EFFECT OF HUMAN CONTACT ON HEART RATE OF PIGS

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Abstract *Animal Welfare 1995, 4:* 351-359

Pigs were selected at random from three lines (homozygous halothane positive, homozygous negative, and the heterozygotes). They were housed for four weeks within standardized environmental conditions with six pigs per pen corresponding to each of the three lines with two treatment combinations (6x3x2). Half of the pigs were allocated to routine care without humans entering the pen, while the other ones received an increased human contact treatment; animal-man interaction times were recorded. Before and after the four-week experimental period, pigs were housed individually for one day. A blood sample was taken for beta-endorphin analysis and heart rate was measured. The final heart rate measurements were continued during a transport of two hours. With respect to animal-man interaction times no clear treatment effect was observed. Increased human contact lowered the plasma beta-endorphin content to a greater extent as a function of time, while heart rate also became lower. The latter may result in an improved heart function during handling and transport. Differences with regard to the halothane gene were observed during housing conditions, but not during transport.

Keywords: *animal-man interaction, animal welfare, beta-endorphin, heart rate, pigs, transport*

Introduction

Transport of pigs may impose stress which impairs welfare, increases mortality rate, reduces meat quality and lowers immunoresponse and growth (Moss 1982; McGlone *et al* 1993). In pigs the so-called halothane or ryanodine receptor gene (MacLennan & Philips 1992) causes defective calcium ion transport through the sarcoplasmatic reticulum of the skeletal muscle tissue. Noradrenaline may rise during transport (Dantzer & Mormede 1983), stimulating an elevated calcium ion release (Britt 1979). In homozygous halothane sensitive pigs, which have a defect in the calcium ion release channel of the sarcoplasmatic reticulum, a cumulative effect on calcium ion transport may occur, increasing mortality before slaughter (PSS, Porcine Stress Syndrome). However, this problem may also occur with heterozygotes, although the so-called halothane gene is considered to be recessive. Indeed, the PSS mutation has been identified in most modern domesticated breeds of swine, including 97 per cent of

Piétrain, 80 per cent of Poland China, 37 per cent of Landrace, 22 per cent of Large White, Duroc and Hampshire, and 17 per cent of Yorkshire pigs (O'Brien 1995). Therefore, it should be worthwhile to reduce the emotional response of pigs during transport.

For sheep, repeated gentle handling procedures reduced the emotional response, as quantified by heart rate (Hargreaves & Hutson 1990). The fear level towards humans was reduced when pigs received gentle human contact before being challenged within an arena (Hemsworth & Barnett 1992). Moreover, lambs trained for handling showed a lower plasma beta-endorphin level after transport as compared to controls, while no difference was observed for cortisol (Fordham *et al* 1989). The feedback system, which exists between ACTH and cortisol, does not seem to exist for beta-endorphin, thus making it more reliable for the study of the effects of stressors (Geers *et al* 1994). Indeed the steady rise of beta-endorphin during transport supports the view (Shaw & Tume 1990) that beta-endorphin is a good variable to evaluate pig's welfare, and suggests a non-concommitant release with ACTH.

Villé *et al* (1993) found that during transport heart rate rose strongly within homozygous halothane pigs. The work reported here investigated the effect of increased human contact during housing, on ECG parameters during the later transport of three kinds of pigs, classified according to their halothane gene status.

Materials and methods

Animals

Thirty-six female piglets (about six-weeks-old) were transported from common housing conditions to the laboratory. Twelve had been selected at random from each of the three genetic lines: homozygote halothane sensitive (nn), homozygote halothane non-sensitive (NN) and heterozygotes (nN). The nn and NN pigs originated from pure-bred Landrace and Large White lines. Both populations have been halothane tested and back-crossed regularly over the last 10 years to produce these lines for breeding programmes. Heterozygotes were made from both homozygote lines. During the experimental period all piglets were housed for four weeks in groups of six (same genotype) within standardized environmental conditions, ie one climatic room for each genotype (Geers *et al* 1990). The floor of the pens were 25 per cent slatted. Food and water were available *ad libitum*. Light (about 70lux) was continuous. The experiment was repeated once to include the second treatment.

Experimental design and treatments

After one week of acclimatization to the new housing environment the following treatment was applied. Six piglets were selected at random from each of the three lines and these were allocated to a control treatment (CT). The remaining six piglets from each line were allocated to the experiencing increased human contact (IHC) treatment. In effect, there were six groups (3 lines x 2 treatments) of six piglets each, that is a total of 36 piglets.

Protocols and methodology of the tests

The CT was made up of routine care without humans entering the pen, except on the first and last experimental day to take blood samples and to measure the animal-man interaction time. For this purpose the experimenter opened the pen door, sat down and waited 10

minutes to allow the pigs to make physical contact. This procedure was based on the work of Hemsworth *et al* (1987). Interaction time was measured for each pig by evaluating time-lapse videotapes, a technique validated by Arnold-Meeks & McGlone (1986) for studying the behaviour of group-housed pigs. Each pig could be identified by reading a number painted on its back.

IHC was conducted at a random time between 0800h and 1800h to introduce the aspect of unpredictability (Weiss 1971). Initially, the experimenter was outside the pen and allowed ten minutes for the pigs to make physical contact with him, the exact time interval to contact was recorded. Then the experimenter walked through the pen for two minutes without attempting to pat or stroke the pigs. The entire procedure was repeated daily from Monday to Friday for four weeks.

At the beginning (7 weeks of age) and at the end (11 weeks of age) of the experimental period for both treatments, a blood sample was taken to determine the beta-endorphin content of the plasma (Radioimmunoassay RIA-kit RIK-8843, Peninsula Laboratories Inc), since variability within plasma beta-endorphin content of sheep has been related to handling procedures (Rodway *et al* 1993). Before taking the blood sample from the jugular vein, pigs were collected from the pen one after another, and anaesthetized (azaperone in combination with metomidate). Anaesthesia was necessary to allow the attachment of an ambulatory electrocardiogram measuring device, as explained further on. The procedure of blood sampling took less than five minutes for each pig, sufficiently short to minimize the handling effect on blood hormone levels as shown by Dalin *et al* (1993).

At the beginning and at the end of each experimental period (4 weeks) each pig was housed singly for about 30 hours in an individual pen without further treatment. Environmental conditions were the same as for group housing, including having sight and sound contact with penmates also being housed individually. After blood sampling and during anaesthesia, an ambulatory electrocardiogram (ECG) measuring device was attached to the pigs (Villé *et al* 1993). ECG parameters were measured from 2000h to 0800h during individual housing conditions, followed by two hours of transport.

Pigs of the same genotype were transported in a trailer, and in two groups of three (2x3 pigs of the same treatment x line combination, 0.32 m^2 floor space per pig) along a standardized route. The QRST-complex of the electrocardiogram provides parameters for evaluating stress, such as heart rate, arrhythmicities and ST-elevations from the iso-electric line of the ECG. The ECG is a measure of the voltage variations around the iso-electric line produced during ventricular activation (Grande & Taylor 1965).

Statistical procedure

At the end of each measuring period, the ECG data were transferred to a personal computer for further data analysis. Maximal, mean and minimal heart rate, and ST-elevation from the iso-electric line of the electrocardiogram were available as mean values per hour, calculated from the individual beats per minute. After testing for normality of distribution of parameters and outlier detection, mean values of interaction times, heart rate and beta-endorphin levels were compared using an analysis of variance (ANOVA) within a generalized linear model (Freund & Littell 1981). Since measuring periods covered only the same few hours of a day, no within-day or time period effect was included into the model. Class variables which were taken into account were: genotype, treatment (CT or IHC) and experimental period (start or

end). The experimental pigs were group-housed from birth. Hence it can be hypothesized that individual behaviour may be biased when each pig is being tested with or without penmates, depending on its individual characteristics. Moreover, in common husbandry and transit systems animals are handled within a group. Therefore the aim of this research was to evaluate the effect of treatments on the behaviour of individual pigs when handled within a group (Arnold-Meeks & McGlone 1986). Thus, the individual animal was considered as the experimental unit, having been selected at random from the available population.

Results

Effects of genotype, treatment, experimental period and interactions were statistically significant. In view of the investigation, attention was focused on effects within genotypes (Table 1). In order to have a better estimate of the approach time, a mean value of three successive observations was calculated for the IHC pigs. This was not possible for the CT pigs, since only one observation was available at the start and end of the experimental period. Table 1 summarizes the results with respect to animal-man interaction time. NN and nN pigs showed strong inter-individual variance (SEM), and inter-group variance for the start values of the approach times. A difference between start and end values was observed, except for the combinations NN/IHC and nn/IHC. Within animals there was no correlation between start and end values. It was not possible to relate approach time data to data of heart rate and beta-endorphin levels, since no statistically significant correlations were found.

Table 1 **Approach time (second; mean with SEM for six pigs) for each genotype treatment combination. IHC: Start are mean values from the first three tests; End are the last three tests. CT: measurements only from the first and the last day.**

	NN		nn		nN	
	Start	**End**	**Start**	**End**	**Start**	**End**
IHC	23 (17)[a]	57 (34)[a]	537 (30)[c]	504 (52)[c]	432 (54)[e]	89 (37)[g]
CT	287 (99)[b]	68 (28)[a]	507 (52)[c]	208 (43)[d]	600 (74)[f]	205 (57)[h]

Within genotypes, superscripts being different within a row and a column are significantly different at $P < 0.05$.

Plasma beta-endorphin levels were not different between genotypes (Start: NN 34.3 ± 11.2, Nn 29.1 ± 12.4, nn 40.5 ± 12.7; End: NN 30.0 ± 7.3, Nn 31.7 ± 13.1, nn 32.6 ± 13.2). Therefore these data have been pooled. Within the same group of six pigs, there was no difference between the first and the last one taken for blood sampling. A clear-cut effect of IHC was shown with respect to a time-related drop of plasma beta-endorphin, ie CT: 6.9 per cent versus IHC: 12.9 per cent with $P < 0.05$ (Table 2).

Table 2 **Plasma beta-endorphin levels (10^{-12}g ml^{-1}; mean with SEM) of pigs as a function of time and treatment (IHC versus CT) (n: number of animals).**

	IHC	CT	Probability
n	18	18	
First day	30.9 (1.9)	40.4 (2.1)	< 0.01
Last day	26.9 (2.0)	37.6 (2.2)	< 0.01
Decrease (%)	12.9	6.9	
Probability	< 0.05	ns	

ns - not significant

IHC-effects were found with respect to the mean minimal and maximal heart rate per hour during individual housing (Table 3). Values were not different between treatments at the start. For the NN-animals the minimum and maximum heart rates were lowered by the IHC treatment. This was not observed for the halothane gene carrying pigs, although the increase was lower within the IHC treatment.

Table 3 **Heart rate (beats per minute; mean with SEM) (HRm - minimal heart rate; HRM - maximal heart rate) for each genotype of individually housed pigs during a 12h period before and after IHC (n = 6) or CT (n = 6) treatment.**

		Start		End	
		IHC	CT	IHC	CT
NN	HRm	91 (4)^a	93 (4)^a	81 (5)^b	90 (7)^a
	HRM	184 (5)^a	180 (5)^a	165 (7)^b	159 (9)^b
nn	HRm	91 (4)^a	91 (4)^a	99 (5)^a	114 (4)^b
	HRM	158 (5)^a	160 (5)^a	170 (7)^a	176 (6)^b
nN	HRm	75 (5)^a	73 (5)^a	101 (6)^b	102 (8)^b
	HRM	176 (6)^a	174 (6)^a	174 (7)^a	168 (8)^a

Superscripts being different within the same row and genotype are significantly different at $P < 0.05$.

During transport, throughout the genotypes a lower minimal and mean heart rate were observed for the IHC-pigs compared to the CT-pigs, as well as a tendency for a lower ST-deviation from the iso-electric line of the cardiogram, although this was not statistically significant (Table 4). No differences with respect to maximal heart rate could be observed.

Table 4 **Heart rate during transport (beats per minute; mean with SEM) (HRm – minimal heart rate; HRx – mean heart rate; ST – ST elevation from the iso-electric line of the electrocardiogram).**

	HRm	HRx	ST
IHC	90 (4)[a]	132 (3)[a]	1.15 (0.06)[a]
CT	102 (4)[b]	143 (3)[b]	1.32 (0.07)[a]

Superscripts being different within the same column are significantly different at $P < 0.05$.

Discussion

When measuring animal–man interactions within group-housed pigs in the present experiment, a clear-cut effect of IHC on animal–man interaction time was not observed. This has also been the case with open field testing of individual pigs (Hemsworth *et al* 1987). Homozygous halothane non-sensitive (NN) piglets were most explorative, while the other two groups exhibited a withdrawal or freezing behaviour when exposed to an experimenter. Indeed, mean values of the approach times are significantly higher for Nn and nn pigs (Table 1). Differences in behavioural related problems between halothane genotypes have already been observed by Schaeffer *et al* (1989). The variability within and between individual pigs seemed to overrule any treatment effect on approach time. To elucidate this problem, further research should include a test to distinguish between active and passive coping types of behaviour (Hessing *et al* 1994). Such information may also be useful to develop groups of grower pigs having a coping strategy which reduces labour input and improves welfare (Hessing 1994).

Nevertheless, increasing animal–man interactions during housing may improve the coping capacity of the pig in transit, as shown by a reduced heart rate and a non-significant trend for a lower ST-elevation (Table 4). This means a reduction in animal's responsiveness (emotionality) to novel stimuli, as observed when being trained on toys (Pearce & Paterson 1993). As a result, the larger potential for increase of heart rate may contribute to an improved physical performance, as observed within human athletes (Peronnet *et al* 1980). However, when housed individually, improvement only existed for homozygous halothane non-sensitive (NN) pigs, as shown by minimal heart rate (Table 3). Moreover, halothane gene carriers showed the highest maximal heart rate, indicating higher excitability. This suggests a potential overriding effect of the new environment on the treatment when housed individually (Hemsworth & Barnett 1992). This was not observed during transport, there was a treatment effect of IHC on heart rate throughout genotypes, ie a drop of about 8 per cent (Table 4). A possible explanation may be the difference between being challenged as an individual (housing) or as a group (transport). Individual characteristics such as social status within the group (McGlone *et al* 1993) or type of behavioural coping strategy (Hessing *et al* 1994), which may influence stressor effects, were not evaluated and therefore a potential interaction could not be taken into account. Such an evaluation of individual characteristics in relation to blood sampling procedures, could also be helpful to explain the variability within plasma beta-endorphin levels between groups before treatment started. For all genotypes beta-endorphin was lower after having experienced increased human contact

(Table 2), ie no interactions from the halothane gene. This corresponds with data reported for lambs (Fordham *et al* 1989). With respect to the relationship between heart rate and beta-endorphin in sows, a distinction has to be made between acute and chronic stress (Schouten & Rushen 1993). These authors hypothesized that a heart rate lowering effect of beta-endorphin is only effective when the pig is suffering acute stress.

Animal welfare implications

Increasing animal–man interactions during housing may improve the coping capacity of the pig when put in a new environment, eg transit. Further research with slaughter pigs could show if the observed beneficial effect from increased human contact during housing on heart function during transport, also exists with respect to mortality rate before, and meat quality after, slaughtering. Indeed, an improved heart function will be able to supply a sufficient blood flow to the skeletal muscle tissue and the heart itself. This is important for maintaining physiological equilibrium (welfare, lower mortality) during, and meat quality after handling and transport (Ruelcker 1968; McKirnan *et al* 1991). This is especially useful for halothane sensitive pigs, where skeletal muscle metabolism switches faster to anaerobic metabolism during physical performance (O'Brien 1995).

Such results may have implications on housing, loading and lairage facilities, which need to be made flexible in view of the behaviour of pigs related to their individual coping strategy (Hessing *et al* 1994), and to previous housing and handling conditions as reported here.

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