Do Fish Feel Pain?

by Victoria Braithwaite

a review by Spike Cover

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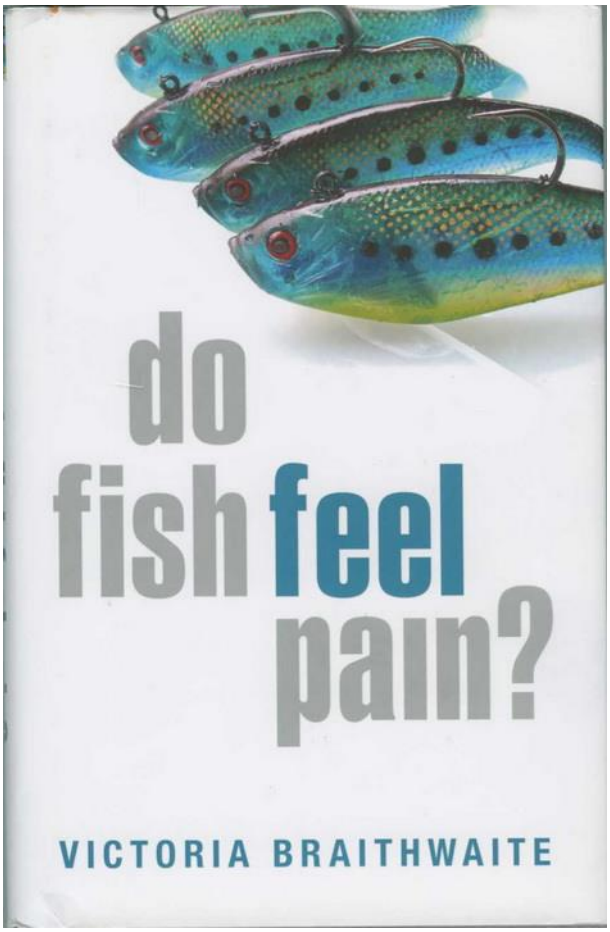

Preface

Victoria Braithwaite had been a bird biologist previously but switched to fish 15 years prior to writing this book. Her stated goal in its writing was to provide a background to promote informed discussion.

Braithwaite authored an Op-Ed piece in the L.A. Times in 2006 on the whether or not fish feel pain. The article created a small media frenzy.

Chapter 1, The Problem

There is a wide variance of opinions on the answer to the question the book's title asks, everything from a definite "yes" to an equally definite "no." In this chapter, Braithwaite surveys the opinions, the possible motivations for those opinions and some of the prior scientific evidence, ethical thinking and legislation that touches on and results from various views about animal welfare. Much of the controversy hinges on the answer to the question, "Do fish have the capacity to suffer?" To answer this question, Braithwaite *et al* wrote grant proposals to investigate a sequence of three questions. They concluded that proceeding to questions two and three would only make sense if the answer to the prior question was "yes." The questions were:

1. Do fish have the necessary receptors and nerve fibers to detect painful events?
2. Does a potentially painful stimulus triggered activity in the nervous system?
3. How does the experience of a potentially painful event affect the behavior of fish and the decisions they make?

In those proposals, the group was obliged to discuss their research with regard to the ethics of animal welfare whose advocates originally focused on five questions:

1. Do the animals have sufficient food and water?
2. Do they have somewhere suitable to rest and shelter?
3. Are they heathy and free from pain and injury?
4. Can they behave normally?

5. Are they able to avoid fear and suffering?

Later the questions were attempted to be simplified to the following [:

1. Is the animal healthy?
2. Does it have what it wants?

Chapter 2 – What Is Pain and Why Does It Hurt?

Braithwaite reviews the probable evolution of damage/injury stimuli and the animal's protective reactions to them and concludes that such stimuli and reactions and are certainly evolutionary advantages and further that their roots are likely quite old. The "old evolutionary roots" leads one to the conclusion that variations of such stimuli and responses can be found in many animals from the lower forms up to and including humans. Scientific inquiry bears this out.

Injury/damage stimuli fall into two general groups: first pain and second pain. The first, the unconscious phase of this process is known as nociception – 'noci' relates to injury or damage and 'ception' refers to perception or detection, so it literally means detection of injury or damage. The second phase is the conscious part where stimuli are transmitted to the brain for processing by the animal's consciousness. So, "Nociception is the unconscious recognition by the nervous system that damage is occurring somewhere, but pain is the emotional sensation that whatever is damaged is hurting."

The pain blocking/relieving properties of opioids were briefly reviewed as they are well known in the animal world. The inference was drawn that verifying opioid blocking of stimuli transmission in fish or other animals would tend to substantiate the existence of a nociception-like system. But, the existence of a capacity to transmit first-pain stimuli does in itself lead to the conclusion that fish "feel" pain. That requires a conscious perception of hurting.

Chapter 3 – Bee Stings and Vinegar: The Evidence That Fish Feel Pain

This chapter is pretty much the meat of the book in that it recounts experiments tailored to answer the title question, gives the results of the experiments and offers discussion on what conclusions may and may not be drawn from those results.

Knowing how pain arises in humans lead Braithwaite and a colleague to speculate on how to conduct experiments to look for similar processes in fish. They searched the literature and found very little relating to the area so they wrote grant proposals outlining a series of tests to answer the three questions described in Chapter 1.

Trout were chosen as the research animal and the grant committee steered the group's research toward pain stimuli in the mouth and head regions of the fish, an obvious link to angling and not farmed fish.

Vertebrate animals (including fish) possess bundles of nerves that transmit injury stimuli for both automatic and conscious processing. Once triggered, the stimuli usually pass to the spinal cord and then to the brain – only after it reaches the conscious portion of the brain is the stimuli able to be felt or experienced. When Braithwaite *et al* examined trout they found that the trigeminal nerve bundle transmits stimuli to the brain stem (not the spinal column but the brain stem acts much as the spinal column relative to noxious stimuli, i.e., triggering a reflex response before the signal is transmitted to other parts of the brain) from the front parts of the fish via:

1. A-delta fibers (larger, insulated, fast transmission) that transmit "first pain," and
2. C fibers (smaller, poorer insulation and slower transmission) that transmit "second pain."

Both types of fibers were found in the trout trigeminal nerve bundles but many less C fibers were found than in other vertebrates, 4% vs. the 50-60% normally found in other vertebrates.

Fish were anesthetized and divided into four groups. Bee venom, vinegar, saline or nothing was injected just under the skin near the mouth of the various groups and the fish were allowed to recover from the anesthesia. Variations in respiration rates and hunger were subsequently observed. Not surprisingly, those with noxious stimuli showed increased respiration rates and depressed hunger levels for a longer time relative to the control groups. At this point, the team felt it had evidence of the presence of pain detectors, evidence that these actively detected tissue damage, this information was transmitted by the trigeminal nerve to the brain and that the fish's behavior was altered as a result. They published their results which again precipitated a large response in lay media.

However, these initial experiments that resulted in variations in normal behavior could be interpreted to be primarily physiological responses, i.e., requiring little or no cognitive processing. So the team devised other experiments to test so called "higher order" behaviors.

Trout have a natural aversion to unfamiliar objects in their environment and show strong avoidance to them initially until they determine they are not a threat. This requires that the trout pay attention and be cognitively aware. The team felt if they could demonstrate that a fish's attention was diverted by noxious stimuli, it would be stronger evidence that fish feel pain.

Experiments were conducted in which two groups of trout were anesthetized and injected with either saline or vinegar then allowed to recover before a novel object (a brightly colored Lego brick tower) was placed a certain distance from their head. The results showed that the saline treated fish showed a strong avoidance response while the vinegar treated fish moved quite close to the tower during about 1/3 of the trial time.

To verify that the noxious stimuli were diverting the fishes' attention, the group repeated the experiments as before except in addition to the vinegar or saline, each fish received a small dose of opiate morphine. As expected, the vinegar-treated fish showed a more normal avoidance response and in fact there was no difference in the avoidance behavior between the

saline and the vinegar treated groups. This was the most direct evidence yet that fish really perceive and experience pain. Being cognitively aware of tissue damage is what is generally meant by *feeling* pain.

Braithwaite's group continued their literature search and found several groups that had done experiments similar to theirs and with similar results. This lent credibility to their findings.

Chapter 4 – Suffer the Little Fishes?

Avoiding animal suffering is a primary motivation for improving animal welfare. It is argued and well accepted that suffering requires consciousness. In attempting to determine if fish have the capacity to suffer, Braithwaite's group explored the consciousness of fish. They used the three categories of consciousness previously identified by Ned Block of New York University, these included:

1. Primary consciousness, the ability to think about a mental state either current or associated with a memory;
2. Phenomenal consciousness, the experience of sensing what's around you and the feelings and emotions generated by what you detect; and
3. Monitoring consciousness and self-consciousness, the experience of thinking about one's own actions and the ability to play out, and reflect on, different potential scenarios.

Again a literature search provided answers to some of the questions about whether or not fish possess abilities in the three categories above. Maze navigation and remembering ranked fighting abilities of other fish experiments provided ample evidence that fish possess primary consciousness abilities.

To explore the second category, which is tightly linked to sentience, it needed to be determined that fish have the ability to experience emotions. In humans, the limbic system has been found to affect our emotional behavior. There is a simpler but roughly equivalent system in fish that is located in the same parts of the fish brain as in the human brain but those parts are situated differently in the actual structure of the brain.

Spanish scientists discovered that fish brains, compared to their land-dwelling relatives, appear inside out, i.e., the amygdala-like and hippocampus-like parts of fish brains that are located on the outside and in the front of their brains are located on the inside of mammalian brans. The following illustration shows this difference.

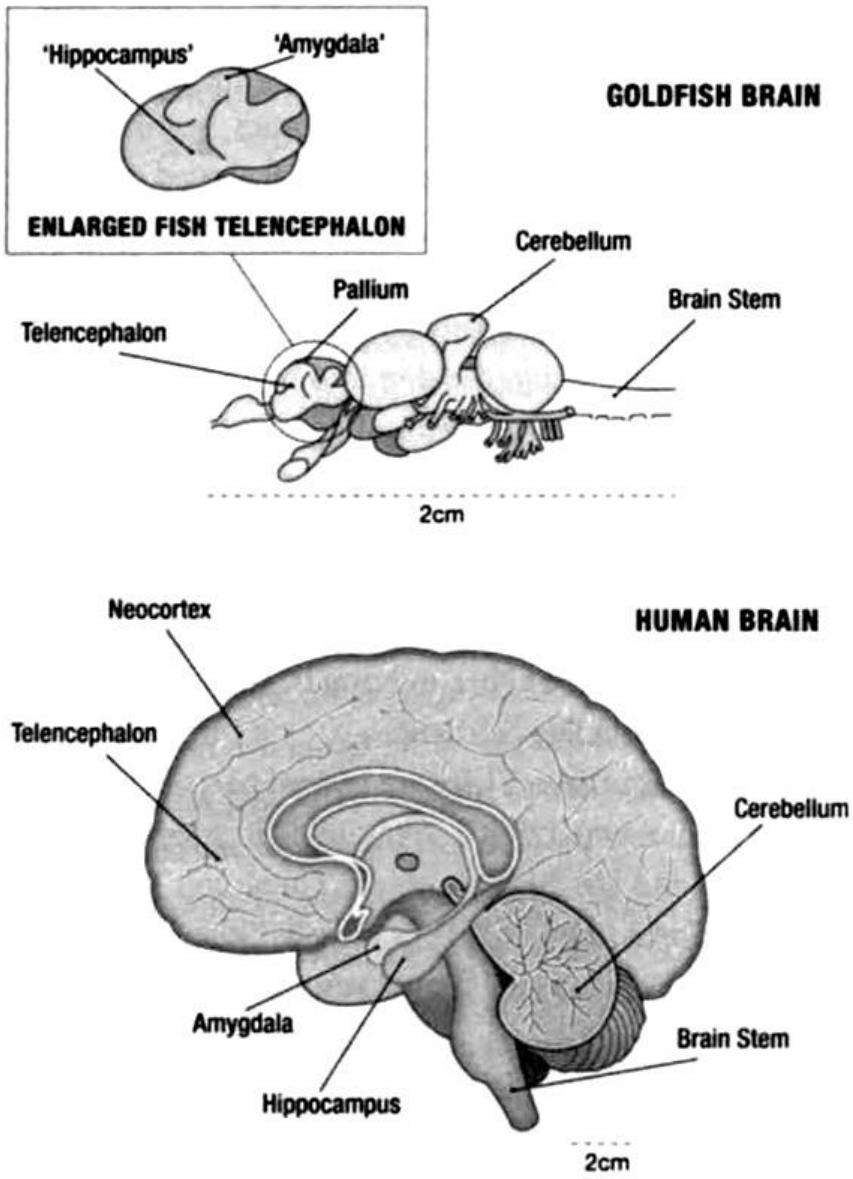

Figure 1 Schematic drawing comparing a human brain to that of a goldfish brain. The human brain is drawn with the external neocortex of the temporal lobe removed to reveal the hippocampus and the amygdala underneath. The Goldfish brain telencephalon has been redrawn to a larger scale on the left to allow the 'hippocampus' and 'amygdala' regions to be labelled.

Further, the Spanish scientists discovered that when the hippocampus-like area was surgically damaged, the fish had difficulty swimming through a maze that they could readily navigate prior to surgery but could still learn to avoid electric shocks. Conversely, goldfish with their

amygdala-like areas surgically rendered inoperative could still solve maze problems but not learn to avoid electric shocks.

The foregoing coupled with the establishment of dopaminergic connections within the fish forebrain lead Braithwaite to the conclusion that showing that fish have a specialized area to process negative, fear-related stimuli was a major finding [presumably in the search of the answer to the title question].

Then the author recounts experiments, conducted by others, with trout and goldfish where in certain parts of test tanks, the fish are given electric shocks. All the fish learn to avoid those areas. However trout, who have a tendency to desire the company of other trout, would swim into the shock area in order to be near other trout while goldfish would not endure shocks in order to be near other goldfish. This demonstrated the situation was being evaluated by the fish, trade-offs were being evaluated and the trout and the goldfish came to different conclusions.

The author then goes on to examine the unusual relationship observed between some groupers and moray eels where the groupers sometimes enlist the help of the eels to root out pray-fish from coral reef, the grouper and the eel each getting a meal roughly half the time. Braithwaite concluded from this that at least some fish possess Block's third level of consciousness, that of experiencing the thinking about their own actions and an ability to play out, and reflect on, different potential scenarios.

By the end of this chapter, the author writes, "On balance then, fish have the capacity for some forms of conscientiousness and so I therefore conclude that they have the mental capacity to feel pain."

Chapter 5 –Drawing the Line?

In this chapter and based on the evidence presented and the conclusions drawn previously by the author, she again concludes that fish have the cognitive capacity to experience emotions and that the interactions of the grouper and the eel are evidence that fish are also self-aware. [Reviewer's note: I don't see this last conclusion.] She then proposes that, based on her conclusion that fish have the capacity to suffer, society should extend welfare concerns to fish much as they do to mammals and birds.

She then asks, if we draw a line for the capacity to suffer under fish, where exactly should that line be drawn? In Braithwaite's judgment, the line is drawn below the ability to be sentient.

Experiments with, and observations of, crustaceans and cephalopods are reviewed with the question of their possible sentience being left undecided in the author's mind.

Chapter 6 – Why It Took So Long to Ask the Fish Pain Question--and Why It Must Be Asked

This chapter is a review of the author's opinions and speculations about the two parts of the chapter title questions. In regard to why it took so long to ask the question, she speculates that there are likely several reasons:

- We see fish as being very different from humans and even from mammals and birds,
- The scientific community has viewed and referred to fish as a "lower" or more "primitive" species,
- The only relatively recent advent of intensive animal farming and mechanized ocean fishing and the attendant perceived apparent increased suffering of the animals involved, and
- The worry anglers have that the fish-pain issue will eventually curtail their hobby.

The author's answer to why the question must be asked is because it's important to the author and others as it allows them and us to make more informed decisions.

Chapter 7 – Looking to the Future

In this chapter, the author reviews the evidence presented earlier in the book and draws the conclusion that based on past actions and current trends and the belief that fish have the capacity to feel pain and therefore suffer, this will likely lead to government regulations attempting to limit that suffering. She warns about moving too quickly without sufficient science-based evidence to support such regulations, however, she accepts the premise that governments can and should promulgate such regulations.

Braithwaite discusses briefly the fact that different species of fish need different things to promote their welfare, e.g., cod need to explore the bottom and edges of their environment while open-ocean fish have no such need.

She also reviews the practices that result in potential suffering, collateral damage or waste commonly known as by products, and other destructive practices associated with marine fisheries and aquaculture. Additionally she reviews the voluntary changes adopted by commercial fishermen and aquaculturists. She believes that some of the changes were done as a result of consumer pressure to adopt what are viewed as more humane treatment of food animals and some are simply economic decisions relating to the quality and quantity of the product produced.

Braithwaite concludes this way:

> The experiments and results presented in the first part of the book provide enough evidence to answer to the question posed in the title—"Do Fish Feel Pain?" Yes, they do…[However,] there is a lot more to learn about what fish need

to promote their welfare…Most importantly, we must proceed carefully with creating laws and guidelines, making sure we do so in an informed way…Knowledge, education and open minds are surely our best guides through this uncharted territory.

Book Details

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Reviewer's comments

Braithwaite makes a compelling case that fish do feel pain. So at least in my mind, that question is behind us, they do. That said and as she is quick to point out, many questions remain as yet unanswered. And in my opinion, one of the biggest questions is how much do they suffer and with what types of pain. The evidence that fish are affected by pain does little to quantify the effect in terms of discomfort. Consider findings like the ones Braithwaite *et al* reported where the C fibers (transmitters of "second pain") in the trigeminal nerve bundles of trout were only about 4% of the bundle compared to 40-50% normally found in other vertebrates. This could easily prompt the question, "Is this indicative of a lesser perceived sensation being transmitted and processed by the fish's brain?"

For those who think that humans should not intentionally contribute in any significant way to animal suffering, there probably needs to be some quantification of this so "significant" can be assessed. Does an animal suffer if it doesn't have its optimally preferred environment or food, and if so, when can these off-optimal conditions be considered cruel? I think we can probably all agree that dropping a fish in a pot of boiling water or cutting it in half while it's still alive and conscious likely results in suffering near the maximum possible for a fish. However, what degree of discomfort or suffering are caused by lesser insults and how can we know or infer this?

Then there is the argument that we should probably err on the side of caution knowing that fish do feel pain. In this regard, unless and until the government gets involved, we all need to make our own decisions. For anglers, barbless and appropriately sized hooks are a step in the right direction, as is wetting hands before handling the fish. Knowing fish do feel pain will certainly effect my decisions. If I'm involved with invasive procedures, I'll try to see that some pain relief is available and used, e.g., tramadol.