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Original paper

A novel method for the analysis of social structure allows in-depth analysis of sow rank in newly grouped sows

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ABSTRACT

Chronic stress response in fearful animals can result in depression of growth and reproductive performance. It is therefore important to be aware of at risk animals in the herd. Thus far 'hierarchy' calculations have involved the use of fights won and lost on the day of mixing or successful displacements over a trial period, or a combination, but not analysis of the two separately and then combined. This experiment used 132, multiparous, Large White x Landrace sows. Following artificial insemination, sows were mixed into groups of 6, for 5 days. Salivary cortisol and behaviour were measured on the day before mixing (d-1) and after mixing d0, d1, d3 and d4. 'Hierarchy' was assessed using the number of successful displacements for each sow over all 4 days and the number of fights won and lost on the day of mixing. For both parameters, the sows were separated into three groups, 1D or 1F sows were involved in no fights or displacements, 2D and 2F sows lost more than they won and 3D and 3F sows won more than they lost. Sows ranked 1D1F received significantly more aggression [$P < 0.05$, eg. bites received; 1D1F = 0.7 ± 0.1 (5.8), average of other groups = 0.4 ± 0.1 (1.9)] suggesting that these sows have the lowest welfare out of the population of sows. 1D2F sows did not record similar findings suggesting that using this method to calculate rank is of use, as the subgroups were different. Sows ranked low by this calculation are at risk of facing more aggression and therefore stress.

1. Introduction

Social structure of domestic pigs is built on dominance hierarchy, which is formed through aggression and threats (Bolhuis et al., 2005). This aggression can affect sow welfare, with the welfare of some sows reduced more than others in the group (Mendl et al., 1992; O'Connell et al., 2003; D'Eath, 2004; Koolhaas et al., 2007, 2010). Sow welfare is often assessed at group level, meaning that the effects of aggression, which often results in stress and injury, on an individual level may be underestimated (Verdon et al., 2016). It is widely accepted that there are many differences in sow group housing systems which can affect aggression levels and welfare (Arey and Edwards, 1998; Barnett et al., 2001; Verdon et al., 2015). Therefore, it is important to investigate not only the differences among certain housing systems at a group level, but to also investigate the welfare of individuals within these systems.

In particular, low ranking animals are fearful of receiving aggression and the resulting injury, and therefore submissive sows may sacrifice the opportunity to feed to ensure their safety, in an attempt to reduce the risk of facing aggression (Boyle et al., 2012). This stress can lead to sustained high levels of cortisol, which have the ability to depress growth and reduce reproductive performance (Hemsworth et al., 1986). This is of concern, as these animals are more likely to be found not pregnant, and therefore, are more likely to be re-mixed, once again being subjected to the aggression that occurs during establishment of social rank or even culled from the breeding herd. Analysis of sow rank and reproductive performance by Borberg and Hoy (2009), using fights and order of feeding at an electronic sow feeder (ESF), showed that sows with a high rank had a significantly higher farrowing rate and total litter size compared to those with a low rank. In a similar study, when ranking was based on success rate of displacement from an ESF, high ranked sows gained more bodyweight in gestation and their success followed on to their offspring, which weighed more at weaning, and had a higher lean tissue percentage at slaughter (Kranendonk et al., 2007). Determining individual differences may identify not only the animals which are not coping in their environment, but also the animals

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which have an increased ability to cope with their environment and stressors (Horback and Parsons, 2016), allowing selection for, or against, certain groups of animals.

There are many and varied ways to assess sow and gilt rank, including the use of fights, displacements or overall aggression in the hours (Jensen, 1982; Mendl et al., 1992; O'Connell et al., 2003; Bolhuis et al., 2005; Tönepöhl et al., 2013) or days post-mixing (Hoy and Bauer, 2005; Borberg and Hoy, 2009; Ison et al., 2010; Stukenborg et al., 2011), and around feeding (Arey, 1999). The use of displacements as an indication of rank is used commonly and allows observation of a particular sow's success in removing another from a resource considered as valuable (Mendl et al., 1992). Fights or aggression is another parameter that has been linked to dominance. It has been found in weaner pigs that engage in fighting in the first hour after mixing are commonly the more dominant animals over the next 24 h (Meese and Ewbank, 1973). However, as it is generally accepted that hierarchies form two to 10 days following mixing (Moore et al., 1993; Arey, 1999; Zurbrigg and Blackwell, 2005), it is possible that this fighting at mixing is an indication of the innate aggression of the sow before she is ranked and not necessarily where she will ultimately end up in the hierarchy. With this reasoning, we created a new method to classify sows with the success of fighting behaviour on the day of mixing in addition to ranking of sows using displacements in the days following mixing, as described by Mendl et al. (1992). Hopefully, this technique would allow observation of the sow's immediate success and her final rank. We hypothesised that sows which avoided initial agonistic interactions on the day of mixing and ranked low by displacements would be the sows which were most negatively affected by mixing.

2. Methods

2.1. Animal management and treatments

This study was conducted in accordance with the guidelines set out in 'Code of Practice for the Care and Use of Animals for Scientific Purposes' (Canberra 2004) and with the approval of The University of Adelaide Animal Ethics Committee (Animal Ethics Committee Project Number: S-2012-062B). All animal work was carried out at The University of Adelaide piggery, at the Roseworthy Campus, Roseworthy, South Australia.

The study utilized 132 multiparous (parity 1–7) Large White x Landrace sows, and was conducted over seven replicates between February and September 2013. Sows were selected at weaning, moved from standard farrowing crates and kept in individual sow stalls prior to mixing. The sows were exposed to boars until exhibition of oestrus, and then received three inseminations 24 h apart (if still standing for the third). The sows were officially introduced into the experiment 4 ± 1 days following the last insemination (7 ± 1 days after first detection of oestrus). Sows were mixed in groups of six and observed for days (d) 0, 1, 3 and 4 after mixing. On the day of mixing, sows were moved so that they were mixed by 0700 h and measures began when all sows were in the pen and the gate shut. They were mixed into groups based on achieving an even parity mix across treatments (parity 3.0 ± 1.3). Sows were mixed into space allowances of 2, 4 or 6 m2/sow but these space allowances did not affect hierarchy and space will not be discussed in this paper (Please see further discussion in 'statistical analysis').

While in stalls, sows were manually fed a standard dry sow diet (13.8% protein, 5% fibre, 0.7% total lysine, 13.0 MJ/kg DE) once daily at 0730 h at a level of 2.5 kg per sow. Following mixing and until d28 of gestation the sows were manually floor-fed the same diet over a 3 m concrete pad at the front of the pen. From mixing until d28 of gestation, water was available without restriction via nipple drinkers located within the pens. All sows were scanned for pregnancy at approximately d28 of gestation, at which point all pregnant animals were relocated to a single straw-based shelter (at approximately 4.2 m^2/sow), in a group of up to 40 where they remained until farrowing.

2.2. Behavioral observations

Sow behaviour was recorded for 6 h on each experimental day before the feeding event from 0700 h until 1300 h (Camera: Legria HFR26, Cannon, Sydney Australia). Sows were fed at 0730 h, 30 min after the start of video recording. Sows were uniquely identified by colour and symbol using stock marker (MAC tail paint and animal marker, Becker Underwood Pty Ltd, NSW, Australia). The footage was analysed using video analysis software (Observer XT 11.5, Nodulus Information Technology,Wageningen, The Netherlands). The number of pigs engaged in several specific general activities (eating, drinking, standing, lying, and exploring floor or pen work) and several social behaviours (displacements and fighting, knocks, bites, lunges, fleeing, mounting and non-aggressive sow–sow contact) was recorded (See ethogram, Table 1). Behaviour was analysed as two types, firstly as a continuous behaviour, which were behaviours that had a duration that could be measured (resting or drinking). Sows had to be performing one of the continuous behaviours at any given time during the recording. Secondly, point behaviours were also analysed, which was a behaviour that did not have a duration, such as a knock. Behaviours were scored using continuous sampling and were analysed in three ways over the six hour recording period; the total number of times that a specific behaviour was observed per sow (e.g. number of fights), the average duration of an individual behaviour event in seconds or seconds/behaviour (e.g. fight duration), and the percentage of total time spent exhibiting a behaviour (e.g. percentage of total time spent fighting).

2.3. Hierarchy calculation

For ease of discussion, our calculation of innate aggression and rank will be referred to as sow classification. Sow classification was assessed using the number of fights won and lost on the day of mixing and the number of successful displacements for each sow over all four days. Displacements and fights were calculated as an overall or 'global' rank and not based on resource rank, such as displacements around food, water and space rankings. For both parameters the sows were separated into three groups; 1D or 1F sows were involved in no fights (F) or displacements (D), 2D or 2F sows lost more fights than they won or were displaced more than they displaced others and 3D and 3F sows won more fights than they lost and displaced others more than they were displaced themselves. The sow classification was analysed with both displacements and fights, for example 1D1F. For ease of understanding and for referral during reading the groups are further outlined in Table 2.

2.4. Saliva sample collection and analysis

Saliva samples were collected from all sows, on d-1, d0, d1, d3 and d4, using cotton plugs (salivettes®, Sarstedt Australia, SA, Australia) attached to plastic ties. Each sow was allowed to chew on the salivette for a maximum of two min to obtain the sample. When it was not possible to obtain the sample in the two min time period, the sow was left and no sample was obtained for this animal. This failure to obtain a cortisol sample occurred on four occasions during the experimental period, equating to four missed samples from a targeted 660 samples (656 samples collected). If sows were noted to be drinking when the cortisol sample was taken, the measurement was discarded. Sampling began at 1330 h on each sample day and concluded approximately one hour later. Sample time was