Physiology & Behavior 106 (2012) 638–644

Contents lists available at SciVerse ScienceDirect

Physiology & Behavior

journal homepage: www.elsevier.com/locate/phb

The effect of biting tails and having tails bitten in pigs

Manja Zupan [a,c,*], Andrew M. Janczak [a], Tore Framstad [a], Adroaldo J. Zanella [b,d]

[a] Norwegian School of Veterinary Science, Department of Production Animal Clinical Sciences, Ullevålsveien 72, P.O. Box 8146 Dep. NO-0033, Oslo, Norway
[b] Norwegian University of Life Sciences, Department of Animal and Aquacultural Sciences P.O. Box 5003 N-1432, Ås, Norway
[c] University of Ljubljana, Biotechnical Faculty, Department of Animal Science, Groblje 3, 1230 Domžale, Slovenia
[d] Animal Behaviour and Welfare, Sustainable Livestock Systems Group, Scottish Agricultural College (SAC), SAC—Roslin Institute Building, Easter Bush, Midlothian, EH259P6, United Kingdom

ARTICLE INFO

Article history:
Received 26 June 2011
Received in revised form 7 November 2011
Accepted 24 April 2012

Keywords:
Pigs
Tail-biting
Welfare
Fear tests
Behavior
Heart rate (max. 6)

ABSTRACT

Tail-biting is a behavioral abnormality which compromises the welfare of pigs. The goal of this study was to characterize the tail-biting phenotype using behavior and measures of heart-rate (HR) and its variability (HRV) in pigs. Thirty pigs were categorized as tail-biters ($n=10$), tail-bite victims ($n=10$), and control pigs ($n=10$) based on the frequency of tail-biting behavior that they performed or received at the farm. The animals' behavioral responses were registered at the experimental facilities for 10 min during test sessions whereas physiological responses were registered for 10 min prior to (basal) and during sessions when subjected to a novel object test (NOT) and to a novel arena test (NAT). Phenotypes differed in most behaviors during the two tests and in the NOT their physiological responses suggested different regulation of vagal tone. Biters had a reduction from baseline values to values during testing for the root mean square of successive R–R intervals (RMSSD) and the high-frequency band (HF) compared to victims, whose RMSSD and HF increased from baseline to test values. In the low-frequency band (LF), an increase was shown in biters and controls while a decrease in victims. LF was found to be strongly positively correlated with HF and RMSSD in biters. During baseline, victims tended to have lower HF and significantly higher power of the low-frequency component divided by power of the high-frequency band (LF:HF ratio) compared to biters and controls. The activity of the autonomic nervous system, especially the suppression of parasympathetic tone, indicated that both victims and biters may have a dysfunctional autonomic regulation which may indicate psychological disturbance. We provide the first documentation of phenotypic differences between pigs that have performed tail-biting, have been victimized, or have not been involved in tail biting using HRV data.

1. Introduction

In commercial pig production systems more than 90% of the 146 million slaughter pigs in the EU are tail docked annually to prevent tail-biting [1]. Tail-biting is an abnormal behavior characterized by oral manipulation of the tail of another pig resulting in lesions [2]. Tail-docking, which is carried out without pain relieving protocols, may reduce the severity of tail-biting outbreaks, but 11% the tail-docked pigs slaughtered still have tail damage which could be attributed to tail-biting [3]. Some pigs may thus experience impaired welfare, resulting from the pain caused by tail-docking and the injuries associated with tail-biting. Economic costs may also arise due to subsequent lesions and diseases caused by tail damage.

Tail-biting, often observed as a compulsive act leading to obsessive biting [2], affects the physical and psychological health of domestic pigs [4]. So far, research focused mainly on risk factors divided into internal, i.e. pig-related characteristics, and external, i.e. related to physical- and social environment, that can induce tail-biting [2,5]. Recently, Zonderland et al. [6] suggested an etiology model with exploration motivation leading to tail-biting outbreaks. They also observed that individual pigs display a large variation in the frequency of tail-biting behavior [7]. Pigs with the highest frequency of tail-biting behavior are considered the pronounced biters while the pronounced victims are the ones with the highest frequency of received behavior.

To our knowledge there has been no investigation done on the effect of being involved in tail-biting on the regulation of certain behavioral and physiological responses when confronted with environmental challenges. The present study aimed at testing the hypothesis that tail-biters, victims, and control pigs may differ in their levels of fearfulness when exposed to different stimuli. Fearfulness has implications for the ability to cope with specific types of environmental changes and challenges. Fearful pigs may become more stressed by environmental changes. Janczak et al. [8] documented that fearfulness is stable over time and therefore reflects a personality dimension in pigs. Behavioral and physiological measures of fear, such as an exposure to a novel object or to a novel

* Corresponding author at: University of Ljubljana, Biotechnical Faculty, Department of Animal Science, Groblje 3, 1230 Domžale, Slovenia. Tel.: +386 13203994; fax: +386 17241005.
E-mail address: manja.zupan@bf.uni-lj.si (M. Zupan).

0031-9384/$ – see front matter
doi:10.1016/j.physbeh.2012.04.025

environment, can help to identify individuals with higher levels of fear and anxiety. Anxiety is the future-oriented mood state in which an individual anticipates negative events and it is a closely related emotion to fear which is defined as a reaction to the perception of actual danger [9]. In regards to the psychological state of pigs in a pen with a tail-biting outbreak, Zonderland et al. [10] argued that it could be that pigs whose tails are bitten regularly and severely, i.e. victims, are more fearful animals.

The autonomic nervous system (ANS) has been found to mediate behavioral and physiological responses to psychological states like stress or fear [11–14] and anxiety disorders such as post-traumatic stress disorder [15], panic disorder [16] or generalized anxiety disorder [17]. However, its primary function is to regulate the internal environment of the body to maintain homeostasis [18] or allostasis [19]. Allostasis is a more recent concept of physiology, based on assumption that the capacity to change is crucial to good physical and psychological health as well as good animal welfare. Heart rate variability (HRV), a neurophysiological measure of cardiac activity, reflects the influence of the ANS on the interval between successive heart beats. The time intervals between these heartbeats in healthy animals are not of equal duration. This reflects ever-changing psychophysiological state of the animal that is predominantly regulated by both branches of ANS, the parasympathetic (vagal) and sympathetic [18]. The primary indicative of vagal activation in the linear components of the cardiac signals is the time domain parameter RMSSD, root mean square of successive differences of inter-beat intervals. It is used to estimate the high frequency beat-to-beat variations. Approximate correspondence of RMSSD is HF, power in high frequency range in the frequency domain method [20]. The power spectrum within the high-frequency component, corresponding to the respiratory frequency of the animal, primarily reflects vagal tone whereas low-frequency component, LF, is reported to be influenced by both sympathetic and vagal tones [21].

For feather pecking, which is a behavioral disorder in poultry similar to tail-biting behavior in pigs, Rodenburg et al. [22] suggested that underlying fearfulness predisposes laying hens to exhibit feather pecking. By investigating the hens divergently selected for feather pecking, Kjaer and Jørgensen [23] found the greatest decrease in LF and HF from basal to during stressful situation in birds from the high feather pecking lines compared to the low feather pecking lines and the controls. In human medicine, Dale et al. [24] compared two groups of infants and found that the group with higher behavioral regulation disorders displayed difficulties in regulation of decreased vagal tone during responses to environmental challenges. This corroborates previously reported results in children [25]. For this reason, we chose to test for effects of biting tails and having tails bitten in pigs on measures of HRV as indicators of autonomic regulation of the heart. In the present study, we studied measures of fear-related behavior, heart rate (HR) which indicates the interaction between the vagal and sympathetic activation of ANS [21] and HRV in tail-biters, victims or control pigs. Time and frequency domain methods were utilized to investigate HRV.

2. Materials and methods

2.1. Selection of experimental animals and general housing conditions

Farm visits followed a report of tail-biting outbreaks on commercial Norwegian farms. Pigs were selected from the farms based on 60 min of continual recordings of the frequency of biting in problematic pens based on direct observation. The pens were of mixed sex. Tail-biters were observed to repeatedly bite the tails of random pigs. The number of bites received for victims was not registered, as we chose victims based on tail damage not bites received. Victims had bloody and severe tail damage. Controls were not involved in tail-biting. After the observation period on the farm, the test persons selected up to two sets of one tail-biter, one tail-bite victim and one control pig from the same pen (a trio). Pigs studied were gilts and barrows, and of two crossbreeds, Landrace × Yorkshire (LY) and Landrace × Yorkshire × Landrace × Duroc (LYLD). In total, 30 pigs were selected from 5 blocks (occasions), six pigs per block (2 trios) and transported to the Norwegian School of Veterinary Science (NVH). On arrival at the experimental facilities at NVH, the pigs were weighed and housed individually in pens. The body weight (mean kg ± SE) of tail-biters ($n = 10$), tail-bite victims ($n = 10$) and controls ($n = 10$) was as follows: 50.1 ± 6.7, 54.60 ± 6.7, 53.20 ± 6.7, respectively. Experimental facilities consisted of 6 pens in 2 rows, the front and the back row. Each pen (1.25 m × 1.79 m) had concrete floors with three solid sides and on the fourth side an iron grid allowing visual, olfactory, auditory, and limited tactile contact between adjacent pens. Wood shavings were provided daily to each pig as bedding and a rope hanging from the pen division was available for oral manipulation. Pelleted feed concentrate and water were available *ad libitum* via a trough and water nipple, respectively. The temperature in the pens ranged from 19 to 21 °C. In addition to natural light, artificial lights were on from 08:00 to 15:00 h.

2.2. Habituation

Once daily, during a week before testing, pigs were habituated to wearing a heart rate belt, which was an electrode belt with built-in transmitter and a wristwatch receiver (RS800™, Polar Electro Oy, Helsinki, Finland). Ultrasound transmission gel (ScanHall AS, Oslo, Norway) was applied at each electrode contact point behind the forelimbs of pigs. Fitting the equipment took less than 2 min to perform and was left on an animal for approximately 5 min. Each habituation session took around 10 min per pig.

The animals were tested in a Novel Object (NOT) and a Novel Arena Test (NAT). Measures of HR and HRV were obtained using Polar device and wristwatch.

2.3. Behavioral phenotyping

2.3.1. Novel object test (NOT)

This test was a modification of the test described by Janczak et al. [8]. A plywood board was attached to the iron grid of the pen to visually isolate the pig in the adjacent pen. Then, the test person entered a pen with a novel object, which was a 6-liter plastic container with stripes on the sides. The object was concealed inside a plastic box until the test started. A string attached to the bottle was tied to the middle of the pen division between adjacent pigs. The bottle was dropped into the pen and the person left the pen with the plastic box to start the test. The behavior of an individual pig was recorded continuously for a period of 10 min from the time the object was dropped and the test person exited the pen. The order in which each pig was tested was determined by randomly selecting a pen-pair. Testing always took place in the front row with the pig housed in the front row of the enclosure tested first. After 10 min of observation, the test person re-entered the pen, turned off and removed the Polar device, and removed the novel object from the pen. The plywood board and metal fourth wall between the adjacent pens were removed in order to exchange the locations of pigs between the pens. The testing of the adjacent pig was then started.

2.3.2. Novel arena test (NAT)

The day after conducting the NOT, the behavioral responses of the same pigs were recorded during social isolation in a novel room (NAT). For the test order, the same randomized procedure was carried out as during the NOT. The test room had white walls and a concrete floor and measured 1.95 m × 2.80 m. The pig was gently herded by the test person from the pen down a short corridor to the test room and remained there undisturbed for 10 min while it was filmed.