Review of: "Growing Confidence and Remaining Uncertainty About Animal Consciousness"

Yuri Arshavsky[1]

1 University of California, San Diego

Potential competing interests: No potential competing interests to declare.

This article is an extensive review of the literature that, to some extent, reflects existing ideas in the field. After describing the main facts and hypotheses, the author discusses three major mysteries that, in his opinion, are the most important for solving the problem of consciousness. This article can be informative for scientists working in this field. However, I have a number of very serious comments and objections.

1, The author makes categorical statements and introduces terms that seem very controversial. Several examples:

At the beginning of the Introduction, the author writes “in humans and other animals.” I doubt that “humans” can be called “animals.” It is better to write “in humans and in animals.”

Elsewhere, the author writes: “Given that fact and the apparent ancient origins of at least sensory consciousness, it seems highly likely that consciousness itself had multiple independent origins and …” What does “sensory consciousness” mean? Does the author believe that there is simply “consciousness” and “sensory consciousness”? Maybe the author means “sensory perception,” but “perception” and “consciousness” are different phenomena. Later, I see the term “the experience of consciousness,” and again, I do not understand what it means.

At the end of the section “The Definitional Problem,” Dr. Irwin gives the following definition of consciousness: “Consciousness is the process by which an animal has perceptual and affective experience or feelings, arising from the material substrate of a nervous system.” I believe this definition has two drawbacks. First, it does not express the whole complexity of the phenomenon that people call consciousness. I think it is impossible to formulate a scientific definition of consciousness (see also Gutfreund Y. 2017. The neuroethological paradox of animal consciousness. *Trends Neurosci.* 40, 196-199), and my recommendation is to eliminate this section. Second, this definition includes the statement that animals have consciousness, which is not obvious (see next comment).

In the section “The Evolutionary Imperative,” Dr. Irwin writes that consciousness exists in all mammals. The evidence of the existence of consciousness is particularly strong for birds and has also been advanced for reptiles, amphibians, and fishes. Among invertebrates, plausible evidence for consciousness has been reported for insects, arachnids, decapod crustaceans, and cephalopods.

The idea that animals have consciousness came from studying their behavior. Animals demonstrate such perfect innate patterns of behavior and such amazing abilities to adapt them to changing environmental conditions that researchers often

describe their behavior in anthropomorphic terms like "reasonable," "smart," or "voluntary." There is only one step from this description to assuming that animals, like humans, have consciousness. As Dr. Koch wrote in his book “The Quest for Consciousness: a Neurobiological Approach” (2004), strictly speaking, we cannot say if other people have consciousness based on their behavior. The only reliable fact that each of us knows about consciousness is that she/he has it. And this is the only reason why we believe that other people also have consciousness. The confidence that other people have consciousness is supported by the fact that, when we pronounce the word "consciousness," people intuitively understand what it means. If they lacked consciousness, they would ask, and we would not be able to explain, as we cannot explain the concept of color to a congenitally blind individual. According to Gutfreund (2017), answering the question of animal consciousness requires understanding the neural mechanisms of human consciousness. This would enable us to evaluate the existence of these mechanisms in animals.

The text related to the problem of animals’ consciousness includes internal contradictions. In the section “The Ontological Issues,” the author writes that “a central feature of consciousness is a sense of self,” and I agree with this. But it is unclear what facts could be used as a foundation to identify whether animals do have a sense of self.

Later, Dr. Irwin writes: “Consciousness became necessary especially once animals started moving about, in order to solve the logistical problems of decision making while in motion.” In other words, it means that consciousness should exist in all moving animals. On the other hand, at the end of the review, it is written that “animal consciousness is implemented by complex nervous systems that process information through neural circuits encompassing at least three hierarchical levels.” Can the author name three levels involved in the generation of consciousness in Agnatha? I am familiar with the behavior of brittle stars and the pteropod mollusk *Clione limacina.* They are moving animals**,** and their behavior is as complex as the behavior of lampreys, some fish, amphibians, and reptiles. However, the nervous system in brittle stars has no hierarchical organization and has only a two-level organization in the pteropod mollusk.

Concluding this commentary, I must emphasize that the author needs to discuss the issue of consciousness in animals more seriously. The author cannot write about consciousness in animals as an indisputable fact, but only as a possible hypothesis. The article by Gutfreund must be quoted and discussed in the text.

3. In his review, the author touches on the issue of*qualia*. In the section “The Neurological Correlates of Consciousness,” he writes that the circuits “are assumed to be local neuronal ensembles whose pattern of activity varies for different *qualia* or for diverse units of perception.” I think that this is a very simplified approach to the*qualia* problem. I formulate this problem in neurophysiological terms (see Hawkins J, 2004, On Intelligence and Arshavsky YI, 2017. Neurons versus networks: The interplay between individual neurons and neural networks in cognitive functions, Neuroscientist 23. 341-355 for detail). Why are the spikes arriving at the occipital cortex perceived as visual images, whereas spikes arriving at the temporal cortex are perceived as auditory images? The visual and auditory cerebral areas consist of the same neuron types, and they have similar laminar and columnar organization. Geniculocortical fibers projecting to these cortical areas terminate at the same neuron types and use the same neurotransmitters. Different functions of these two areas are not established from learning because mature-born ungulate mammals can see and hear from the moment of their birth. The differential perception cannot be explained by quantitative morphological differences between the visual and auditory

areas. Although they significantly vary across species (cf. diurnal and nocturnal animals), the occipital and temporal areas function as visual and auditory centers in all species. What is different? I think that we have to conclude that the difference lies in cerebral neurons processing sensory information. This conclusion means that the neural substrate of consciousness is not “analogous to the pixels of a display on a computer screen,” since cerebral neurons involved in performing cognitive functions, including consciousness, are qualitatively different (see also Arshavsky YI, 2009, Two functions of early language experience, Brain Res Rev 60. 327-340).

I agree that the *qualia* problem has a direct relation to consciousness. However, its description should be more objective and reflect different views. The book by Hawkins and articles by Arshavsky must be quoted and discussed in the text.

4. In the section “Bridging the Gap Between Mechanism and Phenomenology,” the author writes: “The granular details of the neural substrate of consciousness are analogous to the pixels of a display on a computer screen. Though actually based on the sum of all the pixels on the screen, the pixels are not perceived individually but their overall effect is perceived as a complex, holistic gestalt. In like manner, an image emerges in consciousness from the collective activity of millions of neurons as a unified and meaningful holistic image.” If I understood this difficult text correctly, the author follows the commonly accepted viewpoint that cognitive functions, including consciousness, are realized at the level of neuronal circuits, whereas neurons are considered as simple units lacking individuality. This concept meets at least two objections.

Since neurons operate on a millisecond time scale, neuronal circuits consisting of millions of neurons would have to work very slowly. Yet, the brain is able to work very quickly. This was one of the reasons why mathematicians Manin and Manin (Manin DY, Manin YI. 2017, Cognitive networks: brains, internet, and civilizations.In: Sriraman B. (Ed) Humanizing Mathematics and its Philosophy, 85-96) concluded that the brain should not be compared to a computer (or a computer screen), but rather to the Internet, whereby specialized neurons can play the role of computers. Later, biologists Langille and Gallistel came to the same conclusion (Langille JJ, Gallistel CR. 2020, Locating the engram: Should we look for plastic synapses or information-storing molecules? Neurobiol Learn Mem, 169, 107164). A number of mathematicians and physicists developed the idea that the mechanism of cognitive functions, including the mechanism of consciousness, is based on quantum processes occurring inside brain cells, which allows the brain to operate quickly (see references in articles by Arshavsky).

The activation of neuronal circuits consisting of millions of neurons would require a significant increase in energy demand. However, this is not the case. Cerebral activities in humans, such as sensory perception and solving cognitive problems, are not associated with significant energy demand (see Arshavsky YI, 2023, Brain energetics and the connectionist concept in cognitive neuroscience. J Neurophysiol. 130, 61-68 for review).

5. In the section “Bridging the Gap Between Mechanism and Phenomenology,” the author writes: “In all likelihood, the greater the number of neurons involved in neural processing of the stimulus, the higher will be the level of resolution of the resulting perceptual.” It is true that the level of resolution of stimulus perception, as well as cognitive abilities of the brain, including humans’ unique cognitive abilities, depend on the number of neurons. But that is not the whole truth. Cognitive abilities of the brain also depend on qualitative differences in neurons. This was shown in studies on the intellectual abilities of microcephalic individuals. One of the reasons for primary (congenital) microcephaly is mutations

causing disorders of cerebral progenitor cell mitosis. The brain size of these individuals is closer to that of the great ape than to the normal human brain. Nonetheless, these individuals frequently have only minimal deficits in cognitive functions. Moreover, about a dozen articles with approximately the same title, “Microcephaly with normal intelligence,” have been published (see Arshavsky YI, 2023, Memory: Synaptic or Cellular, That Is the Question. Neuroscientist, 29, 538-553 for references). Many individuals described in these papers graduated from high school. Among them were people working as a postman, skilled secretary, kindergarten teacher, bank employee, and even a medical doctor. I strongly recommend to the author to pay attention to this phenomenon.

6. The reviewed text is written in very complex language. The article would benefit from clearer phrasing and language. Several examples:

“Significant variation in brain complexity is repeatedly observed, often within narrow taxonomic bounds as well as across broadly separated clades (Bullock, 1984; Northcutt, 1985; Butler and Hodos, 1996b; Striedter, 2005), consistent with the probability of the independent origin and diverse parallel evolution of different forms of neural complexity (Godfrey-Smith, 2020). Given that fact and the apparent ancient origins of at least sensory consciousness, it seems highly likely that consciousness itself had multiple independent origins and is mediated by a variety of independently evolved neural architectures (Feinberg and Mallatt, 2016; Irwin, 2020; Mallatt and Feinberg, 2021). However, the alternative of a single origin early in the evolution of animals, followed by divergence and loss in some clades cannot be ruled out.”

“Lahav & Neemeh (2021) argue that phenomenology (the experience of consciousness) and the neural processes that give rise to the experience are two different ways the same phenomenon appears based on the perspective of the observer.”

“The agency of consciousness — the ‘witness’ to the neural processes that give rise to phenomenological experience, as opposed to all the other neural activity that simultaneously remains unconscious — has not been determined for humans, much less for any other animal. What that filter or witness or focusing mechanism is in different species is a major challenge in consciousness research.”

Final conclusion. The author should consider presenting the problem of the consciousness existence in animals in a more hypothetical manner; alternative points of view on this problem should be mentioned and discussed. The author should simplify the literary style of the article.