Effect of drinker type and sound stimuli on early-weaned pig performance and behavior$^{1,2}$

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ABSTRACT: Early-weaned pigs appear to be highly motivated to engage in motor patterns associated with nursing, which is thought to lead to the development of abnormal ingestive behaviors. If performance of these behaviors is related to sucking motivation, then the normal stimuli associated with nursing should stimulate pigs to perform these abnormal behaviors, specifically belly nosing. The goal of this study was to determine whether belly nosing could be affected by sow nursing vocalizations and whether the style of the drinker device influenced early-weaned pig behavior.

Over six trials, 352 Yorkshire pigs were weaned at 15 d and assigned to pens (n = 44) of eight pigs based on litter, weight, and sex. Four pens in each of two rooms were outfitted with either a water nipple drinker or a drinker bowl. Rooms either had recorded sow vocalizations broadcast at hourly intervals or no sound (control). Pig behaviors were videotaped in a sample of pens (n = 32) on d 0, 1, 2, 5, 9, 11, 13, 16, and 18 after weaning. Pigs were observed continuously for feeding and drinking behaviors. On d 5 to 18, pigs were observed by scan sampling every 5 min for time budgets. Pigs with drinker bowls had higher apparent feed intakes during the first 2 d after weaning ($P = 0.024$), whereas they spent less time engaged in drinking behavior ($P = 0.001$). This coincided with an overall lower water use ($P = 0.001$) than that of pigs with nipple drinkers. Pigs with bowl drinkers also spent less time belly nosing than those with access to a nipple drinker ($P = 0.012$).

Pigs in the sow vocalization treatment tended to have a higher ADG ($P = 0.075$), whereas they spent less time performing feeding behavior ($P = 0.064$). However, there was no effect of sow nursing grunts on belly nosing. These results suggest that there is a complex relationship between feeding, drinking and sucking, and belly nosing is not controlled by the same external stimuli as sucking. Because drinker type and the motor patterns that it accommodates affect belly nosing, it may be that the internal stimuli associated with nursing, such as the actual act of sucking, play a large role in the development of abnormal oral-nasal behaviors.

Key Words: Behavior, Drinker, Early-Weaning, Pigs, Sow Nursing Vocalizations

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Introduction

Early weaning of pigs is characterized by a delay in feeding, an increase in behavioral problems (specifically belly nosing), and excessive drinking. This suggests that there is an interaction among the motivational systems for ingestive behaviors that interfere with the pig’s ability to adapt to weaning. It has been hypothe-

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Figure 1. Nursery rooms were located adjacent to each other and sound treatments rotated between the two rooms each trial. Each pen contained eight pigs. Pens were divided by solid barriers near the drinkers and slatted walls elsewhere. Speakers were mounted on the ceiling, overhead two adjacent pens. Video cameras were mounted on the walls. V = video recorder; S = audio speaker. Feeders (not labeled) were located on the same wall as the drinker but at the opposite end. Heating pads (not shown) were attached to the slatted floor adjacent to the feeders.

somehow accommodates sucking, but any relationship between drinking behavior and the development of other oral-nasal behavior patterns has not been explored.

The aim of this experiment was to determine whether external factors related to sucking motivation could affect feeding, drinking, and belly nosing in early-weaned pigs. We hypothesized that the addition of sow nursing vocalizations in the nursery room would increase pig-directed oral-nasal behaviors, whereas the use of nipple drinkers (vs. bowl drinkers) would reduce these behaviors.

Materials and Methods

Experimental Design and Animals

The experiment was designed as a randomized complete block design with four treatments in six trials. The experiment was a $2 \times 2$ factorial arrangement with sound (playback sow vocalizations vs. no additional sound) and drinker type (bowl vs. nipple drinker) as the main factors. Over six trials, a total of 352 Yorkshire pigs were weaned at 14.53 ± 0.78 d and assigned to pens (n = 44) of eight pigs based on litter, weight, and sex. Body weights were not different for drinker treatments (n = 44; $P = 0.68$; nipple drinker, 4.61 ± 0.05 kg/pig; bowl drinker, 4.64 ± 0.06 kg/pig), or sound treatments at weaning (n = 36 pens; $P = 0.42$; control, 4.69 ± 0.06 kg/pig; sound treatment, 4.62 ± 0.06 kg/pig). Each pen contained four pairs of two littermates.

Because this experiment involved sound as a variable, the two sound treatment groups were separated into two adjacent, identical rooms of four pens each. Sound treatment was placed in alternating rooms over the trials such that sow vocalizations were played in Room 1 for Trials 1, 3, and 5, and in Room 2 for Trials 2, 4, and 6. Within each room, drinker treatment groups represented two nonadjacent pens each (Figure 1).

All pigs were obtained from and housed at the University of Guelph Arkell Swine Research Station. All procedures in this study were reviewed and approved by the University of Guelph Animal Care Committee in accordance with the Canadian Council on Animal Care.

Drinkers

To account for preweaning drinking experience, all pig-drinking devices were removed from farrowing crates. Sows were able to drink from nipple drinkers that were inaccessible to the young pigs. Therefore, pigs only had access to drinkers after weaning. Four pens per trial (two per sound treatment group) were equipped with standard nursery pig bite nipple drinkers (S. M. Bauman Mfg., 0.95-cm stainless steel Piggy Drinker, model XYZ, Wallenstein, ON, Canada),
whereas the remaining four pens per trial were equipped with stainless steel nursery pig bowl drinkers (Bosman Agri Inc., Egebjerg Drik-O-Mat weaner bowl drinker, No. 93.569, Moorefield, ON, Canada). Water use was measured at each drinker using precalibrated ABB positive displacement water meters (C-700 Polymer). Water flow rates averaged 1.093 ± 0.308 L/min for the four nipple drinkers and 1.060 ± 0.776 L/min for the four bowl drinkers at the start of the trials.

**Sound**

A 3-min compilation of seven sow-nursing vocalizations was obtained from G. M. Cronin at the Victoria Institute of Animal Science (a description of this recording can be found in Cronin et al., 2001). This recording was chosen because it contains varied sow grunts with minimal background noise and has proven successful in increasing pig growth in nursing pigs (Cronin et al., 2001). The recording was burned onto a compact disc along with 57 min of silence that was generated using Goldwave audio program. The recording was played on a RCA five-disc CD changer (RP-8070D, Thomson Multimedia, Indianapolis, IN) and the sound was amplified using an ISL Bogen Acousta-Master solid-state receiver (CT-35, Syosset, NY). Recordings were played through Omage granite indoor-outdoor speakers (GR-308, Montreal, QC, Canada) mounted on the ceiling, with one speaker centered over every two pens (Figure 1).

Sound levels were recorded during synchronized sow nursing grunts in a farrowing room at the University of Guelph Arkell Swine Research Station using a Radio Shack digital sound level meter (33-2055, Barnie, ON, Canada). The peak sound level reached 85 dB in the farrowing room; therefore, the volume of the broadcasts in the nursery rooms was adjusted to equal this sound intensity. Although the two nursery rooms were adjacent to each other, they were separated by concrete block walls and the playback of the sow vocalizations were not detectable in the control room.

The recording was set to repeat; therefore, the treatment pigs were exposed to 3 min of sow nursing vocalizations every hour for the entire trial. For the duration of this paper, pigs exposed to the nursing vocalizations will be referred to as the “sound group” and pigs not exposed to sound will be referred to as the “control.”

**Facilities and Management of the Pigs**

At weaning, pigs were transferred from standard farrowing crates to two adjacent on-site nursery rooms containing eight raised-deck pens. Four adjacent pens in each room were used for this study. Each nursery pen measured 1.2 × 2.4 m and contained one drinker, one four-hole stainless steel feeder, and one heating pad measuring 0.61 × 0.91 m. Heating pads were placed at the front of the pens and were adjusted with rheostats to control temperature to meet the needs of the pigs. Lights remained on continuously to aid video recording.

Pigs were fed a commercial phase I diet (Momentum 10/15 pig starter diet from ADM, Decatur, IL) for the first week after weaning. This diet was available as creep feed preweaning, beginning 10 d after farrowing. From d 7 to 19 postweaning, pigs were fed a standard Phase II starter diet (Table 1).

**Data Collection**

**Feed and Water Intake, Growth Rates, and Mortality.** Apparent feed intake (as-fed basis) was determined for each pen on d 2, 3, 4, 5, 7, 14, and 19 (with weaning occurring at d 0). Apparent average daily feed intakes (AADF I) were calculated and adjusted for the number of pigs per pen if mortalities occurred. Water use was also recorded daily on a per-pen basis and adjusted for the number of pigs per pen. Pig BW were measured on the day before weaning and on d 7, 14, and 19 after weaning. Mortality was recorded as it occurred throughout the experiment.

**Behavior.** Pens were continuously videotaped for the duration of each trial. Cameras (Panasonic WV-BP130, BP140 CCTV cameras, Mississauga, ON, Canada) were

**Table 1. Nutrient levels and ingredient composition (%) of Piglet Starter II diet fed from 1 wk after weaning**

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>32.3</td>
</tr>
<tr>
<td>Barley</td>
<td>8.0</td>
</tr>
<tr>
<td>Wheat</td>
<td>20.0</td>
</tr>
<tr>
<td>Soybean meal</td>
<td>22.0</td>
</tr>
<tr>
<td>Fish meal</td>
<td>5.0</td>
</tr>
<tr>
<td>Whey</td>
<td>8.0</td>
</tr>
<tr>
<td>Fat</td>
<td>2.0</td>
</tr>
<tr>
<td>Lysine-HCl, 79%</td>
<td>0.30</td>
</tr>
<tr>
<td>Methionine</td>
<td>0.01</td>
</tr>
<tr>
<td>Threonine</td>
<td>0.12</td>
</tr>
<tr>
<td>Dicalcium phosphate</td>
<td>0.60</td>
</tr>
<tr>
<td>Limestone</td>
<td>0.70</td>
</tr>
<tr>
<td>Iodized salt</td>
<td>0.30</td>
</tr>
<tr>
<td>Vitamin premixb</td>
<td>0.50</td>
</tr>
<tr>
<td>Mineral premixc</td>
<td>0.10</td>
</tr>
<tr>
<td>Tylosin premixd</td>
<td>0.10</td>
</tr>
</tbody>
</table>

Nutritive value (calculated)

| DE, kcal/kg | 3,450 |
| Crude protein | 19.83 |
| Calcium     | 0.82  |
| Phosphorus  | 0.65  |
| Available phosphorus | 0.62 |

*This diet was available in crumble form and was manufactured at University of Guelph, Arkell Feed Mill, Guelph, ON, Canada.

*bVitamin premix supplied the following per kilogram of finished feed: vitamin A, 10,000 IU; cholecalciferol, 1,000 IU; dl-α-tocopheryl acetate, 56 IU; menadione, 2.5 mg; choline, 500 mg; pantothenic acid, 15 mg; riboflavin, 5 mg; folic acid, 2 mg; niacin, 25 mg; thiamine, 1.5 mg; pyridoxine, 1.5 mg; biotin, 0.20 mg; vitamin B12, 0.025 mg.

*cMineral premix supplied the following per kilogram of finished feed: Cu, 15 mg; Zn, 104 mg; Fe, 100 mg; and Mn, 19 mg.

*dSupplied 22 mg of tylosin/kg of complete feed.
mounted on the walls located behind the pens (Figure 1). Pig behaviors were videotaped on a sample of pens (n = 32) on d 5, 9, 11, 13, 16, and 18 postweaning and observed using 5-min scan sampling to estimate time budgets (Lehner, 1996). Pigs were not individually identified, but all pigs in pens were scanned simultaneously. Nine mutually exclusive behavioral categories were recorded (Table 2). Using a subsample of pens (n = 8), the duration and number of feeding and drinking bouts for the first 48 h postweaning were analyzed using continuous sampling. A feeding bout occurred when any pig had its head in the feeder for greater than or equal to 5 s. A drinking bout occurred when any pig had its snout in contact with the drinker, regardless of duration.

**Statistical Analysis**

The experiment incorporated a randomized complete block design with pen as the experimental unit. There were four treatments in the factorial arrangement consisting of two drinker types (nipple and bowl) and two sound treatments (sow vocalizations and control). All statistical analyses were performed using the SAS statistical software program (SAS Inst., Inc., Cary, NC). The univariate procedure in SAS was used to assess data for normality, and Brown and Forysthe’s modified-Levine test was performed to test homogeneity of variance across treatment groups. Data that were not normally distributed (only water use) were transformed using a natural log transformation. All data were normally distributed following transformation. For BW, weight gain, feed intake, water use, and behaviors, separate mean, linear, and quadratic contrasts were performed using the Repeated Measures procedure to determine whether the treatments differed during any of the four segments.

**Table 2. Ethogram of behavior patterns (adapted from Worobec et al., 1998)**

<table>
<thead>
<tr>
<th>Behavior</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lying</td>
<td>Weight of body not supported by legs, but excluding performance of any of the below behaviors</td>
</tr>
<tr>
<td>Social</td>
<td>Aggressive or play behavior between two or more pigs</td>
</tr>
<tr>
<td>Active</td>
<td>Standing or walking without interaction with another pig</td>
</tr>
<tr>
<td>Feeding</td>
<td>Head, including ears, in feeder</td>
</tr>
<tr>
<td>Drinking</td>
<td>Snout in contact with water nipple or head inside water bowl</td>
</tr>
<tr>
<td>Belly nosing</td>
<td>Repeated rhythmic up-and-down massage with the snout on a pen-mate’s mid-section (Fraser, 1978)</td>
</tr>
<tr>
<td>Pen-mate directed nosing</td>
<td>Nosing, sucking, chewing, or biting another pig in an arrhythmic manner</td>
</tr>
<tr>
<td>Other nosing</td>
<td>Nosing, sucking, chewing, or biting of floor, walls, or other pen fixtures</td>
</tr>
<tr>
<td>Other</td>
<td>Any behavior that cannot be classified in the above descriptions</td>
</tr>
</tbody>
</table>

Drinker treatment had an effect on apparent feed intake \((P = 0.024)\), drinking behavior \((P = 0.006)\), and water use \((P = 0.001)\) during the first 2 d postweaning (Table 3); however, feeding behavior was not different between treatments \((P = 0.20)\).

During the first 48 h after weaning, the control pigs tended to spend more time engaged in feeding behavior than did the sound treatment pigs, and this observation was consistent over the four 12-h periods \((n = 8; P = 0.078)\) (Table 4). There was no difference in the average feed bout length \((P = 0.12)\) or number of feeding bouts \((P = 0.30)\) during the first 48 h. Apparent feed intake was not different between sound treatments \((P = 0.53)\). There was no difference between sound treatments in drinking duration \((P = 0.16)\). Water use during the first 48 h after weaning was similar between the sound treatment groups \((P = 0.65)\).

**Performance and Behavior from Weaning Through d 19**

**Drinker Treatment.** There was no effect of drinker type on pig final weight \((n = 44; P = 0.90)\); nipple drinker, 7.82 ± 0.17 kg/pig; bowl drinker, 7.96 ± 0.19 kg/pig) or ADG \((n = 44; P = 0.36)\); nipple drinker, 180.5 ± 8.0 g/d; bowl drinker, 186.4 ± 8.9 g/d) over the course of the experiment. Overall, pigs with differing drinker types did not differ in their feed intake for the entire trial \((n = 44; P = 0.92)\); nipple drinker, 211.8 ± 3.1 g/pig-d; bowl drinker, 210.7 ± 3.1 g/pig-d). There was also no effect of drinker type on overall feeding behavior \((n = 24; P = 0.23)\); nipple drinker, 7.26 ± 0.57% of time; bowl drinker, 7.39 ± 0.42% of time).
Table 3. Effect of drinker treatment on the behavior and performance of pigs during the first 48 h after weaning (means ± SEM)

<table>
<thead>
<tr>
<th>Measure</th>
<th>Time after weaning, h</th>
<th>Nipple drinker</th>
<th>Bowl drinker</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration of feeding behavior, min/pig; n = 8</td>
<td>0 to 12</td>
<td>2.00 ± 0.39</td>
<td>8.13 ± 4.03</td>
<td>0.21</td>
</tr>
<tr>
<td></td>
<td>12 to 24</td>
<td>0.95 ± 0.40</td>
<td>10.77 ± 8.45</td>
<td>0.30</td>
</tr>
<tr>
<td></td>
<td>24 to 36</td>
<td>14.88 ± 5.08</td>
<td>39.67 ± 9.36</td>
<td>0.52</td>
</tr>
<tr>
<td></td>
<td>36 to 48</td>
<td>24.17 ± 2.36</td>
<td>32.59 ± 9.19</td>
<td>0.41</td>
</tr>
<tr>
<td></td>
<td>0 to 48</td>
<td>41.99 ± 5.51</td>
<td>71.16 ± 26.42</td>
<td>0.20</td>
</tr>
<tr>
<td>Apparent feed intake (as-fed basis), g/(pig·d); n = 36</td>
<td>0 to 48</td>
<td>44.4 ± 5.2</td>
<td>61.7 ± 6.4</td>
<td>0.024</td>
</tr>
<tr>
<td>Duration of drinking behavior, min/pig; n = 8</td>
<td>0 to 12</td>
<td>7.83 ± 1.39</td>
<td>3.89 ± 0.33</td>
<td>0.064</td>
</tr>
<tr>
<td></td>
<td>12 to 24</td>
<td>6.71 ± 0.44</td>
<td>4.70 ± 0.49</td>
<td>0.04</td>
</tr>
<tr>
<td></td>
<td>24 to 36</td>
<td>6.85 ± 0.71</td>
<td>3.39 ± 0.25</td>
<td>0.002</td>
</tr>
<tr>
<td></td>
<td>36 to 48</td>
<td>4.70 ± 0.42</td>
<td>2.54 ± 0.51</td>
<td>0.04</td>
</tr>
<tr>
<td></td>
<td>0 to 48</td>
<td>26.08 ± 2.63</td>
<td>14.52 ± 0.65</td>
<td>0.006</td>
</tr>
<tr>
<td>Water use, L/(pig·d); n = 44</td>
<td>0 to 48</td>
<td>2.08 ± 0.20</td>
<td>0.67 ± 0.07</td>
<td>0.001</td>
</tr>
</tbody>
</table>

Drinker type influenced water use (n = 44; P < 0.001) with pigs in nipple drinker pens using more water than those in bowl drinker pens. Pigs in nipple drinker pens used 1.88 ± 0.17 L/d of water and pigs in bowl drinker pens used 0.85 ± 0.05 L/d of water. Water use increased over time for both treatments as pigs grew and increased their apparent feed intake, but the linear increase in water use over time was greater for pigs using nipples drinkers than for those using bowl drinkers (P = 0.060; Figure 2).

Although water use was much greater in the nipple treatment, there was no treatment difference in mean time spent engaged in drinking behavior overall or over time (n = 24; P = 0.41; nipple drinker, 0.55 ± 0.07% of time; bowl drinker, 0.51 ± 0.05% of time).

Drinker treatments differed in mean time spent belly nosing (n = 24; P < 0.012), with pigs in nipple drinker pens spending almost twice the amount of time belly nosing than those in bowl drinker pens (nipple drinker, 2.04 ± 0.21% of the time spent belly nosing; bowl drinker, 1.16 ± 0.18% of the time; Figure 3). There was also a different quadratic effect between drinker types (P < 0.01), indicating that the development of belly nosing over time differed between the two treatments. For pigs using nipple drinkers, belly nosing increased dramatically over the first 2 wk, peaked around d 11, and then declined. For pigs using bowl drinkers, belly nosing increased to a lesser extent between d 5 and 9 and then remained fairly consistent for the duration of the trial.

There was no difference between drinker treatments in time spent active (n = 24; P = 0.24; nipple drinker, 13.08 ± 0.72% of time; bowl drinker, 12.47 ± 0.82% of time), lying (n = 24; P = 0.45; nipple drinker, 75.35 ± 1.31% of time; bowl drinker, 76.48 ± 1.27% of time), or involved in social interactions (n = 24; P = 0.63; nipple drinker, 0.57 ± 0.06% of time; bowl drinker, 0.66 ± 0.15% of time).

Sound Treatment. There was no effect of treatment on final weight (n = 36; P = 0.28; control, 7.86 ± 0.20 kg/pig; sound treatment, 8.13 ± 0.18 kg/pig) over the course of the experiment. However, there was a tendency for a difference in mean ADG between sound treatments (P = 0.075), with the vocalization treatment group tending to gain more weight than the control group over time (n = 36; control, 178.4 ± 9.2 g/d; sound, 184.0 ± 9.2 g/d).

Table 4. Effect of sound treatment on the behavior and performance of pigs during the first 48 h after weaning (means ± SEM)

<table>
<thead>
<tr>
<th>Measure</th>
<th>Time after weaning, h</th>
<th>Control</th>
<th>Sow vocalizations</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration of feeding behavior, min/pig; n = 8</td>
<td>0 to 12</td>
<td>6.78 ± 4.44</td>
<td>3.35 ± 0.99</td>
<td>0.45</td>
</tr>
<tr>
<td></td>
<td>12 to 24</td>
<td>10.38 ± 8.59</td>
<td>1.33 ± 0.39</td>
<td>0.33</td>
</tr>
<tr>
<td></td>
<td>24 to 36</td>
<td>26.75 ± 5.68</td>
<td>7.80 ± 5.01</td>
<td>0.051</td>
</tr>
<tr>
<td></td>
<td>36 to 48</td>
<td>35.01 ± 4.32</td>
<td>21.74 ± 7.33</td>
<td>0.22</td>
</tr>
<tr>
<td></td>
<td>0 to 48</td>
<td>78.93 ± 22.3</td>
<td>34.21 ± 6.33</td>
<td>0.078</td>
</tr>
<tr>
<td>Apparent feed intake, g/(pig·d); n = 36</td>
<td>0 to 48</td>
<td>50.63 ± 5.84</td>
<td>45.11 ± 7.05</td>
<td>0.53</td>
</tr>
<tr>
<td>Duration of drinking behavior, min/pig; n = 8</td>
<td>0 to 12</td>
<td>5.34 ± 0.94</td>
<td>6.38 ± 1.86</td>
<td>0.54</td>
</tr>
<tr>
<td></td>
<td>12 to 24</td>
<td>5.38 ± 0.41</td>
<td>6.03 ± 0.93</td>
<td>0.38</td>
</tr>
<tr>
<td></td>
<td>24 to 36</td>
<td>4.49 ± 0.77</td>
<td>5.75 ± 1.30</td>
<td>0.05</td>
</tr>
<tr>
<td></td>
<td>36 to 48</td>
<td>3.18 ± 0.56</td>
<td>4.05 ± 0.87</td>
<td>0.26</td>
</tr>
<tr>
<td></td>
<td>0 to 48</td>
<td>18.40 ± 2.45</td>
<td>22.20 ± 4.61</td>
<td>0.16</td>
</tr>
<tr>
<td>Water use, L/(pig·d); n = 36</td>
<td>0 to 48</td>
<td>1.42 ± 0.173</td>
<td>1.30 ± 0.193</td>
<td>0.65</td>
</tr>
</tbody>
</table>
Figure 2. Water use by drinker type over time (means ± SEM). Overall, drinker type influenced water use ($P < 0.001$), with pigs in nipple drinker pens using more water than those in bowl drinker pens.

196.2 ± 9.1 g/d (Figure 4). This difference in ADG resulted in the weights for the two treatment groups following different linear slopes ($P = 0.09$). The majority of this difference was due to the last 5 d of the trial when the sound treatment gained 40 g/d more than the control treatment.

For the entire experiment, the AADFI (used in place of ADFI because feed wastage, although apparently minimal, was not measured) was 211.1 ± 3.1 g/(pig·d). The control treatment had a mean AADFI of 212.3 ± 3.2 g/d, whereas the sound treatment had an AADFI of 210.2 ± 2.9 g/d ($n = 36; P = 0.54$). There was no linear ($P = 0.35$) or quadratic ($P = 0.85$) effect of sound treatment on feed intake.

On average, the pigs spent 7.32% of time engaged in feeding behavior. There was a tendency for an overall mean difference in time spent feeding, with the pigs in the vocalization treatment spending less time feeding than the control pigs ($n = 20; P = 0.064$; control, 7.42 ± 0.30% of time; sound treatment, 7.23 ± 0.64% of time).

Figure 3. Belly nosing by drinker type (means ± SEM). There was a mean and quadratic effect of drinker type ($P < 0.02$), with pigs in nipple drinker pens belly nosing twice as much as those in bowl drinker pens.

Figure 4. Weights and ADG (kg/d) by sound treatments (means ± SEM). Although there was no difference in mean weight gain throughout the trial, the two treatments followed different linear trends over time ($P < 0.1$), as reflected by their difference in mean ADG ($P < 0.08$), with the vocalization treatment group gaining more than the control.

(Figure 5). There was no difference between treatments in linear ($P = 0.54$) or quadratic ($P = 0.64$) contrasts.

On average, the pigs spent 0.53% of time performing drinking behavior. There was no difference in mean time spent engaged in drinking behaviors over the entire experiment for sound treatment ($n = 20; P = 0.27$; control, 0.56 ± 0.07% of time; sound treatment, 0.51 ± 0.06% of time). There was also no effect of sound treatment on water use ($n = 36; P = 0.31$; control, 1.30 ± 0.14 L/(pig·d); sound treatment, 1.52 ± 0.25 L/(pig·d)).

There was no overall mean, linear or quadratic difference between sound treatment and control in mean time spent belly nosing ($n = 20; P = 0.11$; control, 1.64 ± 0.18% of time; sound treatment, 1.67 ± 0.37% of time).

Figure 5. Overall feeding behavior by sound treatment (means ± SEM). There was a tendency for an overall mean difference in time spent feeding, with the vocalization treatment spending less time feeding than the control ($P < 0.07$).
There was no difference between sound treatment groups in time spent active (n = 20; P = 0.24; control, 13.07 ± 0.49% of time; sound treatment, 10.32 ± 0.49% of time), lying (n = 20; P = 0.23; control, 75.58 ± 0.77% of time; sound treatment, 79.77 ± 0.82% of time), or involved in social interactions (n = 20; P = 0.89; control, 0.56 ± 0.07% of time; sound treatment, 0.64 ± 0.21% of time).

Discussion

In ontogenetic rodent models of mammalian ingestive behavior, it is well established that nursing (sucking), feeding, and drinking are controlled by separate motivational systems, each having different control and feedback mechanisms (Blass, 1995). At birth, sucking dominates, whereas feeding and drinking develop over time. Artificial weaning of pigs, especially early weaning, occurs at a time when nursing or sucking is the predominant system for ingestive behavior and when independent feeding and drinking would seldom occur. Age at weaning has been shown to affect the development of ingestive behaviors, as pigs weaned at younger ages take longer to begin feeding, perform more drinking behavior, and develop higher levels of belly nosing (Fraser, 1978; Metz and Gonyou, 1990; Worobec et al., 1999). Belly nosing, or the oral massaging of littermates’ bellies, usually occurs several days after weaning and may be the result of learning a new target for the behavior (Metz and Gonyou, 1990; Weary et al., 1999). While the cause of belly nosing is unknown, it has been hypothesized to be related to the motivation to suckle (Fraser, 1978; Dybkjaer, 1992; Weary et al., 1999) or explore the environment (Bøe, 1991). The performance of belly nosing is somehow linked to feeding and growth rate, but the relationship is still unclear. It does not appear to be directly related to feeding, as altering intake through diet quality did not affect it (Gardner et al., 2001) and it is not temporally associated with feeding behavior (Li and Gonyou, 2002). In some studies, lighter-weight-for-age pigs have been observed to belly nose at higher levels (Gardner et al., 2001; Rau, 2002), whereas in others it was not affected by weaning weight (Straw and Bartlett, 2001). It is becoming clear, however, that individual pigs that belly nose more frequently have slower growth rates (Gonyou and Beltrana, 1998; Straw and Bartlett, 2001; S. Torrey and T. M. Widowski, unpublished data) and those pigs may perform this behavior at the expense of eating. All of this suggests that there is some interaction among sucking, feeding and drinking motivational systems that affect adaptation to weaning. In this experiment, we wanted to investigate how some factors that might be related to sucking affect ingestive behavior and development of belly nosing.

Drinker Type

Over the 3-wk experiment, drinker treatment did not affect weight gain, feed intake, time spent at the feeder, or drinking behavior between the two drinker treatments. However, the pigs with nipple drinkers used significantly more water than those with bowl drinkers. Because of the pen design, it was impossible to measure actual water intake. The design of nipple drinkers, and the drinking method necessary to utilize the drinker, makes them easy targets for water wastage, as simply bumping into the drinker releases water. From a production view, then, bowl drinkers would be preferred because of the reduction in water use.

Contrary to our hypothesis, the nipple drinker did not appear to accommodate nursing behaviors during the postweaning period, as belly nosing was significantly greater in pigs using the nipple drinker than those using the bowl drinkers. These data were surprising but results from kinematic studies of drinking and sucking behavior of miniature pigs may explain how the bowl, and not the nipple drinker, accommodates sucking (Thexton et al., 1998). The natural drinking behavior of pigs from a vessel of water (or milk) involves forming a seal between the tongue and palate so as to create a negative pressure to ensure that fluid is actually taken into the mouth. This is in contrast to the drinking behavior of animals that ingest water through lapping; “lappers” do not create a negative pressure to ingest water. Due to the physical nature of the bite-style nipple drinkers, pigs cannot form suction and still obtain water. Because of the design of the bowl drinker, pigs must create negative pressure and engage in sucking in order to ingest water. The oropharyngeal feedback from this negative pressure may be involved with the motivation to perform nursing behavior. This might also explain why pigs fed a liquid or wet diet engage in less belly nosing than those fed the same diet in a pelleted form (Orgeur et al., 2003; Rau, 2003).

In addition, the bowl drinker may be providing useful tactile stimulation that the nipple drinker cannot (R. Z. German, personal communication, University of Cincinnati, Cincinnati, OH). In rats and kittens, tactile stimulation of the oral-nasal area is important in the control of preweaning sucking behavior (Hofer et al., 1981; Blass et al., 1988; Smotherman et al., 1997). Neonatal pigs also strongly rely on tactile cues to obtain and sustain nipple attachment (Morrow-Tesch and McGlone, 1990). As the pig engages the bowl drinker to access additional water, it is forced to press its snout back from this negative pressure to ingest water. Due to the physical nature of the bite-style nipple drinkers, pigs cannot form suction and still obtain water. Because of the design of the bowl drinker, pigs must create negative pressure and engage in sucking in order to ingest water. The oropharyngeal feedback from this negative pressure may be involved with the motivation to perform nursing behavior. This might also explain why pigs fed a liquid or wet diet engage in less belly nosing than those fed the same diet in a pelleted form (Orgeur et al., 2003; Rau, 2003).

During the first 2 d after weaning, pigs with access to a nipple drinker had significantly lower apparent feed intake and spent more time at the drinker and used more water than those with a bowl drinker. These differences could be satisfying to the weanling pig and replace any tactile stimulation of the oral-nasal area is important in the control of preweaning sucking behavior (Hofer et al., 1981; Blass et al., 1988; Smotherman et al., 1997). Neonatal pigs also strongly rely on tactile cues to obtain and sustain nipple attachment (Morrow-Tesch and McGlone, 1990). As the pig engages the bowl drinker to access additional water, it is forced to press its snout back from this negative pressure to ingest water. Due to the physical nature of the bite-style nipple drinkers, pigs cannot form suction and still obtain water. Because of the design of the bowl drinker, pigs must create negative pressure and engage in sucking in order to ingest water. The oropharyngeal feedback from this negative pressure may be involved with the motivation to perform nursing behavior. This might also explain why pigs fed a liquid or wet diet engage in less belly nosing than those fed the same diet in a pelleted form (Orgeur et al., 2003; Rau, 2003).
growth immediately following weaning (Bark et al., 1986; Metz and Gonyou, 1990), and the use of nipple drinkers may compound this problem by providing them with an easy outlet for oral behaviors that provide no tactile satisfaction. This drinking then may result in gut-fill and a decreased motivation to feed. However, this relationship needs further examination.

Sound

Because of the similarity of the motor patterns involved and in the object/stimuli (udder/belly) at which the behavior is targeted, it has been suggested that belly nosing is redirected nursing behavior (Fraser, 1978; Dybkjaer, 1992; Weary et al., 1999). Broadcasted sow vocalizations have a positive effect on nursing pigs' growth rates (Bate et al., 1999; Cronin et al., 2001; Kasanen and Algiers, 2002), presumably by stimulating pigs to approach the sow, begin massage, and initiate a nursing bout. There is some previous evidence that the sound of nursing grunts may stimulate the performance of belly nosing in weaned pigs. In a study examining the effects of a barrier on pig behavior, Waran and Broom (1993) anecdotally reported extremely high levels of belly nosing in two groups of newly weaned pigs that were kept in pens adjacent to nursing sows and litters, apparently with auditory and/or visual contact. Csermely and Wood-Gush (1981) reported that playback of the sound of pigs “going to suckle and during suckling” stimulated massage and sucking behavior directed at other pigs. Therefore, we anticipated that the pigs exposed to sow nursing grunts would belly nose more. However, we found no difference in belly nosing between the two sound treatments. There could be a number of different reasons for the discrepancy. First and foremost, belly nosing may not be nursing behavior redirected on conspecifics. Because sow nursing grunts are one of the most explicit cues used by pigs to begin nursing, the inability of these grunts to affect belly nosing could point to a lack of relationship between the preweaning and postweaning nosing behaviors. In a natural nursing bout, external (auditory, olfactory) cues may serve to stimulate the pigs to engage in some aspects of nursing behavior, such as udder approach and massage. However, it may be that prolonged nosing of the udder and nonnutritive sucking is motivated by other factors that are primarily internal. Although we could find no relationship between sow nursing grunts and the amount of belly nosing, belly nosing appears to be functionally linked to sucking as it has been demonstrated that providing opportunities to perform nutritive or nonnutritive sucking on nipples or pacifiers in artificially reared (Jeppesen, 1981; Widowski et al., 2003) or weaned (Rau, 2002; Gonyou and Bench, 2003) pigs significantly reduces belly nosing. Alternatively, belly nosing may provide the same feedback as udder massage, but after weaning, it becomes disassociated from the external cues associated with nursing.

Another hypothesis for the lack of difference in belly nosing is that the pigs did not recognize the recordings as sow nursing vocalizations. Previous studies have shown that pigs tested before weaning respond to recordings of nursing vocalizations by approaching the source/speaker (Parfet and Gonyou, 1991) or by initiating a nursing bout either on an artificial udder (Jeppesen, 1981; Lewis and Hurnik, 1986) or on a sow (Cronin et al., 2001). The soundtrack used in our study has been used previously to increase growth rates in nursing pigs (Cronin et al., 2001). Weaned pigs have also been observed to increase feeding and drinking behavior in response to sow nursing grunts (Petrie and Gonyou, 1988). We cannot be certain whether the pigs in our study recognized the sounds as sow nursing grunts or simply as background noise. However, the differences that we observed in time at the feeder suggest that the sounds were somehow acknowledged as stimuli associated with ingestive behaviour.

Although there was no overall difference in weights between the two sound treatments, there was a tendency for the pigs exposed to playback vocalizations to gain more weight over the course of the trial. Because our video recordings were not equipped to record sound, and because we did not synchronize the timing of the video recordings and the sound, we could not examine the temporal relationship between feeding behavior and period of the playback vocalizations. However, it may be possible that the vocalizations serve as hourly cues for the pigs to feed, as occurs on the sow. Although the pigs exposed to the playback vocalizations tended to have higher ADG than the control, they spent significantly less time with their heads in the feeders. This suggests that the treatment pigs are eating more quickly than the control pigs, possibly because their feeding is more synchronized and regimented. A cursory analysis of feeding synchronization (not presented here) yielded no differences between treatment groups. However, a more detailed study, with enough feeder space for all pigs to feed simultaneously, would be necessary to elucidate any relationship between playback vocalizations and feeding synchrony.

Several previous studies have assessed the effectiveness of using other external stimuli normally associated with nursing on the behavior of newly weaned pigs. Applying milk or milk substitute to the feed to provide gustatory or olfactory cues does not appear to affect either feed intake, time spent at the feeder or belly nosing behavior (Petrie and Gonyou, 1988; Gardner et al., 2001). Feed intake is greater when pigs are fed higher-quality diets regardless of whether the diet is formulated with milk products (Gardner et al., 2001). However, when a synthetic version of the maternal pheromone that is known to attract pigs to the sow’s udder is applied to either the snouts of newly weaned pigs or their feeders, pigs spend more time at the feeder and less time at the drinker and fighting during the first 48 h after weaning (McGlone and Anderson, 2002). They also gain significantly more weight during the 4
wk after weaning than pigs not exposed to the pheromone. Interestingly, when maternal pheromone was used, significant differences in average daily gain did not occur until the third week after weaning, similar to the trend observed in our study (McGlone and Anderson, 2002). Any effect of the pheromone on pig-directed behavior has not been determined.

Something important to note is the difference in feeding behavior during the first forty-eight hours after weaning. This period is critical because pigs have to adjust to different diets and environments. Early weaned pigs have been known to consume excessive amounts of water, possibly in place of solid food consumption, during the first couple of days after weaning (Holub, 1991; Gonyou et al., 1998; Worobec et al., 1999). The pigs in the sound treatment group tended to perform less feeding behavior during the first 2 d after weaning. However, apparent feed intake, drinking behavior, and water use were not affected by sound treatment. This difference in feeding behavior, and the lack of difference in drinking behavior, is in direct contradiction with work by Petrie and Gonyou (1988), who found that auditory stimuli (sow nursing grunts) significantly increased feeding bouts on the second day after weaning. However, in that study, they used pigs weaned at 28 d and, in addition to the increase in feeding bouts, they noted an increase in drinking behavior during the first 2 d.

The lack of correspondence between feeding behavior and feed intake in our study was striking and surprising, but we are not the first to report little relationship between time spent with head in the feeder and feed intake measured (Gardner et al., 2001; McGlone and Anderson, 2002). As we look in more detail at the behavior of newly weaned pigs, it seems that time spent at the feeder is not a good predictor of feed intake, possibly because pigs spend a fair amount of time exploring and rooting in the feeder. Pigs reared in seminatural environments begin performing investigative behaviors, such as rooting and foraging, at approximately 2 wk of age (Stolba and Wood-Gush, 1989; Petersen, 1994), behaviors that later lead to independent ingestion. It may be that belly nosing develops in concordance with independent feeding as a result of increasing motivation to root. This idea was first presented by Bøe (1991) and warrants further investigation. Perhaps pigs begin their rooting by directing this behavior at soft surfaces (each other’s bellies) because they are familiar with the surface of the sow’s udder. Over time, rooting at the feeder and in feed may take the place of belly nosing, explaining why there is often discordance between feeding behavior and feed intake in pigs. Possibly, belly nosing should be viewed as a “normal” transitional behavior that occurs as pigs make the shift from nursing to independent feeding and drinking.

**Implications**

Through the examination of factors that are involved in preweaning sucking and postweaning feeding and drinking, the motivating factors involved in belly nosing can be elucidated. With knowledge of these factors, scientists and producers can determine ways to help alleviate abnormal postweaning behaviors. During the first 48 h after weaning, diner style significantly affected pig behavior. Pigs with bowls spent less time at the diner and more time at the feeder, and ate more than pigs with nipple drinkers did. They also belly nosed significantly less over the nursery period. The motor patterns involved with ingesting water from bowl drinkers may provide sensory stimulation either to oropharyngeal regions or the snout that somehow satisfies sucking or nosing motivation. Until these factors are studied more thoroughly, alternative drinkers may be used to help decrease early-weaned pig belly nosing.

**Literature Cited**


