Barrow Behavioral Responsiveness to a Human or Novel Object When Fed Low Versus High Energy Diets

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Summary and Implications

The objective of this study was to determine if diet influences behavioral responsiveness to novel stimuli as assessed by human approach (HAT) and novel object tests (NOT). Eighty Yorkshire barrows were fed a high fiber, low energy diet or a low fiber, high energy diet. Testing occurred over four consecutive weeks between 1300 and 1700 h. Barrows were tested individually within a 4.9 x 2.4 m test arena. Throughout the test, zone activity, escape attempts, freezing, urination, and defecation behaviors were recorded. The results suggest that dietary fiber reduces overall activity and may modify fear responsiveness while undergoing human approach and novel object tests in swine.

Introduction

Low energy, high fiber diets are becoming more prevalent in the U.S. swine industry due to the increasing price of high energy, corn-soy diets. Previous work has reported that increased dietary fiber results in reduced physical activity in pigs. However, little is known about how diets high in fiber contribute to behavioral responsiveness in grow-finisher pigs, particularly while undergoing a stressful situation such as human approach (HAT) and novel object tests (NOT). During these two tests, pigs are isolated from pen-mates and are placed into an unfamiliar situation, which may be perceived by the pig as threatening. These tests are often utilized to quantify an animal's behavioral response to a novel stimulus. Therefore, the objective of this study was to determine if diet influences behavioral responsiveness during HAT and NOT. Such research can further our understanding of how dietary fiber may influence pig behavior.

Materials and Methods

The protocol for this experiment was approved by the Iowa State University Institutional Animal Care and Use Committee.

Housing. This work was conducted at the Lauren Christian Swine Research Center at the Iowa State University (ISU) Bilsland Memorial Farm, near Madrid, Iowa. All barrows were housed in groups (15 to 16 /pen) and each pen contained one Osborne Fire Feeder (FIRE®, Osborne Industries, Inc., Osborne, KS) positioned at the front of the pen.

Experimental design. The experiment was conducted from October to November, 2011. Eighty Yorkshire barrows (46.5 ± 8.6 kg) from the ISU Residual Feed Intake (RFI) selection project were tested, half of the pigs were low-RFI and half of the pigs were high-RFI. The low- and high-RFI pigs were equally allocated to two treatments: high fiber, low energy diet (**HFD**, n=40) and a control, low fiber, high energy diet (**CD**, n=40, Table 1). Forty barrows (n=20 HFD, n=20 CD) were randomized to the HAT first and the remaining 40 barrows (n=20 HFD, n=20 CD) experienced the NOT first. Upon completion of this cycle barrows then experienced the opposite test one week later; creating a crossover experimental design. Testing occurred over four consecutive weeks between 1300 and 1700 h. Diet was blocked by time; therefore, within each testing hour, two HFD and two CD barrows were tested in random order. Barrows were tested in the same order for both tests at the same time of day. The pen of pigs was the experimental unit and the individual pig was the observational unit.

Table 1. Composition and nutrient analysis of the experimental diets, as-fed basis.

	Diet, %	
Ingredient	**HFD**	**CD**
Corn, yellow dent	36.39	73.83
Soybean meal	13.76	22.90
Soybean hulls	20.00	-
Corn bran	7.00	-
Wheat middling's	20.00	-
L-lysine HCL	0.25	0.25
DL-methionine	0.03	0.04
L-threonine L-tryptophan	0.07	0.07
Monocalcium phosphate	0.83	1.14
Limestone	0.86	0.98
Salt	0.50	0.50
ISU vitamin premix	0.15	0.15
ISU trace mineral premix	0.15	0.15

Human approach and novel object tests. Barrows were tested individually within a 4.9 x 2.4 m test arena. Arena sides were lined with black corrugated plastic 1.2 m high. The arena floor was divided into four zones (Figure 1). Three color cameras (Panasonic, Model WV-CP-484,

Matsushita Co. LTD., Kadoma, Japan) were placed above the test arena for video collection. Video was collected onto a computer using HandyAVI (HandyAVI version 4.3 D, Anderson's AZcendant Software, Tempe, AZ) at 10 frames per second. One observer collected live observations throughout the testing. During HAT, the human observer was located in zone 1. During NOT the observer was located behind zone 4, outside the test arena, with corrugated black plastic blocking the pig's view of the observer.

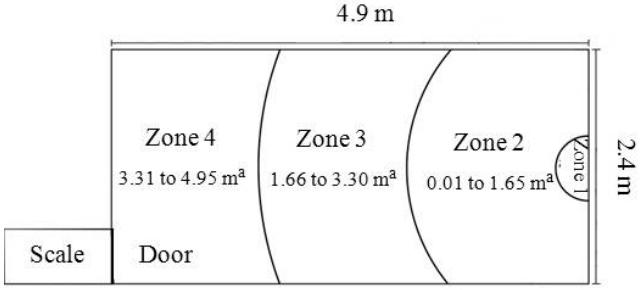

Figure 1. Arena where barrows received human approach and novel object tests.
[a]Indicates the distance of each zone from the human.

During both tests, barrows were individually moved from their home pen to the test arena, which was located in a different room within the same building. Each barrow was weighed and allowed to habituate for one minute on a weigh scale. Following the habituation, the weigh scale door was opened into the back corner of the test arena and each barrow was tested for 10 minutes.

Measures. Continuous observation of video was done by one experienced observer using Observer software (The Observer XT version 10.5, Noldus Information Technology, Wageningen, The Netherlands). Behaviors scored from the video included zone 1 touches, total zone line crossings, escape attempts, and freezing. Urinations and defecations were collected through live observations (Table 2).

Table 2. Definitions for collected behaviors. Latency (s) and/or frequency (n) of behaviors were collected.

Behavior	Definition
Zone 1 (s, n)	The mouth, nose, and/or face of the barrow touch any part of zone 1.
Zone crossing (n)	Total number of times zone 2, 3, and 4 lines crossed, defined as the base of both ears of the barrow crossing each line.
Escape attempt (s, n)	Either both front legs or all four legs of the barrow off the arena floor in attempts to remove itself from the test arena.
Freeze (s, n)	No movement of any portion of the barrow's body was visible for ≥3 sec.
Urination (s, n)	Excreting urine.
Defecation (s, n)	Excreting feces.

Statistical analysis. All data were evaluated for normality before analysis using a Univariate procedure of SAS (SAS Institute Inc., Cary, NC). Since data were not normally distributed, data were analyzed using the Glimmix procedure of SAS. Latency data were analyzed with a gamma distribution and frequency data were analyzed with a poisson distribution. The fixed effects included in the models were diet (HFD and CD) and previous experience within the arena, while body weight was used as a covariate. The significance level was fixed at $P \leq 0.05$.

Results and Discussion

Latency. During HAT, HFD barrows tended to take longer to engage in their first escape attempt ($P=0.06$); however, HDF barrows took less time for first defecation compared to CD barrows ($P=0.03$). No differences were observed between diets for any other latency measures during HAT or NOT (Figure 2).

Frequency. During HAT, HFD barrows tended to urinate fewer times ($P=0.09$); however, they defecated more times compared to CD barrows ($P=0.03$). During NOT, HFD barrows crossed fewer zones compared to CD barrows ($P<0.01$). Additionally, HFD barrows engaged in more escape attempts ($P=0.03$) and tended to freeze and defecate more times compared to CD barrows during NOT ($P=0.07$). No differences were observed between diets for any other frequency measure during HAT or NOT (Table 3).

Differences in defecations are likely due to high fiber content resulting in more waste excretion. Fewer zone crossings and increased freezing during NOT, may be expressions of reduced activity of HFD barrows, explained through the lower dietary energy and composition differences of the HFD. A diet high in fiber may result in reduced overall barrow activity in response to novel stimuli; which could be beneficial for feed efficiency by reducing energy expenditure.

In turn, the increased number of escape attempts and freezing expressed by the HFD barrows during the NOT may be expressions of fear. As HFD and CD barrows did not differ in escape attempts and freezing during the HAT, further investigation should be done to determine if pigs fed a diet high in fiber are more fearful of novel stimuli.

Acknowledgements

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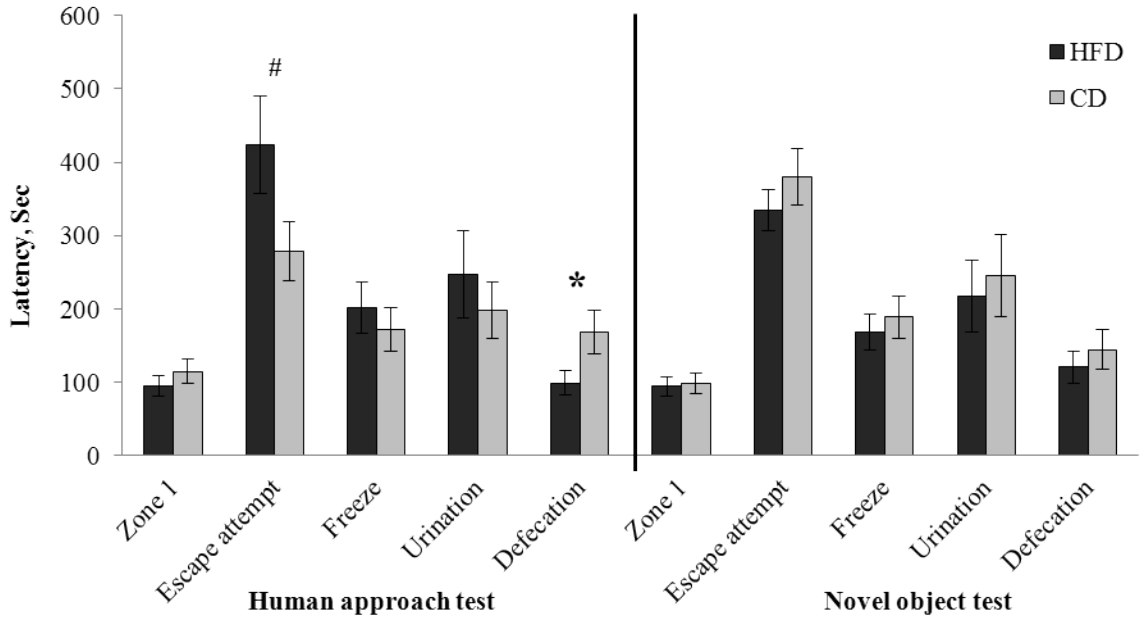

Figure 2. Latency (least square means ± SE) or total time to first perform behaviors during the human approach and novel object tests.
'*' indicates difference (*P*=0.03) and '#' indicates tendency for difference (*P*=0.06).

Table 3. Frequency (least square means ± SE) or total number of times behaviors are performed during the human approach and novel object tests.

	Human approach test			Novel object test		
Measures,	**Diet**			**Diet**		
total number	**HFD**	**CD**	***P*-value**	**HFD**	**CD**	***P*-value**
Zone 1	6.78 ± 0.43	7.15 ± 0.44	0.56	7.41 ± 0.45	8.16 ± 0.47	0.26
Zone crossing	44.78 ± 1.10	44.48 ± 1.10	0.85	40.53 ± 1.04	47.96 ± 1.13	<0.01
Escape attempt	0.84 ± 0.15	1.06 ± 0.17	0.36	1.19 ± 0.18	0.68 ± 0.13	0.03
Freeze	6.46 ± 0.41	7.01 ± 0.43	0.36	6.93 ± 0.43	5.82 ± 0.39	0.07
Urination	0.35 ± 0.09	0.63 ± 0.13	0.09	0.53 ± 0.12	0.56 ± 0.12	0.86
Defecation	4.66 ± 0.36	3.59 ± 0.31	0.03	4.29 ± 0.34	3.44 ± 0.30	0.07