Sow responsiveness to human contacts and piglet vocalization during 24 h after onset of parturition

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Abstract

Sow responsiveness towards external disturbances and concurrent postural changes are proposed to be an important cause of early piglet crushing. The aim of the present study was to assess whether loose housed sows change their responsiveness over time within the first 24 h after birth of the first piglet upon exposure to different types of human contact and towards piglets’ scream. The responsiveness of the sows (n = 17) was scored during: (i) blood sampling of the sow during 24 h after the onset of parturition, (ii) human handling of a piglet at 0, 30 min, 1, 2, 4, 8 and 24 h after birth, (iii) screaming when a piglet was trapped underneath the sow and (iv) exposure to playback of piglets’ screams at 10 and 24 h after the onset of parturition. A sow was scored as responsive if she changed her posture in response to the stimuli. The behavioral scores were analyzed during three predefined periods: parturition (from birth of first piglet to birth of last piglet), phase 1 (from birth of last piglet to 12 h after birth of first piglet) and phase 2 (from 12 h after birth of first piglet to 24 h after birth of first piglet). The responsiveness of sows towards humans during blood sampling differed between the three periods (p < 0.01), whereas it did not differ between periods during human handling of piglets. During blood sampling, fewer sows were responsive during phase 1 (5%) compared to during parturition (11%) and the later phase 2 (17%). We did not detect any temporal changes in sow responsiveness towards natural incidences of screaming of own trapped piglet between the three periods (p > 0.01), whereas it did not differ between periods during human handling of piglets. During blood sampling, fewer sows were responsive during phase 1 (5%) compared to during parturition (11%) and the later phase 2 (17%). We did not detect any temporal changes in sow responsiveness towards natural incidences of screaming of own trapped piglet between the three periods (it remained high: 80%), whereas sows exposed to playback of piglet screams had a higher probability (p < 0.05) to react at 12 h (50%) than at 24 h (25%). In conclusion, the responsiveness of sows toward direct human contact was lower during the first 12 h postpartum. The careful handling of piglets in the home pen had a minimal effect on the probability of postural changes in sows. However, sows were highly reactive towards the screaming of own trapped piglet during the whole 24 h period pp. The relative lower
responsiveness towards playbacks, decreasing from 12 to 24 h pp, cast doubt upon the piglet scream playback test as a useful approach to evaluate maternal responsiveness in sows.

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1. Introduction

In commercial pig production, early piglet mortality is a main problem and varies between systems and farms with mortality rates ranging between 10 and 30% (Cronin et al., 2000; Pedersen et al., 2006; Weber et al., 2006). Many deaths of live-born piglets are caused by sow crushing the piglets when she changes posture. The occurrence of crushing peaks within the first 24 h after farrowing (Edwards, 2002; Marchant et al., 2001; Weary et al., 1996a) puts emphasis on this very early period in relation to maternal responsiveness and early piglet crushing.

It has been shown that the maternal behaviour of sows changes in terms of activity and responsiveness towards piglets after birth (Jarvis et al., 1999; Pedersen et al., 2003). In the initial stage of parturition, a sow is more active and changes her posture more often and she is reactive when a piglet approaches her snout (Jarvis et al., 1999; Pedersen et al., 2003). The responsiveness of the sow towards piglets’ naso-nasal contacts as well as her activity decreases after delivery and increases again about 12 h postpartum (Pedersen et al., 2003). It has been suggested that the inactivity of the sow and her unresponsiveness to piglets may be advantageous by maximizing suckling opportunities and reducing the risk of crushing piglets (Jarvis et al., 1999). However, in the cited study the sow responsiveness is only based on the sows’ reaction towards naso-nasal contacts. It is unknown whether the sows’ responsiveness towards other stimuli, such as human disturbance, also decreases after birth. Knowledge of the temporal development in sow responsiveness is important, since it may allow us to identify optimal time windows of handling, where the sows’ reaction to human contact is minor. Often a stockperson assists during parturition or has to weigh or otherwise process piglets within the first 24 h. Furthermore, for experimental purposes it is sometimes necessary to handle and take samples from the sow or the piglets. Especially in farrowing pens, where the movements of sows are not restricted, the close human contact may be problematic. It has been documented that sows in pens had higher scores of aggression towards a stockperson than sows in crates (Marchant-Forde, 2002) throughout the whole lactation. Thus, a risk could arise that the reaction towards human contact leads to a posture change of the sow (stand up or rolling over) which increases the probability of crushing and mortality. Also, it is unknown whether the responsiveness of sows towards humans changes within the first 24 h after birth.

When an otherwise vital piglet is trapped under the sow, typically it starts to scream immediately unless the snout is trapped under the sow. It seems that the survival of the young when trapped underneath the sow depends on how long it is trapped and how quickly the sow responds to the piglet’s vocalization (Weary et al., 1996a,b). There are several studies assessing how strongly and quickly sows’ respond to a playback of pre-recorded screams of a trapped piglet; however, most studies were done later than during the first 24 h (Grandinson et al., 2003; Held et al., 2006; Hutson et al., 1991, 1993; Wechsler and Hegglin, 1997). Only one study included the first 24 h postpartum, but the piglet age ranged from 5 to 24 h postpartum (Hutson et al., 1992). Therefore, it is not clear whether the sow’s responsiveness to playbacks of trapped piglet screams changes during the first 24 h. We predict that sows should react to the scream
vocalization of trapped piglets independently from the time after birth in order to increase their survival. Furthermore, it is not known whether sows react in the same way to playbacks of piglet scream vocalization and to the real screams of their own piglets being trapped. Such an approach should help to explain the different results from studies analyzing the sow’s responsiveness to playback screams and piglet mortality. In a large dataset (900 sows) Grandinson et al. (2003) found a moderate genetic correlation between mortality and sow responsiveness to a piglet scream test. However, there was no phenotypic correlation between the two traits. Wechsler and Hegglin (1997) and Andersen et al. (2005) reported a lower responsiveness in sows that crushed piglets compared to sows that did not crush piglets in a study including 11 sows and 30 sows, respectively. In contrast, Held et al. (2006) and Špinka et al. (2000) did not find any correlation between sow responsiveness to the playback of screaming piglets and piglet mortality.

The aim of the present study was to assess whether loose housed sows changed their responsiveness towards external disturbances in terms of (i) human blood sampling of the sow, (ii) human handling of a piglet, (iii) screaming of own trapped piglet and (iv) exposure to pre-playback of piglet screams within the 24 h postpartum.

2. Methods

2.1. Animals and housing

This study was a part of a project realized at the Research Centre Foulum in Denmark. We housed pregnant Landrace–Yorkshire sows (n = 17) of the second parity individually in 7.5 m² pens from 1 week before the expected parturition (i.e. day 108–109 of gestation) until 1 week after farrowing. All sows were loose housed during their first farrowing, and were similarly housed prior to the experiment. The sows were fed twice daily with a standard amount and type of dry concentrate sow feed, and they had access to water ad libitum. One kilogram of long barley straw was provided daily in a straw rack, if less than 0.5 kg was left. The house had an average (S.D.) air temperature of 21.2 (0.8) °C with a relative humidity of 47.6 (8.1)%,

2.2. Video recordings

Close-circuit video cameras and microphones were positioned 2 m above the floor and were connected via cables to the VCRs. The behaviour of the sows was continuously recorded during 24 h immediately after the start of parturition. The behaviour of each sow and her piglets were analyzed using the Observer Video Pro 5.0 software (Noldus, Wageningen, The Netherlands).

Based on studies concerning the sows activity and responsiveness (Jarvis et al., 1999; Pedersen et al., 2003), the first 24 h after birth of the first piglet (BFP) were divided into three time periods: parturition (from birth of first piglet to birth of last piglet), phase 1 (from birth of last piglet to 12 h after birth of first piglet) and phase 2 (from 12 h after birth of first piglet to 24 h after birth of first piglet).

2.3. Sow responsiveness to human contacts during blood sampling

The sows were catheterized on days 111–112 as part of another project using the method described by Damm et al. (2000). The entire experiment was approved by the Danish Animal Experiments Inspectorate. From the day after catheterization until the day after farrowing, blood samples were taken once daily at 0900. Additionally, from 8 to 10 h after the onset of nest-building until 24 h after the birth of the first piglet, blood was sampled hourly. The number of blood sampling prior to BFP was 15.3 ± 8.4 (mean ± S.D.). The
generalized linear model with binomially distributed response variable was used to test if the number of blood samplings prior to BFP had an effect on the responsiveness of the sows after BFP.

In this study we analyzed only the sows’ reaction to blood sampling from birth of the first piglet to 24 h after birth of the first piglet. The experimenter entered the pen and very calmly approached the sow and took the blood sample from the catheter. Blood sampling lasted on average (S.D.) 3.5 min (1.2). If the sows responded during blood sampling either by rolling from lateral to ventral position or by sitting/standing up from lying, they were scored as responders. If they either lifted their head or did not respond at all they were scored as non-responders.

Due to technical problems 3 sows out of 17 were excluded from the analysis.

2.4. Sow responsiveness towards piglet manipulation

The experimenter entered the pen and very calmly took every newborn piglet when it reached the floor after birth and then again at time 30 min, 1, 2, 4, 8, 24 h after birth. Samplings (weighing, blood samplings) were done outside the pen and lasted 2.5 min on average. The sow could hear the piglets but could not see them. Subsequently, the piglet was returned to the same place where it had been picked up. For this analysis only one focal newborn piglet was chosen randomly from every litter for testing the reaction of the sow toward processing of the piglet. Handling of this piglet was observed during all 24 h. We choose only focal piglets which had a similar body weight. If the sows responded during piglet processing either by rolling from lateral to ventral position or by sitting/standing up from lying they were scored as responders. If they either lifted their head or did not respond at all they were scored as non-responders.

2.5. Sow responsiveness on scream calls of own trapped piglet

From the video records all events when a sow trapped a piglet and her reaction to the scream calls of the trapped piglet were analyzed. The strongest behavioural response that occurred within the first minute of trapping was scored. A sow was scored as responding if she rolled from lateral to ventral position or sat/stood up from lying within the first minute after trapping the piglet. If she either lifted her head or did not respond at all she was scored as non-responder.

2.6. Sow responsiveness on the playback test of a piglet screams

The scream of an alien 1-day-old piglet that was restrained by holding it tight was recorded prior to the experiment. The analogue tape recorder (Dan-Sound Educational, AV-30 series, MKII.) and microphone (Sony Stereo ECM-929LT) was used. This scream was remotely played back for the sows both at 9–10 h and 24 h after BFP. Each playback was played at natural loudness, approximately 90 dB. The load speaker was placed just outside the pen about 1.5 m from the sow. The playback was remotely controlled from a distance of more than 5 m from the pen (the sows were not able to see the experimenter during the test). The playback lasted for 1 min. In our playback test the screaming was played to the sow when she was already lying on her side. Thodberg et al. (1998) showed that the responses of the sows were independent of whether the sow was laying or standing during the playback. In addition, Thodberg et al. (1998) found no difference whether the playback sound came from own piglets or an alien piglet. Sows were scored to respond if, within the first minute after start of the playback sound, they either rolled from lateral to ventral position or sat/stood up from lying. If they either lifted their head or did not respond at all they were scored as non-responders. In case that the sow reacted faster than 1 min the playback was turned off before the 1 min was elapsed.

2.7. Mortality data

The mortality of the live-born piglets during 24 h after BFP was calculated as the number of live-born piglets immediately after birth minus the total number of live piglets 24 h after.
2.8. Statistical method

For the statistical analyses, the individual sow was used as the experimental unit. During each of the previously described phases a logistic regression model with mixed effects (procedure “GLIMMIX” SAS version 9) was applied to calculate the probability that a sow responded to human contacts during blood sampling and piglet manipulation, to the trapping of own piglets and to the playback scream of an alien piglet. The fixed effects included in the model were one class variable “time period” and three continuous variables “duration of parturition”, “litter size” and “time from the birth”. The class variable “time period” had three levels (parturition, phase 1 and phase 2) in the analysis of the sow responsiveness towards blood sampling and towards the scream calls of the own trapped piglet. In the analysis of the sow responsiveness towards piglet manipulation only two levels were included (parturition and phase 1) because of a low number of events in phase 2. In the analysis of the responsiveness towards playback scream calls the variable “time period” had two levels, phase 1 and phase 2. The random intercept corresponding to the sow was included in the model.

The Wald test was applied to test the significance of the continuous fixed effects and the class variables with two levels. The test statistics is noted by \( T_{\text{d.f.}} \), with d.f. as the degrees of freedom. The likelihood ratio test was used to test the significance of class variables with three levels and test of submodels. The test was noted by \( L_{\text{d.f.}} \) with d.f. as degrees of freedom.

A similar model (using GLIMMIX in SAS, version 9) was used to test if the probability of a sow to respond was affected by type of disturbance (test type). One model tested the probability of responding during blood sampling and piglet manipulation. This model included “test type” (blood sampling and piglet manipulation) and “time period” (parturition and phase 1) as well as their interaction as fixed effects. The other model tested the probability of responding during trapping of own piglets and during playback of the scream of an alien piglet. This model included “test type” (trapping of own piglets and playback of the scream of an alien piglet) and “time period” (phase 1 and phase 2) as well as their interaction as fixed effects.

3. Results

The average length of the parturition was 4 h 22 min ± 1 h 50 min.

3.1. Responsiveness to the human contacts

The reactivity of sows on blood sampling significantly changed in relation to sampling periods (\( L_2 = 9.7, p < 0.01 \)). The Wald test showed that sows were less responsive at phase 1 compared to the parturition period (\( T_{13} = -2.66, p < 0.05 \)) and phase 2 (\( T_{13} = 2.42, p < 0.05 \)). No significant difference was found between parturition and phase 2 (\( T_{13} = -1.09, \text{ns} \)). Sows reacted in 11% of all blood samples (Table 1; 36 out of \( n = 315 \)) during the 24 h, during parturition period in 17%, during phase 1 in 5% and during phase 2 in 14%.

There were no significant effects of the duration of parturition (\( T_{13} = -1.16, \text{ns} \)) and litter size (\( T_{13} = -1.85, \text{ns} \)).

<table>
<thead>
<tr>
<th>Responsiveness (total number) towards blood sampling</th>
<th>No</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parturition</td>
<td>43</td>
<td>9</td>
</tr>
<tr>
<td>Phase 1</td>
<td>101</td>
<td>5</td>
</tr>
<tr>
<td>Phase 2</td>
<td>135</td>
<td>22</td>
</tr>
</tbody>
</table>
The reactivity towards piglet manipulation did not change significantly through the time periods ($T_{16} = 1.08, \text{ ns}$). Sows reacted in 5% of all piglet manipulation (5 out of $n = 99$) during the first 24 h. There were no significant effects of duration of parturition ($T_{16} = 1.72, \text{ ns}$) and of litter size ($T_{16} = -0.29, \text{ ns}$).

There was a significant interaction between “test type” and “time period” for the probability of a sow to respond towards either blood sampling or piglet manipulation ($F_{1,28} = 4.2, p = 0.05$). The probability of responding during blood sampling compared to during piglet processing (17% versus 3%) was significantly higher during parturition, whereas there was no difference during phase 1 (5% versus 7%).

### 3.2. Responsiveness to piglet screams

During the first 24 h after BFP, 38 situations (from 10 of the 17 sows) were recorded where a piglet was trapped by the mother and was screaming. 3 sows trapped a piglet once, 2 sows trapped piglets twice, 3 sows trapped piglets 3 times, 1 sow trapped piglets 5 times and 1 sow trapped piglets 17 times. Trapping occurred during a lying/sitting down event ($n = 14$), during rolling ($n = 21$) or during walking ($n = 3$). The reactivity of the sows to the real scream of a trapped piglet was not affected by the time period during 24 h postpartum ($L_2 = 0.3, \text{ ns}$). In 80% of the occasions where a piglet was trapped and screamed, the sows reacted by a posture change. We did not observe any sow that never responded to piglet screams.

There were no significant effects of the duration of parturition ($T_{13} = -0.39, \text{ ns}$) and litter size ($T_{13} = 0.79, \text{ ns}$).

In the playback test, the Wald test showed a significant higher probability that sows reacted to the playback of a screaming piglet in phase 1 compared to phase 2 (Fig. 1; $T_{12} = 0.20, p < 0.05$). The sows reacted in 38% of all playback tests ($n = 24$): during phase 1 in 50% and during phase 2 in 25%. There were no significant effects of the duration of parturition ($T_{12} = 0.06, \text{ ns}$) and litter size ($T_{12} = 0.08, \text{ ns}$).

During both phase 1 and phase 2 sows were more likely to respond at the trapping of their own piglet than at the playback of an alien piglet ($F_{1,21} = 0.0, p < 0.01$). The probability of responding at the trapping of their own piglets was 83% compared to 37% at the playback of an alien piglet.
3.3. Mortality of piglets during 24 h postpartum

The total mortality was 5.5% (13 out of 238 live-born piglets died), which occurred in 5 sows out of 17 during the first 24 h.

4. Discussion

4.1. Responsiveness to the human contacts

The sow’s responsiveness towards blood sampling depended on the time postpartum. The probability that a sow responded during phase 1 (from birth of last piglet to 12 h after birth of first piglet) was 3 times lower than during parturition and during phase 2 (12–24 h after birth of first piglet). The sow’s responsiveness to blood sampling showed a similar development as the responsiveness towards piglets’ naso-nasal contacts and posture activity (Jarvis et al., 1999; Pedersen et al., 2003). In those studies sows were less active and reactive from 2 to 10 h after the start of parturition, which resembles Phase 1 in the present study. The decrease in the sow’s activity and responsiveness appears to be associated with the cumulative effect of piglet deliveries and releasing of hormones and opioids. Opioids are known to be involved in an endogenous analgesic system which may reduce pain and changes in posture activity (Jarvis et al., 1997, 1999). During the first 12 h postpartum (Jarvis et al., 1999), colostrum is constantly available and the most important factor for the piglet’s survival is the access to the udder. Therefore, the optimal behaviour during this time period for the sow would be to remain lying in lateral recumbency (Pedersen et al., 2003).

The responsiveness towards piglet manipulation was rather low (on average only 5% responded) during all time periods and there were no differences between periods. Thus, during parturition the sow responded significantly less to piglet manipulation than to blood sampling. It suggests that an important factor for the higher responsiveness of the sow during blood sampling was the direct physical and olfactory contact between the experimenter and the sow which did not occur during piglet manipulation. During piglet manipulation the experimenter took a piglet very calmly outside the pen, which did not cause the piglet to vocalize within the pen. However, during weighing outside the pen, the piglets often screamed but they were still out of visible sight of the mother. It is possible that if the piglets had screamed already in the pen, the mother would have reacted more.

To our knowledge, only one study provides some results on sows’ responsiveness towards a stockperson during the first 24 h after birth (Marchant-Forde, 2002). In that study, aggression directed towards a stockperson was based on a scale from 1 to 5 (non-aggressive to extremely aggressive) during routine piglet weighing at birth, at 7 days and at 14 days of age in litters of sows housed in pens or in crates. Sows in pens had a higher aggression score than sows in crates consistently between the observation days (Marchant-Forde, 2002). In that study 16% of the sows from the pen system (5 out of 31) were particularly aggressive towards a stockperson already during birth (score 2.7). In our study sows had a several times lower responsiveness (5%) to the piglet manipulation which also included piglet weighing during birth than the sows in the study by Marchant-Forde (2002). It has been suggested that sows in pens show a higher responsiveness towards humans because they are able to perform natural behaviour pattern (Herskin et al., 1998; Marchant-Forde, 2002). However, our study suggests that when a stockperson manipulates the piglets carefully avoiding the piglets screaming inside the pen, the maternal protectiveness of the sow is not evoked.
4.2. Responsiveness to the piglet screams

In the present study, the sow responded in 80% of the situations where one of its own piglets was screaming when it was trapped underneath the sow’s body. The responsiveness did not change over time being similarly high during all three time periods. On the contrary, the responsiveness of the sows towards playbacks of scream vocalization was much lower with 50% of the sows responding during phase 1 (at 9–10 h after BFP) and only 25% of the sows responding during phase 2 (at 24 h after BFP). The first part of the results confirmed our prediction that sows have a high responsiveness towards vocalization of trapped piglets throughout the 24 h postpartum. Thus, there are no indications that the lower responsiveness towards piglet contacts during parturition, as shown in studies by Jarvis et al. (1999) and Pedersen et al. (2003), is extended to situations that are life threatening to the piglets. It makes sense from an adaptive point of view that sows still lay in the nest during and shortly after parturition but are still responsive towards threatening situations.

However, the prediction that the sows’ responsiveness to playback of scream vocalization would resemble the sows’ response to real trapping could not be confirmed. The lower responsiveness towards the play back of a screaming piglets compared to the scream of a piglet being trapped in situ at 12 h postpartum indicates that the playback situation was not as effective to evoke a response in the sow. Furthermore, the responsiveness to playbacks was found to decrease from 12 to 24 h postpartum. The reason for this reduction may either be due to a general reduction in responsiveness to scream calls or to a habituation to the test due to repetition. The first explanation is less likely seen in the light of the stable responsiveness towards the scream of trapped piglets in situ. A possible habituation to the playbacks was also mentioned in other studies. The test order in which sows were tested after each other significantly influenced their responsiveness in a scream test in a study by Grandinson et al. (2003). Like in the present study, sows tested first had stronger reactions than those that were tested later (Grandinson et al., 2003) and sows tested three times a day responded less during the last test of the day than during the first test (Held et al., 2006). One way to avoid this habituation may be to use different screams for the two test situations. However this needs to be validated. In order to test how much of the reduction in responsiveness was due to test adaptation it would be necessary to include subgroups of sows tested solely at 12 h or 24 h along with subgroups of sows tested both at 12 h and 24 h. However, this was not possible in the present study due to a limited number of experimental animals.

The results thus rise the question whether the playback test of the piglet’s scream is a useful approach to test the maternal responsiveness. First, it seems that a playback experiment does not exactly simulate the situation from real scream vocalization. During the real vocalization sows received not only acoustic stimuli but also tactile stimuli from the piglets. However, Hutson et al. (1991) tested that screaming is the most important stimulus to which sows respond, while tactile stimuli are less important. Another unsolved factor is the location of the loudspeaker which in the present study was placed in the nest or directly in the pen which may have influenced the sound distribution (in the pen or crate: Hutson et al., 1991; Herskin et al., 1998; Grandinson et al., 2003; in the piglets’ nest: Wechsler and Hegglin, 1997; above the ground: Held et al., 2006).

Furthermore, previous studies on the relationship between sow responsiveness and early piglet mortality are not convincing. The only large study carried out was done by Grandinson et al. (2003), who did not find any phenotypic correlation between sow responsiveness in the test and piglet mortality; however they did find a genetic correlation. Wechsler and Hegglin (1997) reported from a small study on 11 sows that sows with a high responsiveness had fewer trapped piglets crushed than sows with a low responsiveness. However, the dataset also showed that the
high responding sows had fewer trapping situations, which makes it difficult to conclude whether the reason for the few crushed piglets in the high responding sows were high responsiveness or few dangerous situations. Andersen et al. (2005) found that sows that never crushed any piglets also responded faster to the piglet scream test and they were faster to contact the piglets after responding. It could however be speculated that sows that never crushed any piglet may have had very little experience with the scream from a trapped piglet and simply due to that also may be more responsive on day 7 to the play back sound. These aspects need to be further considered in future studies. There are also several studies including slightly more sows (Held et al., 2006; Špinka et al., 2000; Pedersen et al., unpublished) where no relationship between responsiveness in the scream test and mortality could be found.

5. Conclusion

This study showed that sow responsiveness to human contact changes across parturition and confirms previous findings that the responsiveness is lowest late in parturition and immediately after. However, sows were highly reactive towards the screaming of their own trapped piglets within the whole 24 h postpartum, which suggest that sows may still be responsive during this postpartum period in life threatening situations. The much lower and decreasing responsiveness towards playback tests indicate that habituation of the sows to the test may occur and may question the use of the piglet scream test as a useful measure of maternal responsiveness.

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