The Effects of Socializing and Environmental Enrichments on Sow and Piglet Behavior and Performance

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ABSTRACT. This study was conducted to, 1) determine the effects of socializing piglets prior to weaning on piglet behavior and performance and sow behavior, and 2) determine the effects of socializing piglets prior to weaning and inclusion of pen enrichment on nursery pig behavior and performance. Socialized piglets spent a shorter amount of time lying down during the first 24 hours following barrier removal compared to all other times and exhibited an increase in agonistic behavior. Sows had higher levels of cortisol and spent less time lying down during the first 48 hours after piglet socialization compared to all other times. In the nursery, piglets that were socialized prior to weaning had higher average daily gain (ADG) (0.48 ± 0.02 kg) and lower occurrence of agonistic behavior (30.0 ± 2.5 percent) during the first six hours after weaning compared to those piglets that were not socialized prior to weaning (0.39 ± 0.03 kg and 85.0 ± 3.5 percent, respectively). Pens with environmental enrichment contained fewer piglets displaying agonistic behavior compared to pens without environmental enrichment during the first 12 hours after weaning. The results of this study suggest that socializing piglets from different litters prior to weaning leads to temporary stress in lactating sows and an increase in agonistic behavior in piglets, but improves their performance after weaning. Inclusion of environmental enrichment in the nursery is an effective means to reduce agonistic behavior between piglets.

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INTRODUCTION

Weaning piglets around 21 days of age is a critical time in hog production, as piglets are exposed to multiple stressors including separation from the sow, transportation, changes in diet, and an increase in aggression as new dominance hierarchies are established following the socialization of previously unfamiliar piglets (Held and Mendl 2001; Jensen 2002; King and Pluske 2003).

The mixing of piglets from different litters is thought to be the main cause of aggression after weaning (Keeling and Jensen 2002) as dominance hierarchy fighting is not seen between piglets from the same litter (Newberry et al. 2000). Studies indicate that socializing piglets from different litters prior to weaning establishes a hierarchy more quickly than when piglets are socialized after weaning (D'Eath 2005; Hesselet al. 2006). Also, the addition of environmental enrichments to the nursery pens appears to alleviate the incidence of aggressive fighting between piglets (Jolly et al. 2002; Wood et al. 2003).

Weight gain in piglets immediately after weaning influences their long-term growth potential (Pluske et al. 2003), however stress associated with weaning causes piglets to experience a reduction in feed and water intake during the first few days after weaning (Bruininx et al. 2002; Dybkjær et al. 2006). The low feed and water intake predisposes them to weaning diarrhea and weight loss (Madec et al. 1998; McCracken et al. 1999).

Therefore, the objectives of this research were to determine the effects of socializing piglets prior to weaning and the inclusion of environmental enrichments in the nursery on the behavior and performance of piglets and sows. The working hypothesis is that socializing the piglets prior to weaning and the incorporation of environmental enrichments in the nursery will improve post-weaning performance as measured by weight gain in the piglets and have no deleterious effects on sow performance.

MATERIALS AND METHODS

Animals and Housing

The study was conducted at the Dr. C. Richard Beckett Animal Science Building in Findlay, OH (United States). In each of four replicates, six crossbred (Yorkshire x Hampshire) confirmed pregnant (trans-abdominal ultrasound) sows (n=24) were washed and

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placed into individual farrowing crates (2.0 m x 1.5 m) within a farrowing room (7.5 m x 6.5 m x 4 m) five days prior to their expected farrowing date. The farrowing crates were arranged in groups of three so that the middle crate shared a common solid partition on each side, with the outer crates. Each group of three crates faced the other three crates. The farrowing room was a controlled-environment room, with automatically controlled fan ventilation set to maintain a room temperature of 20°C and controlled lighting which was on from 0700–1800. Each sow was fed twice daily in the morning and evening a commercial pelleted lactation diet that met or exceeded the nutrient recommendations for lactating sows (NRC 2012), distributed in a stainless steel feeder attached to the front of the farrowing crate. Sows were provided water on an ad libitum basis from individual bite drinkers.

Over the four replicates, 160 piglets were weaned at the average age of 21 days and placed into slatted nursery pens (2.50 m x 1.25 m, 0.31 m^2/piglet, 10 piglets/pen) in a controlled-environment room, with automatically controlled fan ventilation set to maintain a room temperature of 22°C and controlled lighting which was on from 0700–1800. Total transportation time from the farrowing crate to the nursery pen was 10 minutes. Feeding occurred ad libitum in a stainless steel feeder with five feeding stations attached to the nursery pen. The ration was a commercial nursery diet that met or exceeded the nutrient recommendations for nursery pigs (NRC 2012). Piglets were allowed water on an ad libitum basis from bite drinkers.

The study adhered to the guidelines for the treatment of animals in behavioral research and teaching and was approved by the Institutional Review Board (#570) of the University of Findlay, OH (United States).

Experiment 1: Effects of socializing piglets prior to weaning on the behavior and performance of piglets and sows

Approximately 14 days after farrowing, the solid partitions were removed to permit the socializing of piglets from different litters. Piglets were sprayed on their back with standard color stock marker to facilitate litter identification. Piglets were weaned when the group average was 21 days after farrowing. Each piglet was weighed daily from partition removal to weaning to determine performance.

The behavior of sows and piglets was continuously recorded on videotape and analyzed from 48 hours before barrier removal until weaning. The specific behaviors that were observed and analyzed were previously described by Hessel et al. (2006) (Table 1). The behavior of the piglets was scored as a group and a specific behavior was recorded as occurring when more than 75 percent of the piglets were engaged in that particular behavior during a 24-hour time period.

Saliva was obtained from each sow twice per day from 48 hours before barrier removal until weaning to determine cortisol levels. Based on methods previously described by Muneta et al. (2010), medical absorbent cotton was tied to a wooden rod and placed in front of the sow to allow mastication by the sow. After two minutes, the cotton was recovered by withdrawing the rod and placed into a 10 mL syringe. The syringe containing the cotton was then placed into a 50 mL conical tube and saliva was collected by centrifugation at 2500 x *g* for 15 minutes and kept at –30°C until the day of the assay. Salivary levels of cortisol were determined using a cortisol immunoassay kit (Arbor Assays, Ann Arbor, MI, USA) which measured total cortisol in the samples based on a cortisol-peroxidase conjugate color change recorded at 450 nm.

Experiment 2: Effects of environmental enrichment in the nursery on piglet behavior and performance

At weaning, 20 piglets from each treatment group were placed into four nursery pens (0.31 m^2/piglet) with two pens containing environmental enrichment and two pens not containing environmental enrichment. The environmental enrichments included a commercially available 25.5 cm diameter plastic ball (Jolly Ball, Streetsboro, OH, USA) and a 0.5 m x 0.5 m x 0.5 m cube constructed of 1.9 cm diameter polyvinyl chloride tubing. Each piglet was weighed daily from the time of placement in the nursery to 35 days of age to determine performance.

The behavior of piglets was continuously recorded on videotape and analyzed from weaning until 35 days of age. The behaviors of the piglets, as previously described by Hessel et al. (2006) (Table 1), were scored during a 24-hour time period as a group and a specific behavior was recorded as occurring when more than 75 percent of the piglets were engaged in that particular behavior.

Statistical Analysis

Statistical analysis was performed using the MIXED procedures of SAS (SAS Institute Inc., Cary NC, USA). Least squares means were evaluated using the

TUKEY option of SAS and results are reported as the least squares mean ± SEM. In all analyses in both experiments, $P < 0.05$ was considered significant.

Experiment 1, piglet performance (i.e. weight gain) was determined using treatment as a fixed factor and replicate as a random factor. The behavioral data points of the piglets were aggregated into sums of each pen and each observational day and analyzed using fixed effects of observational day and random pen, replicate and operator (individual watching the video) effects. The behavioral data points of the sows were aggregated into sums of each sow and each observational day

TABLE 1
Definition of the specific behaviors that were observed, adapted from Hessel et al. (2006)

Category	Definition
Farrowing room	
Sow	
Standing	Sow adopts an upright position with legs extended
Sitting	The posterior of the body trunk is in contact with and supported by ground
Nursing	Piglet has contact with their snout to the udder
Lying	Sow's body has contact with the ground
Restlessness	One or a combination of the following: a lot of posture changes within a short time; shifting from one foreleg to the other; head shaking; vocalization
Piglet	
Lying	Piglet's body has contact with the ground
Suckling	Piglets massage or suck at the udder
Active	Piglets in the pen perform any action in an upright position with the legs extended
Agnostic	Physical encounters between at least two pigs including head-to-head fights, biting another pig, as well as pushing or knocking another pig with the head
Nursery Room	
Lying	Piglet's body has contact with the ground
Active	Piglets in the pen perform any action in an upright position with the legs extended
Feeding	Piglet is standing at the trough with head down; the head can either be in the the trough or in front of the trough when pegs eat feed
Agnostic	Physical encounters between at least two pigs including head-to-head fights, biting another pig, as well as pusing or knocking another pig with the head

and analyzed using fixed effects of observational day and random sows, replicate and operator (individual watching the video) effects. The cortisol levels analysis used a model that included treatment, sow within treatment, and time as possible sources of variation. Sow effects were not significant (P > 0.05) and deleted from the final model.

Experiment 2 was conducted as a two (socializing between litters during lactation, no socializing between litters during lactation) X 2 (no environmental enrichment in the nursery pen, environmental enrichment in the nursery pen) factorial design. Performance and behavior of piglets were determined as described in Experiment 1.

RESULTS

Experiment 1: Effects of socializing piglets prior to weaning on the behavior and performance of piglets and sows

There were no differences between the average daily weight gain of the piglets socialized prior to weaning (0.25 ± 0.01 kg/day) and the piglets that were not socialized prior to weaning (0.23 ± 0.01 kg/day). Removal of the partitions between the farrowing crates did not influence the suckling and active behaviors in piglets that were socialized in the farrowing room 14 days after birth (Table 2). Removal of the partitions decreased (P < 0.05) the time spent lying down on the day of partition removal compared to all other days. Additionally, after removal of partitions, the time spent exhibiting agonistic behavior increased (P < 0.05) the day of partition removal (0.06 ± 0.01 h) and the day after partition removal (0.05 ± 0.01 h). There was no difference in the time spent exhibiting agonistic behavior between piglets on the day of partition removal and the day after partition removal.

The profiles of sow behavior followed that of the piglets (Table 3). Removal of the partitions decreased (P < 0.05) the time spent lying down on the day of partition removal compared to all other days. Sows were more restless (P < 0.05) the day of partition removal (1.93 ± 0.04 hour) compared to all other times. Similarly, cortisol levels obtained from sow saliva were higher (P < 0.05) on the day of partition removal in both the treatment and control groups compared to all other times (Figure 1). However, salivary cortisol levels remained higher (P < 0.05) the day after partition removal in the treatment group compared to the control group.

Experiment 2: Effects of environmental enrichment in the nursery on piglet behavior and performance

There were no differences between the average daily weight gain of the piglets with environmental enrichment in the nursery (0.44 ± 0.03 kg/day) and

TABLE 2
Time budgets (hours within a 24-hour day, standard error mean) for the behaviors performed by piglets (n= 160) in the experimental group[1] two days before and seven days after removal of the partitions between the farrowing crates

	Days relative to barrier removal										
Behavior	-2	-1	0	1	2	3	5	6	7	8	SEM
Lying, h	18.2	18.45	17.51*	17.66	17.94	17.91	18.04	18.11	17.98	18.41	0.29
Suckling, h	2.5	3.14	2.13	2.31	2.66	3.22	2.86	2.95	2.12	2.14	0.65
Active, h	3.28	2.39	4.3	3.98	3.37	2.85	3.08	2.92	3.88	3.43	0.96
Agonistic, h	0.02	0.02	0.06*	0.05*	0.03	0.02	0.02	0.02	0.02	0.02	0.01

[1]Piglets of sows in the experimental group were socialized in the farrowing room at 14 days of age.

The sows (n = 24) remained confined.

*Within a row, means with different superscripts differ (P < 0.05).

the piglets without environmental enrichment (0.44 ± 0.02 kg/day) for the first 14 days in the nursery. There were no differences between the average daily weight gain of the piglets in the nursery socialized prior to weaning (0.27 ± 0.04 kg/day) and the piglets that were not socialized prior to weaning (0.36 ± 0.04 kg/day) for the first three days in the nursery. However, over the first 14 days in the nursery, piglets socialized prior to weaning (0.48 ± 0.02 kg/day) had a higher ($P < 0.05$) average daily weight gain than the piglets that were not socialized prior to weaning (0.39 ± 0.03 kg/day).

The percent of piglets performing agonistic behavior was higher ($P < 0.05$) during the first 12 hours in the nursery amongst those with no environmental enrichment compared to the piglets with access to environmental enrichment (Figure 2). The percent of piglets performing agonistic behavior was higher ($P < 0.05$) during the first 12 hours in the nursery and between 24 to 36 hours after placement in the nursery amongst those that were not socialized prior to weaning compared to the piglets that were socialized prior to weaning (Figure 3).

DISCUSSION

Weaning and the first days in the nursery are stressful times for piglets (Puppe et al. 1997) because they are mixed with piglets from other litters and have an abrupt change in environment and diet (Merlot et al. 2004). These stressors increase aggressive behavior between piglets (Fels et al. 2012) and reduce performance (Bruininx et al. 2001). Previous studies have shown that socializing piglets prior to weaning decreases fighting behavior in the nursery without reducing performance prior to weaning (Hessel et al. 2006). In addition, socializing piglets prior to weaning does not affect the behavior of the sows during lactation (Hessel et al. 2006) although there are reports that the nursing time of the piglets decreases due to the piglet socialization (Pederson et al. 1998; Weary et al. 1999). Typically, there is a decrease in feed intake observed immediately after weaning which dissipates by 50 hours after placement into the nursery, when the piglets resume normal feed intake patterns (Bruininx et al. 2001, 2002). However, the piglets have already decreased their feed intake and digestibility levels and reduced their average daily gain at this point in time (McCraken et al. 1999).

Researchers have reported that the addition of environmental enrichments for the piglets during lactation (Jolly et al. 2002) or in the nursery (van de Weerd and Day 2009), are effective at reducing aggressive behavior and improving the piglets well being. In agreement with these studies, our results showed that mixing piglets prior to weaning did not affect their weight gain during lactation nor have long-term negative effects on their behavior or well

TABLE 3
Time budgets (hours within a 24-hour day, standard error mean) for the behaviors performed by sows (n = 24) in the experimental group[1] two days before and seven days after removal of the partitions between the farrowing crates while the sows remained confined.

	Days relative to barrier removal										
Behavior	**-2**	**-1**	**0**	**1**	**2**	**3**	**5**	**6**	**7**	**8**	**SEM**
Standing, hours	2.1	2	2.57	2.15	2.22	2.07	2.12	2.17	2.94	1.15	0.81
Sitting, hours	2.1	1.85	2.15	2.1	1.94	1.76	1.97	2.31	1	3.74	1.37
Nursing, hours	2.5	3.14	2.13	2.31	2.66	3.22	2.86	2.95	2.12	2.14	0.65
Lying, hours	17.22	16.96	15.22*	16.64	17.09	16.87	16.98	16.55	17.88	16.91	0.66
Restlessness, hours	0.08	0.05	1.93*	0.8	0.09	0.08	0.07	0.02	0.06	0.06	0.04

[1]Piglets of sows in the experimental group were socialized in the farrowing room at 14 days of age.

*Within a row, means with different superscripts differ ($p < 0.05$).

being or the sows' well being. Additionally, piglets socialized prior to entering the nursery had greater levels of average daily weight gain during the first 14 days and a decrease in agonistic behavior. The inclusion of environmental enrichment in the nursery reduced agonistic behavior but did not improve performance as seen with the piglets socialized prior to weaning.

Few studies have considered the effects of socializing piglets prior to weaning on the sow. Hessel et al. (2006) reported that the socializing of piglets prior to weaning does not adversely affect sow behavior. Sows that are not confined during lactation typically have a reduction in nursing time due to the mixing of piglets (Pederson et al. 1998; Weary et al. 1999) and the piglets spend less time nursing despite an increased incidence of cross-suckling (Wattanakul et al. 1997). The sows in our study were confined during the entire period of lactation. Removal of the partitions between the farrowing pens caused an increase in restless behavior of the sows, which was balanced by a decrease in time spent lying down. We speculate that this is a temporary, short-term effect, caused by environmental changes, as the increase in restlessness was only seen on the day of partition removal. Cortisol levels were determined from saliva samples to evaluate levels of stress in the sows. Comparable to the behavior profiles of the sows, the cortisol levels were higher on the day of partition removal in all of the sows in the farrowing room. This indicates that the stress encountered by the sows experiencing barrier removal also occurs in the sows that were not exposed to socializing. Related to the behavioral changes, this rise in cortisol was temporary, as on the following day the cortisol levels were not significantly higher in the sows that did not experience partition removal and by three days after partition removal, all sows in the room had similar levels of cortisol.

The mixing of pigs can lead to agonistic behavior in order to establish hierarchies within a group (Meese and Ewbank 1973). It should not be a surprise that the same behavioral trend is seen when mixing piglets (Friend et al. 1983; McGlone and Curtis 1985; Keeling and Jensen 2002) in addition to an increase in stress and cortisol levels of sows (Blecha et al. 1985). However, mixing piglets at a young age (less than 28 days) potentially creates non-aggressive interactions (Jensen 2002; Hessel et al. 2006). Pedersen et al. (1998) observed

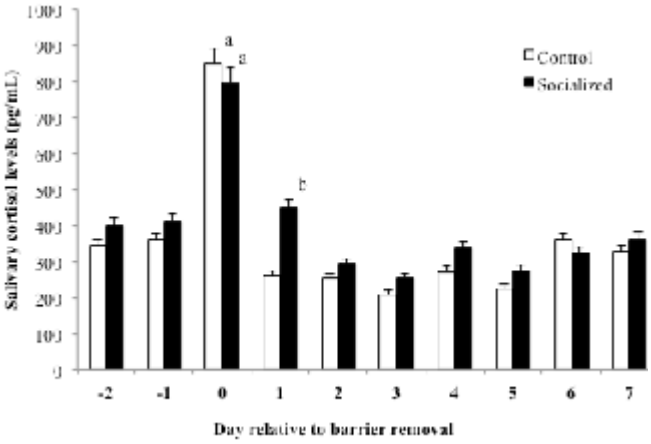

FIGURE 1. Salivary cortisol levels in sows (n=24) two days before and seven days after partition removal that experienced socialization of piglets at 14 days of age (Socialized) or did not experience piglet socialization (Control). Means with different superscripts differ ($P < 0.05$). Data are expressed as mean ± SEM.

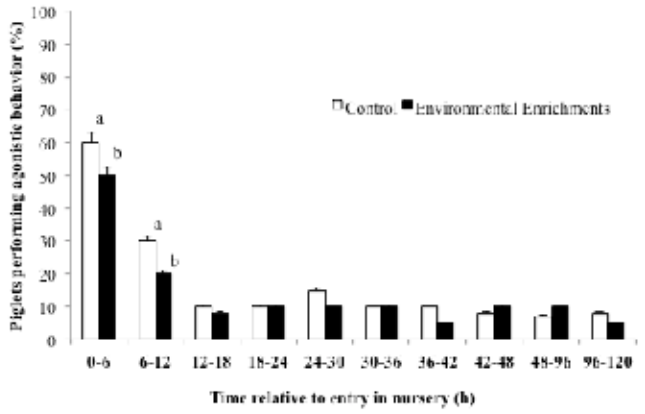

FIGURE 2. Proportion of piglets (n = 160) performing agonistic behavior as a function of time after weaning that experienced environmental enrichment (Environmental Enrichments) in the nursery pen or did not experience environmental enrichment (Control). Agonistic behavior means with different superscripts differ ($P < 0.05$). Values between times are not comparable. Data are expressed as mean ± SEM.

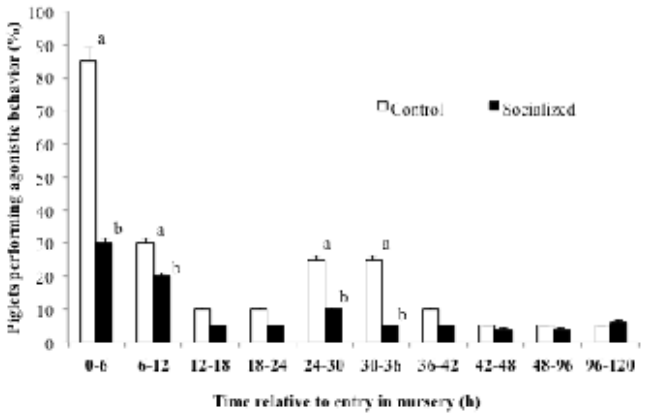

FIGURE 3. Proportion of piglets (n = 160) performing agonistic behavior as a function of time after weaning that experienced socialization prior to weaning (Socialized) or did not experience piglet socialization (Control). Agonistic behavior means with different superscripts differ ($P < 0.05$). Values between times are not comparable. Data are expressed as mean ± SEM.

playful interactions between co-mingled piglets around 28 days of age and the fights that did occur were shorter in duration and fewer in injury (Pitts et al. 2000). In the present study, we socialized the piglets continuously beginning on day 14 after farrowing. We observed an increase in agonistic behavior for the first 48 hours after partition removal, which coincided with a decrease in the amount of time spent lying down. Contrary to previous findings, we did not notice a change in suckling behavior. This is most likely due to the confinement of the sows in our study and not in the previous reported studies. Regardless, there was no difference in the performance of the piglets during lactation regardless of mixing, which is in agreement with other reports (Hessel et al. 2006).

If the stress associated at weaning can be minimized, the performance levels of the nursery piglets should increase (Brooks and Tsourgiannis 2003). The mixing of piglets from different litters based on weight and gender in the nursery increases aggressiveness and fighting and decreases their well being and growth performance (Puppe et al. 1997). Therefore much research has been focused on minimizing the stress associated with weaning through the incorporation of environmental enrichments in the nursery (van de Weerd and Day 2009) or the farrowing room (Wood et al. 2003). However, many believe the stress associated with the change in the diet outweighs the mixing stress (Bruininx et al. 2001; Merlot et al. 2004) and research has been focused on enhancing the feed intake of nursery piglets (Dybkjær et al. 2006) through feed and water additives. We report that the inclusion of environmental enrichments in the nursery reduced the percent of piglets performing agonistic behavior during the first 12 hours in the nursery compared to those piglets that did not have access to environmental enrichment. When considering socializing prior to weaning however, the socialized piglets had higher rates of weight gain during the first 14 days in the nursery compared to those piglets that were not socialized prior to weaning. As expected, the piglets that were not socialized prior to weaning had a higher incidence of agonistic behavior during the daytime of the first two days in the nursery. This further solidifies the claims that social hierarchies are the predominant force relative to stress and well being of the pigs (Meese and Ewbank 1973; Puppe et al. 2008). Our results, together with the findings described above, suggests the importance of minimizing stress on the pigs when changing from the farrowing room to the nursery.

Social hierarchies are found in all stages of pig production (Puppe et al. 2008) and those hierarchies could be based on the litter from which the pigs are from (Fels et al. 2012). Research should focus on alternative management and methods of intervention to reduce the stress, while maintaining or possibly improving performance levels without attempting to eliminate innate behaviors. Our results indicate that socializing earlier in life and providing additional environmental stimulation in the form of enrichment is one such mechanism to reduce stress and maintain performance levels. Further investigation to find a cost-effective, easily manipulated system that producers can utilize in their operation is critical to reduce the stress associated with weaning while maintaining high quality production standards.

Based on the results of our study, we conclude that one way to reduce the stress associated with weaning piglets without affecting the sows in confinement is to socialize them prior to weaning and include environmental enrichment in the nursery pens.

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