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A critique of the paper: "Do fish have nociceptors: Evidence for the evolution of a vertebrate sensory system" published in Proceedings of the Royal Society: Biological Sciences. 270(1520):1115-1121, 2003 by Sneddon, Braithwaite and Gentle (http://fidelio.ingentaselect.com/vl=7787424/cl=12/nw=1/rpsv/cgi-bin/linker?reqidx=/cw/rsl/09628452/v270n1520/s2/p1115.idx&lkey=-182115764&rkey=563874900) .
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The paper by Sneddon, et al. is flawed and does not provide any legitimate evidence that trout are capable of feeling pain. There are numerous problems with methods and data interpretation in this paper but this critique will focus only on those of greatest significance. First, an explanation of the invalid claims for evidence of pain will be presented, followed by an account of the misinterpretations of the behavioral results.

Flaws in the argument for a demonstration of pain.

1. The authors' definitions of pain and nociception are invalid, consequently this paper does not actually deal with pain (a conscious experience), it deals only with nociception (unconscious responses to noxious stimuli). Pain, as defined by the International Association for the Study of Pain is purely a conscious experience, with a sensory component and a component of emotional feeling (suffering). In contrast to this conscious experience of pain, the unconscious detection, transmission and response to noxious stimulation by lower levels of the nervous system is and defined as nociception - not pain. According to Sneddon, and associates, any behavior that is a reflex would be evidence of nociception but any behavior more complex than a reflex would be evidence of pain. This way of distinguishing pain from nociception is invalid because there are clearly complex, non-reflexive behaviors that can be purely nociceptive and unconscious. For example, humans with extensive damage of the cerebral hemispheres can still make a complex of responses including facial grimaces, vocalizations, struggling and avoidance reactions to noxious stimuli, but they are unconscious and unable to experience pain. From the definition of pain used by Sneddon and associates, it would be concluded that these unconscious humans are feeling pain rather than making purely unconscious, nociceptive responses, which is clearly erroneous. There are many other examples of complex, non-reflexive, even distress-like behaviors that can be performed unconsciously. A person having a night terror, for instance, will show a compelling fear-like display, including a scream, terrified facial expression, elevated heart rate, sweating and dilated pupils, even though they are unconscious and in such deep sleep that they are difficult to awaken. The point is that complex behavioral displays that seem to reflect distress can be purely unconscious – even in humans. It should not be hard to appreciate that the behaviors of which a fish is capable could be unconscious as well.

2. In order to show that a fish experiences pain, it is necessary to show that a fish has consciousness. Without consciousness, there is no pain. None of the fish behaviors in this paper require the involvement of consciousness and the authors don't even deal with this essential issue. Furthermore, as I have shown in my 2002 Reviews in Fisheries Science paper, there is extensive scientific evidence that pain and consciousness depend on very specific brain regions, namely specialized neocortex regions of the cerebral hemispheres. These specialized neocortical regions perform the additional levels of neural processing, beyond unconscious nociception, that make the experience of pain possible. These brain regions are absent in fishes and there are no alternative brain systems to perform the same functions. Consequently, there is no neurological basis for assuming that a fish might have a capacity for consciousness or pain. Thus, the burden of proof that trout are conscious and potentially capable of feeling pain remains on these authors. They dealt with this issue only by citing previous studies that also used invalid criteria for pain, such avoidance learning, which actually occurs unconsciously. Only anthropomorphic speculation would lead one to conclude that the trout in this study were experiencing pain.

The behavioral results allegedly showing evidence of pain were misinterpreted.

1. The behavioral studies were done by injecting large volumes of one of three solutions: bee venom, acetic acid solution or saline, into the jaw of rather small trout. For the sizes of the fish used, these injections of liquid would have been equivalent to injecting 100 milliliters (more that 3 ounces) of solution into the lip of a human. Bee venom contains a great variety of toxins that affect the nervous system and cause a hormonal stress response in addition to stimulating receptors signaling tissue injury. In spite of the large dose of venom or acid, the activity level of these fish was not affected, they did not hide under a shelter in the tank and they resumed feeding in less than three hours. Furthermore, fish that received no injection at all or fish that received a saline injection did not feed, on average, for an hour and 20 minutes, showing that a large saline injection produced no more effect than just handling. The acid and venom-injected fish also showed an infrequent rocking behavior that may have reflected a difficulty by the fish in maintaining an upright posture, given the magnitude of the toxic chemical trauma created by the injection. But, even if the infrequent rocking was a response to nociceptive stimulation of the mouth, there is no reason to believe that it is any more than an unconscious nociceptive response, rather than an indication of “pain”.

2. Sneddon and associates also state that the acid-injected fish rubbed their mouths against the gravel (they don’t say how often), but the venom-injected fish did not. They concluded that mouth rubbing was an indication of pain because mammals, including humans, rub injured tissues to alleviate nociceptive input. If so, why did the venom-injected fish, that were also supposed to be in pain, not perform this behavior? In addition, injections of irritants into skin tissues is known to cause hyperalgesia, where skin becomes hypersensitive, like the effect of a sunburn. Who rubs sunburned skin against gravel to alleviate the pain? At one point in the paper, Sneddon and associates say that feeding was suppressed because the fish were avoiding mouth stimulation, which would cause “pain.” But later, they say that mouth rubbing was a way of reducing “pain.” These are contradictory interpretations and you can’t have it both ways. Their interpretations of the mouth-rubbing behaviors don’t make sense nor do they show conscious experience of pain.

3. One of the few effects actually produced by the acid or venom injections was an elevated opercular beat rate (breathing). This response could have resulted directly from gill irritation due to leakage or

blood borne spread of the acid or venom injections, but even if increased opercular beat rate was due to nociceptive stimulation of the mouth, this unconscious movement proves nothing about conscious pain.

4. One caveat regarding the behavioral data described above is the fact that some of the statistical analyses were not done correctly. Data for opercular beat rate and for time to resume feeding were analyzed by one-way analysis of variance, but conclusions were made about specific group differences in these measures. With this type analysis, it is not legitimate to conclude that one group (e.g. acid or venom injected differed from any other group (e.g. handeled or saline injected), but the authors made such conclusions, nonetheless. Given the sizes of the standard errors of the means for these data, however, the group differences reported by the authors would probably have been substantiated following proper statistical analysis.

To summarize, the most impressive thing about the acid and venom injections was the relative absence of behavioral effects, given the magnitude of the toxic injections. How many humans would show little change in behavior or be ready to eat less than three hours after getting a lemon-sized bolus of bee venom or acid solution in their lip? Rather than proving a capacity for pain, these results show a remarkable resistance to oral trauma by the trout. It comes as no surprise, then, that many anglers have had the experience of catching the same fish repeatedly within a span of a few minutes. Of course predatory fishes, including trout, feed avidly on potentially injurious prey like crayfish, crabs and fish that have sharp spines in their fins – which further indicates that these fish are not highly reactive to noxious oral stimuli.

In addition, Sneddon and associates claim to have presented the first evidence for nociceptive sensory receptors in fish, but their results were neither wholly original nor unexpected. In my 2002 Reviews paper, I cited a 1971 study by Whitear that showed the presence of C-fibers in fish. C-fibers are a principal type of nociceptive receptor, so there was very good reason to assume that trout would have nociceptive receptors. Another technical issue arises in the authors' description of their procedure for decerebration of trout in order to make them "insentient." The term sentience is vague and has no standard scientific meaning, but apparently Sneddon, et al. were performing this decerebration in order to eliminate any potential pain that they assumed was within the capacity of the trout. The usual means of producing a decerebration is to remove all brain tissue above the midbrain. According to Sneddon, et. al, however, they removed the "…olfactory and optic lobes and cerebellum…" This is peculiar and counterproductive because the entire pathway for nociceptive information from the periphery through the brainstem to the cerebral hemispheres would have remained intact in these fish, since the "ofactory lobes" but not entire cerebral hemispheres would have been removed according to this description. If fish could feel pain, as the authors contend (and I dispute), these fish probably would have.

The bottom line of this critique is that any attempt to show pain in fish must use valid criteria, including proof of conscious awareness, particularly a kind of awareness that is meaningfully like ours. This is not something that can be taken for granted, because on neurological and behavioral grounds it is so improbable that fish could be conscious and feel pain. Furthermore, the behavioral results of this study show that in spite of very large injections of acid solution or venom, the fish showed little adverse effect, hardly supporting the claim that they were in pain.

I wish to emphasize that the improbability that fish can experience pain in no way diminishes our responsibility for concern about their welfare. Fish are capable of robust, unconscious, behavioral, physiological and hormonal responses to stressors, which if sufficiently intense or sustained, can be detrimental to their health.

Cited reference: Rose, J. D. 2002. The neurobehavioral nature of fishes and the question of awareness and pain. Reviews in Fisheries Science, 10: 1-38. This paper can be obtained in electronic form from the author.

For another neuroscientist's critique of the Sneddon, et al., article, see: http://www.spiked-online.com/articles/00000006DD91.htm