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Impact of stressing a pen mate on physiological responses of growing pigs

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Impact of stressing a pen mate on physiological responses of growing pigs

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ABSTRACT

Crossbred barrows and gilts (n = 36), weighing 16.59 ± 2.1 kg, were used to test the effects of stressing a pen mate on the physiological responses of growing pigs. Pigs were randomly allotted to 6 groups after stratifying according to gender, litter origin, and body weight. Dominance order was determined within each group, and 1 to 3 d prior to the stress treatment the most- and least-dominant pigs within a group were fitted with indwelling catheters in their vena cavas. Over 3 d, groups were either: 1) isolated from audile and visual contact with stressed pigs in a separate room (non-stressed control); 2) separated by a curtain from visual contact with stressed pigs; or 3) allowed to maintain audile and visual contact with stressed pigs. Blood samples were collected 30, 15, and 0 min before exposure to the stressor (snout-snare) treatment and again at 1, 2, 3, 4, 5, 7.5, 10, 15, 20, 25, and 30 min after stressor application. Serum cortisol and plasma glucose, lactate, and nonesterified fatty acids (NEFA) concentrations were measured. There were no treatment × sampling-time interactions ($P > 0.17$) for concentrations of cortisol, glucose, lactate or NEFA, nor were these metabolites affected by stressor treatment ($P > 0.42$). Humoral measures of the stress response were not affected by visual and/or audile contact with pen mates undergoing a stressful event.

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INTRODUCTION

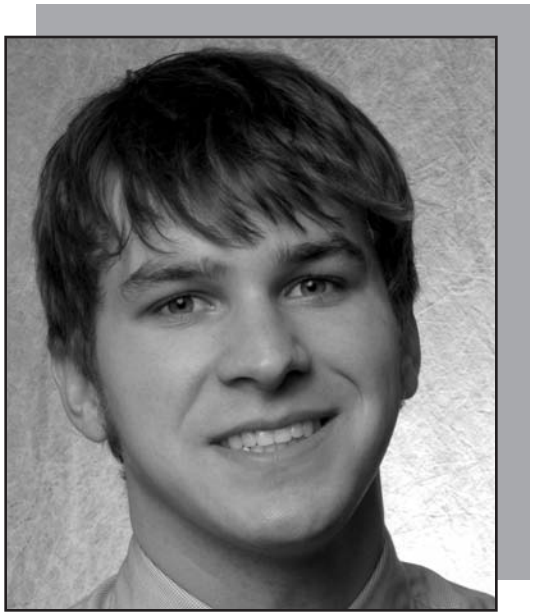
A problem facing the swine industry today is the amount of stress that pigs encounter throughout their lives. This stress may be caused by many factors including overcrowding, separation from cohorts, or any number of environmental factors such as heat stress. While this may seem to be a trivial matter, it is known that stress dramatically impacts a pig's nutritional intake and growth rate (Wellock et al., 2003). Stress may cause prenatal problems in swine if sows are stressed during gestation (Kanitz et al., 2003). Low birth weight and increased death rates during the preweaning period are just a few problems associated with this prenatal stress (Kranendonk et al., 2005). Therefore, swine producers should be conscious of stressors affecting their animals in order to maximize profitability.

More research in this area would benefit swine owners by possibly providing scientific evidence that pigs do in fact stress over other pigs' well-being status. This evidence would then further encourage swine producers to minimize their swine's stress levels not only for the animals' sakes, but also for their own. Reduced stress levels in the pigs would improve feed utilization, and the pigs would be more likely to reach their full potential for growth and efficiency and thus be more profitable for the producer.

The purpose of our research was to determine how indirect stress (stress of a fellow pen mate) affects pigs. The stress status of the pigs was measured by blood metabolite levels. Cortisol, shown to drastically increase during stressful situations, was one of the classic stress-indicating hormones (Widmaier, 2006) that was measured. Other blood metabolite levels that were monitored included lactate, glucose, and non-esterified fatty acids, all of which change in response to the amount of stress an animal experiences. Therefore, the objective of this study was to determine effects of indirect stress on pigs.

MATERIALS AND METHODS

During this 25 d study, the project utilized 36, 35 to 40 d old pigs (approximately 20 kg, 18 barrows, and 18 gilts), from the University of Arkansas Division of Agriculture swine herd. Pigs were blocked by gender, then divided into 6 groups of 6 pigs after stratification for litter origin and weight (3 groups of barrows and 3 groups of gilts). Pigs were housed in an off-site nursery facility with 2 separate rooms (Fig. 1). In one of the rooms, a curtain was hung dividing it into 2 equal sections, thus producing 3 visually isolated areas among 2 rooms. Two pens (4.2 × 1.2 m) in each of the 3 areas were used for housing the 6 groups, within each area



Brent Koonce

MEET THE STUDENT-AUTHOR

After graduating from Catholic High School (Little Rock, Ark.) in 2003, I began my college career at the University of California, Santa Barbara. However, after only a couple of semesters, my affinity for the Razorbacks and Arkansas' outdoors was too much to resist. In 2004 I enrolled in the Dale Bumpers College and the Honors College at the University of Arkansas as an Animal Science major.

Since joining the Animal Science program my sophomore year, I have become an active member in the Pre-Veterinarian Club, worked as an Animal Lab technician for the University of Arkansas' Central Laboratory Animal Facility, received the Alumni Society Scholarship, and completed an undergraduate research project funded by the Dale Bumpers College of Agricultural, Food and Life Sciences, as well as by an Honors College Undergraduate Research Grant. After college I plan on attending veterinary school to pursue my passion for the field.

None of the achievements above could have been possible without the help of my mentor, advisor, and friend, Dr. Beth Kegley. Also, my appreciation is given to Doug Galloway, who guided me throughout my entire research trial.

there was always one group of each gender. These large pens had completely slatted floors and were equipped with a 5-hole nursery feeder and 4 nipple waterers. From d 1 to 25, pigs had ad libitum access to water and typical grower diet (Table 1) that was formulated to meet all current NRC (1998) requirements for growing swine.

Every third day, groups were rotated among pens in order to become acclimated to human contact and pen rotation. Additionally, dominance order was determined within the groups by using an index of displacements equation (number of times a pig displaced another pig/(number of times a pig displaced another pig + number of times a pig was displaced)). Pigs were monitored for 30 min/d, on d 8, 9, 10, 14, 15, and 16. After social rank was determined, the most and least dominant pigs in each group were chosen for cannulation, and the middle-ranked pigs were used for snout snaring (the stressor).

On d 20 and 21, 2 pigs/group were fitted with cannulas in the vena cava. Pigs were anesthetized with isoflurane and nitrous oxide gas before being implanted with 90 cm of Tygon Microbore tubing (i.d. 1.27 mm). Sodium citrate was infused into the tubing, acting as an anticoagulant. Cannulated pigs were then housed individually after surgery but were returned to their respective areas (Fig. 1). Although now separated from original pen mates by a panel with vertical bars 5 cm apart, pigs were allowed visual and tactile (snout) contact with their cohorts.

On d 23, 24, and 25, the stressor treatments imposed were: 1) no contact with snared pigs (control), 2) audile contact with snared pigs, or 3) audile and visual contact with snared pigs. On these days, blood samples were taken from the cannulated pigs at -30, -15, and 0 min before snaring of their cohorts. Then, starting immediately after time 0, 2 pigs (one/pen) in the audile and visual treatment area (Area A, Fig. 1) were snared for a duration of 2 min. Blood samples were taken from the cannulated pigs at 1, 2, 3, 4, 5, 7.5, 10, 15, 20, 25, and 30 min after snaring began. At each sampling time, 4 ml of blood were drawn and then split and stored in plain tubes (1 ml) for serum collection and in tubes containing sodium fluoride (3 ml) for collection of plasma. Samples were stored on ice prior to centrifugation at 2,100 × g for 20 min for separation of serum or plasma. Serum was used to analyze cortisol concentrations by radioimmunoassay (DPC, Los Angeles, Calif.). Plasma was analyzed for glucose, NEFA, and lactate concentrations with colorimetric procedures.

This experiment was arranged as 3 × 3 Latin square design, replicated within gender, in which all groups were exposed to all 3 treatments over the 3 d. Data were analyzed using the PROC MIXED in SAS. The repeated statement was used with the SP(POW) covariance structure. The subject was group within day, whereas the experimental unit was group. Fixed effects were gender, treatment, day, replicate, gender × treatment, time, and time × treatment. Means were separated with an F-protected t-test.

RESULTS AND DISCUSSION

There was no treatment × sampling-time interaction (P = 0.55) for concentrations of cortisol (Fig. 2). Additionally, cortisol concentrations were not affected by stress treatment (P = 0.43) or gender (P = 0.57). Regardless of treatment, cortisol concentrations were greater 10 min after stress treatment began and lowest 1, 4, 5, 25, and 30 min after stress treatment began (time effect, P = 0.03). Also, serum cortisol levels tended to be greater (P = 0.10) on d 2 vs. d 1 of the experiment with d 3 being intermediate (data not shown). Cortisol, shown to dramatically increase in response to a stressor, is the classic stress-indicating hormone (Widmaier, 2006). Stress events such as regrouping pigs cause increased concentrations of cortisol (Coutellier et al., 2007). In the current study, no samples contained cortisol concentrations that would indicate high levels of stress; thus, the vocalizations and/or sight of a snared cohort did not elicit a classic stress response in other pigs.

Apple et al. (2005) reported an increase in glucose concentrations when finishing pigs were exposed to a stressor (transportation). Therefore, increased concentrations of plasma glucose would be expected in stressed animals due to mobilization of glycogen (Prunier et al., 2005). In this study, there was no treatment × sampling time interaction (P = 0.46) for circulating concentrations of glucose (Fig. 3). Furthermore, glucose concentrations were neither affected by stress treatment (P = 0.97) nor gender (P = 0.78), and plasma glucose concentrations were similar (P = 0.70) before and during stressor treatment. Additionally, plasma glucose levels did not (P = 0.62) differ across the 3 d of stressor treatments.

There were no main effects of stressor treatment (P = 0.91) or gender (P = 0.48), nor was there a treatment × sampling time interaction (P = 0.17) on plasma NEFA concentrations (Fig. 4). Plasma NEFA concentrations were not (P = 0.55) different before or during stressor treatment; however, NEFA concentrations measured on d 3 were greater (P = 0.01) than concentrations measured on d 1 and 2 of the stressor treatments (107 vs. 92, and 97 mmol/L for d 3, 1, and 2, respectively). In previously reported research with pigs (Apple et al., 2005), plasma NEFA levels decreased dramatically during the first 30 min of transportation, but plasma NEFA concentrations increased to levels greater than pre-transit levels

after 2 h of transportation. This is due to increased lipolysis and may explain the increase observed on d 3 in the cannulated pigs in the current study. Yet, absence of an increase in the plasma NEFA concentrations during stressor treatment would indicate there was not a stress response due to snaring the cohort.

Plasma lactate concentrations (Fig. 5) had no treatment × time interaction (P = 0.96) and were not affected by stress treatment (P = 0.60). However, barrows had greater (P = 0.003) plasma lactate concentrations than gilts. Plasma lactate concentrations were comparable before and during stressor treatment (P = 0.75). An increase in plasma lactate in monogastrics is related to catecholamine-initiated glycogenolysis and is another response to a stressor (Apple et al., 2005), but the lack of differences in plasma lactate concentrations is further support that study pigs did not respond to their cohorts exposed to a stressor.

In summary, swine undergoing stressful events have been shown to have reduced performance and produce poor meat quality. Knowing what causes stress would help reduce stress. Results of the current study suggest that humoral measures of the stress response are not affected by visual and/or audile contact with pen mates undergoing a stressful event.

ACKNOWLEDGMENTS

Financial support for this project was provided by the University of Arkansas Honors College and a Dale Bumpers College of Agricultural, Food and Life Sciences Undergraduate Research Grant. Also, the assistance of Matt Akins, Karen Anschutz, Clay Bailey, Benjamin Bass, Shollie Behrends, Lucy Bowman, Casey Bradley, James Caldwell, Tyler Davis, Dawn Elkins, Jason Frank, Mike Freyaldenhoven, Carlee Jamison, Linda Jones, Alex Kelch, Michele Lee, Becky Lockhart, Robin Ogden, Michael Person, Jeremy Powell, Sarah Sears, Jenny Thurlow, and Janeal Yancey is greatly appreciated.

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Table 1. Diet composition (as fed basis)

Item	%
Yellow corn	65.95
Soybean meal, 48% CP	28.86
Fat, yellow grease	2.30
Ethoxyquin	0.03
Lysine HCL	0.15
Threonine	0.02
Methionine	0.02
Tylan-40	0.05
Mineral premix[1]	0.10
Vitamin premix[2]	0.15
Monocalcium Phosphate	0.75
Calcium carbonate	0.92
Salt	0.50

[1] Mineral levels meet or exceed NRC (1998) recommendations
[2] Vitamin levels meet or exceed NRC (1998) recommendations

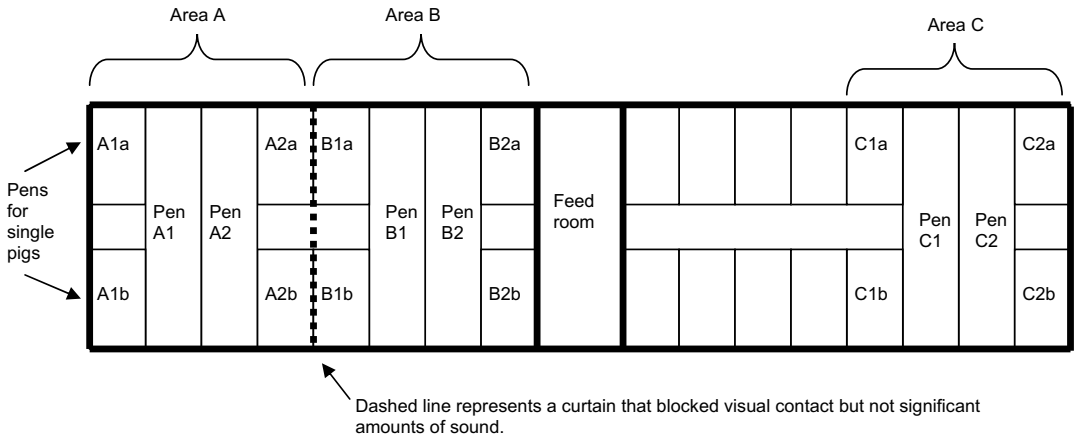

Fig. 1. Off-site nursery design (not to scale)

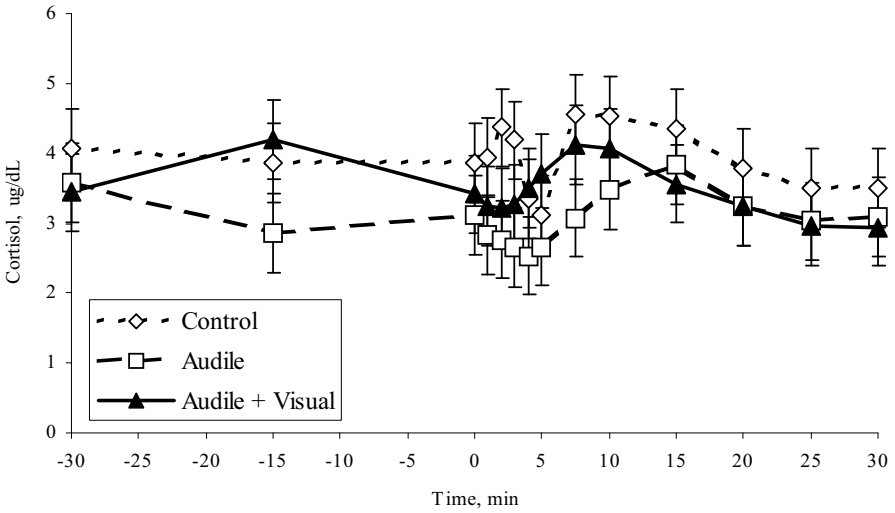

Fig. 2. Serum cortisol concentrations before and after stress treatment (stress treatment × time interaction, $P = 0.55$).

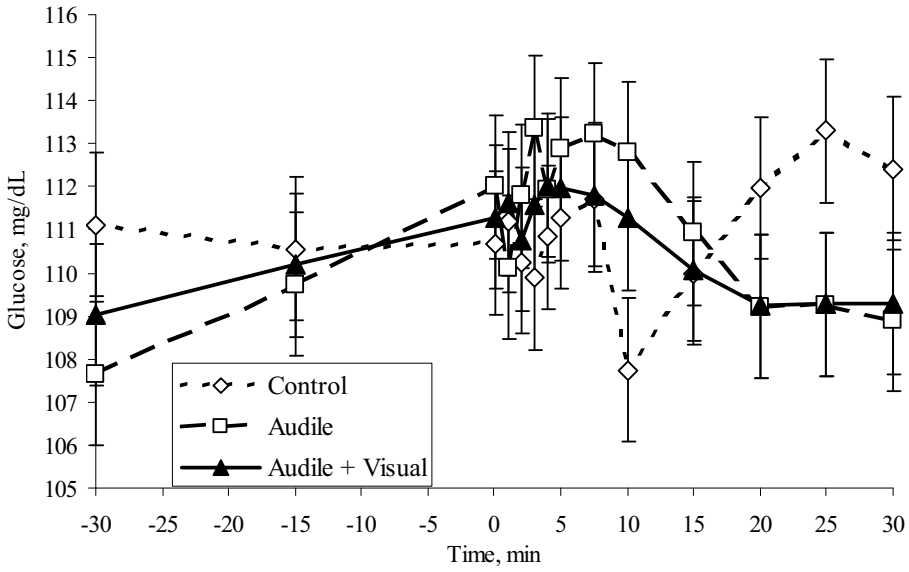

Fig. 3. Plasma glucose concentrations before and after stress treatment (stress treatment × time interaction, $P = 0.46$).

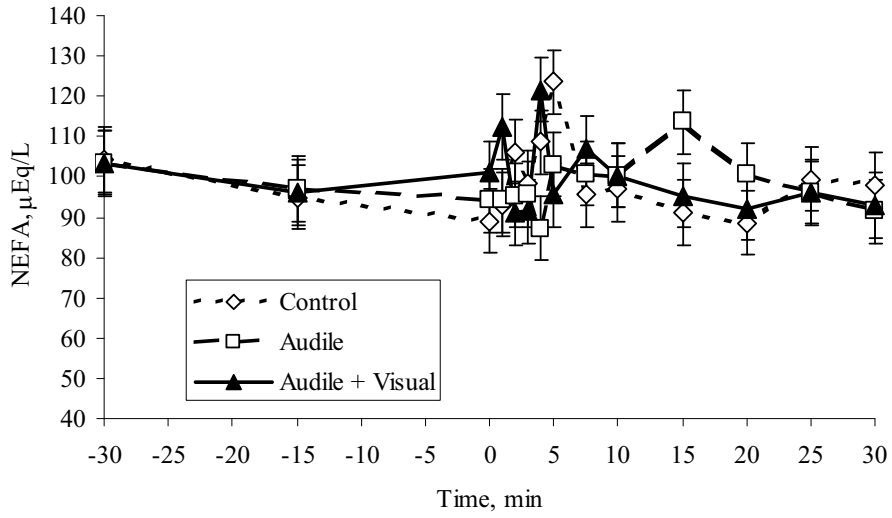

Fig. 4. *P*lasma NEFA concentrations before and after stress treatment (stress treatment × time interaction, *P* = 0.17).

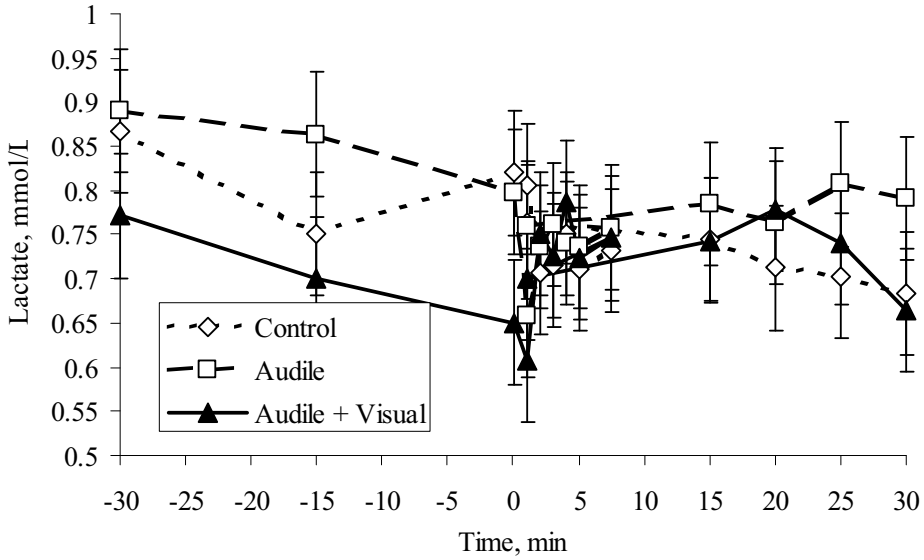

Fig. 5. Plasma lactate concentrations before and after stress treatment (stress treatment × time interaction, P = 0.96).