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ABSTRACT

Although most abnormal behaviors, including all stereotypies, indicate poor welfare, some that occur in rare situations are functional and do not indicate a negative situation. There is a wide range of abnormal behaviors that occur in conditions where the animal's needs are not met, and these can be valuable welfare indicators, but these should never be called "vices". Some behaviors, both normal and abnormal, can be used as motivation-modifying methods. Such behaviors affect subsequent behavior and physiology, including feelings and emotions. The feelings and emotions in turn affect future behavior. Such complex mechanisms are a part of the regulatory functioning of sentient animals. The existence of these mechanisms helps to explain some abnormal behaviors and their consequences.

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Abnormal behavior

A definition of abnormal behavior is *behavior which differs in pattern, frequency or context from that which is shown by most members of the species in conditions that allow a full range of behavior* (Fraser and Broom, 1990; Broom and Fraser, 2015). Although it is the animal's behavior that is described, the identification of abnormality is human. To recognize that behavior is abnormal, the person observing must be familiar with the range of normal behavior of that species, and this familiarity depends on level of knowledge. The knowledge should just be that of not only the animal's movements but also how often they occur and of the circumstances of occurrence.

The word *vice* is sometimes used to refer to abnormal behavior. However, when used in a human context, this word implies that blame should be attributed to the individual showing the behavior. Because almost all the so-called vices shown by domestic animals have been shown to be a consequence of the ways in which the animals are housed or managed, it is an illogical term and should not be used (Broom and Fraser, 2015, p. 246). The use of the word

can be damaging to the animals kept because if people think that the abnormal behavior concerned is not their responsibility but is a fault of the animal, they may fail to rectify the bad practice or inadequate housing and continue with the system causing the poor welfare.

Behavior categorized as abnormal includes (1) behavior forced by impact of an adverse environment. This includes behavior induced by pathologies resulting from the effects of viruses, bacteria, or parasites. It also includes behavior caused by predators, conspecific attack, physical danger such as imminent falling, crushing, dangerous collision, and so on, and an inadequate environment that does not meet the needs of the individual. Examples include abnormal lying movements when the floor is slippery (Schlichting and Smidt, 1987), abnormal reactivity such as lack of normal response when closely confined for long periods (Broom, 1986, 1987), abnormal maternal behavior such as failure to respond to newly born young after lack of early social experience (Harlow and Harlow, 1965), and abnormal behavior associated with disease or parasites, such as fish with an eye-fluke parasite that swim near the surface when they would not otherwise do this (Crowden and Broom 1980; Broom and Fraser 2015, pp. 72, 86, 87, 237, 244, 275, etc.).

A further category of abnormal behavior is (2) behavior that is used by the animal to help it to cope with an adverse or potentially adverse environment. Some of the responses to the negative environmental effects listed previously are obviously adaptive, for example, lying in such a way that injury is less likely. Others may be

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useful in keeping attentional or perceptual mechanisms functioning, for example, repeated glances or repetitive touches. Another response that may seem to the animal to be functional is, when confined in a cage with a door that is known to be the way out, to repeatedly visit the door and manipulate a part that might open the door. Some stereotypies start in this way, as described by Fentress (1968) for voles put in a cage.

Some behaviors might initially be in category (2) but, when no solution to the problem or reduction in degree of adverse effects occurs, become a category (1) behavior. It may be that some stereotypies are initially helpful to the perpetrator, as described previously, where a *stereotypy is defined as a repeated, relatively invariable sequence of movements which has no obvious purpose*. Studies of the causation of stereotypies in sows (Fraser, 1975; Broom, 1981, 1983; Mason and Rushen, 2008) suggest that bar-biting may start as an escape attempt, drinker-pressing as an effort to control when food can be obtained, and sham-chewing as a substitute for actual eating. However, these behaviors probably soon become functionally divorced from these aims and merely indicate that the environment is still very negative. This definition of stereotypy is one that can be used by a human observer with some experience of the behavior of animals. Such an observer can make a reasonable attempt to evaluate which movements have purpose and which do not. The word *purpose* is used, rather than *function*, because an immediate function of the movement may be apparent, but the long-term purpose is not. Stereotypies occur in situations where the individual lacks control of its environment. It may be because of current environmental inadequacy or because of brain changes resulting from previous environmental inadequacy or because of a specific pathology. The stereotyped action may or may not have a function at the time that it is carried out, but stereotypies indicate poor welfare, in the animal showing them, whether there is a function. Welfare is poor in any animal that has to use a stereotypy to try to cope with its environment and in an animal showing a stereotypy because it has been negatively affected by a previous inadequate environment. The latter case is like an individual with a wound that is not yet healed. Hence, all individuals showing stereotypies have poor welfare. For further discussion of the occurrence and possible functions of stereotypies, see Mason and Rushen (2008) as well as Broom and Fraser (2015, chapter 24).

A third category of abnormal behavior (3) is behavior that occurs in rare situations but is fully functional and not at all negative. Some courtship, parental, and other reproductive behavior was initially thought to be indicative of a problem in the animal, but it was not.

(1) and (2) behaviors are indicators of poor, or very poor, welfare, whereas behaviors in category (3) are not.

The use of behavior to manipulate motivational state

All changes in behavior and many physiological changes are a manifestation of the animal's response to changes in causal factors (Hinde, 1970; McFarland, 1971). The motivational state of an animal is a combination of the levels of all causal factors (Broom, 1981; Broom and Fraser, 2015, p. 47). Hence, as Toates (2002) emphasizes, motivational systems are complex but are subject to analysis. Studies of motivation are crucial for our understanding of behavioral indicators of good and poor welfare.

When an individual starts showing a behavior, the action itself, and its consequences, are likely to change the motivational state. Responses shown to stimuli are different according to which behavior is being shown (Fentress, 1968; Forrester and Broom, 1980) and for how long the bout of behavior has continued (Culshaw and Broom, 1980).

An example of a behavior that may have a motivation-modifying function is head-shaking in domestic fowl (Broom and Fraser, 2015,

p. 250). Head-shaking involves a rotary movement of the head, with a series of rapid side-to-side turns ending with a slight downward movement (Levy, 1944; Kruijt, 1964; Forrester, 1980) suggesting that head-shaking is linked to attentional mechanisms and the preparation for making a response. If the behavior is shown occasionally, the motivational change ensuing after the action may well be useful to the individual. However, the behavior should be regarded as abnormal and a stereotypy when shown often. Humans in close proximity are disturbing to domestic fowl, and head-shaking sometimes results if the bird cannot escape from a person. In certain strains of birds, the incidence of head-shaking increased 5-fold in the presence of an observer who was obvious to the bird (Hughes, 1980). There appears to be more head-shaking in caged birds than in floor-housed hens, and it is affected by breed, space allocation, group size, transfer to novel conditions, and social rank (Hughes, 1981; Bessei, 1982). When chickens are exposed to a noxious gas or deep foam, sometimes used to kill large numbers of poultry that might be diseased, they show head-shakes (Coenen et al., 2009; McKeegan et al., 2013).

Both normal and abnormal behaviors are used to affect motivational state, and hence subsequent behavior and physiology. For example, if an individual perceives that there is a risk of predator attack, in a species that is camouflaged, or at least inconspicuous, it is advantageous to remain motionless. It can respond to the danger by slowing or ceasing movement, slowing heart rate, and hence reducing the likelihood of showing any sudden response to new stimuli. The predator may then fail to notice it. On the other hand, vigorous movement increases the likelihood of an active response. Courtship behavior by males can increase plasma testosterone levels and greatly increase the probability of copulation attempts. The courtship behavior may be a frequent part of the behavioral repertoire in some individuals but rare enough to be evaluated by an observer to be abnormal in other individuals. Similarly, the antipredator freezing response, and its consequences, may occur daily or only once in a lifetime. The abnormal behavior of an individual, just after it has been confined, involving repeated attention to the door region could have a calming effect and reduce the likelihood of glucocorticoid concentration increase in blood and of actions that would cause injury to the individual. All these examples could be attempts to self-regulate motivational state. However, the fact that the behavior in response to a negative situation alters motivational state, sometimes in an adaptive way, does not mean that the problem is solved. The behavior is still an indicator of poor welfare. This argument is relevant to discussions of abnormal behaviors such as stereotypies and the interpretation of these behaviors in relation to welfare.

Consequences of modified motivation for behavior and physiology

When motivation is modified, some of the ensuing changes will be to behavior and physiology. This statement applies to all animals. However, some animals are sentient, that is, they have the awareness and cognitive ability necessary to have feelings (Broom, 2014). A feeling is a brain construct, involving at least perceptual awareness, which is associated with a life-regulating system, is recognizable by the individual when it recurs, and may change behavior or act as a reinforcer in learning (Broom, 1998). An emotion is a physiologically describable component of a feeling characterized by electrical and neurochemical activity in particular regions of the brain, autonomic nervous system activity, hormone release, and peripheral consequences including behavior (Broom, 2014, p. 59). The modified motivational state will often affect feelings. Feelings such as pain, fear, and the various forms of pleasure are adaptive, and these are parts of the mechanism used to attempt to cope with the environment, therefore are an important part of welfare

(Broom, 1998; Fraser, 2008; Broom and Fraser, 2015). The control of behavior and physiology via modification of motivational state often operates by motivation altering feelings and emotion with the consequence that a useful change in behavior or other physiological mechanism occurs.

The role of feelings and emotion in mediating motivational change

As discussed by Boissy and Lee (2014) and Broom (2014), emotions and feelings can influence both cognition and motivation, and cognition and motivation can induce emotions and feelings. When an individual has various negative feelings, these will be among the causal factors that contribute to motivational state. A degree of pain, or fear, or depression, or achievement pleasure will therefore alter the likelihood that any particular response will occur when a stimulus is presented. This is the basis for the use of tests of cognitive bias or cognitive affective bias (Mendl et al., 2009). The concept of cognitive bias is more to do with motivation and emotion than cognition, and the results of cognitive bias studies are used in welfare assessment. The bias referred to here is not a bias in the cognitive mechanism but rather in the direction of the decision reached (Broom, 2014). Cognitive bias is the influence of affect on a range of processes, some of which are cognitive, for example, judgment. Although judgment is necessarily cognitive, the term has also been used for effects on attention, motivation, and memory that may not be cognitive.

Behavior, whether normal or abnormal, can and often does result in changes in motivational state. This is therefore a method for individuals to use to modify motivational state. A modification in motivational state can alter behavior and physiology in the future. Some of these changes can alter feelings and emotion, and this, in turn, can alter subsequent motivational state. Individuals can have some control over their future by initiating a particular behavior and hence changing the likelihood of future responses and emotions. Such complex mechanisms are a part of the regulatory functioning of sentient animals. The existence of these mechanisms helps to explain some abnormal behaviors and their consequences.

Conclusions

(1) Most abnormal behavior indicates poor welfare, even if initially adaptive, whereas some is rare but functional. All stereotypes indicate poor welfare. (2) Behavior can be used to modify motivational state. Some abnormal behavior may have this function. (3) The modification of motivational state makes it likely that certain changes in behavior and physiology, often associated with feelings and emotions in sentient animals, will occur. (4) Changes in feelings and emotions affect future behavior and form part of a complex system for regulating behavior and physiology and helping the individual to cope with its environment. (5) These complex mechanisms for regulating motivation, behavior, and physiology should be taken into account when attempts are made to explain abnormal behavior.

Conflict of interest

The author declares no conflict of interest.

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