Can slat-compatible enrichment influence the behaviour and response of pigs to a disease challenge?

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Disease is a leading cause of economic loss and reduced animal welfare in the swine industry. Outbreaks of disease such as Porcine Epidemic Diarrhea (PED) demonstrate the conventional approaches to health management do not always suffice. Biosecurity measures may not always prevent disease spread, vaccines take time and investment to develop, and efforts to reduce antimicrobial use must continue to support longer term human and animal health. Therefore, the fundamental resilience of the animal is an important component of health management, and the question shifts from "how do we control disease?" to "how do we make animals less susceptible to disease?". Breeding animals for greater disease resilience, the ability to maintain production performance regardless of disease status or pathogen load, is one approach. But whether and how the rearing environment can influence disease resilience is also of value to understand, especially considering that stress will influence immune function.

Provision of environmental enrichment is considered an important component of good animal care for swine and is a requirement in the Code of Practice for the care and handling of pigs (NFACC, 2014). Environmental enrichment should improve the biological functioning of a captively reared animal (Newberry, 1995). For pigs, enrichment can provide an outlet for the performance of species-specific behaviours such as rooting and chewing for exploration and foraging, and in turn may reduce the likelihood of pigs redirecting nosing and biting towards pen-mates and pen fixtures, with the former potentially reducing chronic social stress within the group.

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Rearing pigs in highly enriched environments with a greater space allowance and provision of substrates (straw, mushroom compost, sawdust, wood branches) for rooting and chewing has been found to reduce the disease susceptibility of pigs to co-infection with porcine reproductive and respiratory syndrome virus (PRRSV) and Actinobacillus pleuropneumoniae, increasing

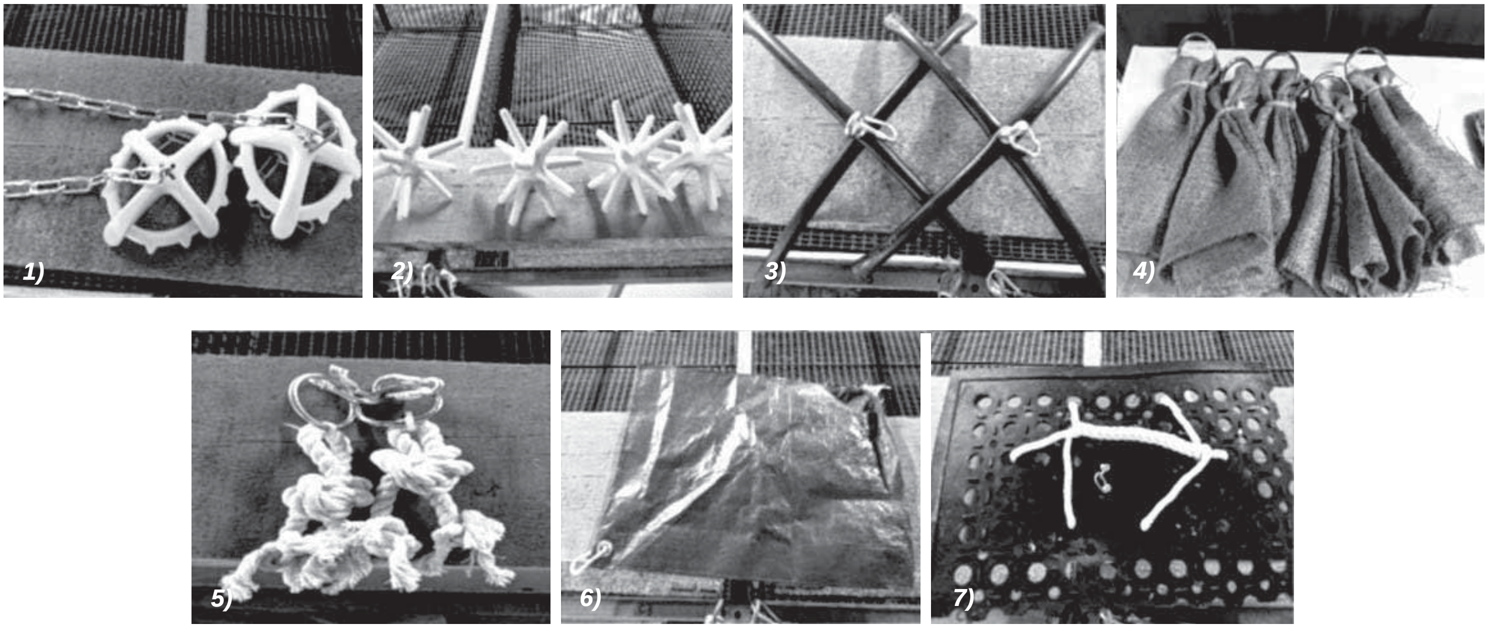

Figure 1. Point-source enrichment objects provided to growing swine during a natural disease challenge. One type of enrichment was provided at a time and the type of object presented was rotated three times weekly. Top row (left to right): 1) Porchichew (NutraPet, East Yorkshire, UK); 2) EasyFix Luna ((EasyFix, Ballinasloe, Ireland); 3) Flexible PVC pipe, 4) jute (burlap) sack. Bottom row (left to right): 5) cotton rope; 6) tarpaulin; 7) rubber rooting mat with cotton rope treaded through.

the speed of viral clearance and reducing the prevalence of lung lesions (van Dixhoorn et al., 2016). However, provision of these types of substrates is not practical in fully slatted rearing systems and may present a biosecurity risk. Instead, slat compatible enrichment, such as reusable commercial pig 'toys' or chewable materials such as natural rope, flexible PVC pipe, or rubber, are more readily provided to pigs in fully-slatted farms. However, scientific evidence is limited and conflicting on the efficacy of chewable, inedible enrichments to influence the productivity, behaviour, or immune function of pigs. The aim of this work was to determine if provision of a rotation of slat compatible enrichments could beneficially influence the physiological responses of pigs when exposed to a disease challenge. Individual pig behaviour within a group influences the health and welfare of pen mates. Enrichment is also known to influence the social behaviour of swine. Therefore, observations of individual pig behaviour were also taken to determine if and how the provision of slat compatible enrichment shaped social behaviour during the disease challenge, and whether relationships between individual pig behaviour and performance (growth and immune response) to a disease challenge exist. The information learnt from this study can help to develop strategies to optimize herd health management, enrichment provision, and phenotypic identification of pigs that perform well under challenge.

Study Methodology

Nineteen batches of barrows (n=1220) were studied at the Deschambault Swine Testing Station, QC. Pigs were transported to the station at weaning, where they first entered a high-health quarantine nursery where they remained for 19 days (day -18 to day 0). Upon arrival each batch of pigs was split equally into pens assigned to a treatment group (Enriched) or to control pens. Enriched pens were reared with a rotation of seven different inedible point-source enrichment objects (Figure 1), with control pens receiving up to two metal chains as a basic enrichment. Point-source enrichment is an item of a limited size that is typically fixed in location, such as by suspending the enrichments. Each type of enrichment was presented to pigs one at a time, at a rate of one enrichment object per seven pigs. To help support novelty and retain interest, objects were rotated three times weekly (Monday, Wednesday, Friday) so that each type of object was presented for two to three days at a time and then not re-presented to the pigs for a period of nine days.

On day 0 at 37-40 days of age, pigs were transferred into a continuous flow barn and exposed to a polymicrobial natural disease challenge including economically significant pathogens such as porcine reproductive and respiratory syndrome virus (PRRSV), swine influenza A, and Salmonella spp. for a period of four weeks, after which they were transferred to a finisher barn where they remained until slaughter.

Pens of pigs remained in their respective control or treatment groups throughout each growth phase, with enriched pens continuing to receive a rotation of enrichment from quarantine, through the disease challenge, and to grow-finish. Measurements of pig behaviour (enrichment interaction and postures), productivity (average daily gain and feed efficiency), morbidity and mortality, and immune cell counts (white blood cells, red blood cells, haematocrit and haemoglobin) were collected and compared between the two treatment groups at time points before (quarantine phase), during, and after disease challenge (finisher phase). Additionally, to understand how enrichment shapes behaviour, and the characteristics of successful pigs, a preliminary exploration into relationships

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between the performance of social and exploratory behaviours by individual pigs when exposed to a disease challenge and their performance (growth, cellular immune response) was performed on a subset of 70 pigs. For this, the social behaviour (positive: gentle nosing, and negative: biting) of pigs towards pen mates and the environment (exploring enrichment, rooting pen fittings) was recorded at two-minute intervals over four hours in the quarantine phase (day -18) and in the natural disease challenge barn on day 13 following exposure.

Results & Discussion

Results showed that pigs provided with a rotation of point-source enrichments were more likely to interact with these objects than control pigs interacted with the chains that they were provided with as the only point-source enrichment (Figure 2). However, the probability of interaction with the point-source enrichment declined over time within each growth phase. This was particularly evident in the finisher phase, where the probability of observing a pig interacting with the enrichment was 0% in the control pens and 1-2% in the enrichment pens. Enriched pens did not differ from control pens in mortality, average daily gain, feed conversion ratio, or the change in immune cell concentrations from baseline to post-disease challenge (day 42). Therefore, despite frequent rotation, the enrichment objects were not able to generate a benefit in terms of pig performance or response to disease challenge. This may be because the enrichment was not rewarding enough to the pigs, which is also reflected in the decline in their use over time. If reduced use of enrichment is taking place, it can be expected there is minimal benefit. Despite this, observations of pig postures found that pigs in enriched pens were more likely to be observed lying laterally (side lying) and performed less standing and lying sternally (stomach lying) throughout the quarantine and disease challenge phases (P<0.001), which could indicate that enriched pigs were resting more comfortably and spending less time awake and inactive, which may also reflect the increased expenditure of activity on enrichment.

Observations of individual social and exploratory behaviour performed by 70 pigs identified that pigs in enriched pens were more active in the quarantine phase, performing more positive and negative social behaviours and more pen rooting than pigs in control pens (P<0.05 for all). On day 13 of disease challenge, pigs in enriched pens displayed greater levels of enrichment use (P<0.001) and negative social behaviour (P=0.04), but pigs in control and enriched pens did not differ in positive social behaviour and pen rooting. An examination of relationships between the behaviours found that pigs in enriched pens on day -18 (Figure 3) showed positive correlations of moderate strength of enrichment interaction with positive social nosing, negative social behaviours, and pen-directed rooting. These relationships were not significant for pigs in the control pens, suggesting the presence of enrichment increased the overall oral-nasal-facial behaviour of pigs. In control pens, interacting with the chain enrichment showed a positive relationship with levels of negative biting behaviour.

It has been suggested that when enrichment does not meet the behavioural needs of the pigs, their behaviour is redirected towards penmates or towards pen fixtures, walls, and floors. Whereas, when enrichment is effective, it is associated with a reduction in pen-mate manipulation. This suggests that provision of a rotation of point-source enrichment may not have met the enrichment needs of the pigs in our study. Additionally,

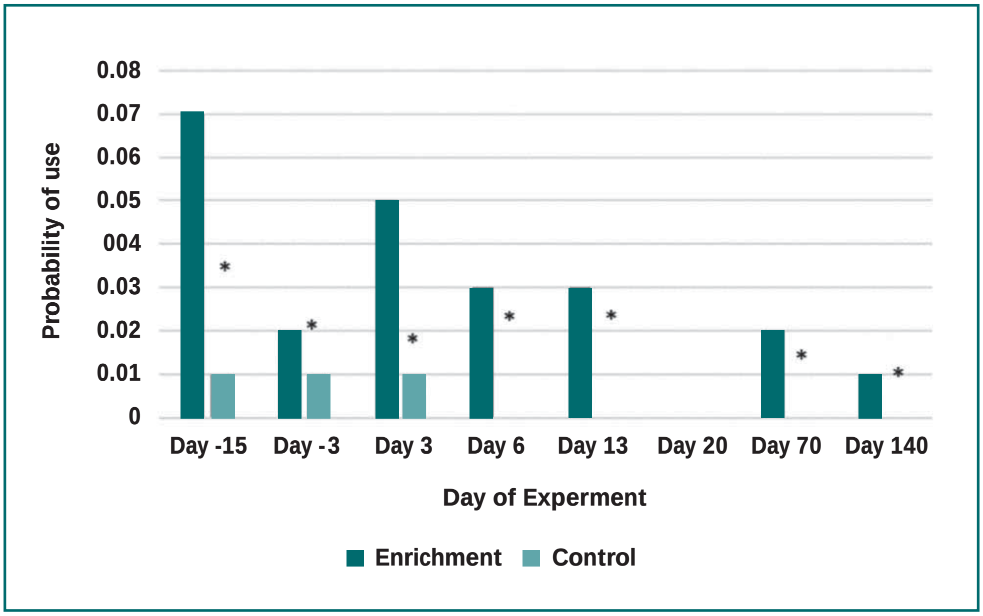

Figure 2. Probability of pens of pigs in interacting with a point-source enrichment object (Enrichment) or a metal chain (Control) during a two-hour observation period on sampling days within three experimental phases: quarantine phase (Day -15, Day -3), disease challenge phase (Day 3, Day 6, Day 13, Day 20) and finisher phase (Day 70, Day 140). Statistically significant differences (P<0.05) between treatment groups are denoted by an asterisk (*).

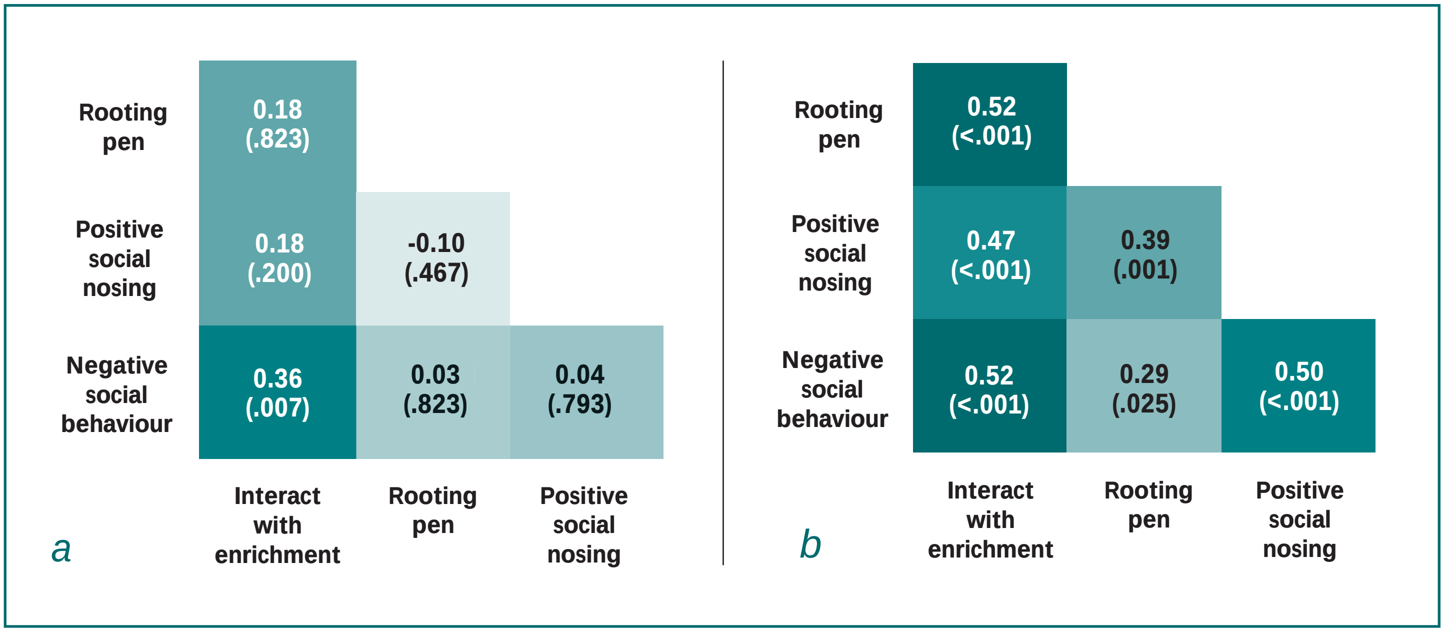

Figure 3. Heat map representation of a Spearman correlation matrix of behaviour frequencies of pig social and exploratory behaviour within enrichment ("a" n = 30) and control ("b" n = 30) treatment groups during a quarantine phase (Day -18). P-values of the correlations are in parentheses. Significance is established as P≤0.003.

the interpretation of social behaviour may not always have been accurate and could have been a precursor for negative behaviours, or simply exploratory behaviour towards another pig.

Relationships were found between the performance of specific behaviours and performance in the disease challenge for both control and enriched pens. In both treatment groups, animals that performed a greater frequency of pen rooting during disease challenge had a greater average daily gain in the finisher phase (P<0.01). For enriched pens only, there was a moderate, positive relationship of the performance of pen rooting with positive social behaviour and higher counts of total white blood cells, lymphocytes, total red blood cells, and hemoglobin measured at day 42 post disease exposure. This suggests that pigs that perform functional (rooting) and positive social behaviour may perform better under challenge, showing higher growth rate and quicker recovery. Based on this preliminary exploration in a sub-sample of pigs, there could be value in further categorizing individuals based on their behaviour, for their ability to perform when under challenge. Furthermore, because the relationships were between functional (rooting) and positive social behaviour, there may also be value in exploring ways to encourage supporting expression of these behaviours to improve performance of pigs under challenge.

Implications

The provision of a rotation of inedible point-source enrichments to pigs reared in fully slatted housing increased the interaction with enrichment compared to provision of a single chain but was not effective at beneficially influencing the response of pigs to a natural disease challenge. Further research on providing enrichment that sustains pig interaction, that satisfies motivational needs, and that can deliver biological benefits is warranted. This will ensure investments made into enrichment that meet Code of Practice requirements can deliver good benefits for pig welfare and for the producer. Relationships between individual pig behaviour and performance when under challenge suggests there is value in exploring this further, which may lead to development of additional phenotypic measures for resilient animals.

The results of this work can help provide information for the development of sustainable and effective environmental enrichment practices that meet animal care requirements while supporting the health and economic viability of Canadian swine production.

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