Journal of Veterinary Behavior 20 (2017) 1–10

Contents lists available at ScienceDirect

Journal of Veterinary Behavior

journal homepage: www.journalvetbehavior.com

Special Section on Stereotypic Behavior

Is the expression of stereotypic behavior a performance-limiting factor in animals?

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ARTICLE INFO

Article history:
Received 28 June 2016
Received in revised form
22 September 2016
Accepted 17 February 2017
Available online 27 February 2017

Keywords:
livestock
equine athlete
performance
production
abnormal behavior

ABSTRACT

Stereotypical behavior (STB) has been observed in a wide range of species regardless of its classification. Despite extensive research into factors that contribute to the etiology of STB and/or influence the expression of STB, few studies have explicitly evaluated if relationships exist between STB and performance variables in livestock or equine athletes. This review explores the effect of STBs on animal performance, using the horse and production animals as examples, to establish whether their expression should be viewed as a positive or negative attribute by the animal industry. Emergent themes within livestock and equine research suggest that individuals that exhibit STBs also demonstrate impaired performance attributes that support the proposal that STB is a negative characteristic. Much of the available empirical evidence suggests that negative environmental stressors represent a greater risk to the economic value of animals compared with STB. Within equestrianism, stereotypic performing horses appear to react and learn in a different way to nonstereotypic horses, which, in professional hands, could enhance their performance potential and value, but with amateur riders could reinforce the negative associations that exist. However, performance is a complex phenomenon with any species, and multiple endogenous and exogenous factors will contribute to success at any one time. Further research is required that explicitly explores how different STBs influence performance variables alongside consideration of the effect of management systems and environmental stressors and their role in STB expression in both livestock and horses.

Introduction

Stereotypical behavior (STB) has been observed in a wide range of species, regardless of their classification, including livestock (e.g., Adenkola and Ayo, 2010) and companion animals (dogs [Protopopova et al., 2014], parrots [Cussen and Mench, 2015], rodents [Novak et al., 2015], and horses [Albright et al., 2015]). STBs are also reported in zoo animals including animals housed in managed environments (Shepherdson et al., 2013; Padalino et al., 2014) and those kept in more natural environments such as in extensive game parks (Kiley-Worthington and Randle, 2005). Both groups of these nondomesticated animals require periodic management for health and veterinary treatment or to facilitate human-animal (paying visitor) interaction (Randle and Kiley-Worthington, 2004). STB can occur in a wide range of ages. They have been noted to occur from birth (Latham and Mason, 2008) as has been reported in horses (e.g., Wickens and Houpt, 2015) through to old age (Qi et al., 2008), although for some species, key risk times have been identified. Mason and Rushen (2008) highlighted that horses and foals are at the greatest risk of developing a new form of STB between 15 and 35 weeks and that emergence of new stereotypies peaks at 40 weeks.

The expression of STBs in nonhuman animals is often considered a visual indicator of response to environmental (Hemmings and Hale, 2013; Shepherdson et al., 2013; Averos et al., 2014) or psychological stressors (McBride and Mills, 2012; Pomerantz et al., 2012; Gottleib et al., 2013) and can also be influenced by an individual's temperament (Shepherdson et al., 2013) and personality (Ijichi et al., 2013). STBs are thought to indirectly reflect the welfare status of animals by some (e.g., Mason and Rushen, 2008). Gottlieb

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http://dx.doi.org/10.1016/j.jveb.2017.02.006
1558-7878/

et al. (2013) warned that individual behavior expression cannot necessarily be used to assess welfare between subjects because some individuals may express high rates of STB because of frustration (in the sense of not being able to gain access to a resource that may be present in the animal's environment), whereas others may do so to cope with a suboptimal environment (i.e., an environment that does not provide all the animal's basic requirements).

Many of the associations proposed between STB and negative performance variables, such as increased injury risk in horses that weave or reduced milk yields in cattle, are often not supported by evidence of causal relationships and are largely based on assumption. This review aims to establish the effect of STB on animal performance, using production animals and performance horses as examples, to establish whether the evidence supports if their expression should be viewed as a positive or negative attribute by the animal industry.

Stress

STB is often associated with stress in animals. Stress is defined as a *biological response elicited when an individual perceives a threat to its homeostasis and the threat that causes stress is referred to as a stressor* (Moberg, 2000), *the inability of animals to cope with their environment* (Broom and Johnson, 1993), and *unfitness to adapt to the environment and reproduce effectively* (Ewing et al., 1999). Stressors may be positive or eustressors (e.g., hormones that trigger arousal and mating behavior) or negative, known as distressors (e.g., restricted environment that does not facilitate expression of normal behaviors). Stressors are detected by animals' sensory systems to seemingly produce an instantaneous biological response that may or may not be externally observable (Von Borell et al., 2007). Biological reactions depend on the recognition of the features of a stressor and elicit a neurophysiological response that typically comprises cognitive and noncognitive elements and include behavioral, autonomic, neuroendocrinological, and/or immunological responses (Ichiji et al., 2013). The precise nature and duration of responses to stress depend on the nature of the stressor. A stimulus and/or situation that is perceived (cognitive element) as a short-term threat is characterized by sympathetic adrenal medullary system and central nervous system activity resulting in release of the epinephrine neurotransmitter that prepares the body for action. Conversely, a stimulus and/or situation that is perceived (cognitive element) as a long-term threat is characterized by responses indicative of long-term challenge and the initiation of a coping mechanism. In this situation, the hypothalamic-pituitary-adrenocortical (HPA) stress-response system is activated and results in a sustained production of glucocorticoids and mineralocorticoids that are known to enable proactive coping. Once an individual is sufficiently stressed, the HPA axis becomes more sensitive and more easily triggered by stressors. This process is accompanied by high sympathetic reactivity resulting in increased concentrations of catecholamines and elevated parasympathetic reactivity and as a consequence affects on individual animal performance (Von Borell et al., 2007).

Stress is broadly understood by both scientists and laypersons to be characterized by the outcomes or responses given by animals to a series of stressors. Stressors include various aspects of the animal's internal and/or external environment that are compromising homeostasis either physically and/or psychologically and causing a disruption to what is considered to be normal for that species/breed/individual (Levine, 1985). Furthermore, Levine (1985) among others emphasized that various measures of an individual suffering from stress are often conflicting, for example, behavioral indicators and heart rate variability. Smith et al. (2016) proposed that heart rate correlates with behavioral indices of stress in horses. Although behaviors assumed to be related to stress were seen more frequently when subjects encountered negative stimuli than with positive ones, heart rate responses did not follow the same pattern. It is reasonable to suggest that the view of Moberg that stress was better described as a syndrome (a group of symptoms or signs that commonly appear together) in which the visible response/s may represent varying combinations of causes remains wholly applicable. Rightly or wrongly, stress is often implicated in the etiology of STB, regardless of the species under examination and is commonly attributed, at least in part, to deficiencies in general husbandry and management (mainly lack of space and direct contact with conspecifics, e.g., Varadharajan et al., 2015) and/or to specific stressors within the environments in which they and/or individuals are housed (e.g., Shepherdson et al., 2013; Romero et al., 2015). The critical role of stress in the development of resilience in individuals enabling them to cope with the various challenges encountered in the course of daily life, particularly those related to their physical environment, and of increased concern, their social environment is emphasized by Romero et al. (2015). The expression of STB may be one way of coping with such challenges.

Behavior

Stereotypies are often described as abnormal behaviors. Behavior can be broadly described as *actions or reactions of an individual in response to a particular situation or stimulus* (e.g., Grier, 1984 cited by King et al., 2012) or more simply anything an individual does, although it has also been acknowledged that the term behavior also applies when there is no visible change in behavior, that is, no observable response (Randle, 1995). Although methods of observing, recording, and analyzing behavior vary substantially, frequently, the first sign of illness is detected through observation of changes in the normal behavior of an individual (Grandin, 2015).

There are many arguments about the status and indeed importance of the exhibition of natural behavior for species that are now under the direct management of humans. Although studies of individuals within the natural environments in which they evolved are useful for determining and assessing if the behavioral needs of the species are met, account must also be taken of the restrictions associated with the modern-day environments in which animals and/or individuals are kept and expected to perform. Compliance with the 5 freedoms/5 needs ensures that individual domesticated animals' behavioral needs are considered at the very least (Bramble Report, 1965; Animal Welfare Act, 2006). The main measures of environmental adequacy focus on the occurrence of the so-called natural behaviors (without having an adverse effect on conspecifics and herdmates; Kiley-Worthington, 1990; Randle, 1995) and the absence of behaviors commonly believed to be indicative of stress including STBs.

In this article, the horse is used as a frequent example as a prey species, known to roam extended distances daily, to spend most of the day grazing and to be social, that has been subjected to what can only be considered to be extensive—severe restriction being housed individually and often for extended periods. The gravity of this restriction has been recently recognized in Switzerland where daily turnout for horses is now mandatory and group housing strongly recommended (Swiss Animal Protection Organisation, 2016).

Performance

Performance has multiple definitions, including *how well an individual does a piece of work or an activity* (Cambridge online dictionary and thesaurus, 2010), *the action or process of performing a task or function … capability of an entity … task or operation*