The Science of Animal Suffering

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Abstract

Can suffering in non-human animals be studied scientifically? Apart from verbal reports of subjective feelings, which are uniquely human, I argue that it is possible to study the negative emotions we refer to as suffering by the same methods we use in ourselves. In particular, by asking animals what they find positively and negatively reinforcing (what they want and do not want), we can define positive and negative emotional states. Such emotional states may or may not be accompanied by subjective feelings but fortunately it is not necessary to solve the problem of consciousness to construct a scientific study of suffering and welfare. Improvements in animal welfare can be based on the answers to two questions: Q1: Will it improve animal health? and Q2: Will it give the animals something they want? This apparently simple formulation has the advantage of capturing what most people mean by 'improving welfare' and so halting a potentially dangerous split between scientific and non-scientific definitions of welfare. It can also be used to validate other controversial approaches to welfare such as naturalness, stereotypies, physiological and biochemical measures. Health and what animals want are thus not just two of many measures of welfare. They provide the definition of welfare against which others can be validated. They also tell us what research we have to do and how we can judge whether welfare of animals has been genuinely improved. What is important, however, is for this research to be done *in situ* so that it is directly applicable to the real world of farming, the sea or an animal's wild habitat. It is here that ethology can make major contributions.

Introduction

At first sight, 'suffering' and 'scientific' are not terms that can or should be considered together. When applied to ourselves, 'suffering' refers to the subjective experience of unpleasant emotions such as fear, pain and frustration that are private and known only to the person experiencing them (Blackmore 2003; Koch 2004). To use the term in relation to non-human animals, therefore, is to make the assumption that they too have subjective experiences that are private to them and therefore unknowable by us. 'Scientific' on the other hand, means the acquisition of knowledge through the testing of hypotheses using publicly observable events. The problem is that we know so little about human consciousness (Koch 2004) that we do not know what publicly observable events to look for in ourselves, let alone other species, to ascertain whether they are subjectively experiencing anything like our suffering (Dawkins 2001; Bateson 2004a,b). The scientific study of animal suffering would, therefore, seems to rest on an inherent contradiction: it requires the testing of the untestable.

There are two good reasons for not being defeated by this apparent contradiction and for embracing a science of animal welfare that includes rather than excludes subjective feelings of suffering, pain and

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pleasure. The first is that there is a growing public interest in the welfare of animals. The way the animals are treated on farms, in zoos and in research laboratories has been of concern to many people for a long time. But now this is assuming ever higher priority and there is further concern about animals in conservation projects, in sport, in pest control and even in the way people treat the pet and companion animals they keep in their homes. Laws, guidelines, regulations, best practice, standards and codes for how animals should be treated already abound and are increasing in number all the time. Whether we like it or not, people are constantly making decision about how animals *should* be treated. What we as scientists need to do is to make sure that those decisions are based as much as possible on sound scientific information.

Science cannot, of course, tell us what we ought to do – for example, that we ought not to kill animals or that it is morally acceptable to inflict pain on them. But it can provide the scientific underpinning for the moral beliefs about them that we do have. This is an important distinction. If you not only believed that it was wrong to inflict pain on an organism but also thought that fish did not subjectively feel pain, you might believe that it was morally acceptable to cut up living fish or fish with hooks. But if you then came across some of the newer evidence that has been used to suggest that fish not only struggle and attempt to escape but also subjectively feel pain (Sneddon et al. 2003; Chandroo et al. 2004), you might begin to reconsider your behaviour. Your moral belief (that it is wrong to inflict pain) would not have changed, but the scientific evidence about which organisms are capable of feeling pain could radically change how you behaved towards fish. It is this informative role – providing the factual basis for the goals that people want to achieve with respect to animals – that is the practical driving force for a science of animal welfare. We can either let people who do not understand animal biology or evolution or animal behaviour, take decisions about how animal should be treated or we can attempt to contribute what scientific information there is and, if we can, add to the body of existing knowledge through research. As I shall argue in this article, we can both acknowledge the limits of a science of animal suffering and still answer the growing imperative to use science to improve animal welfare and reduce animal suffering.

The second reason for building and strengthening a science of animal welfare is that it provides a central unifying core for the whole of biology. Animal welfare science is built upon a strong framework of Tinbergen's (1963) 'four questions' (causation, adaptation, phylogeny and development) and this in turn encourages multidisciplinary links with physiology, ethology (including behavioural ecology), immunology, affective neuroscience, cognitive science, consciousness studies. For example, asking whether animals suffer if deprived of the opportunity to perform natural behaviour might require an understanding of how behaviour is triggered and controlled, the effects of early experience and genetics, the behavioural and hormonal effects of deprivation, a knowledge of how that species behaves in the wild, its brain activity and probably a great deal more as well. A simple 'applied' question about the welfare of a zoo animal in a cage could therefore take the animal welfare scientist to the cutting edge of pure research questions in several different disciplines and provides the opportunity for making links between them that more narrowly focussed scientists would miss. As I also hope to show in the course of this article, animal welfare science very much needs contributions from other disciplines, particularly ethology, and in turn offers a great deal to them by way of its practical importance and its multidisciplinary approach.

A particular contribution that ethologists, with their emphasis on the evolutionary significance of behaviour, may be able to make is to clarify questions about why, in an adaptive sense, the capacity to suffer evolved at all. Why should we *feel* pain as opposed to just having mechanisms for avoiding danger and damage? Why should we *feel* hungry as opposed to just taking steps to find or conserve food? These questions are much more difficult to answer than they appear at first. While it may be obvious that escaping from a predator or seeking food lead to an increase in fitness, it would also appear to be quite possible to build a machine that removed itself from danger and sought fuel when it was running low without having to imply that the machine subjectively felt anything at all. So what is the 'extra' that the capacity to suffer gives over and above an efficient, flexible but non-sentient rule-based machine? Ethologists have been at the forefront of developing techniques for showing how natural selection has shaped behaviour and the underlying processes in the brain. Now an even greater challenge awaits them.

What is Suffering?

'Suffering', when we apply the term to ourselves, covers a wide range of different emotional states

such as fear, boredom, exhaustion, pain, grief, thirst, hunger etc that have in common that we experience them all as unpleasant (Dawkins 1990). The striking thing about the way we use it in common speech is that we are quite happy to use this single word when we know perfectly well how different these states are. We know that what we do and, above all, what we subjectively feel when we are 'suffering from fear' is quite different from what we do and what we feel when we are 'suffering from thirst'. So we use the term knowing that, at some level, these diverse states have at least something in common. In fact, what they have in common is that they are all states that are unpleasant enough that, if we could, we would endeavour to get out of them. Behaviourally, we would work or strive to relieve the pain if we were suffering from pain, attempt to quench our thirst if we were suffering from thirst and remove ourselves from danger if we were suffering from fear and so on.

This behavioural way of recognizing suffering as states that people would work to get out of or avoid if they could also provides us with a way of recognizing animal suffering in an objective way. Relieving pain, finding shelter and finding water to drink are all what psychologists call positive 'reinforcers' that is, they are sufficiently positive or rewarding to cause people (or animals) to repeat the action that resulted in them. Conversely, having pain inflicted or being subjected to a frightening stimulus are negative reinforcers or punishers and cause people and animals to avoid doing the action that led to them in the future. By defining suffering as emotional states characterised by being caused by negative reinforcers gives us an objective, measurable and behavioural way of understanding what matters to animals (Kilgour et al. 1991; Boissy et al. 2007). It also coincides with recent ideas of studying human emotion. Rolls (2005) defined emotions as ' states elicited by rewards and punishers, that is, by instrumental reinforcers'. The negative emotions we call suffering can be caused either by the presence of negative reinforcers (such as predators) or the absence of positive reinforcers (states we call 'deprivation'). Either way, we have an objective way of asking the animal whether its emotional state is positive or negative. We ask whether the animal will work (perform some arbitrary task such as pecking a key or pushing a door) for the result of obtaining something it wants (positive reinforcers leading to a positive emotional state) or of avoiding something it does not want (negative reinforcer leading to a negative emotional state).

Now, so as to make it clear that I have not performed some subtle trick to make the very real problems of studying animal suffering disappear in a puff of operant conditioning, I want to spell out more exactly what is being proposed as the connection between emotions (positive and negative) and subjective feelings. The ability to learn an operant task does not in itself indicate the existence of subjective feelings because emotional states, even in ourselves, do not always indicate subjective awareness. Emotions can be unconscious (Berridge & Winkielman 2003).

Even in humans, different measures of emotions do not always coincide (Damasio 1994; Oatley & Jenkins 1996; Rolls 2005). Psychologists study emotions in several different ways:

1. People are asked what they are subjectively feeling. Their verbal reports are taken to be the most accurate read-out of what people are subjectively experiencing.

2. What people find positively and negatively reinforcing.

3. Autonomic changes such as temperatures, heart rate, hormone levels.

4. Brain activity associated with different emotions and recorded with brain imaging techniques.

5. The behaviour, facial expressions and sounds associated with different emotions (Ekman 2003).

It is very difficult to tell, just from knowing about someone's autonomic responses, whether they are feeling angry or fearful or just excited (Oatley & Jenkins 1996). The increase in heart rate, the rush of adrenalin and increase in body temperature are very similar because all of these emotions require the body to do something and the autonomic responses would be an equally appropriate preparation for all of them (Sapolsky 1994; Toates 1995). It is therefore not surprising that we cannot 'read' specific emotions from a system designed to have a general mobilising response. Shifts in emotional state can occur unconsciously (Berridge & Winkielman 2003). Our autonomic systems control our blood pressure, heart rate and many other symptoms of our 'emotional state' without our being consciously aware of them at all. Brief (25 ms) presentations of happy, sad or angry faces can produce emotional responses and biased interpretations of stimuli even though people will report that they have not consciously seen any faces at all (Murphy & Zajonc 1993; Winkielman & Berridge 2005).

These findings have major implications for our understanding of emotions in other animals. As humans can have unconscious emotions, we have,

even in ourselves, to distinguish 'emotional state' (the physiological and behavioural changes that we can observe in others) from the subjective experiences (that we cannot observe) (Dawkins 2001, 2006). Emotional states, as defined by what animals find positively or negatively reinforcing *may* be accompanied by subjective feelings of pleasure or suffering but not necessarily. The ability to perform an operant task represents an evolutionary step in complexity (Rolls 2005), but it does not prove consciousness (Dawkins 2001).

Some people find such caution over attributing consciousness to animals unnecessary and even damaging to animals (Bekoff 2002; Balcomb 2006). On the contrary, animal welfare scientists are more likely to be taken seriously if they show that they understand the conceptual difficulties with attributing conscious experiences to animals than if they seem unaware of the very real difficulties raised by other disciplines. Personally, I do believe that many animals subjectively experience suffering but I also believe that my own belief is not scientific and I would not attempt to justify it on scientific grounds.

Fortunately however, we do not have to solve the problem of consciousness to have a science of animal welfare. There are good reasons for wanting to improve animal welfare (and wanting to employ science to do so) that leave the difficult question of consciousness carefully parked in one corner and provide their own imperative for taking what happens to animals seriously. These include the fact that animals, like plants and valuable works of art, have an intrinsic value and should be taken care of as part of our environment, the fact that many people do believe that animals are sentient and (for the really cynical) the fact that human health and well-being is intimately tied up with animal health and welfare. The health of our food and our protection against disease and starvation are all heavily dependent on good animal welfare, regardless of whether those animals are actually subjectively experiencing anything at all (Dawkins & Bonney 2008).

Emotions, Reinforcement and What Animals Want

Of the ways we have of studying human emotions, all but one of them – the verbal reports – can be applied to other species. Other animals can show us by their behaviour what they find positively and negatively reinforcing: they can peck keys, push doors (e.g. Olssen & Keeling 2005; Mason et al. 2001) or press levers to obtain what they want. Other animals have autonomic responses such as increases in heart rate or hormone levels associated with different emotional situations such as fear and aggression (Broom 1998; Boissy et al. 2007). Other animals, too, have specific behaviours, vocalisations and 'expressions' associated with their emotional states, (Darwin 1872; Ekman 2003).

Just as with humans, however, these different components of emotion do not always go together. Laying hens prefer an enriched environment with grass and somewhere to scratch to a barren environment with a wire floor. But when first introduced to the enriched environment, hens have higher levels of corticosteroids and more distortion of their egg shells than hens introduced into a barren wire-floored cage (Dawkins et al. 2004a,b). If all we had to go on were the autonomic responses, we would not know whether the birds were in a positive or negative emotional state and it is only when we look at what the hens find reinforcing (what they choose to repeat) that we can understand what is going on.

Animal welfare scientists often refer to these autonomic emotional responses as 'physiological measures of welfare' and then go to great lengths to discuss their merits as 'indicators' of good or bad welfare, often without defining welfare operationally (Webster et al. 2004). Seeing autonomic responses as emotional responses and defining emotions operationally as states induced by positive and negative reinforcers, however, allows us to see a way out of this circular argument. Autonomic emotional responses do not define welfare in themselves and are not in themselves independent indicators of suffering. They are only useful in the assessment of an animal's emotional state if they can be shown to be reliably linked to situations that animals find negatively reinforcing. If they are as much associated with positively reinforcing situations as they are with negative ones, they are more useful as indicators of arousal or excitement than anything else (Barnett & Hemsworth 1990; Rushen 1991; Toates 1995). A human example will make this clear. The autonomic responses – white knuckles and screams of a person greatly enjoying a scary ride on a roller coaster – will be similar to those of someone genuinely terrified and suffering throughout the ride. The best way of deciding what emotional state a person is in is to see whether they repeat the experience or not – whether it was positively or negatively reinforcing.

Using positive and negative reinforcement as the core definition of suffering in this way allows us to view other 'measures' of suffering coherently by asking how well they correlate with the core. For

example, rather than using behaviour such as vocalisations as independent measures of emotion, we ask whether these correlate reliably with what animals find negatively or positively reinforcing. Weary & 6 Fraser (1995) showed that levels of squealing in piglets were reliable signals of need for food in that underweight piglets and piglets that had been 7 deprived of food vocalised more. As food is a powerful positive reinforcer, we can conclude that squealing indicates that the animal is in the emotional state of wanting something it does not have. Similarly, Sandem & Braastad (2005) and Sandem et al. (2002) showed that if cows were shown a positive reinforcer (food in the form of silage, or their own calf) and then prevented from actually being able to get to it, they started rolling their eyes so that a high percent of eye white visible is thus an indication of frustration in cows, and we know this because the expression of this emotion was empirically linked to a situation the cows found negatively reinforcing (a positive reinforcer, food or calf kept out of reach).

Reinforcement is, therefore a powerful way of operationally deciding what gives rise to positive and negative emotional states in animals (although, as we have seen, not necessarily conscious states) and of validating other measures. A number of objections have been raised to such an approach (Fraser & Matthews 1997) and there is a need for ethologists to help to address these. One objection is that any results will be heavily dependent on the context in which the tests take place, on the previous experience of the animals and how many other options are available (Bateson 2004a,b). However, hormone levels, heart rate, behavioural expression and other measures of 'suffering' will be affected by exactly the same factors. The challenging task we now need to undertake is how to discover what animals find reinforcing in unusual environments. We have to move out of the laboratory to where the animals are living. For example, the environment in which farm animals are reared will almost certainly affect what they find reinforcing, so if we want to know what is reinforcing to commercially reared animals (as opposed to ones reared in a laboratory), we need to develop ways of testing the preferences of the commercially reared animals *in situ* – that is, on farms. Reinforcement should not just be studied in a Skinner box or a T-maze but in the real world. This might be sheep showing that they find being electrically immobilised for shearing highly aversive (Rushen 1990) or wild animals showing what they do and do not like in the ocean or savannah. Dolphins off the coast of New Zealand were shown to find the presence of whale watching tourist boats negatively reinforcing, as indicated by the fact that they avoided their feeding areas if the tourist boats came too frequently (Lusseau 2004). Elephants carrying GPS trackers have been shown to dislike climbing hills. By correlating elephant tracks with the gradients of the terrain, Wall et al. (2006) found that the elephants were carefully avoiding going up hill, even if it meant taking longer routes or missing out on food. If we want to know what animals want in the real world, we have to regard the whole world as a gigantic choice test and expand our methods accordingly.

We are already beginning to see the development of new approaches. Looking for 'cognitive biases' is an indirect way of finding out whether animals are contented or discontented with what they have (Harding et al. 2004). Instead of giving animals choices or making them work for a reinforcer directly, the animals are trained to discriminate between two previously neutral stimuli, such as one tone that is associated with food and another that is associated with something unpleasant, such as a burst of white noise. They are then exposed to a stimulus that is intermediate between the two. Animals that have been living in less preferred environments are more likely to interpret the intermediate stimulus as associated with the negative stimulus ('negative bias') than animals that have been living in preferred or enriched environments (Paul et al. 2005; Bateson & Mather 2007).

In a variety of ways, then, we can discover empirically what animals find positively and negatively reinforcing. By defining emotions as states induced by these positive and negative reinforcers, we arrive at an operational definition of suffering, which also corresponds to what we colloquially mean by suffering – namely, a wide range of unpleasant emotional states. By discovering what animals dislike or find sufficiently unpleasant that they will work to escape from them or avoid them in the future, we can recognize when animals are in one of the negative emotional states we call 'suffering'.

Emotion, Health and Welfare

An operational definition of negative emotion, however, does not completely define 'welfare' because what animals choose or will work for may not be good for their health in the long run. Even humans do not always choose what is good for them, as we know all too well from peoples' tendencies to overeat or take drugs. Children might find going to the

doctor or dentist very negatively reinforcing, but this has to be balanced against the health value of insisting that they do so. In deciding what is best for a child's welfare, we take into account *both* the long term health effects and what the child itself wants now.

Any assessment of animal welfare must similarly take into account what improves physical health, both what reduces disease, deformity and injury as well as what promotes positive health, good growth and longevity (Moberg 1985, Moberg 1999). Good health is so fundamental to good welfare that we cannot define welfare or suffering without it. Emotions, even defined by what animals find reinforcing, are not enough. We need to know both what the animals themselves want and what is good for their health. The most direct way of approaching animal welfare is therefore to ask simultaneously two questions:

Q1. Are the animals healthy?

Q2. Do the animals have what they want?

The first advantage of this apparently simple but practical approach to animal welfare is that it directly addresses a dangerous split that is now opening up between scientific definitions of animal welfare on the one hand and welfare as viewed by members of the general public on the other. Animal welfare scientists tend to base their assessments on what they call 'outcome measures' that is, on measures of health, physiology and behaviour of animals in different environments (Broom & Johnston 1993; Appleby & Hughes 1997). They tend to favour complex auditing procedures in which many different factors are measured, then weighted in different ways to give with an overall assessment of welfare (Scott et al. 2003; Spoolder et al. 2003; Aerts et al. 2006; Botreau et al. 2007). Consumers and non-scientists, on the other hand, tend to value 'naturalness' and are more influenced by the aesthetic appearance of a system than by whether the scientist's detailed measurements have indicated that welfare is better or worse. They tend to assume that what is good for animal welfare will automatically be best for food quality, taste, the environment and their own health and often have difficulty separating these factors (Main 2008).

Making genuine improvements in animal welfare requires a definition of 'welfare' that everyone can buy into, not a split between a scientific view of welfare and a lay view of welfare. Putting emphasis on good health and animals having what they want captures what most people mean by welfare. It can be readily understood by people who are not biologists and at the same time it shows what research scientists have to do: they have to come up with solutions that improve animal health and give animals what they want, as defined by what they find positively reinforcing. It also provides a way of incorporating and making sense of many other 'measures' of welfare that have been proposed. Even 'quality of life' (Scott et al. 2007) can be expressed as a life in which animals have what they want.

For example, many people have argued that 'naturalness' of behaviour should be used as a criterion of good welfare (Wechsler 2007) and that animals suffer if they are unable to perform natural behaviour as seen in the wild. The Farm Animal Welfare Council (fawc.org.uk/freedoms.html) lists as one of the essential Five Freedoms 'the ability to perform most natural patterns of behaviour'. The environments of captive animals are often enriched with the express purpose of encouraging natural behaviour (Sherpherdson et al. 1998). But to what extent can 'natural' be equated with good welfare and the absence of suffering? Being chased by a predator is 'natural' for wild animals but few people would advocate releasing a predator at them every day to prevent suffering, even if escape were possible. Asking what animals find reinforcing provides a way out of this dilemma. Some natural behaviours, such as the opportunity to scratch and dustbathe in hens can be shown to be positively reinforcing in that hens will push heavy weights to gain access to earth or litter substrates (Olssen & Keeling 2005). But others, such are being chased by a predator may not be. Some animals choose to approach predators and inspect them (Dugatkin 1992) but there is no evidence to show that being chased by a predator is positively reinforcing. It may be natural and occur all the time in the wild, but this in itself is not a justification for requiring this in captivity. Unless we can show that animals will work to make it happen, there is no reason to suppose that they suffer if it does not happen. It is not the 'naturalness' of the behaviour that should be our criterion for whether an animal suffers but what the animal's own behaviour has shown us it finds reinforcing or not.

Similarly with stereotypies – repetitive, unvarying and apparently functionless behaviour seen in some captive animals, such as pacing in polar bears. Although the occurrence of stereotypies may indicate poor welfare, Mason & Latham (2004) argued that some stereotypies actually benefit the animals. For example, stereotyped non-nutritive sucking where a calf sucks repetitively on an object without getting any food, actually benefits the calf by aiding its digestion (De Passillé et al. 1993). The 'two

questions' approach is implicitly used to argue that some (but certainly not all stereotypies) either benefit the health of the animals or are something that the animal actually wants to do. The welfare implications of the behaviour are thus not judged by whether 'stereotypies' are a good or a poor measure of welfare, but by whether the animal is doing something that benefits its health and/or is something the animal wants to do.

Other suggested measures of welfare such as sleep (Abou-Ismail et al. 2007), fractal analyses (Rutherford et al. 2004), play (Vinke et al. 2005) or leucocyte coping capacity (McLaren et al. 2003) can also be judged by how well they contribute to either or both health and positive emotions. If they tell us something either about health or about what the animal finds reinforcing, then they have potential. Health and what animals want are thus not just two of many measures of welfare. They provide the definition of welfare against which others can be validated.

They also tell us what research we have to do and how we can judge whether welfare of animals has been genuinely improved. Putting this into practice provides us with one of the most important challenges for the future. We need to find the best ways of measuring what animals want and develop ways of answering these questions in the places where there is real concern for animal welfare such as farms and zoos. As an example, the welfare of intensively housed broiler (meat) chickens has recently aroused a great deal of public concern because of the high densities at which these birds are kept (European Commission 2000). A large scale study carried out on commercial farms used the 'two question' approach to find out whether welfare would be improved by reducing the stocking density and giving the birds more space. The results were somewhat surprising. Although the health of the birds (walking ability in particularly) was worse at the very highest stocking densities, most other health measures (including mortality and the state of their legs and feet) was much more affected by environmental factors such as air and litter quality (Dawkins et al. 12 2004a,b). It appeared that it was not the crowding *per se* that was affecting bird health, as most people thought, but the fact that high stocking densities tended to result in wet sticky litter and poor air 13 quality (Jones et al. 2005). Furthermore, it was not clear whether birds actually wanted more space. The distribution of the birds with respect to each other suggested that they were not avoiding each other at all (Febrer et al. 2006), but seemed positively attracted to other birds. The two questions about what improves bird health and what the birds themselves want thus help us to find objective, scientifically based ways of improving chicken welfare on commercial farms (Bessei 2006).

The same two questions can be asked whenever there is a controversy about how to improve animal welfare. If it cannot be shown that a suggested 'improvement in welfare', such as environmental enrichment, does not improve animal health and/or does not give the animals something they want, then it is difficult to argue that there has been any genuine improvement in animal welfare at all.

Conclusions

'Suffering' is not an elusive, non-scientific term but can be seen as an important part of biology and used in both the definition and practical assessment of animal welfare. It can be defined as a set of negative emotions such as fear, pain and boredom, and recognized operationally as states caused by negative reinforcers. It may or may not be accompanied by subjective experiences similar to our own. The use of positive and negative reinforcers (what animals want and what animals do not want) together with basic measures of animal health provides a two-question framework for animal welfare science. The two questions are: Q1. Are the animals healthy? Q2. Do the animals have what they want? These two questions have the advantage that they cover what most people mean by good welfare and therefore provide a definition of good welfare (healthy animals that have what they want) that can be understood and subscribed to by farmers, scientists and the public at large. They allow us to make sense of other controversial measures of welfare such as 'naturalness', 'stress' hormones and above all they tell us what we have to find out in practice so as to assess and improve animal welfare in the real world.

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