Do
Fish
Feel
PAIN?

NO! According to Dr. James D. Rose, professor of zoology and physiology at the University of Wyoming. He has been working on questions concerning neurology for about 30 years.

Here is Dr. Rose's primer on his academic paper that appeared in **Reviews of Fisheries Science*.***

Dr. Rose concludes that the brains of fish are not sufficiently developed to allow them to sense pain or fear.

How does this affect PETA and other anti-fishing activists?

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Do Fish Feel Pain?

By Dr. James D. Rose, University of Wyoming

Do fish, like humans, experience pain and suffering? People hold very differing beliefs about this question. Some would believe that if fish react to stimuli that would cause a person to feel pain that the fish must also be feeling pain. Others assume that fish are too different from humans for the matter to be of concern. Many people don't know quite what to think about the issue. Neuroscience research has clarified the neurological and psychological processes that cause the experience of pain, so we can address this question from a large base of factual information.

Pain is a psychological experience that is separate from behavioral reactions to injurious stimuli

It has become very clear that pain is a psychological experience with both a perceptual aspect and an emotional aspect. The perceptual aspect tells us that we have been injured, like the first sensation when you hit your thumb with a hammer. The emotional aspect is separate as in the suffering that follows after we are first aware of hitting our thumb. But, injurious stimuli do not always lead to the experience of pain. Think of a trip to the dentist. When a dentist injects a local anesthetic into your jaw to block nerve conduction, some of your teeth and a part of your mouth feel numb. When a tooth is then drilled, the sensory nerve cells in the tooth that would normally trigger pain are still excited, but the nerve block prevents activity in these receptors from being sent to the brain, so pain is not felt. In addition, a person's behavioral reaction to pain is separate from pain experience. We see this separation when a person endures pain without showing any discomfort. On the other hand, people sometimes react behaviorally to injury without any feeling any experience of pain or suffering. This kind of separation between behavioral and psychological responses to injury results from certain forms of damage of the brain or spinal cord. Because the experience of pain is separate from the behavioral response to injury, the term nociception is used to refer to detection of injury by the nervous system (which may or may not lead to pain). Injurious stimuli that usually lead to pain experience are called nociceptive stimuli. The term pain should be used only to refer to the unpleasant psychological experience that can result from a nociceptive stimulus.

Reactions to injury are present in all forms of animal life but these reactions do not mean that pain is experienced-it is not necessary for a nociceptive stimulus to be consciously experienced for a behavioral reaction to occur

In humans, reactions to nociceptive stimuli are usually associated with feelings of pain. Consequently, humans often assume that reactions by animals to nociceptive stimuli mean that these animals experience similar pain. In reality, reactions to nociceptive stimuli are protective responses that can occur in forms of life that are incapable of perceiving pain. The ability to detect and react to nociceptive stimuli is a widespread characteristic of animal life. Single-celled creatures such as an ameba will move away from irritating chemical or mechanical stimuli. These reactions are automatic and because the ameba doesn't have a nervous system, it has no ability to actually sense the stimulus that causes its reaction or to feel pain. There are many other invertebrate organisms (animals without backbones) that also react to nociceptive stimuli, but with somewhat more complex patterns of escape than an ameba. For example, starfish have a primitive nervous system that interconnects sensory receptors detecting injurious stimuli with muscle cells that cause movements, enabling the starfish to slowly move away from a nociceptive stimulus. The starfish's nervous system has only a small number of nerve cells. It has no brain, so like the ameba, its reactions are not very precise or complex and it can't experience, in the way of humans, the stimuli that trigger its reactions. Thus, protective reactions don't require very complex nervous systems and can occur in animals incapable of perceiving, that is being aware of, the stimuli that cause such reactions.

In vertebrates, reactions to injurious stimuli are controlled by the spinal cord and brainstem

Vertebrates generally have more complex nervous systems than invertebrates and vertebrates have a clearly developed brain. This brain receives information from the spinal cord about nociceptive stimuli that contact the body surface. Working together with the spinal cord, the brain generates rapid, coordinated responses that cause the organism to escape these stimuli. These automatically generated responses include withdrawal of the stimulated body part, struggling, locomotion and in some animals, vocalizations. All of these responses are generated by the lower levels of the nervous system, including the brainstem and spinal cord.

Human existence is cerebrally-dominated;
A fish's existence is brainstem-dominated

Human existence is dominated by functions of the massively developed cerebral hemispheres. Fishes have only primitive cerebral hemispheres and their existence is dominated by brainstem functions. The brains of vertebrate animals differ greatly in structural and functional complexity. Cold-blooded animals, such as fish, frogs, salamanders, lizards and snakes, have simpler brains than warm-blooded vertebrates, the birds and mammals. Fish have the simplest types of brains, of any vertebrates, while humans, have the most complex brains of any species. All mammals have enlarged cerebral hemispheres that are mainly an outer layer of neocortex. Conscious awareness of sensations, emotions and pain in humans depend on our massively-developed neocortex and other specialized brain regions in the cerebral hemispheres. If the cerebral hemispheres of a human are destroyed, a comatose, vegetative state results. Fish, in contrast, have very small cerebral hemispheres that lack neocortex. If the cerebral hemispheres of a fish are destroyed, the fish's behavior is quite normal, because the simple behaviors of which a fish is capable (including all of its reactions to nociceptive stimuli) depend mainly on the brainstem and spinal cord. Thus, a human's existence is dominated by the cerebral hemispheres, but a fish is a brainstem-dominated organism.

The capacity to perceive and be aware of sensory stimuli, rather than just react to such stimuli requires a complex brain. In humans, the cerebral hemispheres, especially the neocortex, is the functional system that allows us to be aware of sensory stimuli. If the cortex of the human brain is damaged or made dysfunctional, we lose our awareness of sensations. For example, damage of the visual part of the cortex causes blindness, even though vision-related sensory activity is still occurring in subcortical parts of the brain. If the neocortex is widely damaged we lose our capacity to be aware of our existence in general. This loss of awareness occurs in spite of the fact that the levels of our nervous system below the cerebral hemispheres, the brainstem and spinal cord, can still be functioning and processing signals from sensory stimuli, including injurious stimuli. In a fish, “seeing” is performed by the brainstem and occurs automatically without awareness. Consequently, a fish’s visual behavior is quite normal if the small cerebral hemispheres are removed, but a human is blind if the visual cortex region of the cerebral hemispheres is destroyed. This is because our visual behavior depends greatly on conscious awareness of visual sensations.

In spite of our unawareness of brainstem functions, the brainstem and spinal cord contain programs that control our more automatic behavioral functions. Smiling and laughter, vocalizations, keeping our balance, breathing, swallowing and sleeping are all processes that are generated by these lower, brainstem and spinal cord programs.

Fish do not have the brain development that is necessary for the psychological experience of pain or any other type of awareness

The experience of pain depends on functions of our complex, enlarged cerebral hemispheres. The unpleasant emotional aspect of pain is generated by specific regions of the human cerebral hemispheres, especially the frontal lobes. The functional activity of these frontal lobe regions is closely tied to the emotional aspect of pain in humans and damage of these brain regions in people eliminates the unpleasantness of pain. These regions do not exist in a fish brain. Therefore, a fish doesn’t appear to have the neurological capacity to experience the unpleasant psychological aspect of pain. This point is especially important, because some opponents of fishing have argued that fish are capable of feeling pain because some of the lower, subcortical nervous system pathways important for nociception are present in fish. Obviously this argument has no validity because without the special frontal lobe regions that are essential for pain experiences, lower pathways alone can’t produce this experience. The rapid, well-coordinated escape responses of a fish to nociceptive stimuli are generated automatically at brainstem and spinal cord levels but, if a fish’s brainstem and spinal cord work like a humans (and it is very likely that they do) there is no awareness of neural activity occurring at these levels.
It might be argued that fish have the capacity to generate the psychological experience of pain by a different process than that occurring in the frontal lobes of the human brain, but such an argument is insupportable. The capacity to experience pain, as we know it, has required the massive expansion of our cerebral hemispheres, thus allocating large numbers of brain cells to the task of conscious experience, including the emotional reaction of pain. The small, relatively simple fish brain is fully devoted to regulating just the functions of which a fish is capable. A fish brain is simple and efficient, and capable of only a limited number of operations, much like a 1949 Volkswagen automobile. By comparison, the human brain is built on the same basic plan as that of a fish, but with massive expansions and additional capacities. The human brain is more like a modern luxury car with all-wheel drive, climate control, emission controls, electronic fuel injection, anti-theft devices and computerized systems monitoring. These refinements and additional functions couldn’t exist without massive additional hardware. The massive additional neurological hardware of the human cerebral hemispheres makes possible the psychological dimension of our existence, including pain experience.

There are also huge differences between mammals in the degree of complexity of cerebral hemisphere development, especially within the frontal lobes. The brains of predatory mammals are typically larger and more complex than brains of their prey. For example, the brains of sheep and deer have a tiny fraction of the frontal lobe mass that is present in humans, making it probable that the kinds of psychological experience of these animals, including pain, is quite different from human experience.

The reactions of fish to nociceptive stimuli are similar to their reactions to predators and other non-nociceptive stimuli

When a fish is hooked by an angler, it typically responds with rapid swimming behavior that appears to be a flight response. Human observers sometimes interpret this flight response to be a reaction to pain, as if the fish was capable of the same kind of pain experience as a human. From the previous explanation, it should be clear that fish behavior is a result of brainstem and spinal patterns of activity that are automatically elicited by the stimulation of being hooked, but that fish don't have the brain systems necessary to experience pain. It is very important to note that the flight responses of a hooked fish are essentially no different from responses of a fish being pursued by a visible predator or a fish that has been startled by a vibration in the water. These visual and vibratory stimuli do not activate nociceptive types of sensory neurons so the flight responses can't be due to activation of pain-triggering neural systems. Instead, these flight responses of fish are a general reaction to many types of potentially threatening stimuli and can't be taken to represent a response to pain. Also, these flight responses are unlikely to reflect fear because the brain regions known to be responsible for the experience of fear, which include some of the same regions necessary for the emotional aspect of pain, are not present in a fish brain. Instead, these responses are simply protective reactions to a wide range of stimuli associated with predators or other threats, to which a fish automatically and rapidly responds.

Although fish don't have the capacity to experience human-like pain or suffering, their reactions to nociceptive stimuli or capture are still important because these reactions include the secretion of stress hormones. These stress hormones can have undesirable health effects on fish if they are secreted in large amounts over a long period of time. So, it's important when practicing catch-and-release fishing to observe the usually recommended procedures of landing a fish before it is exhausted and returning it to the water quickly.

The facts about the neurological processes that generate pain make it highly unlikely that fish experience the emotional distress and suffering of pain. Thus, the struggles of a fish don't signify suffering when the fish is seized in the talons of an osprey, when it is devoured while still alive by a Kodiak bear, or when it is caught by an angler.

Further reading

Much of the evidence supporting the conclusions of this paper is found only in specialized neuroscience literature. The references designated by * are more appropriate for the interests of non-specialist readers wishing to know more about species differences in brain function or the bases of conscious awareness of experiences, including pain.

*Allman, J. 1998. Evolving brains. Scientific American Library: New York

Butler, A. B. and Hodos, W. 1996. Comparative vertebrate neuroanatomy: Evolution and adaptation. Wiley-Liss: New York.

Craig, K.D. 1994. Emotional aspects of pain. In P.D. Wall & R. Melzack (Eds.), Textbook of Pain, 3rd Ed (pp. 261-274). Churchill Livingston: Edinburgh.

Davis, R. E. and Kassel, J. 1983. Behavioral functions of the teleostean telencephalon. In R. Davis and G. Northcutt (Eds.) Fish neurobiology. Vol. 2. Higher brain functions. (pp. 237-264). University of Michigan Press: Ann Arbor.

*Donald, M. 1991. Origins of the modern mind. Harvard University Press: Cambridge.

Jouvet, M. 1969. Coma and other disorders of consciousness. In P.J. Vinken & G.W. Bruyn (Eds.) Handbook of Clinical Neurology, Vol. (3) (pp. 62-79). New York: Elsevier Science Publishers.

Kandel, E. R., Schwartz, J. H. and Jessel, T. M. 2000. Principles of neural science. McGraw-Hill: New York.

*Kennedy, J. S. 1992. The new anthropomorphism._Cambridge University Press: Cambridge.

*Kolb, B. and Whishaw, I. Q. 1995. Fundamentals of human neuropsychology. W. H. Freeman: New York.

Libet, B. 1997. Consciousness: neural basis of conscious experience. G. Adelman and B. H. Smith (Eds.), The encyclopedia of neuroscience. Elsevier: Amsterdam. CD ROM

*Macphail,-Euan-M. 1998. The evolution of consciousness. Oxford University Press: New York.
Melzack, R., and Fuchs, P.N. 1997. Pain, general. In G. Adelman & B. Smith (Eds.) Encyclopedia of Neuroscience. Elsevier: Amsterdam. CD ROM.

Nieuwenhuys, R., ten Donkelaar, H. J. and Nicholson, C. 1998 The central nervous system of vertebrates. Springer: Berlin

Overmier, J.B. and Hollis, K. 1983. The teleostean telencephalon and learning. In R. Davis and G. Northcutt (Eds.) Fish neurobiology. Vol. 2. Higher brain functions. (pp. 265-284). University of Michigan Press: Ann Arbor.

Preuss, T. M. 2000. What's human about the human brain? In M. S. Gazzaniga (Ed.), The new cognitive neurosciences. (pp. 1219-1234). MIT Press: Cambridge.

Treede, R.-D., Kenshalo, D. R., Gracely, R. H. and Jones, A. K. P. 1999. The cortical representation of pain. Pain. 79/105-111.

Wall, P.D. 1987. Pain: Neurophysiological mechanisms. In G. Adelman & B. Smith (Eds.) Encyclopedia of Neuroscience. Elsevier: Amsterdam. CD ROM.

Wulliman, M. F. The central nervous system. 1998. In D. H. Evans (Ed.) The Physiology of Fishes. (pp. 245-282). CRC Press: Boca Raton

Young, G. B., Ropper, A. H. and Bolton, C. F. 1998. Coma and impaired consciousness. McGraw-Hill: New York.

Xu, X., Fukuyama, H., Yazawa, S., Mima T., Hanakawa, T., Magata, Y., Kanda, M., Fujiwara, N., Shindo, K., Nagamine, T., and Shibasaki, H. 1997. Functional localization of pain perception in the human brain studied by PET. NeuroReport, 8/ 555-559.

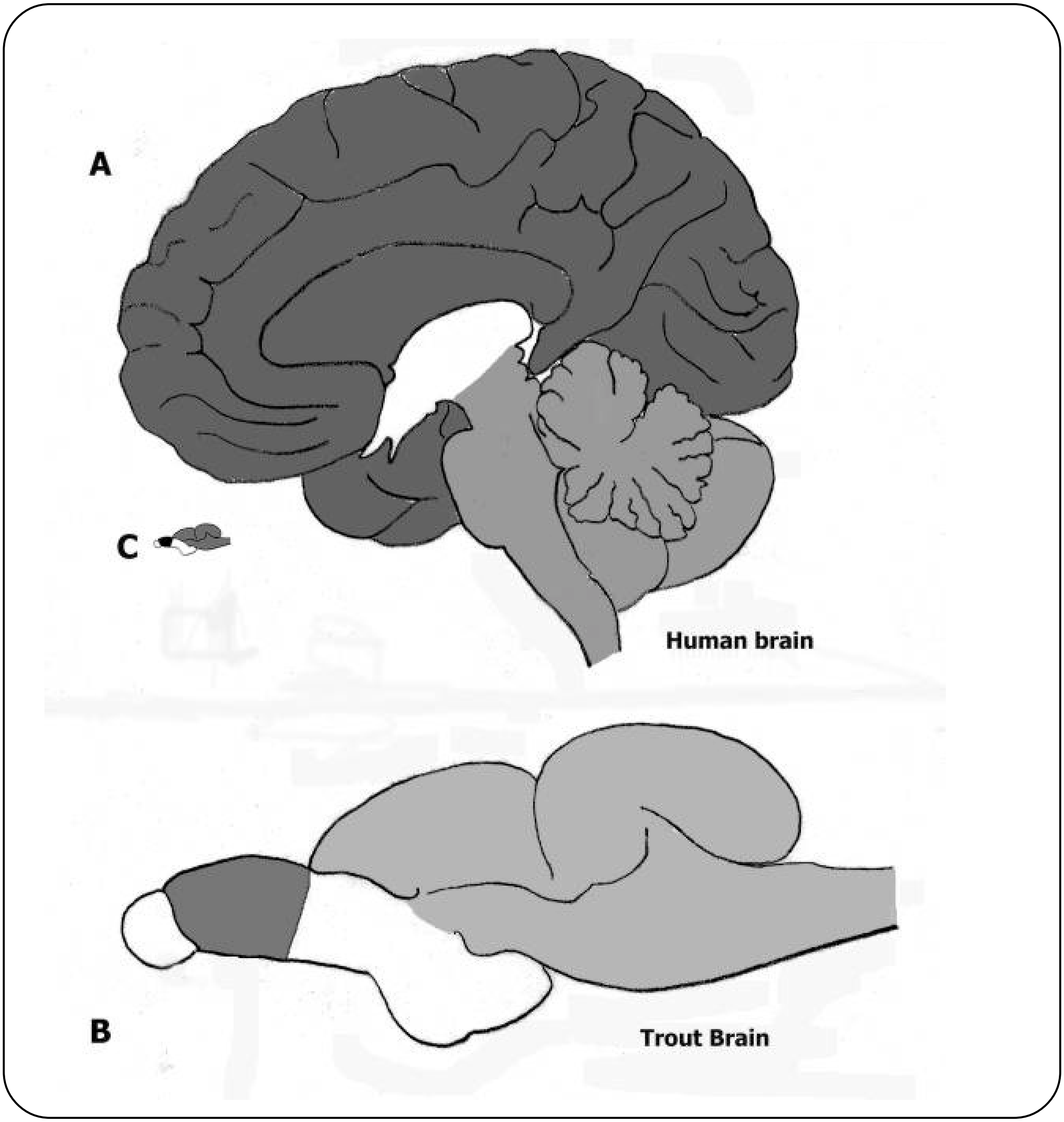

Figure 1. Comparison of human brain with a trout brain. ***A.*** Diagram of a midline view of the human brain. The cerebral hemisphere is shaded in darker gray and the brainstem is in lighter gray. ***B.*** Diagram of a midline view of a rainbow trout brain. The cerebral hemisphere (darker gray) is very small relative to the size of the brainstem (lighter gray). The white region at the left of the cerebral hemisphere is the olfactory bulb, which processes odor information. The olfactory bulb of a trout and many other fishes is large compared to the size of the brain as a whole, but the olfactory bulb in humans is relatively small. ***C.*** Diagram of the brain of a 12-inch rainbow trout shown at the same scale as the human brain diagram.

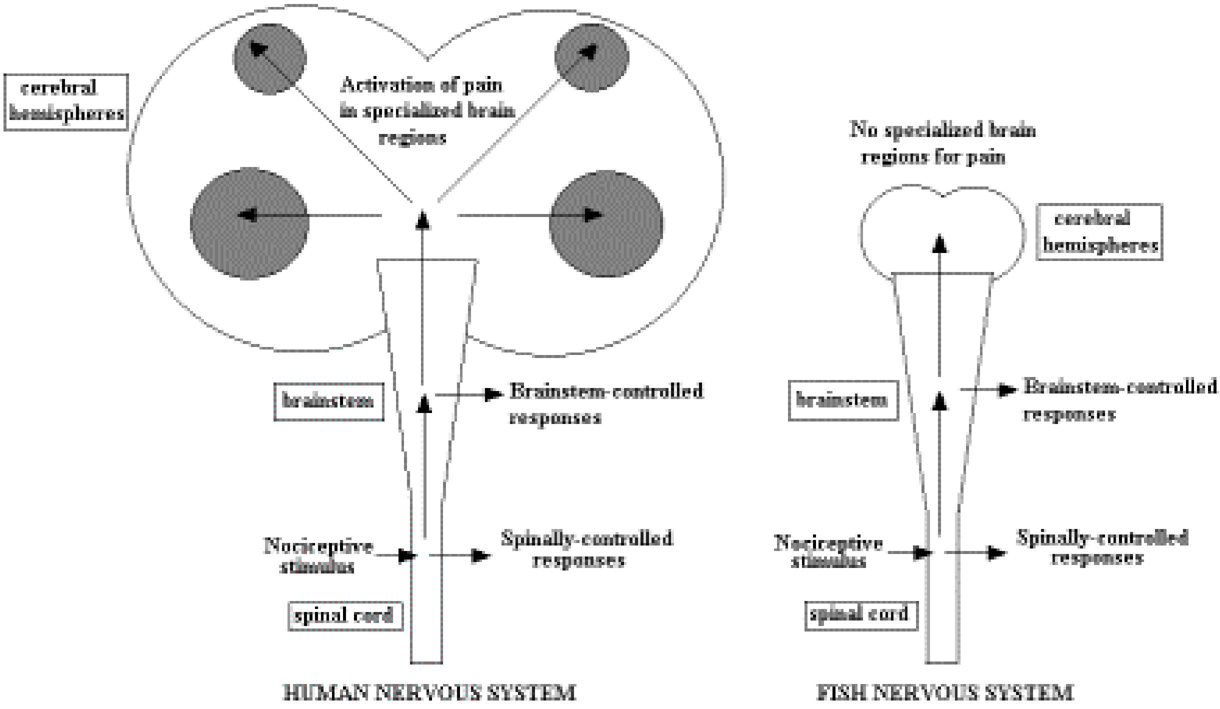

Figure 2. The diagram on the left shows the basic regions of the human central nervous system, the large cerebral hemispheres, the brainstem and the spinal cord. Injurious sensory stimuli (nociceptive stimuli) on the body surface activate receptor neurons, which conduct that neural activity to the spinal cord. At the spinal cord level, some protective reactions are generated, including withdrawal of the stimulated body part and some aspects of locomotion. The nociceptive activity is transmitted to the brainstem where additional protective reactions are generated, including turning toward the stimulus, fully-developed locomotor and avoidance responses and vocalizations. The nociceptive activity is transmitted from the brainstem to certain parts of hemispheres cerebral where it activates conscious awareness of the nociceptive stimulus and generates the emotional unpleasantness of pain. Until the neural activity reaches the cerebral hemispheres, the reactions to the nociceptive stimulus are not consciously experienced, that is they are not associated with a feeling of pain. The fish central nervous system, shown on the right, consists of a simpler version of spinal cord and brainstem, with only very small and primitive cerebral hemispheres. The neural functions that generate behavioral responses to a nociceptive stimulus are much the same at the spinal cord and brainstem levels as in a human. But, because the fish cerebral hemispheres lack the regions necessary for conscious awareness and for generation of pain experience, there is no pain associated with the brainstem and spinally-generated behavioral reactions.