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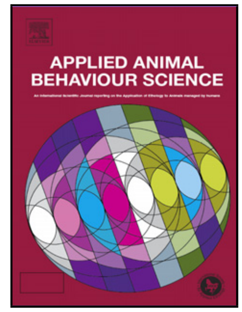

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Broadcasting human voice to piglets (*Sus Scrofa domestica*) modifies their behavioural reaction to human presence in the home pen and in arena tests

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Highlights

- Regular human presence for three weeks increases piglets attraction toward the experimenter.
- Human voice is attractive for piglets in their home pen.
- Preventing piglets from the usual human interactions modifies their behaviour.

Abstract

The human-pig relationship develops through visual, tactile, olfactory, and auditory interactions. Our objective was to determine the effect of human voices on the development of the human-pig relationship. We hypothesised that human voice facilitates the development of the human-pig relationship. We studied the behaviour of 90 weaned female piglets divided into three treatments: human presence with (HPV) or without (HP) voice, and control (CTRL). For the HPV piglets, the experimenter was present (idle) for 5 min/day in the pen for three weeks and a female voice was broadcast from a speaker. The HP treatment was the same, but a recorded background noise was broadcast instead of the voice. For the CTRL piglets, only routine husbandry care was provided. Piglets were then tested twice in a 3x3 m test area alone for 5 min and then in the presence of the experimenter for 5 min. For test 1, the human voice was broadcast for HPV piglets and the background noise was broadcast for the others. In test 1, HPV and HP piglets investigated the experimenter earlier and more often than CTRL piglets ($P < 0.05$). HPV piglets moved sooner in the pen than CTRL piglets (P < 0.05). For test 2, only the background noise was broadcast; HPV piglets were thus deprived of the human voice they were used to. In test 2, HPV piglets expressed more stress reactions: their latency to move was longer compared to the others (P < 0.05). HPV piglets also had more physical and vocal interactions: they stayed in the experimenter area longer than HP and CTRL piglets (P < 0.05), and grunted more (P < 0.05). Finally we measured the time taken to move the pigs from their home pen to the truck to move to the farrowing building; we found no effect of the treatment (P < 0.05).

In conclusion, broadcasting a human voice did not modify the pig response to human presence and handling in auditory conditions similar to the interaction sessions (i.e. test 1 and moving). However, not broadcasting human voice (test 2) induced stress responses and increased interactive behaviour, which suggests that piglets identified human voice as part of the experimenter's necessary properties.

Keywords

Human-Animal relationship; acoustic communication; visual cues; pig; handling

1. Introduction

The human-animal relationship is a dynamic process that develops from the interactions between humans and animals (Hinde, 1976; Estep and Hetts, 1992; Hausberger et al., 2008). Each partner has expectations of the behaviour of the other partner, and successive interactions bring more knowledge about how the other will react, hinting towards the outcome of the present interaction or what the next encounter will induce (Hinde, 1976; Hemsworth and Coleman, 2011b). Animals are able to provide a valence (pleasant, neutral or unpleasant) to these interactions, which has short- and long-term influences on their relationship with humans (Waiblinger et al., 2006; Hausberger et al., 2008; Hemsworth and Coleman, 2011a). A positive perception of humans (approach behaviour) positively affects the emotional state of animals (Schmied et al., 2008; Tallet et al., 2014) and their cognitive abilities (Brajon et al., 2015c), and thus animal welfare (Tallet et al., 2018).

Interactions between two individuals involve all the senses, but all communicative channels have not received the same attention by researchers studying the relationship between farm animals and humans. Tactile interactions are well documented. Gentle tactile interactions, such as brushing, stroking, scratching or petting, increase approaches, interaction and the time spent with humans for lambs (Markowitz et al., 1998), poultry (Jones, 1993), cattle (Hemsworth et al., 1996) and pigs (Tallet et al., 2014). Stroking and brushing have calming effects, as observed through a relaxed body posture in horses (Lynch et al., 1974), decreased locomotor activity in rats (Uvnäs-Moberg et al., 1996) and decreased heart rates in horses (Lynch et al., 1974), lambs (Coulon et al., 2015), cows (Schmied et al., 2008) and dogs (Kostarczyk, 1992), but not in pigs (Tallet et al., 2014). Holding and stroking lambs (Tallet et al., 2005), and stroking and scratching pigs (Tallet et al., 2014) are sufficient to develop an affinity response (positive approach).

Visual and auditory cues have been less investigated. Human posture may affect the immediate response of animals to humans (Hemsworth et al., 1986; Miura et al., 1996). Repeated exposure to a motionless experimenter facilitates approach toward humans in wolves (Woolpy and Ginsburg, 1967), sheep (Tallet et al., 2008) and chickens (Jones, 1993). Animals may become habituated to human presence. Moreover, though speaking gently is often cited in treatments including the gentle tactile handling of animals (Jones, 1993; Lensink et al., 2000; Brajon et al., 2015c), its effects on animal behaviour have not been studied *per se*, to our knowledge. Thus our study investigates the impact of human presence and human voice on the pig-human relationship.

Pigs are social animals that develop relationships with conspecifics, and they are able to develop relationships with humans too (Graves, 1984). Positive and negative interactions can have a long-term effect on the human-pig relationship (Hemsworth, 2003). The evaluation of the human-pig relationship has often been done in individual tests in novel environments, after a period of familiarisation to the novel environment. In this tests, positive regular tactile contacts, such as stroking, brushing, and scratching reduce pigs' fear of humans expressed by a higher distance to the human, more movements and longer time spent looking at the experimenter or gazing (Hemsworth and Barnett, 1987; Tallet et al., 2014; de Oliveira et al., 2015) and increase approach behaviour like the time spent close to the human and positive interactions like sniffing, jumping on the human knees (Tallet et al., 2014; Brajon et al., 2015b). Pigs have a well-developed sense of hearing (42 Hz to 40.5 kHz (Heffner and Heffner, 1990)) and human vocal productions (40 Hz to 1.5 kHz) fit within their auditory spectrum. Field observations suggest that pigs are sensitive to vocal interactions (Seabrook and Bartle, 1992). Piglets are attentive to the human voice (Bensoussan et al., 2019) and are able to discriminate two handlers based on auditory and olfactory cues (Tanida and Nagano, 1998). The effects of human voice on the development of the human-pig relationship have not been studied. As talking to piglets is confounded with the mere presence of humans, piglets need to be exposed to the presence of humans to determine the effect of the human voice *per se*. Passive presence is attractive to piglets in the home environment (Brajon et al., 2015b), however we lack information on its impact outside of the home pen.

In the present experiment, we tested the consequences of repeated exposure to human presence and/or human voice on the behaviour of weaned piglets in the presence of a familiar person in their home pen and in an unfamiliar environment. We first hypothesised that piglets exposed to passive human presence would show more positive attraction to the caregiver (expressed by more contacts with the caregiver and for a longer period) than piglets receiving minimal human contact that would rather express fear reactions like staying away from the human and gazing at her, in their group and in individual tests. Secondly we hypothesised that adding human voice to human presence would be more attractive and positive for piglets, leading to more approach to the caregiver than simple presence alone (more contacts with the caregiver and for a longer period), in their group and in individual tests. Finally, we hypothesised that preventing piglets that were used to hearing human voice from these acoustic interactions would make the presence of the caregiver more stressful (vocalisations, non-exploratory locomotor activity: (Murphy et al., 2014; Zebunke et al., 2017)), due to the frustration of an unexpected event.

2. Material and methods

The design of this experiment was approved by the Ministry of Research, with authorisation under experiment number 2015032709553906.

2.1. Animals and rearing conditions

We studied 90 weaned female piglets (*Sus scrofa domesticus*), in two groups of 45 piglets. They were born at the experimental unit of Saint-Gilles (UEPR, France) from Large White x Landrace sows inseminated with Pietrain semen. Piglets were weaned on a Thursday at 28 ± 2 days of age (Day 1 = D1) and transferred to post-weaning pens. Animals were equipped with an ear tag for identification. They were housed in groups of three siblings in a 1.30 x 1.20 m pen on a slatted floor, equipped with a chain as enrichment material, a feeder (0.6 x 0.2 m) and a drinking bowl. They were fed a standard commercial pelleted weaning feed and had *ad libitum* access to food and water. A stockperson visually checked the health status of the animals twice per day. The ambient temperature was on average 25.5°C, decreasing from 28°C to 23°C throughout the post-weaning period. Artificial light was switched on from 8 a.m. to 5 p.m. and a window provided natural light.

2.2. Experimental set-up

2.2.1. Interaction sessions

Treatment application started on the Monday following weaning (32 days of age, D5) and lasted for three weeks (Table 1). Each piglet group was allocated to one of three treatments, varying in the quality of human interaction:

- **human presence and voice** (HPV, N = 10 groups). In the HPV treatment, piglets were submitted to the presence of experimenter A in their pen every morning for 5 minutes, 5 days per week (15 sessions total). Experimenter A, a 1.61 m tall woman, always wore the same outfit: a blue coat and dark green boots. She entered the pen with a loudspeaker (MA-100su Mipro Electronics, Taiwan) hanging around her neck and turned it on. We used the same procedure in two steps as in Tallet et al. (2014). She stood still for 30 s so that all piglets had the opportunity to see and eventually contact her. Then she sat on a plastic bucket and remained motionless for 4 min 30 s with the loudspeaker broadcasting a sound signal. At the end of the 5 min period, the experimenter quietly stood to leave the pen and turned off the loudspeaker. The loudspeaker broadcasted a modified female voice (285 ± 34 Hz) pronouncing a 4.4 s long French sentence: “De ce côté, cochon. Allez. Par ici. Viens là” (UK version “On this side, pig. Come on. Over here. Come there”). It was broadcasted at 65.0 ± 2.0 dB max sound pressure level (at 1 m from the source, determined using a sound level meter, SL-100 Voltcraft, Germany). The voice had been recorded in WAV format with a microphone (MKH 50 P 48 Sennheiser, Germany) fixed with a microphone module and an acoustic foam windscreen (K6/ME66 Sennheiser, Germany). The microphone module was connected to an audio digital portable recorder (Portable Solid State recorder, PMD661 Marantz Professional, The Netherlands; amplitude resolution: 16 bits; sampling rate: 44.1 kHz). The initial soundtrack parameters (248 ± 31 Hz, 3.0 s determined with Praat (5.2.01, www.praat.org)) were modified with Audacity software (2.0.6, www.audacityteam.org): the fundamental frequency was increased (+15%) and the tempo was lowered (-33%). These modifications were chosen because they are attractive to piglets at this age (Bensoussan et al., 2019).

- **human presence** (HP, N = 10 groups). In the HP treatment, piglets were submitted to the presence of experimenter A in their pen every morning for 5 minutes, 5 days per week (15 sessions total). The procedure was the same as that of the HPV treatment, except that the loudspeaker broadcasted the background sound that was recorded when we recorded human voice for the HPV treatment, with no human voice.
- **control** with minimal contact (CTRL, N = 10 groups). The control treatment (CTRL) received the necessary husbandry care and no contact with experimenter A.

Table 1: Timeline of the experiment

Day	Event	Description
1	Weaning and transfer to home pen	1 h
5 to 9	Interaction sessions week 1	5 min, once/day
12 to 16	Interaction sessions week 2	5 min, once/day
19 to 22	Interaction sessions week 3	5 min, once/day

26	Interaction session	5 min, once
27 and 28	Reactivity test 1: HPV treatment: voice broadcast HP and CTRL treatment: background broadcast	1 test/piglet 3 min familiarisation + 5 min with the experimenter
29 and 33	Reactivity test 2: HPV, HP and CTRL treatment: background broadcast	1 test/piglet 3 min familiarisation + 5 min with the experimenter

2.2.2. Reactivity to experimenter A, tests 1 and 2

Twenty seven to 33 days after weaning, the piglets' reactivity to experimenter A was evaluated through two successive tests (test 1 and test 2). These tests consisted of 3 min of isolation (piglet alone) followed by 5 min of human presence in a new arena (Figure 1). This method was developed by Hemsworth et al (e.g. Hemsworth et al., 1981; de Oliveira et al., 2015; Muns et al., 2015); the first phase aims at familiarising the piglets to the novel environment. In this phase, the emotional reactivity and exploration of piglets from the different treatment is evaluated. Then, human presence allow us to evaluation human-pig relationship, according to the previous treatment.

Each piglet to be tested was carried to a waiting box (0.50 x 1.00 m) by their usual caretaker or by experimenter B, using a trolley. The waiting box was then opened and the piglet was free to enter the test area (3 x 3 m). The piglets had 30 s to leave the box, otherwise they were gently pushed by experimenter B. The test started once the piglet had its four legs in the test area. Each test consisted of two phases: (1) the animal remained alone for 3 min in the test area with no sound broadcast; (2) experimenter A entered the test area, sat on a plastic box and remained motionless for 5 min. Experimenter A held the switched-on loudspeaker that was used for the treatments.

For each test, phase 2 (human presence) was different depending on the treatment group:

- During test 1, the same sound as that used during the treatment application was broadcast for the HPV (modified female voice) and HP (background noise) animals, and the background noise was broadcast for the CTRL animals.
- During test 2, the background noise recording was broadcast for all piglets.

Figure 1 position

2.2.3. Observations

During the interaction sessions and the reactivity tests, video recordings were done with cameras (Panasonic PC25-2230P33) fixed above the home pen or the test area. The cameras were connected to a computer equipped with a video acquisition card and Mpeg recorder (Mpeg Noldus 2.1, Noldus, The Netherlands).

The ethogram used for the observations is described in Table 2. All animals were observed individually, in their group or alone. Virtual lines (Figure 1) drawn on the screen allowed for scoring the locomotor activity of the piglets. Piglet behaviour during the interaction sessions and the vocalisations during tests were analysed from the videos using The Observer XT11.0 (Noldus, The Netherlands). For reactivity tests, piglet behaviour was scored via a Psion (Workabout Pro3, Psion Teklogix, The United Kingdom) equipped with Pocket Observer 3 (Noldus, The Netherlands).

Table 2. Behavioural activities observed during the interaction sessions and reactivity tests 1 and 2.

Behaviour	Description
Behaviour directed toward experimenter A during interaction sessions and tests (latency (s), number and duration (s))	
Gaze	Piglet's head directed to experimenter A.
Contact	Animal sniffing or touching experimenter A or chewing her overalls, without aggressive intention.
Observation during the tests: alone and with experimenter A	
Latency to enter the test area (s)	Time spent in the starting box before entering the test area with all four legs.
Number of high-pitched vocalizations	Including screams, squeals and grunt-squeals, ending in an open mouth.
Number of low-pitched vocalizations	Grunts, with a closed mouth.
Time spent exploring the test area (s)	Sniffing the ground or the wall, standing or walking.
Time spent in each zone (s)	An animal was considered in a zone when its two front legs crossed the virtual delimiting line.
Number of zones crossed	Animal crossing a line delimiting a zone with its two front legs.

2.3. Statistical analysis

Results were analysed using the RStudio Version 1.1.453 (https://www.rstudio.com/). To analyse the behaviour of piglets over the 15 interaction sessions in the home pen, we first calculated the mean values for data by pen. We proceeded in two steps and had to use non-parametric statistics due to the non-normal distributions of residuals. First we tested the effect of treatment during each first interaction session of each week (D5, D12, D19 corresponding to sessions 1, 6 and 11) with Mann-Whitney tests. Then we calculated the effect of treatment, session and their interaction within each week. To do so, we used non-parametric tests for repeated measures, using the nparLD package (Noguchi et al., 2012). Treatment was tested as an independent factor and session was tested as the repeated factor. When treatment*session revealed significant effects, we analysed the session effect within a treatment via Friedman tests and compared the data between sessions by treatment using a Nemenyi multiple comparison test from the PMCMR package (Pohlert, 2014). Differences were considered statistically significant when $P < 0.05$. We dissociated the period when the human was standing (to stimulate piglet's attention) and the period when the human was sitting. Results are presented as medians and interquartile ranges (Md (IQ1-IQ3)).

Data obtained during the reactivity tests (test 1 and test 2) were analysed by test phase (1: before the entrance of the experimenter; 2: with the presence of the experimenter) as in De Oliveira et al. (de Oliveira et al., 2015) to determine the effect of the treatments on the piglets' behaviour. According to the distribution of the data and the residuals of the models, we had to use three methods to test the treatment effects (Table 4):

- We used linear mixed models (lme of the package lme4) with treatment as a fixed effect and pen and repetition as random effects. This model was built using data or transformed data (square root). Pairwise comparisons were tested with the lsmeans package (Lenth, 2015).
- When the distribution of the data resembled an inverse distribution, it was analysed with generalised linear models with a gamma error structure and an inverse link function was used. Pairwise comparisons were tested with the lsmeans package (Lenth, 2015).

- Data not fitting the parametric models hypothesis were analysed using non-parametric methods. We tested the effect of treatment with kws of the coin package (non-parametric method using permutations rather than rank) and post hoc comparisons were performed using nparcomp of the nparcomp package.

Results are expressed as means and s.e.m. for non-transformed data analysed using parametric statistics, and as medians and interquartile ranges for all other variables.

One animal from the HPV treatment died during the treatment application period, so 29 HPV, 30 HP and 30 CTRL piglets were used in the tests.

3.Results

3.1.Piglet responses during interaction sessions

During the first session of human interactions, when the experimenter was standing, HP piglets spent more time gazing at the experimenter than HPV piglets (W: 79; P = 0.03, Figure 2). There was no effect of treatment on the other observed parameters during each first session of each week (i.e. session 1, session 6 and session 11) while the experimenter was standing or sitting (Table 3). During the standing phase (30 s), the latency to gaze at the experimenter significantly increased during the second week of treatment, while the time spent gazing at the experimenter decreased significantly during the first and second weeks (Table 3). During the last session (session 15), only one animal gazed at the experimenter, 24 s after her entry (HP treatment). The latency to the first contact with the experimenter significantly decreased during the first week and the time spent in contact with the experimenter significantly increased (Table 3); there was no significant session effect during the second and third weeks of treatment (Table 3, Figure 2). During the last session (session 15), piglets entered into contact with the experimenter after 0.4 s (IQ: 0.0 s–2.3 s) and they spent 25.6 s (IQ: 21.1 – 30.0 s) in contact with her. Calculations by week revealed no significant effect of treatment.

During the sitting phase (4 min 30 s), there was no effect of the treatment on the first session of each week (i.e. session 1, 6 and 11). The latency to gaze at the experimenter increased throughout the weeks and the time spent gazing decreased (Table 3). During the last session (session 15), no animal gazed at the experimenter. The latency to enter into contact with the experimenter decreased throughout the first week and then remained stable throughout the following weeks (Table 3). The time spent interacting with the experimenter increased for HPV piglets throughout the first week, but there was no significant time effect for HP piglets (Table 3, treatment x time effect); specifically, it was higher for HPV piglets during the second interaction session (P = 0.02). During the last session (session 15), piglets entered into contact with the experimenter after 0.4 s (IQ: 0.4 s – 0.9 s) and they spent 223 s (IQ: 175 – 251 s) in contact (Figure 3). Calculations by week revealed no significant effect of the treatment.

Table 3. Statistical analysis results from the interaction sessions

	Treatment effect			Week 1			Week 2			Week 3		
	S 1	S 6	S 11	session	treat * session		session	treat * session		session	treat * session	
Experimenter standing												
Latency to gaze at the experimenter (s)	0.06	0.65	0 pig	0.51	0.10		**<0.01**	0.56	↗	0.52	0.52	
Time spent gazing at the experimenter (s)	**0.03**	0.71	0 pig	**<0.01**	0.09	↘	**<0.01**	0.60	↘	0.52	0.52	
Latency to first contact with the experimenter (s)	0.58	0.79	0.91	**<0.001**	0.35	↘	0.11	0.56		0.07	0.51	
Time spent in contact with the experimenter (s)	0.58	0.88	0.79	**<0.001**	0.54	↗	0.31	0.58		0.32	0.92	
Experimenter sitting												
Latency to gaze at the experimenter (s)	1	0.81	1	**<0.001**	0.60	↗	**<0.01**	0.71	↗	**0.04**	0.70	↗
Time spent gazing at the experimenter (s)	0.85	0.35	0.96	**<0.001**	0.19	↘	**0.01**	0.81	↘	**0.04**	0.71	↘
Latency to contact the experimenter (s)	0.12	0.55	0.47	**<0.001**	0.74	↘	0.57	0.14		0.24	0.73	
Time spent in contact with the experimenter (s)	0.16	0.22	0.35	**<0.001**	**0.03**	HPV ↗	0.16	0.24		0.06	0.75	

S = session of treatment; session: session effect (ddl = 2.5-3.5); treat *session: treatment * session effect (df = 2.5-3.5); 0 pig: no piglets observed performing this behaviour; ↘: behaviour decreased with session; ↗: behaviour increased with session; HPV: evolution for piglets from the HPV treatment only. HP: N=30; HPV: N=29.

3.2. Piglet responses during test 1

We found no significant effect of treatment on the behaviour of isolated piglets during test 1. In test 1, it took 19 s (6 s – 30 s, P = 0.85) for piglets to enter the test area and they spent 177 s (168 s – 180 s, P = 0.72) exploring the test area. They crossed 19 (14 – 25, P = 0.32) zones and expressed 10 (1 – 23, P = 0.90) low-pitched vocalisations.

When experimenter A was seated in the test area, CTRL piglets did not behave in the same way as HPV and HP piglets (Table 4). Indeed CTRL piglets took more time than HPV and HP piglets to move again in the area. They spent more time gazing at the experimenter than HPV and HP piglets, and entered into contact with her later and less often. They also spent more time in the zone distant from the experimenter and less frequently entered the zone with the experimenter than HPV and HP piglets. HPV and HP piglets did not behave significantly differently, but HP piglets were intermediate between CTRL and HPV piglets in terms of their latency to gaze at the experimenter, with this latency being higher for HPV than CTRL piglets. HP piglets were also intermediate in terms of their latency to first move in the test area, with this latency being higher for CTRL piglets than HPV piglets.

3.2. Piglet responses during test 2

We found no significant effect of treatment on the behaviour of isolated piglets during test 2 ($P > 0.05$). In test 2, it took 12 s (± 1.3 s, $F_2 = 0.58$, $P = 0.75$) for piglets to enter the test area and they spent 176 s (170 s – 180 s, P = 0.52) exploring the test area. They crossed 18.2 ± 0.8 ($F_2 = 1.9$, P = 0.17) zones and expressed 23.2 ± 0.3 ($F_2 = 0.71$, P = 0.50) low-pitched vocalisations.

When experimenter A was seated in the test area, CTRL piglets spent more time in the zone distant from the experimenter and had a higher latency to enter into contact with the experimenter (Table 4) than HP and HPV piglets. HPV piglets were more frequently in contact with the experimenter than CTRL piglets and they expressed more low-pitched vocalisations; HP piglets were intermediate in terms of the frequency of contact.

Table 4: Piglet behavioural responses during both reactivity tests in the presence of experimenter A (test 1 and test 2), according to their treatment:

HPV: human presence and voice, HP: human presence, CTRL: control**.**

Behaviour	Treatment	Test 1 values	Test 1 P	Test 2 values	Test 2 P
Latency to first movement (s)	HPV	8 (3-33) a	0.04 [2]	12 (6-38)	0.08 [3]
	HP	17 (4-46) ab		11 (3-24)	
	CTRL	45 (17-85) b		27 (9-63)	
Number of lines crossed	HPV	22 ± 2	0.06 [1]	17 (13-23)	0.18 [1a]
	HP	22 ± 2		18 (15-26)	
	CTRL	16 ± 2		14 (8-21)	
Time spent exploring the test area (s)	HPV	218 ± 10 b	<0.01 [1]	195 ± 13	0.59 [1]
	HP	204 ± 10 b		198 ± 13	
	CTRL	164 ± 10 a		181 ± 13	
Number of low-pitch vocalisations	HPV	45 (9-66)	0.28 [2]	55 (26-90) b	0.03 [1a]
	HP	35 (15-62)		54 (29-70) ab	
	CTRL	24 (6.8-40.8)		29 (8-48) a	
Latency before gazing at experimenter A	HPV	8 (3-19) b	0.03 [1a]	12 (2-28)	0.64 [3]
	HP	3 (2-13) ab		12 (3-26)	
	CTRL	2 (2-3) a		3 (2-29)	
Time spent gazing at experimenter A	HPV	4.2 ± 0.5 a	<0.001 [1a]	17 (11-26)	0.46 [1a]
	HP	5.0 ± 0.5 a		18 (9-30)	
	CTRL	7.3 ± 0.5 b		42 (12-64)	
Number of gazes at experimenter A	HPV	7 (5-8)	0.13 [1a]	5 (4-8)	0.34 [1]
	HP	8 (6-11)		6 (4-9)	
	CTRL	10 (7-14)		8 (5-12)	
Latency before first contact with experimenter A (s)	HPV	51 ± 3 a	<0.001 [1a]	11 (3-62) a	<0.001 [3]
	HP	45 ± 3 a		8 (2-46) a	
	CTRL	171 ± 4 b		72 (18-253) b	
Time spent in contact with experimenter A (s)	HPV	37 (25-60)	0.84 [1a]	43 (23-75)	0.20 [1a]
	HP	32 (19-49)		32 (14-41)	
	CTRL	42 (0-72)		30 (14-51)	
	HPV	6.8 ± 0.7 b	<0.01 [1]	5 (4-7) a	0.05 [1a]

Number of periods of contact with experimenter A (s)	HP	6.7 ± 0.7 b		4 (3-6) ab	
	CTRL	3.4 ± 0.7 a		4 (1-5) b	
Time spent in the zone distant from experimenter A (s)	HPV	102 ± 16 a		96 (71-133) a	
	HP	125 ± 16 a	0.04 [1]	108 (72-141) a	0.01 [3]
	CTRL	163 ± 16 b		143 (113-172) b	
Number of entries in the experimenter zone (s)	HPV	4.9 ± 0.5 b		4.3 ± 0.5	
	HP	5.4 ± 0.5 b	<0.001 [1]	4.6 ± 0.5	0.06 [1]
	CTRL	2.5 ± 0.5 a		3.0 ± 0.5	
Time spent in the experimenter zone (s)	HPV	88 (58-132)		98 (71-153)	
	HP	79 (54-119)	0.86 [2]	79 (51-103)	0.10 [1a]
	CTRL	85 (13-115)		68 (30-102)	

[1]ANOVA mixed model (df: 2/27); [1a]ANOVA mixed model based on square root (df: 2/27); [2]ANOVA generalised mixed model (df: 1/2); [3]Kruskal–Wallis test (df=2)

Data analysed with parametric tests based on non-transformed data are expressed as means and standard error means (m ± SEM), and all other data are expressed with medians and interquartile ranges (md (Q25 – Q75)).

3. Discussion

This study provides additional understanding of the perception and use of human presence and voice by piglets. For the first interaction (visual, or visual and auditory) sessions, aimed to create a relationship between the piglets and the experimenter, the human voice broadcast decreased the number of gazes directed towards the experimenter. Throughout the first week of interaction sessions, human voice broadcast accelerated an increase in the time spent investigating the experimenter compared to simple presence. After three weeks of treatment, piglets spent 83% (65-93%) of their time in contact with the experimenter regardless of the treatment. Later, the individual responses of piglets to human presence in a new arena differed between treatments. Piglets that were used to human presence (with or without voice broadcast) showed more positive attraction towards their caregiver (lower latency to enter into contact, higher number of contacts, reduced time spent far away from the caregiver…) than control piglets, whereas piglets that were used to human voice broadcast expressed less avoidance reactions (lower latency to first movement, higher latency to look at the experimenter). When piglets that were used to human voice were deprived of human voice in the second test, they interacted more with the experimenter (physically and vocally) than the other piglets.

Piglet behaviour during interaction sessions in the home pen: influence of human voice broadcast on the development of the relationship

In our experimental design, human voice broadcast facilitated the interactions of piglets with the experimenter. Indeed, piglets gazed less in the direction of the experimenter during the first interaction session and their attraction toward the experimenter increased more rapidly than without human voice broadcast, being higher during the second interaction session. Thus speaking to piglets is a way to attract piglets to humans. Gazes, sometimes referred to as orientation of the head toward a stimulus, are signs of attention toward novelty in many species (cattles: Boivin et al., 1998; pigs: Tallet et al., 2014; horses: Bulens et al., 2015; human infants: Schieler et al., 2018), and are interpreted as fear reactions (Tallet et al., 2014). Gazes are also a method to obtain information on the target of the attention (Schieler et al., 2018). The presence of the silent experimenter in the home pen probably attracted the attention of the piglets, as it was not a usual situation. Physiological measurements like heart-rate and its variability (von Borell et al., 2007; Murphy et al., 2014), along with other aspects of validation, would have been necessary to conclude this was fear or attention only. The effect of the treatment on gazing was short lasting and for HPV and HP piglets, the time spent gazing towards the experimenter continued to decrease until the end of the three weeks of human interaction. It may be that piglets who became more and more familiar with the experimenter as they interacted more and more with her decreased their vigilance to her presence.

While gazing decreased until the end of the three weeks of treatment, contact with the experimenter increased for the first week and then remained stable. Contact (i.e. contact with the snout and sniffing) was probably a way for piglets to become familiar with the experimenter, by obtaining somatosensory and olfactory information. Then subsequent contact stability could mean that the attraction to the experimenter reached a threshold (223 s). In a preceding study under comparable conditions (piglet breed, age, rearing environment, feeding conditions), after three and a half weeks of human interaction (2 sessions per day, including physical contact and soft speaking) piglets spent 74 s in contact with the experimenter (Tallet et al., 2014). The piglets in the present study were thus highly attracted to the experimenter in their home pen. The inter-individual variability was high, specifically for the HPV groups, which may reveal individual sensitivity to human voice. The potential inter-individual variation in sensibility to human voice in piglets has been already noted in discrimination tests using voice broadcast (Bensoussan et al., 2019). The underlying explanations for this phenomenon remain to be tested, but we hypothesize that different hearing capacities, genetic backgrounds, and temperament traits related to sensory sensitivity, like in horses, may be responsible (Lansade et al., 2008).

This is, to our knowledge, the first time the real consequences of speaking (not directly but through voice broadcast) on the development of the pig-human relationship has been measured. Preceding studies reported only scarcely using human voice during interactions with pigs: some expressed the use of voice (Terlouw and Porcher, 2005; Andersen et al., 2006; Brajon et al., 2015c; Muns et al., 2015), others reported being silent (Day et al., 2002; Brajon et al., 2015a), and most publications did not mention vocal interactions, which suggested that they were not used (e.g. Hemsworth et al., 1981; Pearce et al., 1989; Geverink et al., 1998; Pedersen et al., 1998; de Oliveira et al., 2015; Carreras et al., 2017). Here we show that human voice influences pig behaviour.

Impact of preceding human presence with or without voice broadcast on individual behaviour in a new arena

Interaction sessions did not affect the response (exploration, locomotion, vocalisations) of piglets to isolation in a new environment. Those behaviours in a new pen are supposed to reflect the emotional reactivity of pigs (Murphy et al., 2014). Thus, piglets from the three treatments were probably in a similar emotional state or psychological level in the sense of De Oliveira et al. (2015) when the experimenter entered the pen. Differences in their behaviour in human presence probably reflected the impact of their previous experience with humans.

Our results suggest that regular human presence – whether talking to piglets or not – helped to reduce the piglets' avoidance of the experimenter and increased their attraction towards her. During the first test, HP and HPV piglets gazed less at the experimenter, spent less time at a distance from her and spent more time exploring the testing area; these behaviours are thought to be associated witha greater level of fear (Hemsworth and Barnett, 1987). Such differences between control and handled animals have been reported in chicks (Jones, 1993; Hemsworth et al., 1994), laying hens (Edwards et al., 2013) and piglets exposed to a passive human presence (Brajon et al., 2015b). In addition, attraction towards the experimenter was increased by regular human presence: latency to first contact was lower, and the number of entries in the human zone and the number of contacts were higher compared to controls. This is in line with the attractiveness of a passive experimenter in the home pen, as shown by Brajon et al. (2015b). We notice that the difference of gazing duration remains low (about 2s), but that control piglets gazed immediately at the experimenter (2 (2-3) s) while it was more variable for the other animals. Further research is needed to understand what the difference in latency to gaze means in terms of emotional states.

In the test area, the latency before interaction with the experimenter (45-51 s) was shorter for HPV and HP piglets than those found in studies involving positive interactions with piglets, such as stroking or scratching (92.2 s in Gonyou et al. (Gonyou et al., 1986) and 81.0 s in Tallet et al. (2014). Given that a passive experimenter may be less frightening than an active one (e.g. attempting to touch the pig), the passivity of the experimenter during the interaction with piglets could have encouraged them to more quickly interact (Hemsworth et al., 1986).

Even though no significant differences were found between HPV and HP piglets for the first test, HPV piglets were the only piglets that expressed a quicker first movement and later gaze than the controls, with HP piglets demonstrating intermediate responses. We make the assumption that gazing may be connected to the emotion fear and attention directed towards the source of fear. The latency to first movement, in an arena test, may also an expression of fear: the later it is, the higher the fear level (Forkman et al., 2007). This suggests that human voice broadcast (during interaction sessions and during the test) may have decreased the fear reactions of piglets, but further work would be needed to validate that an emotional state is, indeed, involved. We note that novelty of the broadcast of a background noise for control piglets may have add to their avoidance reaction. However, the background noise considered here was almost silence in a closed room. Human voice broadcast did not increase attractiveness towards the caregiver, contrary to our hypothesis. As the voice was continuously broadcast during the interaction sessions and test 1, it might have been perceived as a permanent cue of the human presence, which did not specifically attract piglets' attention towards the experimenter during the test. Similarly, habituation to tactile stroking and scratching was observed in piglets that did not react to it on a physiological level in a testing situation, contrary to control piglets (Tallet et al., 2014).

However, HPV piglets were disturbed by the absence of voice broadcast during human presence in the test area: HPV piglets more frequently contacted the experimenter and expressed more low-pitched vocalisations than control piglets in test 2. This was not the case for HP piglets. These increases in physical and vocal interactions may reflect a search for interactions and information from the experimenter. Low-pitched calls may be used both in positive and negative valence situations in pigs (Tallet et al., 2013), and thus we cannot determine the internal state of piglets who emit this type of vocalisations. At least, we can be sure that the situation did not became negative enough to induce the production of high-pitched calls. These results suggest that human voice could be an element for the recognition of the experimenter as piglets are able to rely on auditory cues in the discrimination of familiar humans (Tanida and Nagano, 1998). In a preceding study, depriving piglets from the usual type of contact (physical interactions) induced reactions interpreted as frustration (Tallet et al., 2014). Depriving piglets from the one cue they are used to relying on would have altered their perception of the experimenter.

5. Conclusion

Regular human presence with or without voice broadcast for three weeks in the piglets' home pen decreased their avoidance of the experimenter and increased their interactions with the experimenter; this was true in the home pen and in a novel arena, in comparison to control piglets. When a voice broadcast was not available to the piglets that were used to it, the piglets expressed behavioural disturbances that can be interpreted as a search for interactions with the experimenter.

Conflict of Interest

None.

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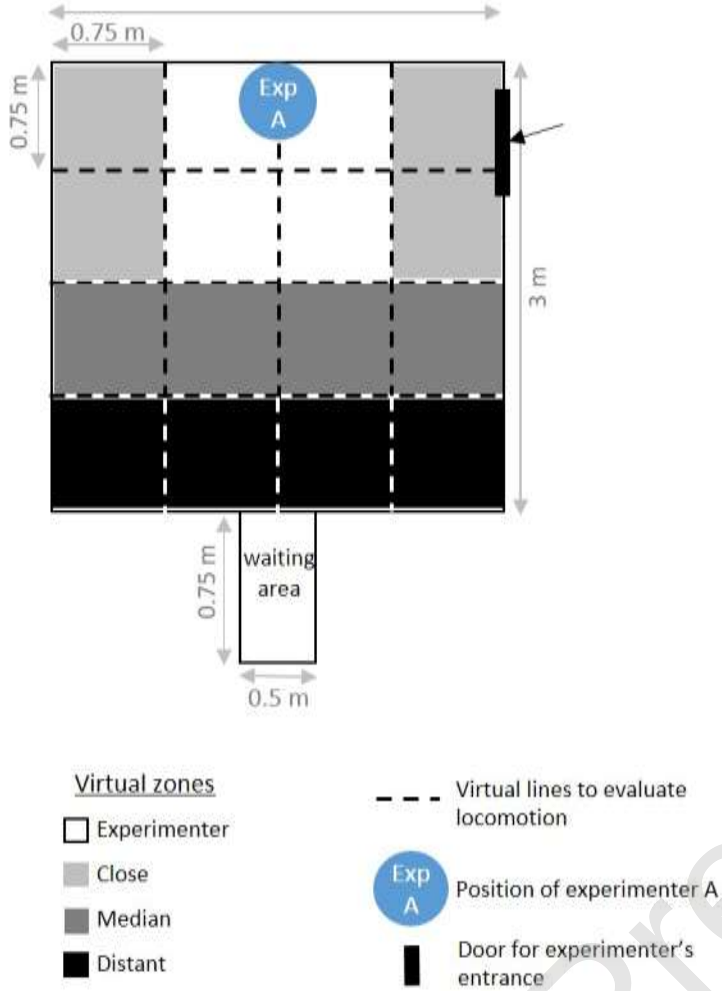
Figure captions

Figure 1: Schematic representation of the test arena, including the waiting zone and the test area. The camera, suspended above the test area door, is not represented. Dotted lines represent the virtual limits of the 16 areas used to evaluate the locomotion of the piglets. Virtual zones were also used to evaluate distance to the experimenter: white zone = experimenter zone, light grey = close zone, dark grey = median zone, black zone = distant zone.

Figure 2: Median (IQ) time spent gazing at the experimenter by HP and HPV piglets, according to the interaction sessions with the experimenter standing. *: treatment effect by session, session**: session effect $p<0.01$ within a week.

Figure 3: Median (IQ) time spent investigating the experimenter by HP and HPV piglets, according to the interaction sessions with the experimenter sitting. *: treatment effect by session $P < 0.05$, session***: session effect $P < 0.001$ within a week.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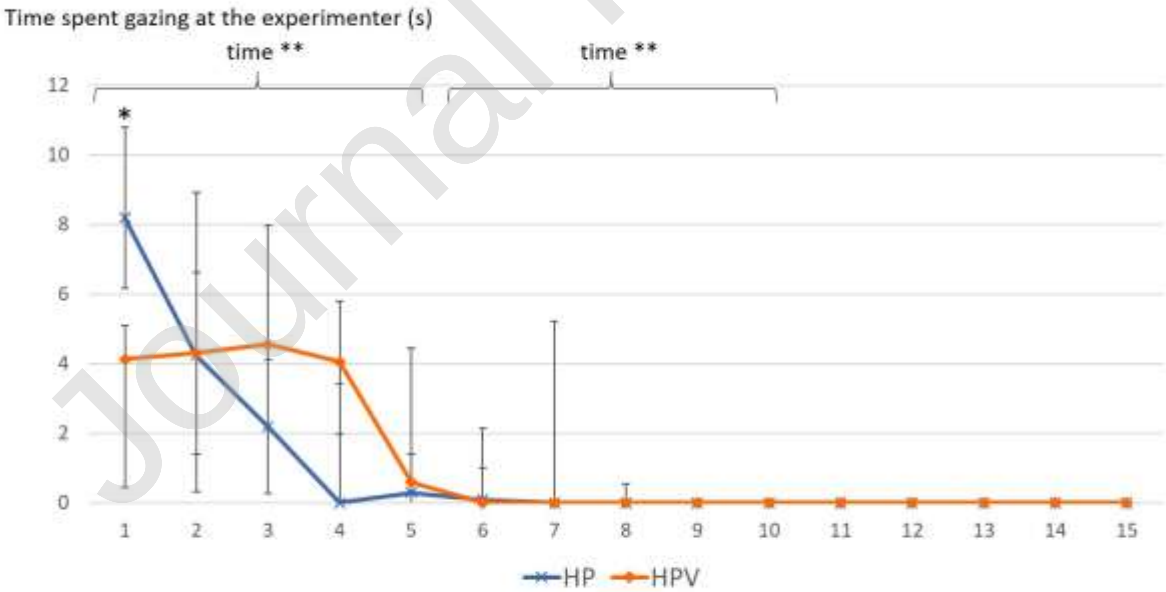
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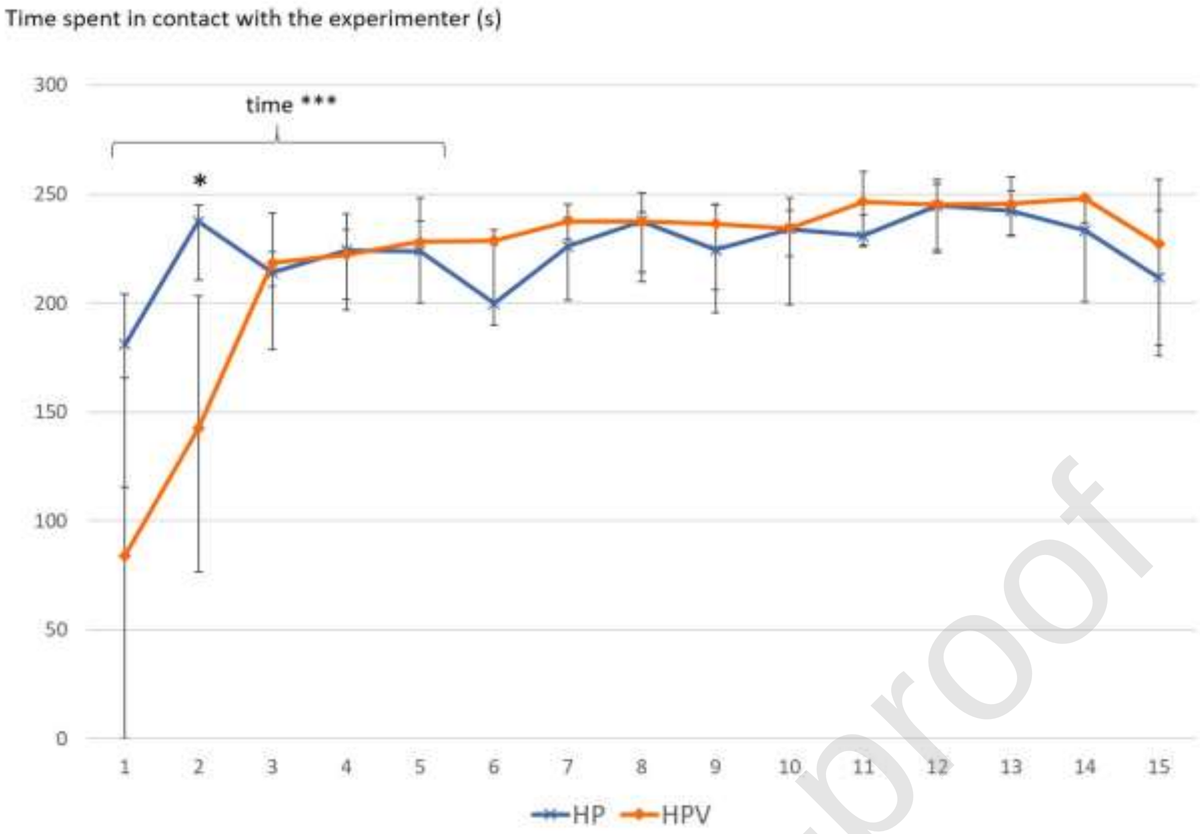
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