Applied Animal Behaviour Science xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

Applied Animal Behaviour Science

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

Effects of confinement duration and parity on behavioural responses and the degree of psychological fear in pregnant sows

Ming-yue Zhang[a,1], Xiang Li[a,1], Xiao-hui Zhang[a], Hong-gui Liu[a], Jian-hong Li[b], Jun Bao[a,*]

[a] College of Animal Science and Technology, Northeast Agricultural University, Harbin 150030, China
[b] College of Life Science, Northeast Agricultural University, Harbin 150030, China

ARTICLE INFO

Keyword:
Confinement
Parity
Pregnant sows
Behaviour
Novel stimuli
Gestation duration

ABSTRACT

The aim of this study was to evaluate the effects of space restriction stress on the behavior of different parity sows, and it is necessary to understand such effects due to space restriction to improve the welfare of the sows in confined conditions. We selected 264 pregnant sows (Large White) at primiparity, and at first to fifth parity in a commercial farm for the same due date (3 day ± 1.5). Behavioural observations and the novel object test (NOT) were carried out during the stages of confinement throughout their pregnancy. The results showed that there were no significant changes ($p = 0.767$; $p = 0.761$; $p = 0.766$; $p = 0.960$; $p = 0.498$) in standing, vacuum-chewing, bar-biting, trough-biting or rooting frequency of primiparous sows during the initial confinement (0–8 days). With the increase of the confinement duration, the vacuum-chewing frequency of the sows in all of the experimental groups increased significantly ($p < 0.01$) and the frequencies of fifth parity sows were significantly higher than those of the other groups ($p < 0.01$) throughout the entire stages of confinement. The rooting frequency of the experimental sows decreased continuously, and the younger groups (primiparity and first parity) had a significantly higher rooting frequency than the older groups ($p < 0.01$) from the 85th day of gestation. The NOT results showed that the frequencies and the durations of contact with the novel object of the older sows were significantly decreased from the 25th day to the 85th day of gestation ($p < 0.01$). The standing, bar-biting and trough-biting frequencies of all parity sows were decreased significantly ($p < 0.01$) after entering the farrowing pens. In conclusion, at least throughout the gestation period, short-term confinement will not cause adaptive changes in sow behaviour, but long-term confinement can significantly increase the frequency of vacuum-chewing and fear of novel stimuli.

1. Introduction

The current intensive swine farming systems lead to large economic benefits to farmers, however, at the same time, the intensive production system may cause stress and seriously affect the welfare of pigs (Black et al., 1993; Damgaard et al., 2009). Especially during the gestation period, confinement, such as gestation stalls as common facility, is a source of chronic stressor to sows (Schouten and Wiepkema, 1991; van der Beek et al., 2004) because confined sows cannot walk, turn around, play or communicate with other pigs. Sows in confined conditions cannot express the behaviours that meet their specific needs, such as exploring or rooting behaviour, so they express abnormal behaviours such as vacuum-chewing, bar-biting or trough-biting, which result in physiological and psychological disorders (Wood-Gush and Beilharz, 1983; Spinelli and Markowitz, 1985; Chamove, 1989; Wemelsfelder, 1990; Poole, 1992). Previous studies have shown that the long-lasting confinement of sows not only leads to abnormal behavioural responses and physiological reactions but also negatively influences the psychology of sows (van der Staay et al., 2010), therefore, the pregnant sows' welfare is poor and may even increase their piglets mortality (Jarvis et al., 2004; Fraser, 1990), even lead to serious economic losses for producers (English and Morrison, 1984). Thus, the welfare of sows in production is a matter of concern.

The welfare of livestock is related to its adaptability (Fraser, 1999). Short-term stress does not cause harm to an individual, but once stress persists beyond the scope of the body's adaptability, it has adverse effects on the body and on mental health (Skovgaard et al., 2009). Fear is a psychological reaction of animals (Boissy, 1995) that is related to animal emotions, and it affects the animal's motivation to explore or its exploration behaviour (Forkman et al., 2007). The novel object test (NOT) is a conventional method to measure the degree of fear and anxiety of animals in reaction to novel stimuli. The measured indicators

* Corresponding author at: College of Animal Science and Technology, Northeast Agricultural University, Mucai Street No.59, Harbin 150030, China.
E-mail address: jbao@neau.edu.cn (J. Bao).
[1] Equal contribution to the study.

http://dx.doi.org/10.1016/j.applanim.2017.03.016
Received 7 November 2016; Received in revised form 18 February 2017; Accepted 5 March 2017

include the duration, latency of first contact with the novel stimulus and the total contact numbers (Forkman et al., 2007). Pigs are naturally born to explore familiar environments (Spinka, 2009), and many studies have found that pigs also have a high motivation to explore novel stimuli (Wood-Gush and Vestergaard, 1991). At present, there are two methods of testing in pigs: the target-guided exploratory mode and curiosity-driven exploration mode (Day et al., 1995; Studnitz et al., 2007; Wood-Gush and Vestergaard, 1991).

In this study, we investigated the effects of long-term confinement on the behavioural responses and degree of fear in sows of different parity, the behaviour of sows (especially the stereotypic behaviour) and changes of the NOT test responses were observed over the entire gestation period. The aim was to observe behavioral responses and fear to a novel stimulus in sows with different parity of sows as confinement duration progressed to evaluate the welfare of sow in intensive farming systems.

2. Materials and methods

2.1. Animals and management

264 Sows (44 from each of the six parity groups) came from same genetic line (Large White) and all sows were bred and reared under the same management condition and their arrangement was given in Table 1.

Before entering the experimental stage, there was sufficient space at least 2.2 m^2 floor space for the primiparous gilts before breeding (10 pigs in a pen at 2.5 m^2/pig, pen size was 350 cm × 715 cm). The primiparous gilts were transferred into confined crates at approximately 200 days of age with a body weight of 90–120 kg. The initial restricted stress test began on the first day from gilt confined crates. The long-term restricted stress test for pregnancy in each group started on the 1st day of gestation. After weaning, the sows immediately returned to the original confined crates that they inhabited during the gestation period and were prepared to be bred again after 1–2 days. In general, multiparous sows would be estrous on 9th day after weaning and start a new round of gestation. The primiparous gilts and multiparous sows from the same group experienced the same stage of confinement (Fig. 1). In this experiment, the restricted crate size during the gestation period was 200 cm (L) × 65 cm (W) × 92 cm (H) and the farrowing pen size was 210 cm (L) × 65 cm (W) × 90 cm (H).

Sows were fed twice daily during pregnancy at 4:30 h and at 14:00 h. Each sow was fed 3 kg of sow pellets per day during pregnancy, and 2–3 days before delivery to the farrowing pens, the feed amount was reduced to 2 kg per day. There was no feeding on the day of delivery and after delivery. The sows had ad libitum feeding during the lactation period. After 35d of lactation, the sows returned to the pregnancy restricted crates. All experimental sows were fed a premixed feed with the same nutrient composition (Table 2) during the lactation period. The formula of the feed was a mixed meal of corn, wheat bran and soybean and premixed feed, and the proportion was 54:24:18:4. ME was 12.9 MJ with 12.0 g of lysine.

The gestation and farrowing rooms were naturally ventilated. The temperature of the farrowing room maintained at 20.9 ± 1.1 °C with a relative humidity of 86 ± 2%. The temperature of the gestation stall maintained at 18.2 ± 2.8 °C, and the humidity was 66.5 ± 3.5%. The sows had free access to water. The routine inspection for temperature, water drinkers and physical conditions of the sows was conducted daily by an experienced technician.

2.2. Behavioural observations

In each experimental group, 12 sows were randomly selected for behavioural observation. A video inspecting and recording systems (Hikvision DS-IT5, Hangzhou Hikvision Digital Technology Co., Ltd, Hangzhou, China) was used for behavioural data collection. In each observational day the sows were continuously filmed from 6:00 h to 18:00 h in order to avoid morning feeding and afternoon feeding hours, which occurred from 4:00 h to 5:00 h and from 13:30 h to 14:30 h, and also to avoid cleaning hours, which occurred from 5:00 h to 5:30 h and from 14:30 h to 15:00 h. On each behavioural observation day, each participant was continuously recorded for a total of 4 h of daily activity, 2 h in the morning and 2 h in the afternoon. The key observation times were from 9:00 h to 11:00 h and from 15:30 h to 17:30 h (for specific behaviours and definitions, see Table 2). Short-term stress tests were performed on the 1st, 4th, 8th, and 15th day after the primiparous gilts entered the restricted crates for all of the test groups and then performed again on the 25th, 40th, 55th, 70th, 85th, 100th and prenatal day of gestation for the long term stress test. Behavioral categories were classified as state and event behavior. The state behaviors were standing, ventral lying and lateral lying; the event behaviors were vacuum-chewing, bar-biting, trough-biting and rooting; their definitions were given in Table 3. Scan Sampling method was used to sample the state behaviors at 1 min interval over a 4-h observation period, therefore, there were 240 samples collected for each observed behavior and was they were counted as percentage (%). Continuous Sampling and Instantaneous Recording were used to sample the event behaviors over the 4-h observation, and they were counted as the frequency of occurrences (n). The definition of all behaviors was given in Table 3.

NOT: Three sows were randomly selected from each experimental group on each detection day for each NOT test, and the other three sows were randomly selected for another detection day, so there was no sow had a chance to be exposed to the ball. The testing day was carried out on the 25th, 40th, 55th, 70th, 85th, 100th day of gestation.

The behaviour responses during each NOT period was obtained by using a video recorder (IPHONE, Apple corporation, USA), and the observation last for two hour every test day (from 9:00 h to 11:00 h). Before NOT started each sow was introduced into the testing crate with the enclosed side bars closed, the sow was not allowed to have visual contact with its neighbor. A yellow light plastic ball with a diameter of 30 cm and 800 g in weight was used as the novel stimulus object. When the sow entered the crate, the yellow ball was dropped into the feed trough, and then the observation for its the reaction to the ball was

Table 1
Experiment grouping design.

	G[a] (44 pigs)	P1[b] (44 pigs)	P2[c] (44 pigs)	P3[d] (44 pigs)	P4[e] (44 pigs)	P5[f] (44 pigs)
Behavior observation	12	12	12	12	12	12
NOT	32	32	32	32	32	32

[a] G: Primiparous gilt.
[b] P1: First parity sow.
[c] P2: Second parity sow.
[d] P3: Third parity sow.
[e] P4: Fourth parity sow.
[f] P5: Fifth parity sow.