

Social communication during a sow-piglet foraging paradigm

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ARTICLE INFO

Keywords:

Sus scrofa
Social cognition
Social facilitation
Foraging behaviour
Mother-offspring relationship
Pig
Communication

ABSTRACT

Offspring may use various sensory modalities to learn from the mother, but this has in pigs received relatively little research attention. The objective of this study was to investigate social cues between sow and piglet during a learning scenario related to foraging. We hypothesized that 1) the sow and piglet make frequent visual, auditory and tactile contact, 2) that their behaviour is related, and 3) that frequent sow-piglet communication translates to health benefits for the offspring. Four-week old piglets ($n = 95$) were tested individually with their mother ($n = 11$ sows) in a 3-min foraging paradigm. Two food types were available which were known to the sow but unfamiliar to the piglet. Foraging, social behaviour and vocalisations were recorded. In the test, the sow and piglet interacted frequently, but mostly through visual and auditory contact rather than physical contact. Food-related and social behaviour of the sow positively related to the piglets' behaviour. There was no significant relationship between the weight gain of the litter and the sows' food-related or social behaviour. In conclusion, sows and piglets showed a bidirectional communication in a learning scenario, whereby the sow mainly has a demonstrator role.

1. Introduction

Most young mammals learn in early life from their social environment (Arbon and Thornton, 2023; Arbon et al., 2025) through vertical transmission of information (e.g. through perinatal learning by the mother: Figueroa et al., 2013) or horizontal information transmission (for example by peers: Nicol and Pope, 1994; Gariépy et al., 2014). Such social facilitation is important to gain knowledge on how to survive (Galef and Laland, 2005; Thornton and Clutton-Brock, 2011), for example by gaining appropriate foraging tactics. Young farm animals face a difficult learning trajectory, as they are typically separated from their mother at a much earlier age than would be the case in nature (Weary et al., 2008). Early life separation is particularly prevailing in intensive farms, where production efficiency is favoured over mother-offspring relationships (Newberry and Swanson, 2008). Not only are the young separated from the mother, but they also generally lack contact to any adult conspecifics to learn from. The lack of learning opportunities through social facilitation can increase food neophobia, resulting in a poor feed intake and a reduced growth performance (Oostindjer et al., 2011a; Keeling and Hurnik, 1996). Insight in how young animals communicate and acquire information from others may

provide insight in how early life learning can be supported under farm circumstances.

Young pigs are known to gain information from the sow both prenatally (Oostindjer et al., 2009; Figueroa et al., 2013) and postnatally (Oostindjer et al., 2010), using all sensory modalities. At birth, they find the milk through olfaction as they are attracted to the maternal pheromones of the udder (Sankarganesh et al., 2021). They are also directly exposed to frequent auditory cues from the sow, as she will grunt to indicate each nursing bout (Illmann et al., 2002; Špinka et al., 2002). Through the milk, piglets also gain flavour cues on what to eat as soon as they start consuming solid feed (Oostindjer et al., 2010). Visual learning is possibly the least studied sensory learning modality in young pigs. Pigs have poor vision and may respond less well to visual cues (Hutson et al., 1993). Visual learning might also be less relevant, because within the natural habitat of the forest it may be difficult for a piglet to keep sight of the sow.

Under (semi) natural conditions, piglets will start following the sow from two weeks of age on foraging excursions, whereby they can copy the feeding behaviour of the sow (Jensen and Redbo, 1987). Commercial farms provide a starkly different learning environment. Sows are mostly kept in farrowing crates, which substantially reduces the ability of the

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<https://doi.org/10.1016/j.beproc.2026.105424>

Received 8 February 2026; Received in revised form 14 August 2026; Accepted 15 August 2026

Available online 17 August 2026

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sow and piglets to interact as the sow cannot move towards her piglets. Sows and piglets do interact through snout contact (Portele et al., 2019), which may provide olfactory, tactile and visual information. In commercial farming, piglets do not have much opportunity to learn about foraging from the sow as they receive food separately, with the sow's trough above piglet height. A shared feeder at piglet eye level can increase piglet feed intake considerably (Oostindjer et al., 2011b), suggesting an important role of visual learning. In a foraging task where the sow and her litter could forage for feed items, Oostindjer and colleagues reported that the piglets ate more when the sow was present, but that the sow and piglets did not show any social interactions (Oostindjer et al., 2011a). While it is clear that the piglets benefitted from the presence of the mother, it is not clear how they gained the information from the sow, for example, whether she demonstrated what to eat. This raises the question whether piglets learn by observation or whether the sow uses active communication to transfer information to the piglets.

The objective of this study was to investigate sow-piglet communication in a learning scenario. This was investigated through a foraging task in which piglets were exposed to novel food items that were known to the sow. We hypothesized that 1) both piglet and sow make visual, auditory and tactile contact with each other; 2) the foraging behaviour of the sow and piglet is related, and 3) sow-piglet communication during the foraging test has benefits to the offspring in terms of piglet weight gain.

2. Methods

The pigs were studied under the ethics license (nr WAW2/054/2023) approved by the Local Animal Ethics Committee (II) of Warsaw, Poland. Additionally, the experiment was evaluated and approved by the R(D) SVS Veterinary Ethical Review Committee, Edinburgh, UK.

2.1. Animals and housing

In total, 16 litters originating from 11 sows (purebred Puławska breed) participated in the test with their piglets ($n = 95$). The pigs were studied across six farrowing batches between March 2023 and March 2024. Sows had on average a litter size of 8 piglets (means $\pm$ standard deviation (SD): 7.6 ± 2.63 piglets), but on average 6 piglets (5.8 ± 2.78) were tested per sow to avoid test fatigue. Sows and piglets were housed in free farrowing pens (based on the PigSAFE design) measuring 2×3 m (6 m²) with a solid floor, a creep area for the piglets (1.0 m²) and a sloped wall to facilitate the sow when lying down. The sows could move freely at all times (no physical restriction) and were provided with a layer of straw for nest building and bedding. A concrete feeder (length $52 \times$ width $38 \times$ height 18 cm) was fixed at the floor level to enable the sow and piglets to eat from the same feeder, which facilitates social learning (Bolhuis et al., 2025).

From 2 weeks post-partum, five litters were on a barren housing treatment for the purpose of an overarching experiment. The farrowing pens were the same but barren pens had no straw bedding and only two enrichment items (chain and sisal rope), while enriched pens had fresh straw added daily (5 – 10 kg) and a new enrichment item was presented twice a week to stimulate exploration. The housing contrast was not relevant to the specific research questions but accounted for in the statistical analyses.

Sows were fed three times a day with a commercial meal for lactating sows, which was manually mixed with water into a porridge consistency to increase palatability. The amount was based on body condition, litter size and appetite, up to a maximum of 4 kg dry weight per meal. From 5 days postpartum, a piglet feeder with commercial granulated piglet feed was added to the creep area. Pigs had *ad libitum* access to water. Piglets were weighed at five days and again at four weeks of age. The average daily body weight gain (ADG, in kg / d) was calculated based on the exact number of days between the weighing moments at day 5 and week 4 of age.

2.2. Habituation

Two habituation protocols were used; one for the sows during gestation and one for the sow with her piglets. During gestation, sows were habituated to the test arena by gently moving them into the arena three times within one week. They were offered biscuits and cheese (details below) to habituate them to the food used during the test. They were let out of the test arena when they had consumed the food, or otherwise after 3 min. The habituation took place during gestation to prevent the piglets gaining olfactory cues from the sow after birth. In this manner, piglets would experience a new food type during the test while the sows were habituated to the food. Prenatal piglets can learn about flavours from the sows' diet during late gestation (Oostindjer et al., 2009; 2010), but due to the limited exposure in the current study (3 times a small portion) we do not expect this to provide sufficient exposure to the piglets to recognise the food items two weeks post-partum.

From two weeks after farrowing, sows and their piglets were habituated to the test arena to avoid a behavioural response related to novelty of the arena. During this process, small pieces of apple were placed on the floor of the test area to motivate the sow to remain in the test room voluntarily. The sows and piglets were, by litter, led into the test arena three sessions within a week. At the first occasion, the full litter went into the test room with the sow for 5 min. At the second session, the sow went into the room with half of the litter for 3 min, while the remaining piglets stayed on the neighbouring corridor. Immediately after, the sow went another time into the test room with the other half of the litter. For the third session, the sow was led into the test room with one of her piglets for 1 min, while the remaining piglets stayed on the corridor (Fig. 1). This was repeated with maximum six piglets per habituation session (total 6 min for the sow to be in the test room), with at least a 2-hour break between the morning and afternoon session.

2.3. Foraging test

The test was based on the study conducted by Oostindjer et al. (2011a), using the same set up. However, Oostindjer et al. (2011a) tested the sow with the whole litter whereas here we tested each sow with only one of her piglets at a time to study social interactions more precisely. The test was conducted when piglets were on average 27 ± 2.5 (SD) days of age and not yet weaned, but accustomed to consuming solid food. The foraging task took place in a 3.5×3.5 m test arena, with a 2.0×2.0 m square drawn in the centre with non-toxic white paint, on a grey tiled floor (Fig. 1). Food items novel to the piglet, but not to the sow, were placed in the marked square. Following Oostindjer et al. (2011a), we used as novel food items pieces of Gouda cheese ($1.5 \times 1.5 \times 1.5$ cm, 4.5 g average weight). While Oostindjer et al. (2011a) used chocolate peanuts, we used small round biscuits (1.5 – 2 cm diameter, 0.5 g average weight; ingredients: wheat flour, sugar, eggs) to increase the visibility on the camera footage. Per test, 10 pieces of cheese and 30 biscuits were divided across the marked area. The total volume of food items was weighed per test, and the average combined weight of the food items per test was 73 ± 6.0 (SD) g.

The sow and one of her piglets were moved into the test room, following a predetermined test order for the sows, balanced for sow and housing condition. Piglets were subjected to the test in random order, because tests could not be balanced for piglet sex due to uneven sex ratios within the litters. The test started when the sow and piglet had fully entered the arena and ended after 3 min. If the sow showed signs of distress (repeated loud vocalisations and pushing the exit door), she and the piglet were let out before the 3-minute time mark, which was noted as a time-out. The left-over food was collected and weighed, and the arena was cleaned from excreta if needed. The sow had a maximum of five tests in a row to avoid repeated handling and test fatigue, as repeatedly moving in and out of the test arena and consuming food items may reduce motivation and appetite. In between repeated tests, the sow

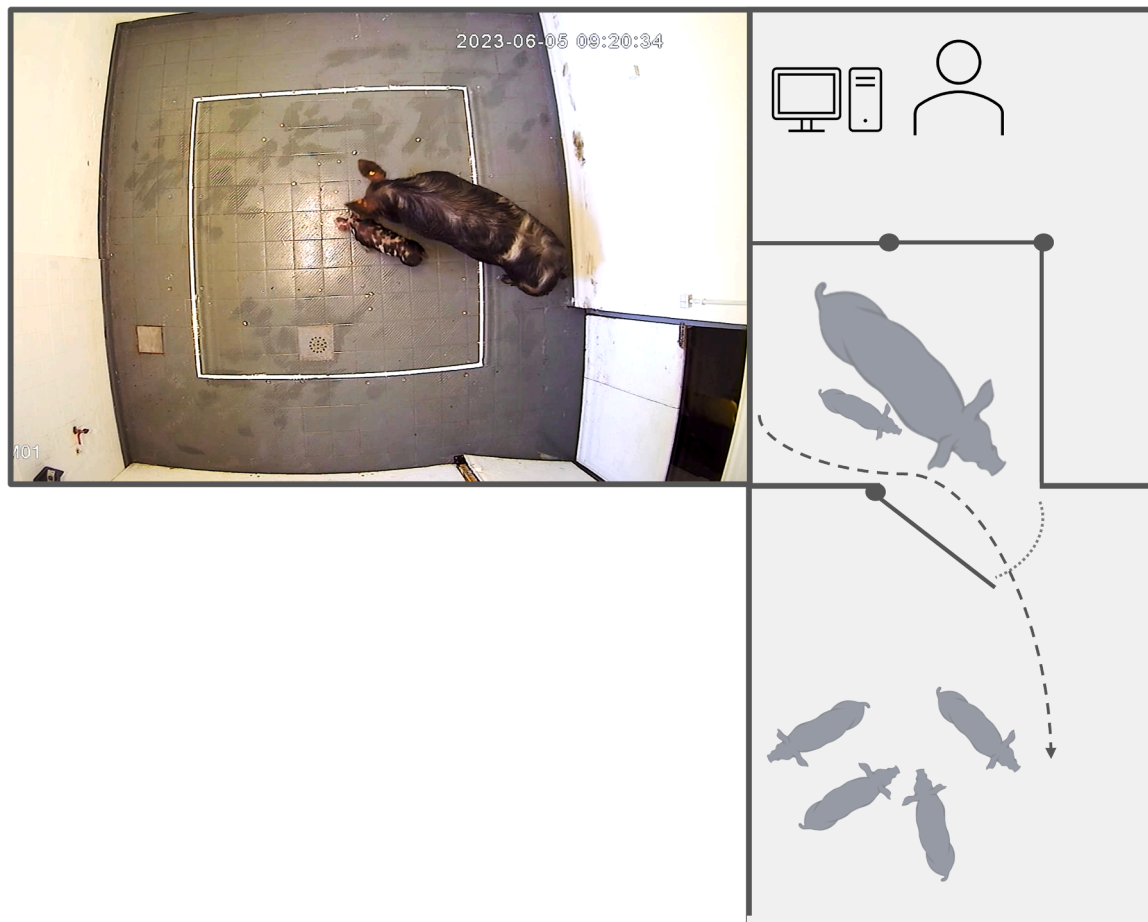


Fig. 1. Camera screenshot of the experimental set-up with a sow-piglet interaction in the test arena, as well as the layout of the corridor where the remaining piglets are during the test sessions of the sow. The white marked square in the test arena is the area where food items were placed. The exit gate is on the bottom right of the photo.

was moved to the neighbouring corridor and allowed to reunite with her full litter (Fig. 1). After approximately a minute on the corridor, she was moved back into the test arena with another piglet. After a maximum of five tests per test session, the sow and her litter were returned to the home pen. Test sessions were spaced by at least 2 h and were not within 2 h of feeding times to avoid a reduced food motivation. The number of piglets tested per sow varied depending on the litter size and the sows' motivation to voluntarily enter the test arena. One sow was only tested once because she wanted to nurse the litter after the first test. Due to the tight time schedule she could not be tested again and was excluded from the analyses on within-individual variation.

2.4. Behavioural observations

Tests were recorded with an overhead colour camera placed at the centre of the ceiling. An observer manually scored the videos from VLC media player (version 3.0.21) using the ethogram described in Table 1. The ethogram was based on common social behaviours between sows and their piglets (Portele et al., 2019), food-related behaviour (based on Oostindjer et al., 2011a) and behaviours that were noted while conducting the test (without behavioural scoring). The behaviour from video was observed from the moment that the piglet and sow had entered the arena with their front legs, and the observation was stopped when the sow and piglet were let out of the arena. Behaviours were scored for the sow and piglet in frequency of occurrence. In addition, the duration of food-related behaviour and waiting at the gate were recorded. Each video was watched twice: once to observe the behaviour of the sow and a second time to observe the behaviour of the piglet. Videos

were played at normal rate. All videos were observed by one observer, who reached an intra-observer reliability of on average $r = 0.83$ for the social and non-social behaviours (based on 21% of the videos). Inter-observer reliability was tested between the main observer (JMO) and an additional animal behaviour researcher (IC), using 30% of the videos, resulting in a correlation of $r = 0.93$.

2.5. Vocalisations

An additional camera (either AKASO sports camera or GoPro) was used to record sound. For 55 tests, audio recordings were available from the tests. The frequency of high pitch and low pitch vocalisations of the sows were recorded manually from video. High-pitched vocalisations included screams, squeals and grunt-squeals while low-pitched vocalisations included short and long grunts. Each vocalisation was counted separately regardless of its duration. For the sows, a distinction was made for vocalising while standing directly in front of the exit gate (facing the gate) and vocalising in any other part of the arena. Piglet vocalisations were too frequent (continuous low pitch vocalisations) or too faint (low in amplitude) to reliably score as individual counts in most of the videos. Therefore, high and low pitch vocalisations of the piglets were categorized, separately, into 1) no audible vocalisation; 2) occasional (from circa 1–40 vocalisations, threshold based on the distribution of the approximate count) and 3) frequent (>40 vocalisations).

2.6. Data analysis

Data were analysed in SAS (SAS Institute inc., Cary, NC, USA) version

Table 1

Ethogram used for the sow and piglet during the foraging test. Behaviours were scored from video as frequencies, while the food-related behaviour and waiting at the gate were also observed for their duration.

Behaviour	Description
Social	
Turning head towards sow/piglet	Sow / piglet changes the position of the head to face the other pig, either sideways (one eye) or frontal
Approach	Stretches neck, walks or runs to come nearer to the other pig
Snout-snout contact	Snout disc makes direct contact with snout disc of the other pig
Snout-body contact	Snout disc makes contact or is at < 10 cm with any part of the body (besides the snout) of the other pig
Non-social	
Food-related behaviour	Touches or ingests food item. Snout hovers over food item; or is taken in the mouth and consumed or not. Includes foraging behaviour whereby the snout moves over the floor area where food items are placed (within the white-marked quadrant, Fig. 1). Frequencies are scored as bouts of uninterrupted behaviour.
Exploration	Investigates the surrounding environment by sniffing the wall or floor without food, outside the white-marked quadrant). Frequencies are scored as bouts of uninterrupted exploration behaviour.
Waiting at the exit gate	Stands at the exit gate with head up or head exploring or pushing the gate. Frequencies are scored as bouts of uninterrupted standing at the gate
Other	
Pushing or shoving piglet	Sow gives the piglet an upward or sideways push with her snout and visibly moves the piglet out of its position. Only scored for the sow
Defecation	Sow expels faeces, either standing or walking
Play	Piglet pivots, head tosses, flops or hops or runs in repeated short bouts. Only scored for the piglet

9.4. The main data set was organised by piglet (data available online), with repeated observations for the sows. A data set by litter was used to analyse the influence of sow and litter traits (based on averages per litter). As some social behaviours occurred too infrequently to analyse on their own, the frequencies for turning head, approach, snout-body and snout-contact were combined into the variable 'social behaviour'. This resulted in the following response variables, recorded for sows and piglets separately: duration of food-related behaviour, duration of waiting at the gate, and the combined frequency of social behaviour. P-values < 0.05 were considered significant. In the results section, values are means with standard error (SE) unless stated otherwise. Figures were made in R (version 4.5.1), package ggplot2 (Hadley, 2016).

2.6.1. Analysis of hypothesis 1: Sow and piglet make contact

Behaviours were first described descriptively. Differences in the frequencies of sow and piglet behaviours with a normal distribution were explored using a paired *t*-test. The vocalisations of the sow were square root transformed to obtain a normal distribution, before testing the difference between vocalising in the arena or at the gate, using a paired *t*-test. Using the dataset by litter, the influence of litter traits on sow behaviour was investigated in three separate linear mixed models (MIXED procedure) with as the response variables the sows' duration of food-related behaviour, frequency of social behaviour and the total number of vocalisations, averaged by litter. The predictor variables were litter size (number of weaned piglets), housing condition (barren / enriched) and parity (first / second), with the sow as a repeated variable and batch as random variable.

2.6.2. Analysis of hypothesis 2: Sow and piglet behaviour is related

For the second prediction, the duration of the food-related behaviour, duration of waiting at the gate, and the frequency of social behaviour of the piglet were analysed as response variables in three separate linear mixed models (MIXED procedure). The predictor variables were the frequency of sow social behaviour, the duration of food-

related behaviour of the sow, the frequency of sow vocalisations, housing condition (barren / enriched), the piglet's sex (male / female), and average daily gain of the piglet (which provided a better model fit than body weight). The litter, nested within sow, was included as a random variable, as well as batch. The sows' duration of food-related behaviour and waiting at the gate showed an inverse relationship (Pearson correlation: $r = -0.72$, $p < 0.001$) and was therefore excluded from the models on piglet's food-related and social behaviour, but not from the model on the piglet's duration at the gate. Model residuals were inspected for their distribution, and met the assumption of normality. Heteroscedasticity was assessed using White's test (SPEC option in the REG Procedure), showing no significant heteroscedasticity for the three models.

The relationship between sow and piglet vocalisations was tested in a generalised linear mixed model (GLIMMIX procedure) with the category of piglet vocalisations (silent / occasional / frequent) as response variable. The predictor variable was the frequency of sow vocalisations, and the random variables were the batch and litter (nested within sow).

2.6.3. Analysis of hypothesis 3: Communication is associated with weight gain

For the third prediction, average daily body weight gain (ADG) was analysed as a response variable in two linear mixed models (MIXED procedure). First, the relation between piglet ADG and piglet food-related behaviour in the test was assessed, while accounting for litter size, sex and housing condition (predictor variables) and batch and litter effects (nested within sow) (random variables). Second, average litter ADG was analysed as response variable with as predictor variables the sow's social behaviour, food-related behaviour, and vocalisations, while accounting for the housing conditions and the litter size. Batch was included as a random variable. Both models met the assumptions for normal distribution of the residuals and showed no significant heteroscedasticity.

3. Results

3.1. Hypothesis 1. Sow and piglet make contact

The sow and piglet made visual contact with each other through turning the head towards the other and approach, whereby the approach behaviour was mostly initiated by the piglet ($t_{93} = -12.44$, $p < 0.001$; Table 2). Tactile contact occurred to a lesser extent, and snout-body contact was partly driven by two outlier piglets who tried to suckle the udder (18 and 23 times contact). Around 45% of the 3-min test duration was spent on food-related behaviour (means $\pm$ SD: 80.4 ± 45.98 s by the sow and 84.6 ± 44.71 s by the piglet). Another 42% of the sows' time was spent at the gate (75.5 ± 43.08 s) while the piglet was significantly less at the gate (25%; 45.9 ± 34.04 s; $t_{93} = 8.66$, $p < 0.001$). There was an infrequent occurrence of the sow pushing or shoving piglet (means $\pm$ SD: 0.6 ± 0.89 times) or defecating (0.3 ± 0.66) and piglet play did not occur.

Sows made on average 11 low pitch vocalisations (SD: 10.6, range 1–62) in the arena and 13 low pitch vocalisations in front of the exit gate

Table 2

Means with standard deviations (SD) of the frequencies of behaviours shown by the sows ($n = 11$) and piglets ($n = 94$) during the 3-min foraging test.

Behaviour	Sow	Piglet
Turning head towards sow/piglet	2.6 ± 1.26	2.1 ± 1.77
Approach	3.9 ± 4.03	10.9 ± 5.46
Snout-snout contact	0.0 ± 0.20	0.3 ± 2.79
Snout-body contact	0.5 ± 0.70	1.9 ± 3.29
Vocalisations	23.3 ± 22.55	n.a.
Food-related behaviour	1.5 ± 0.79	2.1 ± 1.35
Exploration	0.3 ± 1.60	2.2 ± 9.81
Waiting at the exit gate	2.0 ± 1.23	2.2 ± 1.50

(SD: 16.3, range 0–79), with no significant effect of location ($t_{54} = 0.07$, $p = 0.94$). Sows made no high pitch vocalisations. Piglets were classified as silent (25%, 14 piglets), occasionally vocalising (36%, 20 piglets) and frequently vocalising (38%, 21 piglets). High pitch vocalisations were made by 34% of piglets (19/55) and were infrequent (except by 4 piglets) and usually in response to being pushed aside by the sow at the gate.

Sows showed a high within- and between-sow variability for food-related behaviour (Fig. 2a) but varied relatively little in their social behaviour and vocalisations across the tests (Fig. 2). The sows' duration of food-related and social behaviour and frequency of vocalisations were not significantly influenced by their litter size, housing conditions or parity (all $p > 0.05$).

3.2. Hypothesis 2. Sow and piglet foraging behaviour is related

The duration of food-related behaviour of the piglet was strongly related to the duration of food-related behaviour of the sow ($b = 0.59 \pm 0.175$ s, $F_{1,38} = 11.68$, $p = 0.001$), whereby piglets' time spent on food increased linearly with that of the sow (Fig. 3a). Piglet's duration of

food-related behaviour was unrelated to the frequency of the sows' social behaviour ($p = 0.516$). Conversely, the frequency of social behaviour of the piglet increased with the frequency of social behaviour of the sow ($b = 0.57 \pm 0.186$ times, $F_{1,38} = 9.27$, $p = 0.004$; Fig. 3b) but was unrelated to the sows' food-related behaviour ($p = 0.819$). Piglets spent more time at the gate when the sow did so too ($b = 0.53 \pm 0.124$, $F_{1,37} = 18.29$, $p < 0.001$; Fig. 3c), while sows who spent more time at the gate spent less time eating ($r_p = -0.72$, $p < 0.001$; Fig. 3d). Piglets that spent less time at the gate had sows who tended to vocalise more ($b = -0.43 \pm 0.236$ s / vocalisation, $F_{1,37} = 3.29$, $p = 0.078$). For the rest, sow vocalisations did not significantly relate to the piglet behaviours or piglet vocalisations (all $p > 0.05$). There was no significant effect of piglet ADG, sex or housing condition on any of the piglet behaviours (all $p > 0.05$).

3.3. Hypothesis 3. Communication is associated with weight gain

The average amount of food remaining was 16 ± 23.0 g (SD, range 0–79), showing that most of the provided food was consumed. Piglets that spent more time on food-related behaviour during the test did not

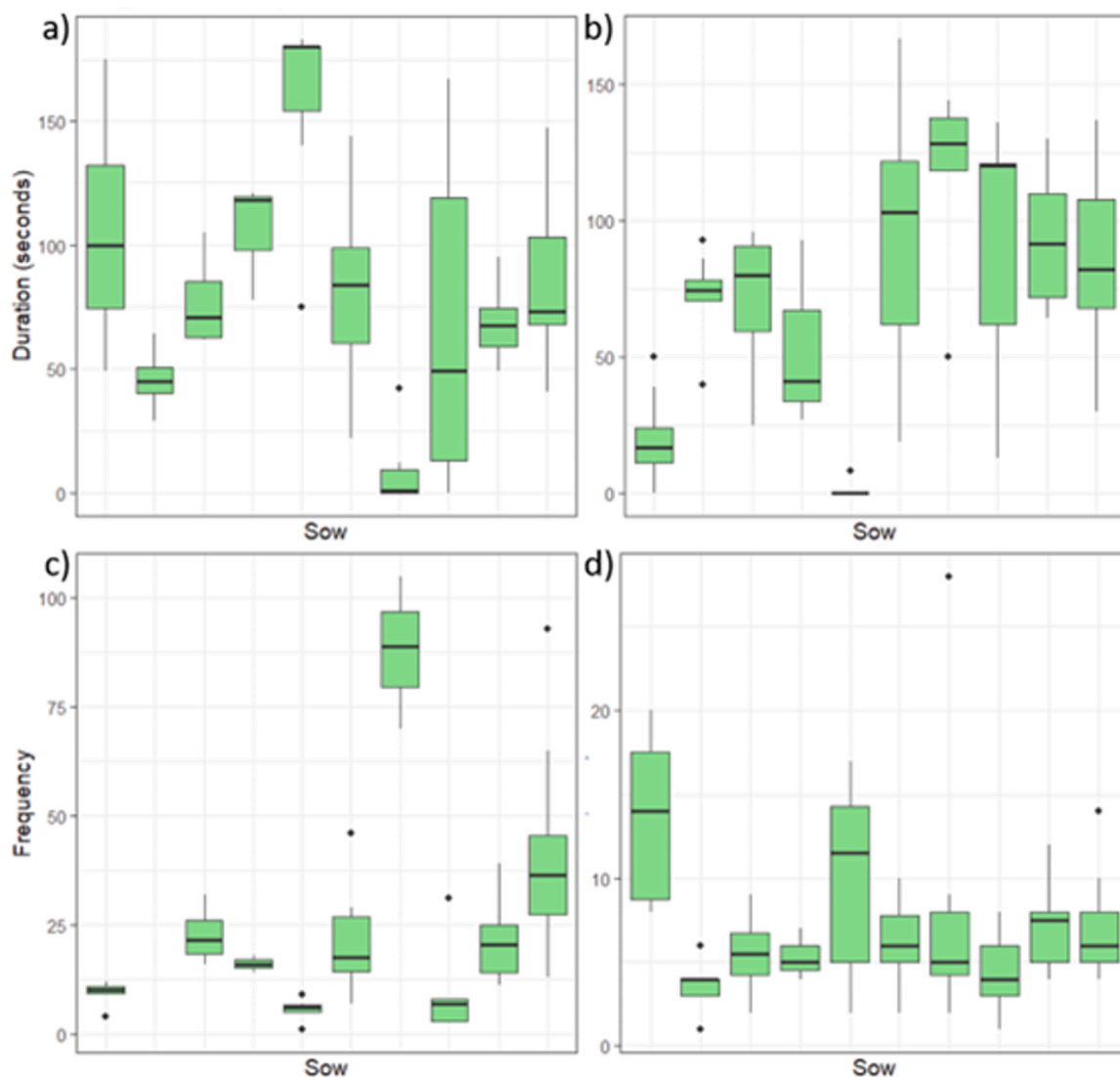


Fig. 2. Between and within sow variation for a) the duration of food-related behaviour, b) the duration of waiting at the exit gate, c) the total frequency of social behaviour (visual and tactile), and d) the total frequency of low pitch vocalisations made by the sow. Boxplots are presented by sow ($n = 10$), with the coloured area depicting the inter quartile range with a thicker horizontal line for the median. The whiskers indicate the minimum and maximum, whereas the dots outside of the boxplot represent outliers.

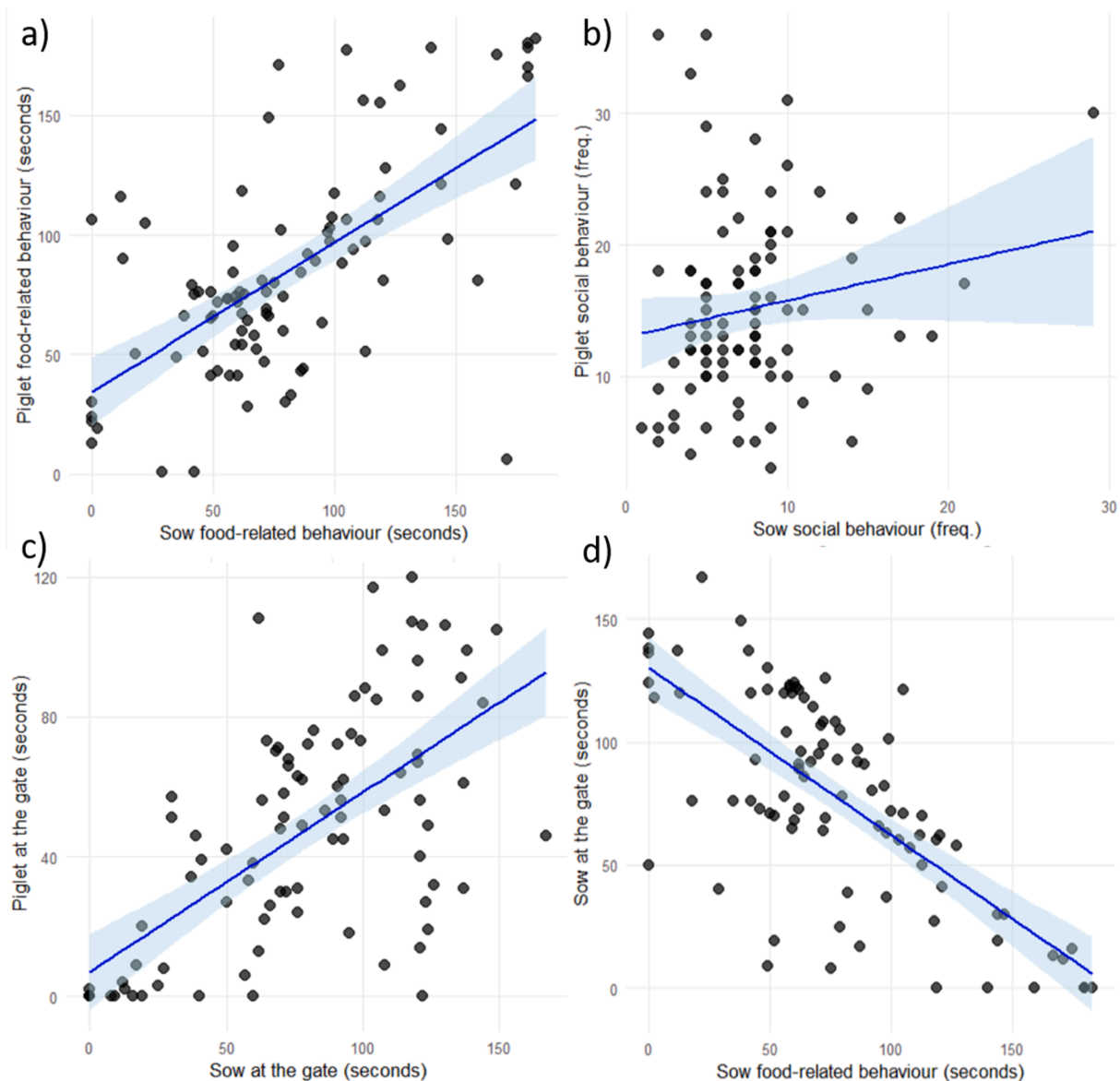


Fig. 3. Relationships between sow and piglet behaviour for a) food-related behaviour ($R^2 = 0.46$); b) social behaviour ($R^2 = 0.29$); and c) waiting at the gate ($R^2 = 0.55$); and d) the correlation for the sows' duration at the gate against her duration of food-related behaviour ($r_p = -0.72$).

have a greater ADG ($p = 0.903$). Average litter weight gain was not significantly influenced by the duration of food-related or social behaviour of the sow in the test or by the housing conditions (all $p > 0.05$).

4. Discussion

This study aimed to explore visual, tactile and auditory communication between piglet and sow in a foraging task with novel food items. We expected that the sow and piglet would make contact with each other in this novel situation and that their behaviour would be related. Sows and piglets indeed showed frequent bidirectional social interactions, such as turning towards each other and approach (either by walking towards the other or stretching the neck to reach out). However, physical contact such as snout contact was limited. There was a strong relationship between sow and piglet food-related behaviour and between their social behaviour. We further expected that sow-piglet communication during the test would relate to piglet weight gain. This hypothesis could not be confirmed as the effect of litter size overshadowed the subtle relationship between sow behaviour and piglet

growth. Together, the results suggest that the sow takes an active role in demonstrating foraging behaviour, but that this does not extend to fitness benefits for the piglet.

4.1. Visual and tactile contact between sow and piglet

Sows and piglets made frequent visual contact, thereby supporting the notion that piglets are attentive observers while sows provide socially relevant cues. Prior research has demonstrated that pigs can use visual cues in object-choice paradigms and discrimination tasks, for instance to infer the location of food (Nawroth and von Borell, 2015). In the foraging task, visual contact was observed through turning the head towards the other and approaching the other. Head turning was equally shown by the sow and the piglet, confirming they were attentive of each other, as has also been described in semi-natural foraging situations (Newberry and Wood-Gush, 1986). Piglets approached their mother nearly three times more than vice versa. This could be supportive of social learning through observation (Nicol and Pope, 1994), for example by gaze-following during foraging (Gariépy et al., 2014). The relatively small arena size may have affected piglets' proximity to the sow, thereby

enhancing visual cues.

Despite the limited size of the test arena, physical contact between the sow and piglet was rare during the tests. Studies on home pen behaviour show frequent contact behaviours such as snout-to-snout contact (Portele et al., 2019; Tomas et al., 2024). The lack of this in the test shows that pigs communicate differently in a foraging situation than in the home pen (Nicol and Pope, 1994).

Oostindjer et al. (2011a) reported that in their foraging test, no active behaviours were made by the sows towards their piglets, but they tested the sow with the entire litter. Our results show that the sow actively engages with the piglet through visual and auditory contact when there is one piglet. While we closely replicated the test of Oostindjer et al. (2011a) aside from the individual testing of piglets, it is unclear whether the observed difference is related to the pairwise set-up (rather than per litter), or whether it is due to factors such as breed-related differences in maternal behaviour (Ocepek and Andersen, 2018). Most of the behaviours of the sow and piglet were food related although there was substantial variation between sows. Oostindjer et al. (2011a) also reported mostly food-related behaviours, with a large individual variation.

Piglets become more independent as they increase in age, even when maternal contact still offers protection (Horrell and Hodgson, 1992), and they were observed to independently explore and sample from the novel food items. Piglet exploration is influenced by perceived safety and risk, while maternal contact may act as a social buffer (Tomas et al., 2024). Piglets may have balanced the requirement for maternal safety cues with the desire to investigate, as seen in many mammals (Vrtilek et al., 2021; Muthersbaugh et al., 2024).

4.2. Auditory contact

Sows vocalised frequently, using only low-pitch vocalisations such as grunts. Auditory cues are potentially the most relevant cue in pigs' natural settings where piglets wander freely on foraging excursions while their view may be obscured by trees and shrubs. Vocalisations were made while in the food baited area but equally when the sow was standing in front of the exit gate. This suggests that at least part of her vocalisations was directed to the other piglets. While not recorded, the other piglets of the litter were not producing distress calls as they were usually playing and exploring in the neighbouring area, whereby the increased space allowance likely formed a positive experience. As in a (semi)natural foraging situation, the sow keeps in contact with her piglets through grunts and particularly long grunts to attract her piglets (Jensen and Redbo, 1987). While sows made no high-pitch (high frequency) vocalisations that could indicate a negative valence (Briefer et al., 2022) we did not record the duration (rather than frequency) of low-pitch vocalisations, which can provide nuances of the experience (Friel et al., 2019).

Piglets strongly varied in their vocal behaviour, showing individual differences in their vocalisation frequency regardless of the sow. Previous studies have shown that pigs are consistent in their vocalisation frequency, reflective of personality (Friel et al., 2016) and emotionality (Leliveld et al., 2017). The absent or infrequent occurrence of vocalisations in at least one-fourth of the piglets is consistent with previous reports of their role of follower and hider, while the sow adopts the leader or demonstrator role during foraging excursions (Jensen and Redbo, 1987). The more numerous vocalisations made by other piglets may relate to the still relatively novel experience of the test arena and separation from the rest of the litter, as well as the novelty of the food items (Middelkoop et al., 2020). While piglets were habituated to the room, they were only once exposed to the room alone with the sow. While 35% of the piglets made at least one high-pitch vocalisation, only four piglets did this more frequently, which is comparable to other research with novelty exposure (Middelkoop et al., 2020).

4.3. Relationship between sow and piglet behaviour

The piglet's feeding and social behaviour related to that of the sow, suggesting that the piglet relied on vertical transmission as well as individual exploration. The sow's food-related activity may have acted as a local enhancement for the piglet to imitate what the sow was eating (Oostindjer et al., 2014). The duration of food-related behaviour may indicate her role of demonstrator in showing her piglets what to consume (Oostindjer et al., 2011a). Feeding habits are influenced by social facilitation as well as internal motivation (e.g. Neave et al., 2018). Previous work has shown that the presence of the sow improves the acceptance of new foods and lessens food neophobia in piglets (Oostindjer et al., 2011a). This gives the sow an active rather than passive role in enhancing piglet development.

The sow's time spent on food-related behaviour was strongly related to her duration at the exit gate, whereby the piglet partly followed the sows' behaviour. The movement to the gate may have been a contextual cue that could indicate potential transitional possibilities from the enclosed arena to the outside, in line with the frequent vocalisations of the sow when at the gate. The sow will possibly have experienced a motivational conflict between eating and returning to her other piglets. Sows knew the gate as the location from which to return to the home pen and could potentially hear their piglets in the neighbouring area. Some sows would first finish all food items before turning to the gate, while others turned to the gate even without consuming the food items. This suggests a high social motivation (Hemsworth et al., 2011), even at four weeks into lactation, which may relate to the maternal behaviour of this native breed. Providing more food in the test arena may have helped for some sows to remain food-oriented for longer.

4.4. Benefits of communication

The absence of a relationship between piglet weight gain and food consumption in the test could be because we scored touching and ingesting of the food as a combined behaviour, due to the limitations of observing the exact difference. Oostindjer et al. (2011a) found that the presence of the sow did not affect piglets' frequency of contact with food items, whereas the sow's presence did result in piglets ingesting more food. Piglets may, therefore, have touched the food without ingesting it due to exploratory motivations, while heavier or faster growing piglets may have ingested more as they were presumably consuming more solid food in the home pen.

When analysed at litter level, the average weight gain of the litter did not relate to the sows' behaviour in the test. In the model, the subtle relationship between piglet ADG and sow food-related and vocal behaviour disappeared when correcting for litter size. Hence, we did not find evidence that the sows' behaviour was influencing the growth of the piglets. Our hypothesis was based on the idea that sows who show strong maternal care may communicate more with their piglets, nurse more frequently and have heavier piglets at weaning (Ocepek and Andersen, 2018; Baxter et al., 2023). Our result is partly in contrast with the findings of Ocepek and Andersen (Ocepek and Andersen, 2018), who found that piglet survival and litter weight at weaning were favourably correlated with more actively interacting sows, using behaviours such as sniffing, nudging, or grunting. The difference in findings may be because of the test scenario, whereby foraging may require different social contact than in the home pen. Nevertheless, the findings emphasise the importance of supporting good maternal behaviour and allowing sow-piglet contact. The behavioural pattern during the test could still reflect the sows' general maternal engagement, as maternal behaviour shows consistency across time (King et al., 2019). Indeed, we did not find an effect of parity on sows' behaviour, showing that the sows behaved relatively similarly in the test when they had their second litter.

4.5. The housing environment

The contrast in housing conditions did not affect the behaviour in the test. The early life environment can influence behaviour and learning opportunities (Cox and Cooper, 2001; Tuytens, 2005; Martin et al., 2015). The absence of an effect in the current study is possibly because both housing conditions provided equal opportunities for sow-piglet contact in the free farrowing pens. Sows may have made equal amounts of contact with their piglet regardless of the different conditions (Oostindjer et al., 2011c). All piglets had access to the sow's feeder which was at floor level, and could sample her food freely, as well as watch her eating. The shared feeder design is known to increase food-related learning in piglets (Oostindjer et al., 2014) and to increase their feed intake and subsequent weight gain (Oostindjer et al., 2014; Hald et al., 2025). It could also have given the piglets more confidence around new foods (Jensen, 1988; Le Goff et al., 2002). Overall, it suggests that the sow's ability to communicate with her piglets is more important to piglet feeding behaviour than elements in the environment that increase piglets' novelty exposure and exploration.

CRediT authorship contribution statement

Piero Seddaiu: Writing – review & editing, Investigation, Formal analysis. **Katja Zumer:** Writing – review & editing, Writing – original draft, Investigation. **Joab Malanda Osotsi:** Writing – original draft, Investigation, Formal analysis. **Irene Camerlink:** Writing – review & editing, Supervision, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization.

Funding

The research was funded by the National Science Centre (NCN) Poland, grant number 2020/39/B/NZ8/02508. PS received funding from the National Science Centre (NCN) Poland, grant number 2021/43/O/NZ8/00711. The authors are thankful to CEEPUS and NAWA for the scholarship of JMO (grant number 644Z24/25). KZ received funding from the University of Edinburgh for her dissertation project.

Acknowledgements

We thank Sunil Khatiwada for his help during the data collection.

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