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Battlefish contention

Commentary on **Woodruff** on *Teleost Consciousness*

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Abstract: Contrary to Woodruff's suggestion, investigations into possible reasoning capacities of cichlid fighting fish and trace memory in goldfish do not support claims about sentience. This is disputed by research results about learning and implicit processing, sleep, vegetative states, amnesia, semantic priming, artificial network modeling, and even insects. A novel, deflationary, interpretation of Grosenick et al.'s experiments on *A. burtoni* is also offered.

Keywords: cichlids, goldfish, transitive inference, trace memory

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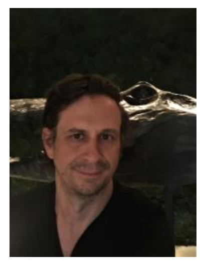

Woodruff's (2017) assemblage of ideas and data from the neuroantaomy, physiology, and behavior of teleost fish is more than one short commentary can digest. Accordingly, my focus will be on some of the behavioral results he points to as evidence of sentience in sections 5.1 to 5.3.

Grosenick et al. (2007) interpret observational learning as showing that cichlids can reason in the form of transitive inference (TI). Incidentally, this example has begun to attract notice from fish-positive philosophers such as Tye (2016, pp. 99-100), who finds it "especially interesting." As for what TI has to do with sentience, Woodruff argues that the connection is by way of declarative memory. Declarative memory differs from implicit memory in going beyond classical associative processes, having different anatomical dependences, especially the mammalian hippocampus, and, according to some, only occurring consciously (Smith and Squire 2005). Woodruff bolsters the behavioral evidence with a comparison of structure and function of the hippocampus to region DL in the fish pallium.

Following Allen (2013), we can wonder how transportable are findings about various "fish," (even if teleost) to other species, even when somewhat closely related. For example, taking evidence of TI in cichlids at face value, does this give confidence we would find TI in goldfish? Does it matter? I take it that TI is just an example of how we might establish a plausible link to consciousness via declarative memory (i.e., explicit memory of things like facts and events). So its presence is not necessary, though it is offered as one of multiple indicators sufficient for sentience on their own.

Yet there are several reasons we cannot suppose an organism is sentient just because it exhibits TI-style responses, starting with uncertainty about the character of the relevant information-processing architectures (McFarland and Bösser 1993, p. 27). Researchers and philosophers cannot decide between cognitive models and ones drawing only on reinforcement (Lazareva 2012; Allen 2006; Beck 2012, p. 226). Even assuming a cognitive model, the step from declarative memory to sentience needs more support in light of the apparent acquisition of declarative knowledge by amnesiacs and phenomena such as semantic priming: The representation of declarative knowledge need not be available to consciousness. In addition, performance on TI tasks does not depend on explicit awareness in human subjects (Frank et al. 2005; Leo and Greene 2008).

Similar doubts can be raised about trace memory, such as when there is a delay (the trace interval) between hearing a buzzer (the conditioned stimulus, CS) and a puff of air that induces blinking. In goldfish, conditioning can take place when the trace interval between the CS and the unconditioned stimulus is almost 14 seconds (Rodríguez-Expósito et al. 2017, p. 130). Woodruff points us to Clark and Squire (1998, 2004) who propose that trace memory is a form of declarative memory requiring awareness (see also Manns et al., p. 192; Clark et al. 2002). But adaptive response only requires that the trace left by the CS be a memory representation. That it is a conscious memory representation cannot be assumed without further argument (cf. Key 2016 on Bowers 2016). Trace conditioning is known to occur in insects (Carew et al. 1983; Dylla et al. 2013), leading some to worry that it cannot be trusted to reveal covert consciousness in seemingly vegetative patients (Bekinschtein et al. 2009, p. 1348). Two other areas suggestive of trace conditioning in the absence of awareness are sleep research (Arzi et al. 2012; Nakano et al. 2008) and implicit fear conditioning (Morris et al., 1998). The trace interval paradigm has also been applied to computational models of firing dynamics consisting of only 8,000 cells (Thomas and Levy 2014).

While others could point to additional evidence about goldfish, including avoidance learning, tradeoffs, and sensitivity to opioids (Sneddon et al. 2014), once again deflationary explanations are not ruled out — morphine also inhibits non-conscious nociception, for example (Rose 2002). More could be said, but because several of these points will be familiar to many, I will close with something new about the cichlid fighting fish (*Astatotilapia burtoni*) under contention.

Beyond the possibility of implicit processing, we can stop to question the assumption that the cichlids' responses were driven by observations of social rank. What if instead of thinking logically about relative status, there is just some cue typical of fiercer fighters (perhaps size, coloration, or what-have-you)? Could the difference between the Mike Tysons and A. J. Ayers[1] be manifest in some perceptible difference in morphology that the researchers did not notice?

This is not idle hypothesis mongering. The fish were bred under naturalistic conditions, including that the males were permitted to "establish and maintain territories" separated only by traversable obstructions, such as pieces of terracotta (Grosenick et al. 2007, Supplemental

[1] http://www.nytimes.com/books/00/12/24/reviews/001224.24spurlit.html?mcubz=0

Materials, p. 1). I took this to imply that they had many opportunities for interaction, including combat, prior to their use in the study. After all, the outcomes of matches staged on behalf of bystanders were preplanned, so the researchers must have known the relative prowess of individuals. This might matter because, as Grosenick et al. note (2007, p. 429), losing induces a physiological effect whereby the male's bright coloration gradually dulls.[2] So might this fading of brilliance correlated with lesser fighting ability be something the fish are sensitive to? The various checks made of their training procedure (see their Supplementary Material) do not rule this out (color is not mentioned at all, save for the brief acknowledgement just mentioned). Since this alternative hypothesis has some antecedent plausibility, what we really need to know is whether an untrained bystander would have chosen Ayer over Tyson anyway, and whether they would generally tend to avoid the more brightly colored of two potential rivals. Likewise, would trained bystanders ignore fighting prowess and respond to coloration if these were uncorrelated? In the absence of data on these matters, it is premature to draw any conclusions whatsoever about the inferential capacities of *A. burtoni*. This is but one example of the preference of scholars and audiences for exciting research results over metaphorical buckets of ice water.

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[2] Stevan Harnad informs me that something similar happens with the testosterone of human males in sporting competitions, with an apparent feedback effect reinforcing the winners' probability of winning again (Booth et al. 1989).

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