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Of cortex and consciousness: “Phenomenal,” “access,” or otherwise

Commentary on [Woodruff](#) on *Fish Feel*

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Abstract: From the perspective of a comparative neuroanatomist studying the avian pallium, Woodruff’s (2017) claims about the behavioral and electrophysiological evidence for teleost sentience blur the lines between phenomenal and access consciousness (Block, 1995). I discuss the bias that complex cognition can only arise in the cortical layering typical of the mammalian pallium and conclude that Woodruff makes a good case that the tecto-pallial connections in teleosts are sufficiently complex to support something like sentience.

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Woodruff (2017) presents two main propositions in his article: (1) teleost fish are sentient, and (2) this sentience (what it "feels like" to be a fish) has sufficient neuroanatomical support via tecto-pallial interconnections. The first claim might strike some as audacious. Whereas Woodruff does not have me fully convinced, he does provide interesting lines of evidence that might shed some light on the question. His second proposition is one that I fully support; my commentary comes from my perspective as a comparative neuroanatomist (largely working in birds) whose larger research interests include brain evolution in vertebrates.

1. The Hard (and Messy) Problem of Animal Consciousness. Woodruff uses the term “sentience” to convey the same meaning as “sensory consciousness” (Feinberg & Mallatt, 2016; Mallatt & Feinberg, 2016) or “primary consciousness” (Edelman, 1989). A key aspect of the consciousness debate is one’s position on consciousness as either *qualitative* or *quantitative* among organisms. If one adopts the former (either you have “it” or you don’t) as the null hypothesis, then sufficient evidence would be exceedingly difficult to accrue to satisfy the skeptic. If one takes the quantitative position (consciousness is a matter of degree), then the kinds of evidence we can bring to bear broadens. To this end, Woodruff does an excellent job. Sufficiently well-controlled

experiments could (in principle) yield data allowing the observed behaviors to be more parsimoniously ascribed to some form or another of consciousness.

Using Block's (1995) two aspects of consciousness, *phenomenal (p) consciousness* aligns best with Woodruff's "sentience." The raw material for p-consciousness is *qualia* — what it "feels like" to smell a rose, have a song stuck in your head, or experience pain. The sensory richness of this raw material in creating Uexküll's "self-centered" world or *Umwelt* (Sutrop, 2001) can be as great as, or greater, than that of humans. It can even incorporate senses for which we have no frame of reference (e.g., electroreception). There should be no *a priori* assumption that the p-consciousness of other animals (if it exists) is impoverished in any fundamental way. Woodruff addresses this indirectly in his discussion concerning retinotopic mapping onto the optic tectum ("sensory isomorphism"; Feinberg & Mallatt, 2016) and the existence of both modality-specific and more "associative" areas of the fish pallium. Block's (1995) *access (a) consciousness* is (in part) where focused attention brings some subset of qualia to the forefront for some purpose (e.g., for the control of action). Experiments on selective attention in fish, which can vary the "force and focus of sentience" (as Woodruff elegantly puts it), indicate that teleosts possess both parallel modes (associated with "pop-out" phenomena) and serial search modes (where increasing distractors increase search time). In addition, these modes have corresponding neural correlates in the fish tectum. This is reminiscent of Crick's (1995) emphasis on aspects of visual attention and the "binding problem" as one of the few experimentally tractable approaches to the study of consciousness. The boundary of p- versus a-consciousness can certainly be fuzzy. It seems to me that the type of evidence Woodruff provides speaks more to a-consciousness than sentience *per se*. He is on stronger ground when addressing the notion of whether consciousness can be supported by brains without the cortical layering characteristic of the mammalian brain.

2. Animals Without Cortex Need Not Apply? I am in complete agreement with Woodruff's second proposition that the neural substrates necessary to support something as grand as consciousness (however defined) do not require a cerebral cortex. The intellectual roots of this bias are deep, informed by an ingrained *scala naturae* view of animal intelligence — a linear arrangement from fish to mammals with, of course, humans at its pinnacle (Buffon, 1749). The pioneering early 20th century neuroanatomists (limited by techniques of the time) were arguably still influenced by this view as they attempted to understand brain evolution in non-mammalian species (Ariëns-Kappers, 1922; Huber & Crosby, 1929; Johnston, 1923). These anatomists viewed brain evolution as an accumulation of layers whereby "higher functions" migrated from mesencephalic substrates (e.g., tectum) to the telencephalon. In birds, this led to the assertion that the avian forebrain was dominated by basal ganglia and was hence limited primarily to instinct rather than cognitive flexibility (Edinger, 1908; Herrick, 1956). This was reflected in terminology applying the suffix "-striatum" to many avian forebrain areas. Later, more advanced techniques demonstrated that the majority of the avian forebrain is pallial, with areas homologous or functionally analogous to features of the mammalian neocortex (Reiner et al., 2004; The Avian Brain Nomenclature Consortium, 2005).

The aforementioned *scala naturae* view of brain evolution still has influence. The argument that a neocortex is essential for as grand a function as consciousness is not self-evident (although many seem to think so). Definitive studies establishing the minimal architecture necessary for complex cognition (substantiated in either brains or microprocessors) do not yet

exist. Evidence for the cognitive sophistication of birds (in both the field and laboratory) has been steadily accumulating (Emery & Clayton, 2004; Taylor, 2014; Weir, 2002) and these abilities are supported by a decidedly non-cortical pallium (Karten, 2015). Consciousness need not be homologous among organisms that (potentially) possess it, and bound to the cortical architecture exclusive to mammals. Perhaps several evolutionary trajectories have arrived at brains with some degree of sentience.

3. Conclusions on Teleost Sentience. To his credit, Woodruff brings a diverse set of anatomical, physiological, and behavioral lines of evidence to bear on the question of teleost sentience. I will leave the heavy intellectual lifting to the philosophers on what constitutes consciousness, and to the ethicists about what sentience means for where the “lines” are ultimately drawn in terms of the moral standing of other organisms. I will be interested to see further anatomical and behavioral work on the teleost pallium that could shed more light on the question of whether they (and other organisms) share in that elusive quality we call consciousness.

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ANIMAL CONSCIOUSNESS

On **November 17-18, 2017**, the NYU Center for Mind, Brain and Consciousness, the [NYU Center for Bioethics](#), and NYU Animal Studies will host a conference on [Animal Consciousness](#).

This conference will bring together philosophers and scientists to discuss questions such as: *Are invertebrates conscious? Do fish feel pain? Are non-human mammals self-conscious? How did consciousness evolve? How does research on animal consciousness affect the ethical treatment of animals? What is the impact of issues about animal consciousness on theories of consciousness and vice versa? What are the best methods for assessing consciousness in non-human animals?*

Speakers and panelists include:

[Colin Allen](#) (University of Pittsburgh, Department of History & Philosophy of Science), [Andrew Barron](#) (Macquarie, Cognitive Neuroethology), [Victoria Braithwaite](#) (Penn State, Biology), [Peter Carruthers](#) (Maryland, Philosophy), [Marian Dawkins](#) (Oxford, Zoology), [Dan Dennett](#) (Tufts, Philosophy), [David Edelman](#) (San Diego, Neuroscience), [Todd Feinberg](#) (Mt. Sinai, Neurology), [Peter Godfrey-Smith](#) (Sydney, Philosophy), [Lori Gruen](#) (Wesleyan, Philosophy), [Brian Hare](#) (Duke, Evolutionary Anthropology), [Stevan Harnad](#) (Montreal, Cognitive Science), [Eva Jablonka](#) (Tel Aviv, Cohn Institute), [Björn Merker](#) (Neuroscience), [Diana Reiss](#) (Hunter, Psychology), [Peter Singer](#) (Princeton, Philosophy), [Michael Tye](#) (Texas, Philosophy)



Organizers: Ned Block, David Chalmers, Dale Jamieson, S. Matthew Liao.

The conference will run from 9am on Friday November 17 to 6pm on Saturday November 18 at the NYU Cantor Film Center (36 E 8th St).

Friday sessions will include “Invertebrates and the evolution of consciousness”, “Do fish feel pain?”, and “Animal consciousness and ethics”.

Saturday sessions will include “Animal self-consciousness”, “Animal consciousness and theories of consciousness”, and a panel discussion.

A detailed schedule will be circulated closer to the conference date.

Registration is free but required.

Register [here](#).

See also [the conference website](#).