves are part of that species group, to mate with them and to recognize enemies. Each individual recognizes itself as different from other species members and must also be self-aware. Again, comparisons with predetermined molecular or image networks probably form the basis of self-awareness.

Olsson and Forkman's primary concern seems to centre on animal welfare, which animals are conscious and which are not by their definition—an entirely subjective exercise—and presumably the resulting legislation. Similarly, they include the qualities of pleasure and pain, which even in humans are entirely variable qualities and thus indeterminate in animals. Again, only subjective assessments are available. The trap to avoid here is that of Lovejoy's discredited *The Great Chain of Being* [5] that

assumes mankind to be perfection, ranks other organisms according to their degree of perfection and ordered usually according to their similarity or proximity to human beings. It is crudely anthropocentric. Animal welfare research and legislation have contributed a lot to improve the welfare of laboratory animals. Yet, if we want to seriously improve the fate of most animals, it is more efficient to tell farmers that well-treated animals give better yields and to educate children to respect the planet on which they live and the organisms with which they share it.

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English of science or scientific English?

In his recent editorial, *All Chinese to me*, Howy Jacobs raised the issue of language in science [1]. I feel that some debate is necessary to determine what one might call the 'English of Science Communications'.

The Nobel Laureate and eminent physicist Niels Bohr once remarked that science is deeply immersed in language, which influences the way it is interpreted and practiced. Present-day biology, with an explosive rate of quantitative data generation, certainly needs a consistent language code for communications. It will both help to create an objective criterion for editorial decisions and make the computerized scanning of the scientific literature and automated content analysis more effective. Most importantly, however, the non-native English speakers, who are otherwise capable of producing excellent data, would get an opportunity to report them, independently of an interpreter.

With English as a basis, each discipline of science has progressively developed its own style of communication, effectively defined to describe objective thinking and

quantifiable results. Thus, the message is easily translated into any other language. It is distinct from both creative writing in English and creative English. In order to broaden the scope and help non-native English speakers communicate the results of their research in English, we should minimize the emphasis on 'readability', which is subjective and not so well-defined, and ensure simply that the manuscripts are written following proper syntax and present logically constructed arguments and analysis. Sometimes, thinking about science in a language other than English might help to discover a whole new paradigm. One should not foreclose on recognizing that opportunity.

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