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Are fish the victims of 'speciesism'? A discussion about fear, pain and animal consciousness

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Abstract Fish welfare is currently a hotly debated topic; this is mainly due to the issue of whether or not fish have the capacity for conscious awareness, or subjective states. Because of the contentious nature of animal consciousness, the subject is often avoided in many welfare arguments, but it is argued that since welfare should be about how animals feel, this issue is unavoidable. There is also good reason to believe that the issue of assessing subjective states is not as insurmountable as some believe.

Keywords Fish · Fear · Pain · Consciousness · Animal welfare · Speciesism

Introduction

What is animal welfare?

The scientific community has a difficult time discussing animal welfare matters mainly because there is no exact or universal definition of 'animal welfare' (Duncan 2002). Part of the problem is that there are many approaches to animal welfare science, although the two dominant approaches are the 'biological functioning school' and the 'feelings school'. The biological functioning school suggests that welfare equates to the lack of large physiological stress responses and good physical health. The feelings school proposes that welfare is really about psychological health and how the animal feels (Duncan 2005). Then there are some that take both aspects into consideration. Broom (1998) believes that welfare encompasses "…bad as well as good states and measured by disease, immnosuppression, injury, and abnormal behavior and physiological indicators of comfort, satisfaction, or pleasure and indications of control and social support". Similarly, the OIE considers both schools of thought as they think that "an animal is in a good state of welfare if (as indicated by scientific evidence) it is healthy, comfortable, well nourished, safe, able to express innate behaviour and it is not suffering from unpleasant states such as pain, fear and distress…" (OIE 2010, Article 7.1.1 of the Terrestrial Animal Health Code). Hence, animal welfare scientists struggle to define 'animal welfare'. However, when asked to use a common-sense approach, most people's description of 'animal welfare' is strikingly similar. In surveys of schoolchildren to graduate students to arrays of lay audiences asked to give examples of animals with poor welfare, Duncan (2002) found that responses were consistently alike and comprised of answers such as an animal that is "ill", "in pain", "frightened", "frustrated", "bored". Answers to examples

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of poor welfare did not consist of phrases such as "an animal that is showing high levels of cortisol" or "has a significant white blood cell count". When people express concern about animal welfare, it is the conscious experiences of suffering (like pain and fear) that worry them most (Dawkins 1998). If it were not for this psychological component, welfare would not matter. For instance, plant producers worry about the health and growth of their tomatoes in the way a pet owner would worry about the health and growth of his puppy, but it is the belief that dogs are sentient (i.e. have the ability to consciously experience suffering and well-being) that the pet owner may be concerned about his dog's welfare; by contrast, the concept of tomato welfare is nonsense. As Dawkins (1998) put it, "If "welfare" just means "health", then isn't animal welfare simply veterinary science or animal health studies under another name?" Duncan and Dawkins (1983) defined 'suffering' as 'a wide range of unpleasant emotional states' and suggested a broad working description of 'welfare' as that which included the notions of mental and physical health, being in harmony with the environment, being able to adapt without suffering to an artificial environment and somehow taking into account the animal's feelings.

Fish welfare from the feelings perspective

The topic of fish welfare has recently attracted much attention. In fact, the European Food Safety Authority (2010) has recently come out with several documents concerning transport, husbandry and slaughter of an array of farmed fish species. This is because many handling methods, husbandry procedures and management practices in aquaculture can potentially cause pain and fear and therefore reduced welfare. Because welfare should be about how an animal 'feels' rather than how healthy it is or how well it biologically functions, a main point of contention has been the issue of whether or not fish have the capacity to experience mental subjective states, like pain and fear. Thus, two main camps have resulted—those who believe that the feelings-based approach to welfare should not be applied to fish (Arlinghaus et al. 2007) because they lack some neuroanatomical structures, which in humans are associated with conscious subjective states (Rose 2002) and those who believe that fish have the mental capacity as well as the neurological and physiological apparatus that enables them to suffer from negative subjective experiences (Chandroo et al. 2004a, b).

During this debate, it has been noted that fish have a host of cognitive abilities that aid in negotiating different types of aversive situations (Beukema 1970; Gallon 1972; Lima and Dill 1990; Overmier and Hollis 1990; Pyanov 1993; Chivers and Smith 1998). Although some of their cognitive feats are impressive, it is still valid to question whether aversive situations may be accompanied by negative conscious experiences. Basically, do fish show purely 'reflexive' avoidance responses to negative stimuli, or is their avoidance behaviour sometimes motivated by fear? Some would contend that this question cannot be answered due to the fact that it is impossible to directly measure intangible conscious thoughts. Therefore, because of the contentious and somewhat subjective nature of animal consciousness, this topic is often purposely avoided in many welfare arguments (Arlinghaus et al. 2007). However, it is not possible to engage in an in-depth discussion of fish welfare issues without taking into account the feelings-based approach to animal welfare (Duncan 2004), which does attempt to measure and assess (albeit using indirect methods) mental phenomena such as subjective states.

The conundrum of consciousness

The topic of consciousness has had a tumultuous history ranging from Behaviourism's[1] reluctance to accept it as a legitimate scientific subject (see for example James 1904; Watson 1928; Skinner 1975) to the modern resurrection of animal consciousness as an unavoidable issue in the study of animal welfare science (see for example Dawkins 2000; Duncan 2004). It is only in the past 30 years that words like 'consciousness' and 'sentience' have reappeared in the scientific animal literature. Hence, we are only slowly overcoming the taboo of studying conscious thought processes and voluntary behaviour (as

[1] Behaviorism: an approach in psychology (which predominated in the mid 1900s) that believed only in the study of visible and quantifiable aspects of behaviour and rejected subjective experiences such as emotions, motivation or conscious thought processes.

opposed to reflexive or 'instinctive' responses). After centuries of debate about animal consciousness, one would think we should have a better understanding, yet this does not always appear to be the case (Dawkins 2001). Part of the problem is that 'consciousness' is an ambiguous term. It can refer to a physical waking state (i.e. not asleep or comatose), a sensory experience (i.e. being aware of moment to moment events) or the possession of any mental state (i.e. having beliefs, fears, intentions, desires, etc.) (Zeman 2001). Damasio (1999) defined 'extended consciousness' as something that provides the organism with a complex sense of self, ability to think about one's own thoughts, awareness of others and others' minds, ability to ponder about past and the future; it is extended consciousness at its pinnacle that is distinctively human. Whereas when mentioning animal consciousness, we are generally referring to what's known as 'core consciousness', a type of basic sense of self in the immediate moment that is not dependent on reasoning or language. It is this type of simple awareness of one's own state of being that is of interest in teleost fish.

As difficult as this may be, the study of animal welfare science forces scientists to come to grips with this mysterious issue on a daily basis, because subjective experiences such as pain, fear, frustration and pleasure are inextricably linked to welfare. Interestingly, some scientists still seem unable to break free from the ancient Cartesian view of man as intrinsically unique, blessed with a conscious mind, while animals are mindless automatons. Gallup (1985) boldly stated that the only thing defining man as special or even rational is man himself. He also went on to say that our sympathetic tendencies are generally prejudiced depending on whether animals are considered as pests or pets, attractive or ugly, cuddly or slimy or homeothermic versus poikilothermic. The last example of 'cold-bloodedness' is used routinely as a reason why it is often doubted that fish may be capable of subjective experiences as mammals are. However, homeothermy is merely a metabolic distinction, not a psychological one (Gallup 1985); why this obvious fact of thermoregulatory physiology would count as evidence against fish consciousness is quite curious. Upon close examination, all of the above characteristics are unfounded when it comes to animal consciousness. Mendl (2004) shares Gallup's view when he wrote of the human 'speciesist' tendency of attributing human-like conscious abilities to animals more similar to ourselves, than to phylogenetically more distant species even when identical behaviour is displayed. One problem is that most people are content dealing with issues of animal mind based on emotional, preconceived beliefs rather than logical reason. The other problem is the crux of the issue, notably that consciousness is essentially a subjective private experience and as such is not open to observation or empirical measurement. Because one can never access the experiences of anyone else except for their own, one can never be certain that such experiences actually exist in other fellow humans, let alone in non-human animal species. In addition, there are many examples of human behaviour that happens without any apparent conscious awareness. The much cited 'implicit learning' is usually characterized as a passive process, where the subject is exposed to information and subsequently acquires knowledge of that information simply through that exposure. For example, language is something human babies naturally and easily acquire, but as adults, cannot explain how they ever learned to do it. Because of this 'automatic' nature, it has been taken to represent a form of learning devoid of conscious thought. Given the limits in even human consciousness, it is not surprising that there has been little room to welcome the possibility for conscious thought processes in animals. It has been proposed that perhaps animals simply sense and respond to stimuli in an appropriate manner without experiencing the stimuli in a subjective way (Rose 2002); hence, even a type of non-conscious existence could be completely biologically sufficient. Therefore, according to Watsonian principles, why not leave the subject matter of subjective experience out of the scientific realm (Watson 1929). However, only the extreme solipsist would contend that consciousness is some metaphysical phenomenon and that there is simply no way of ever verifying mental states in others. Though, however, challenging, it is necessary to make at least some assumptions about consciousness in other species (Wasserman 1984), because if we close the discussion altogether, we may fail to notice potential animal consciousness all around us (Dawkins 2001).

It has been said that excessive pessimism about the study of animal minds only serves to inhibit scientific

progress (Griffin 1995), and the view that subjective experiences are not scientifically accessible is archaic and simply false (Damasio 1999). In fact, in the real world, human beings (and some animals to a certain extent) can and do make reasonable inferences about others' mentality in such a way that it allows us to engage in appropriate social interactions (Griffin 1995). Imagine if we were all convinced that we could not detect intentions, preferences, pain, sadness, anger, etc. in our fellow humans and behaved in a manner consistent with our disbelief of conscious minds, human culture and our orderly, civilized way of living would cease to exist. So, on a practical level, we live out our lives carrying out social interactions under the assumption that others do indeed have separate minds. Yet on the scientific level, we demand full proof of the existence of a phenomenon we already use on a daily basis. Griffin (1998) pointed out the double standard of demanding absolute certainty before accepting the idea of mental experiences in animals (which he termed 'paralytic perfectionism') and that in other scientific disciplines, we customarily make the best of incomplete, ambiguous or intangible data. In the early days of genetics and physics, studies dealt with ideas and predictive models based on what are now known as chromosomes and atomic particles, despite the fact that these elusive components were not even visible to the naked eye; we trusted that these 'things' existed simply, because we could manipulate them and subsequently observe their real effects. In a similar concept, electroencephalograms (EEG) and functional MRI (fMRI) scans can capture correlates of the conscious mind (Klemm 1992; Cavanna and Trimble 2006), even if those correlates are not the mind. Upon being presented a frightening picture or thinking about something sad, the human subject can cause different EEG profiles, giving researchers tools to indirectly probe the neural mechanisms underlying the physical manifestation of emotional experiences. The fact that we must use indirect methods should be no cause for concern and because mental experiences can be only truly accessed by their owners does not make them any less real, nor does it deny its organic and neural origin (Damasio 1999).

Interestingly, it seems that the strongest argument against the case for fish consciousness is based on what we *do not know* (i.e. the argument that we can never know what they perceive due to the private nature of mental subjective states). However, this is not an appropriate argument. Decisions should be based on the evidence of what we presently have, not what we do not have. Science (and society) would never progress, if we refrained from making decisions because of perpetually waiting for infinitely more information. In addition, theories and beliefs are not set in stone. If, in the near future, new experimental evidence firmly contradicts present theories in support of fish consciousness, we are then obliged to re-evaluate our perspectives on the matter. Until then, the growing body of literature supports the argument for subjective experiences in fish.

Pain: a conscious state

Comparative approach to animal minds

Although behavioural research has somewhat relaxed its views about animal consciousness, many scientists still avoid the issue, not because they deny the possibility for subjective experiences, but simply because of the difficulty of the subject (Griffin 1998). Fortunately, there is an ever-growing body of knowledge regarding the biology of diverse types of animals including lower vertebrates and, more recently, invertebrates. Damasio (1999) gives a refreshingly simple and logical means to making reasonable inferences about human private states. His 'three-way linkage' brings together: (1) certain external signs like wakefulness, attention, observable behaviour, (2) corresponding internal signs that we can report on and (3) the internal signs that we, as observers, can verify in ourselves when we are in situations similar to those of the observed individual. This method sums up in part, and sometimes in full, many comparable techniques animal scientists have used in attempts to get a glimpse inside the animal mind. A widely used method of assessing animal experiences is by comparing the similarity of its responses with those of humans and other higher animal species generally accepted as having the capacity for consciousness. This is known as the argument-by-analogy. Though it is important to stress that 'analogous' does not mean 'identical'—for example, all animals have the ability to see, touch, smell, hear and taste, albeit in different manners (Sherwin 2001). Although an animal like a fish might have parts of their physiology vastly differing from

their mammalian counterparts, they may still be able to experience mental states, even though those states would likely be qualitatively different. In reality, a quick search of the literature will show that the relevant behaviour and physiology associated with consciousness is strikingly more similar to higher vertebrate animals than previously acknowledged. Until recently, animal welfare studies have been done almost exclusively on mammalian and higher vertebrate animals, so they will be used as the benchmark from which to compare evidence. Beginning with physiology, it appears that teleost fish have the same relevant stress hormones (Donaldson 1981; Mazeaud and Mazeaud 1981) produced and released within a hypothalamic-pituitary-interrenal (HPI) axis (Donaldson 1981), analogous to the mammalian hypothalamic-pituitary-adrenal (HPA) axis. Correspondingly, fish show strikingly similar behavioural stress responses (e.g. freezing/tonic immobility) to other animals ranging from mammals (Davis 1992) to domestic fowl (Gallup 1979). There is, in fact, an exhaustive list of behavioural variables routinely employed to investigate subjective mental states in animals that has likewise been successfully demonstrated in fish. A variety of fish species have shown avoidance learning (Coble et al. 1985), long-term memory (Aronson 1971), conditioned suppression (Geller 1964; Yue et al. 2008), social learning (Brown and Laland 2003), operant responding (Anthouard 1987), nociceptive behaviour (Sneddon et al. 2003), demonstration of complex or flexible behaviour (Topál and Csányi 1999), problem-solving ability (Mizukami et al. 1999), demonstrated preferences (e.g. taste aversion) (Little 1977) and capacity to use 'trade-offs' according to 'consumer demand' theory (Dunlop et al. 2006). It could be argued that if fish perform similarly in these types of tests, they might experience something analogous to mammalian 'emotions' and motivation—an important point in the study of conscious minds. For higher vertebrate and especially mammalian species, we almost always employ argument-by-analogy and accept that if an animal responds with both similar physiological and behavioural mechanisms to negative stimuli, that they are presumably having an analogously negative experience (Sherwin 2001).

Much of the study of animal minds has been done through ethological efforts (Griffin 1976; Duncan 1996; Dawkins 2000; Griffin and Speck 2004), and now more recently, scientists are going beyond the realm of behaviour into the fields of neuroanatomy and neurophysiology. Though researchers often use some form of argument-by-analogy, many now argue that subjective experiences can also be found in animals by methods of homology. Some neurophysiologists maintain that the basic anatomy and physiology of the brain is highly conserved in mammals and even in lower vertebrates (Baars 2005). In humans, conscious perception and various cognitive functions depend on the thalamocortical complex (Seth et al. 2005). Many animals do not posses this thalamocortical system yet have been found to possess functionally equivalent neuroanatomy—which really is the crucial point when comparing conscious states from a neurobiological framework (Edelman et al. 2005). Birds for instance lack a significant cerebral cortex, but developmental, morphological and comparative evidence indicate that part of the avian pallium, known as 'the Wulst', is structurally homologous to the mammalian neocortex (Medina and Reiner 2000). In teleost fish, the lateral and medial pallia are proposed to be homologous to the hippocampus and amygdala, respectively (Broglio et al. 2005; Portavella and Vargas 2005). The amygdala, in particular, is well accepted as a brain region that plays a major role in the production of fear and fear responses (LeDoux 1996). Just as one would expect from comparative neurophysiology, lesions to the teleost lateral pallium produce significant deficits in some forms of learning and memory, but in contrast, lesions to the medial pallium disrupt emotional heart rate conditioning and avoidance learning (Broglio et al. 2005). It has also been found that the teleost forebrain, the telencephalon, receives a pattern of projections from the thalamus incredibly alike to those of land vertebrates, supporting the theory of telencephalic homologies with higher vertebrates (Echteler and Saidel 1981). It is obvious that more distantly related animals to mammals will have fewer homologous traits, but the basic structure of neurons, synapses, neurotransmitters and even patterns of connectivity resembling those of the human cortex remain the same (Baars 2005). Therefore, the neurobiological evidence suggests that there is robust developmental conservation of structure throughout evolution, a conclusion that is easily overlooked if we limit ourselves to looking for gross anatomical and histological comparisons (Edelman et al. 2005).

Indeed, we will see even more similarities between fish and other animals when we compare their usage as subjects in studies of drug development. Vertebrate animals are often employed as models in the development of analgesic and psychoactive drugs. Undeniably, the industry of pharmaceutical drugs and its testing rests on the assumption that these animal subjects do experience conscious experiences (like pain and fear) similar to humans, because it is humans for whom these drugs are ultimately intended (Sherwin 2001). Broiler chickens with leg problems will selectively choose diets containing analgesics, presumably to alleviate their negative mental experience comparable to what we call pain (Danbury et al. 2000). Similarly, studies employing rats have shown that they will self-administer or seek out addictive psychostimulant drugs like amphetamine, morphine, cocaine and heroine (Deminiere et al. 1989; Parker 1992; Klebaur et al. 2001; Kearns et al. 2002; Lenoir and Ahmed 2007). Such animal studies are carried out in hopes of elucidating the nature of human drug addiction. Now because it is believed by some pharmacological researchers that fish, in common with other 'more complex' vertebrates, will seek out pleasure and avoid pain, fish have been used as models to investigate the hedonic effects of addictive drugs (Lett and Grant 1989). Studies of this sort are done in attempt to understand the psychological underpinnings of substance abuse, and more current investigations are also interested in its genetic basis. Darland and Dowling (2001) showed that zebrafish exhibit strong or weak cocaine-induced conditioned place preference behaviour depending on their genetic make-up. Having similar dopaminergic pathways and behavioural responses to more complex animals, zebrafish are "currently the vertebrate of choice" (Darland and Dowling 2001) and can provide a good model for understanding this human affliction (Satora and Morawska 2003).

So, there is a growing body of evidence that fish may have some ability for subjective experiences. Perhaps, the question of whether or not fish can experience fear may become clearer. Although a review of the literature will reveal that there is almost no information regarding this topic, fear, like pain, is a negative mental experience that relies on an animal's capacity for conscious awareness. Also like pain, fear has no direct physical correlate that can be measured. So, by examining the current debate regarding the issue of fish pain, in addition to results from studies of avoidance behaviour, together with the more modern understanding of animal consciousness, we can obtain a reasonable assessment about the topic of subjectively experiencing fear.

Argument for pain as a conscious experience

It should be first mentioned that pain is a negative mental experience (e.g. feeling of distress or agony), whereas nociception is the physical, unconscious response to noxious stimuli that results in a behavioural or physiological change (IASP 1994). In Gregory's (1999) short review on subjective experiences in fish, he mentions the importance of this question, because it can influence our views on how we should manage these animals. Obviously, the question of pain perception in fish is a particularly hot topic, since our current methods of handling, rearing and slaughter could potentially cause them pain. Consequently, the subject of fish pain has, of late, been given substantial attention. Gregory (1999) provided criteria for the assessment of fish pain. First was to establish whether or not fish possess neurotransmitters, neuron types and neuroanatomy known to mediate the pain experience in other animals. Second is to inflict what we consider to be painful stimuli on fish and then assess their responses to the stimuli and then determine whether those responses can be suppressed with analgesic drugs, which can in turn be blocked with analgesic inhibitors. The last method is to teach fish to associate the aversive stimulus with a neutral-conditioned stimulus and examine whether they show avoidance behaviour to the conditioned stimulus alone. Finally, by collating the information from all three approaches, it should be possible to decide whether fish can perceive and experience the negative mental state of pain. With respect to the first criterion, some hypothesize that conscious awareness and therefore mental states such as pain and fear depends specifically and almost solely on the neocortex and that the absence of this brain region makes it impossible for conscious awareness (LaChat 1996; Rose 2002). Rose (2002) argues that decorticate or neocortically damaged humans have no consciousness, yet noxious stimulation applied to the faces of vegetative patients can evoke facial grimaces, flinches and expressions reminiscent of a person in pain. The patient, of

course, is not aware of his reflexive responses. This is the argument of the difference between nociception, the sensory response to noxious stimulation, and pain, the negative psychological experience. The fish's behavioural responses to negative stimulation are therefore compared to these types of reflexive withdrawal reactions of decorticate humans. Unfortunately, Rose's (2002) lengthy review of the matter is built completely upon the thesis of the neocortex being the seat of consciousness. Although an interesting proposition, its Achilles heel is that he compares the normal functioning physiology of intact fish to that of a human pathological state. This is simply not a reasonable or logical argument (see Chandroo et al. 2004a, b). Imagine if you will, a fish stating to humans "I have fins. If I am missing my fins, I can no longer swim. Fins are therefore essential for swimming. Humans do not possess fins. Therefore, humans cannot swim". Of course, this is not true; humans, although not possessing fins, can use their arms, legs, hands and feet in order to propel themselves through the water. In addition, although humans do not swim in the exact manner that does a trout, it is an accepted fact that humans can indeed swim. In fact, Sneddon et al. (2003) discovered that rainbow trout possess cutaneous nociceptors capable of detecting noxious stimuli. This electrophysiological study not only identified the physical location of the nociceptors, but also that the nociceptive nerves demonstrate properties similar to those described in the higher-vertebrate pain system. Like in mammals, nerve endings of A-delta and C fibres act as nociceptors in fish. These fibres differ in diameter, myelination and information transmission speed and are associated with different types of pain like pricking or dull, aching pain. Complemented with the behavioural component to the study, it was proposed that the avoidance behaviour induced by painful stimuli is not likely to be merely reflexive, but accompanied with discomfort. With respect to Gregory's second criterion, Chervova et al. (1994) addressed that issue well over a decade ago when they found that trout's strong tail flick avoidance reaction in response to electric shock, needle prick or fin pinching decreased in intensity with increasing dosage of the endogenous mammalian opioid and analgesic, dermorphin. Under a similar set-up with cod, Chervova (1997) found that there was decrease in pain sensitivity (as measured by tail undulation) under the action of even non-opioid substances and suggested the presence of another endogenous analgesia system in fish in addition to the opioid system. In addition, naloxone, an antagonist of opioid receptors, is able to reverse the analgesic effect of morphine in goldfish and carp (Ehrensing et al. 1982; Chervova and Lapshin 2000). These findings are not surprising, given the fact that fish do possess opioid receptors and endogenous opioids in their nervous systems (Sneddon 2004). Sneddon (2003) contributed more supporting evidence when she found that administration of morphine significantly reduced pain-related types of behaviours (induced by acetic acid injection to trout lips) and opercular beat rate. Lastly, with respect to Gregory's (1999) third criterion, there is an abundance of studies demonstrating avoidance learning and is easily found in experimental, zoological, ecological and aquacultural literature (Pfeiffer 1963; Behrend and Bitterman 1964; Atchison et al. 1987; Knudsen et al. 1997; Yue et al. 2004; Dunlop et al. 2006). Since then, there have been plenty more studies investigating noxious stimuli and analgesics on nociceptive responses (Reilly et al. 2008; Nordgreen et al. 2009) all with results showing that various species of fish respond to noxious stimuli as well as analgesia in a manner consistent with pain. Taken collectively, it seems that teleost fish have been able to successfully fulfil all the various criteria and requirements researchers often demand in their quest to assess animal consciousness.

Despite all this evidence, the debate continues. This was seen in the vigorous exchange of views regarding fish welfare that revolved around whether or not fish have feelings. Huntingford et al. (2006) have reviewed a variety of practices, such as commercial fishing, recreational angling and aquaculture, on the welfare of fish and have taken a feelings-based approach in doing this. They concluded that some of these practices will have an adverse effect on fish welfare. Their findings were strongly challenged by Arlinghaus et al. (2007) who were extremely critical of the feelings-based approach and who rejected most of the conclusions of Huntingford et al. (2006). The criticisms of Arlinghaus et al. (2007) were based almost entirely on the fact that there are neuro-anatomical brain differences between fish and the higher vertebrates and in particular that fish lack a neocortex (Rose 2002). However, neuroanatomical similarities or

differences play no role in the feelings-based approach.

Since subjective experiences are not available for direct investigation, sentience, or the capacity to feel, is deduced from indirect evidence, mainly behavioural evidence (Duncan 1996, 2004). As aforementioned, in the absence of the capacity to feel, welfare is a non-issue. If fish cannot suffer, then they can be treated like tomatoes. We may try to avoid damaging them, but only because their instrumental value would be reduced.

Avoiding the concept of fear?

Do fish exhibit fear or non-conscious avoidance behaviour? A comprehensive literature review suggests that some finfish demonstrate a combination of both. But first, why should we not simply deal with 'stimuli' and their respective 'responses' and cut out the intervening variable and ambiguous term called 'fear'? Would it not be easier just to acknowledge and measure the stimuli we can manipulate and responses we can measure? Davey (1981) argued that when a previously neutral stimulus becomes a conditioned aversive stimulus by being paired with an aversive event, it is not the stimulus that changes, but *some aspect of the animal* through the mediation of a central state. Anger (1963) agrees that the new conditioned response to the CS be called a 'fear reaction'.

A common idea is that fear is a 'primitive' emotional experience that evolved as a biological adaptation as a simple means of dealing with dangerous situations (Dawkins 2000). In a world full of unpredictable situations, it makes much more sense to use the memory of frightening events to avoid dangerous situations altogether than to repeatedly engage in the same potentially fatal situation in hopes that automatic escape responses will be successful with each encounter. Life would become essentially a game of biological Russian roulette. Avoidance behaviour motivated by fear, a negative emotion, rather than by automatic responses triggered by key stimuli, makes sense. Says Dawkins (1998) "[B]y causing an animal to flee or hide, fear probably evolved and reduced the likelihood of physical injury occurring at all. Just as pain helps to avoid death, fear helps to avoid pain".

Overall, on the basis of probability, it is likely that some teleost species like rainbow trout, for example, are sentient creatures and have at least a rudimentary level of conscious awareness. If one takes a moderately systematic investigation of fear (and pain) in fish, it now seems that the question to be asking is not 'Do fish have conscious awareness', but 'What is the level and nature of their conscious awareness?' Admittedly, what fish are proposed to consciously experience when subjected to fearful or painful stimuli is likely to be qualitatively and perhaps quantitatively very different from human fear. However, this does not matter; the fish's experience may be unpleasant and aversive enough to cause negative mental states. Therefore, their mental experiences (whatever they may be) are important from their perspective. Subsequently, being their stewards, it should also be important from our perspective as human caregivers.

Nonetheless, much of society largely continues to treat fish in a manner that indicates our belief that they do not experience negative mental states and are incapable of suffering. We are curiously unlikely to draw positive conclusions about subjective experiences even when fish fulfil the same criteria satisfied by other animals deemed sentient. In the EFSA's opinion, the concept of welfare should be the same for fish, as it is with mammals and birds. This is because "there is scientific evidence to support the assumption that some fish species have brain structures potentially capable of experiencing pain and fear. The balance of evidence indicates that some fish species have the capacity to experience pain" (EFSA 2009). Also, although we are far from understanding the mechanism of sentience, studies of brain anatomy functionality to behaviour illustrate that there is some evidence of sentience in some species of fish (European Food Safety Authority 2009).

Looking ahead

In a relatively short period of time, the high level of interest in the topic of fish welfare has been matched with an equal amount of scientific research. Nonetheless, many questions remain to be answered, and often, new questions arise in place of answers; the topic of fish welfare is still in its pioneering stages. Scientists have, by no means, solved the origin or the

mechanism of consciousness. However, these are not needed to assess whether an animal possesses subjective experiences.

With evidence for the existence of at least a basic capacity for fear and other mental experiences, perhaps it should be concluded that the question of fish awareness (and animal consciousness in general) should remain a philosophical question. For in our real, practical world, it is simply not reasonable to be searching for scientific answers to philosophical questions. In our real world, veterinarians treat animals on a daily basis for a variety of problems—but imagine challenging a veterinarian to practice without ever being allowed to use words, such as 'pain', 'anxiety', 'fear', 'distress'. This would literally be impossible. The time has come when we should be using the knowledge that we *do* know to answer concerns about what the needs of animals really are and how they are to be met (Jennings 1998) and what we do know is that we now have logical reason and scientific evidence to start treating fish[2] as sentient creatures. The conundrum of consciousness is not as hopeless as it may seem. Approaching the subject of mental experiences logically, reasonably and systematically can, to some extent, help demystify it and put it back into a realistic realm alongside other scientific fields of study.

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[2] The term 'fish' refers to species for which we have sufficient evidence to infer subjective experience using the same objective standards employed to infer consciousness in humans and other phylogenetically advanced vertebrate animals.

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