Characterisation of Spontaneous Behaviour in Göttingen Minipigs in the Home Pen

by *Lene Vammen Søndergaard[1], Karin Hjelholt Jensen[2], Ralf Hemmingsen[3], Axel Kornerup Hansen[1,*] & Nanna Marie Lind[1,3]*

[1]Division of Laboratory Animal Science and Welfare, Department of Veterinary Pathobiology, Faculty of Life Science, Frederiksberg, Denmark

[2]Department of Animal Health and Welfare, Danish Institute of Agricultural Science, Foulum, Denmark

[3]Department of Psychiatry, University Hospital of Copenhagen, Bispebjerg, Denmark

Summary

Spontaneous behaviour in the home pen of group-housed minipigs was characterised with respect to social interaction, activity, locomotion, exploration and resting behaviour.

Sixteen adult male and female Göttingen minipigs were allocated in three groups. Data were acquired at the age of seven and 16 months. Behaviour sampling was made by video recordings for two consecutive days per group.

The median values for initiating and receiving social contact were one to four times per individual during 30 min of observation in the main "activity period" (found to be 4 – 4.30 pm with the feeding regime) at both ages; the variation between pigs was considerable. The animals spend a large amount of their active time (during this time) exploring (76 %). During the six-hours resting period, three bouts of activity were conspicuous in all three groups, and the highest level of activity was around midnight. The level of social interaction at seven and 16 months of age did not differ significantly, and the social hierarchy of the pigs in the three groups showed a high degree of consistency at seven and 16 months. However, correlation analysis did not indicate a statistically significant relationship between the level of social interaction of the individual pig at the young age and the older age.

As relatively little is known about spontaneous behaviour of Göttingen minipigs this basal characterisation of normal behaviour may serve as normative data for future studies of Göttingen minipig behaviour.

Introduction

Purpose-bred laboratory minipigs (*Sus scrofa*) possess several advantages compared to randomly bred animals in relation to biomedical research. The Göttingen minipig, which is microbiologically standardised, thus fulfils the needs of modern laboratory animal science in addition to being suitable for long-term studies in which other swine breeds become too large. Behaviour is a critical parameter and a response variable in, for instance, welfare assessment. Several studies have already addressed various aspects of this in minipigs *(Tanida & Nagano, 1998; Koba & Tanida, 1999; Krohn et al., 2000; Koba & Tanida, 2001; Tsutsumi et al., 2001)*. An ethological approach to phenotypical characterisation will in many cases be a valuable tool in investigating biological processes or assessing possible effects of experimental interventions such as structurally or chemically induced symptoms of diseases. As such, behavioural effects have been measured in Göttingen minipigs after administration of drugs which after the brain dopamine system

**Correspondence:* Axel Kornerup Hansen
Division of Laboratory Animal Science and Welfare, Department of Veterinary Pathobiology, Faculty of Life Science, Dyrlægevej 88, 1st Floor, DK-1870 Frederiksberg C, Denmark
Tel: +45 35 28 27 26
Fax: +45 35 28 27 55
E-mail: akh@life.ku.dk

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(Lind et al., 2005a,b), including 1-methyl-4-phenyl-1,2,3,6-tetrahydropyridine (MPTP), as a method of experimentally inducing Parkinsonism *(Mikkelsen et al., 1999)*.

Behavioural research in laboratory animals is mainly based on using standard behavioural tests to measure the effects of certain experimental treatments *(Crawley, 1998)*. The purpose of applying such standard behavioural tests is often to quantify the expression of specific behaviours, where the nature of the experimental set-up supports the occurrence of the behaviour of interest. In pigs for instance, the elevated plus maze has been suggested to measure anxiety-evoked behaviours *(Andersen et al., 2000)* and the novel object test has been suggested as a method to assess temperament traits homologous to a human trait *(Lind & Moustgaard, 2005; Lind et al., 2005b)*. Standard behavioural test to assess learning and memory of minipigs has also been established, as for instance the Go/No-go task *(Moustgaard et al., 2004; Moustgaard et al., 2005)* and the spontaneous object recognition test *(Moustgaard et al., 2002)*.

Studies of spontaneous behaviour of laboratory animal species implies least possible interference with the behavioural data acquisition from the handler and the experimental set-up. Hence, characterisation of spontaneous behaviour provides means for mapping out the manifestation of normal behaviour. The spontaneous behaviour of production pigs has been the matter of attention in numerous studies relating to optimisation of pork production. For instance, studies of pig behaviour in semi-natural environment have contributed to the present knowledge on the subject *(Jensen & Wood-Gush, 1984; Jensen, 1986; Jensen et al., 1987; Stolba & Wood-Gush, 1989)*. The spontaneous behaviour of miniature pigs has received less attention. Patterns of normal behaviour and the effect of age, strain, gender and season on various types of behaviour in Göttingen minipigs has been investigated *(Sippel & Oldigs, 1982)*. Feeding behaviour was studied in Munich minipigs *(Musial et al., 1998)*, the spontaneous nursing behaviour in Mini-Lewe sows *(Illmann & Madlafousek, 1995)*, and suckling behaviour in infant minipigs *(German et al., 1997)*. Yet, much is still to be learned about minipig behaviour. Consequently, the aim of the present study was to characterise spontaneous behaviour in the home pen of group-housed Göttingen minipigs. The Göttingen minipig was chosen due to the high degree of standardisation and microbiological status in addition to worldwide availability. The objective was to describe social interaction, activity, locomotion, exploration and resting behaviour in adult male and female minipigs of two ages.

Materials and Methods

Animals and housing

Sixteen Göttingen minipigs (Göttingen minipigs™, Dalmose, Denmark) were housed in our research facility from birth and allocated in three groups (Pen A, B and C) comprising five, five and six minipigs, respectively (three males and two or three hysterectomised females). The minipigs were housed in pens of 3.25 x 2.95 m. To minimise abnormal behaviour all minipigs were kept in an enriched environment with shavings and straw bedding. Visual and tactile communication was limited between pens. The room was illuminated with electric light from 7.30 am to 3.00 pm, and in addition natural light entered the room through windows. The room temperature varied between 17 and 21 °C. Animals were fed restrictively twice daily at 7.30 am and 2.30 pm according to the recommendations of the breeder with commercial pelleted diet for minipigs (Altromin 9010, Brogaarden, Gentofte, Denmark) dispersed over the entire pen floor. Water was available *ad libitum*. A schematic overview of the research facility is provided in Figure 1.

Data were collected at two ages: at seven months (February, 11-18 kg) and at 16 months (November, 15-27 kg). At 16 months, the data from one pig from pen B were missing. Prior to the present experiment, all the animals had been included in the same behavioural test, which included exposure to d-amphetamine on two (seven months) to five (16 months) occasions, the last exposure being more

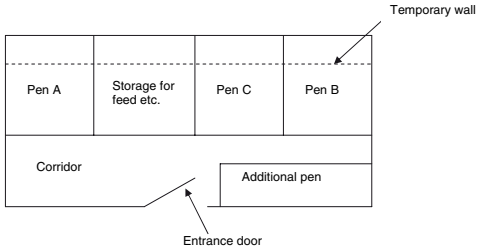

Figure 1. Schematic illustration of research facilities.

than one month prior to the data collection.

Apparatus and procedures

Behavioural sampling was made by video recordings. A monochrome video camera (TOPICA TP-606D/3, Videosystemer A/S, Hedehusene, Denmark) with an 8 mm wide-angle CCTV lens was mounted in the ceiling above the pen and connected to a digital hard disk recorder (VSD-1000, Videosystmer A/S, Hedehusene, Denmark). The recorded behaviour was analysed offline using a PC (2.0 GHz Intel® Pentium 4 processor, 256 MB RAM, WindFast GeForce4 64 MB). Each of the three groups was recorded over the two successive weekends (Friday 6.00 pm to Sunday 6.00 pm, i.e. 48 hours) at age seven months and at age 16 months. The camera was placed in the ceiling above the home pen. Due to technical limitations of the camera lens/ceiling height, the pens were reduced in size (2 x 3 m) during video recordings, and approximately one week prior to recording, a temporary wall was set-up to diminish the size of the pen (Fig. 1). Pilot studies had revealed that infrared light was not sufficient to make acceptable recordings during the dark periods and therefore electric light was provided 24 hours a day. The windows in the room were covered to avoid varied illumination. Three hours prior to initiating the video recording, the pigs, which were accustomed to human handling, were marked individually with a speed marker on the back. The amount of straw bedding supplied during periods of recording was reduced to avoid possible hiding of the markings on the animals. Otherwise, daily routines were maintained during the recording period.

Behavioural observations

Recorded behaviours were divided into five categories: 1) Activity level; 2) Social interaction; 3) Locomotion; 4) Exploration; and 5) Resting behaviour, where 1) and 5) as well as 2), 3), and 4) are mutually exclusive (Table 1). At each age all behavioural sampling occurred at two consecutive days. "Activity level" was recorded by scan sampling every minute for 48 continuous hours per group at two ages (seven and 16 months). Duration and frequency of "Social interaction" was recorded at two ages (seven and 16 months) and the data were acquired manually by all occurrence sampling during a 30 min period in the afternoon found to be the time when all animals were particularly active (4.00 pm - 4.30 pm, the "activity period": **see Results, below**). Duration and frequency of "Locomotion" were also registered in the activity period by means of all occurrence sampling employing the computer software program 'The Observer', Version 3.0 (Noldus Information Technology, Wageningen, the Netherlands), but only at the age of seven months. Duration and frequency of "Exploration" and "Oral manipulation of inventory (i.e. the pen's content)" were acquired by all occurrence sampling during the activity period using The Observer (category *Exploring*) and manually (category *Oral manipulation of inventory*) at seven months of age. For recording the behaviours of "Social interaction", "Locomotion" and "Exploration", only behavioural events lasting more than one second were included. "Resting behaviour" was recorded manually during a six hours period in the evening and night characterised by long intervals of resting behaviour interrupted by short bouts of activity at pen level (9.00 pm to 3.00 am = "Resting period") using scan sampling every five min.

The possible effect of 24-hours light on the activity pattern was tested on the animals in one of the groups (Pen B) by video recording the animals for

Table 1. Definitions of the recorded behaviours assigned to five categories: Activity level, Social interaction, Locomotion, Exploration and Resting behaviour. I. Recorded by behaviour sampling. II. Recorded by scan sampling. A. Recorded during activity period (4.00 pm – 4.30 pm). B. Recorded during 24 hours period. C. Recorded during resting period (9.00 pm – 3.00 am).¤ Only recorded at the age of 7 months.

BEHAVIOUR	DEFINITION
Activity II, B	Standing upright, moving around
Social interaction	
Non-agonistic initiative I, A	
Nose-to-body	Snout contact to any part of the body behind the ears, apart from genital region, of the receiver without massage-like movements
Nose-to-nose	Snout contact to nose, head or ears of the receiver without massage-like movements
Nose-to-anogenital	Snout contact to the genital region incl. tail of the receiver without massage-like movements
Belly-nosing	Massage-like movements with the snout against the belly, flank or the soft tissue between the legs of the receiver
Rubbing	Massage-like movements with the snout against or oral manipulation of the head, tail or leg of the receiver
Agonistic initiative I A	
Head-to-head knock	A rapid thrust upwards or sideways with the head or snout against the neck, head or ear of the receiver
Head-to-body knock	A rapid thrust upwards or sideways with the head or snout against any part of the body behind the ears of the receiver
Body pressing, Parallel	Standing side by side, and the performer pushes hard with the shoulders against the receiver, throwing the head against the neck or head of the other
Body pressing, Inverse	The animals face front to front, and the performer pushes its shoulders hard against the receiver, throwing the head against the neck or head of the receiver
Pushing	Pushing against the receiver; less violent that knocking
Levering	Putting the snout under the body of the receiver (from behind or from the side) and lifting it up
Sexual initiative I, A	
Mounting	Placing the front legs on the back of the receiver, both pigs facing the same direction
Response I, A	
Ignoring	Continuation of an individual activity despite contact initiative
Passive	Standing still, attention directed against the performer
Head down	Standing still presenting its rump; the head is lowered and turned away from the performer
Leaving	Walking calmly away from the performer
Withdrawing	Moving away from the performer, rapidly with head high
Aggression	Performing head knock or pushing
Locomotion I, A, ¤	
Walking	Walking without exploring
Standing	Standing still without exploring
Lying	Lying on the abdomen or on the side of the body, resting against pen mates or floor; the weight of the body does not rest on the limbs
Sitting	Sitting with the forelegs stretched under the body, without exploring
Running	Running, incl. making jumps and pirouettes
Exploration I, A, ¤	
Exploring	Making horizontal movements of the head over the floor, sniffs the floor
Oral manipulation of inventory	Licking, manipulating, sniffing or biting the content of the pen
Resting II, C	Lying without any activities (twitching is allowed)

four days: two days with normal illumination (electric light on from 7.30 am to 3.00 pm) followed by two days with 24 hours light regime. The measurement comprised registration of all occurrences of standing up by means of behaviour sampling from 9.00 am to 4.00 pm.

At both age levels the social hierarchy of the animals in the three groups was determined. This was done in a Food Competition Test using a feed dispenser familiar to the animals that only allowed one pig to eat at a time *(Forkman et al., 1995)*.

Data analysis

To test if the animals may be regarded as a homogenous experimental group, the variables, as obtained at age seven months, were subjected to analysis of variance using the MIXED procedure in the SAS System for Windows (version 8.2, SAS Institute Inc., 1999-2001). For variables regarding "Social interaction", "Locomotion" and "Exploration", the model included Pen (A, B, C), Day (Day 1, Day 2), and Gender (Male, Female) as fixed effects. No interactions were included due to lack of available degrees of freedom. Day was used as a random effect with the identity of the pig nested within pen as subject. If non-significant, the fixed effects were omitted from the model. To obtain homogenous variance, data were transformed to either logarithmic values or square root, depending on the data distribution. Individual pigs nested within pen were used as experimental units. The Differences of Least Squares Means were used for comparison with the individual treatments, and all analyses were performed as two-tailed tests (α = 0.05). In case of low frequency, data were tested by one-way Wilcoxon – Kruskal-Wallis test (SAS System version 8.2, SAS Institute Inc., 1999-2001). Seven behavioural measures (Frequency of *Mounting* and Frequencies and Durations of *Lying, Running* and *Sitting*) were not tested statistically due to a scarce occurrence.

Differences between frequencies of four behavioural measures of social interaction (*Frequency of initiative to non-agonistic contact*, of *initiative to agonistic contact*, of *receiving non-agonistic contact* and of *receiving agonistic contact*) obtained at age seven months and at age 16 months were tested by one-sample t-test for mean equal to zero (two-tailed, α = 0.05) using the Analyst application to the SAS System (version 8.2, SAS Institute Inc., 1999-2001).

To test whether the same individuals were involved in social interaction at the two age levels, the relationship between social behaviour (*Frequency of initiating social contact* and *Frequency of receiving social contact*) at age seven and age 16 months was analysed using Pearson's Partial Correlation Coefficient, with gender and pen excluded(Analyst application to the SAS System version 8.2, SAS Institute Inc., 1999-2001).

Additionally, the social hierarchy at the two ages was compared by a subjective assessment of individual scores obtained from the Food Competition Test.

The effect of constant electric illumination on the activity pattern in the time period 9.00 am to 4.00 pm was analysed by comparing data from the recording of activity (i.e. number of minutes in which more than three out of four animals were standing up) for two days with normal light regime with data from two days with a 24 hours light-schedule. Differences between activity after normal light regime (per day, i.e. mean of day 1 and day 2) and the activity after constant lighting (day 1, day 2 and per day, i.e. mean of day 1 and day 2),) were compared (for mean equal to zero) by one-sample t-test (two-tailed, α = 0.05), using the Analyst application to the SAS system (version 8.2, SAS Institute Inc., 1999-2001).

Results

Initially in the study (age seven months) the effects of Pen (A, B, C), Days (1, 2), and Gender (male, female) on behavioural measures of social interaction, locomotion and exploration were not found to be statistically significant (data not shown). The data on these behaviours from the 16 animals in the study were therefore considered as one sample for

the further analysis. Furthermore, on this basis it was assumed that this was valid throughout the study.

Activity pattern

The activity of the minipigs was highly related to feeding. After morning feeding, all animals were active for 80 min at the age of seven months and for 60 min at the age of 16 months. After afternoon feeding, all animals were active for 90 min at the age of seven months, whereas they were all active for 120 min at 16 months of age. In the case of activity following both morning and afternoon feeding, the animals were occupied with eating immediately after feed allocation. Not until 60 min after feed allocation, did the foraging behaviour fade to be replaced by other types of activity-related behaviour such as social interaction (data not shown). Accordingly, being the most extended, the period of activity after afternoon feeding was chosen for recording activity-related behaviours, i.e. 4 – 4.30 pm with this regime.

Social interaction

The median values for initiating and receiving social contact (non-agonistic and agonistic) are presented for the two ages in Fig. 2. The median values for initiating and receiving social contact were one to four times during 30 min observation in the activity period at both ages; the variation between pigs was considerable. The level of social interaction at seven and 16 months of age was not significantly different between the two ages (*Frequency of initiating non-agonistic contact*: p = 0.96; *Frequency of initiating agonistic contact*: p = 0.45; *Frequency of receiving non-agonistic contact*: p = 0.65; *Frequency of receiving agonistic contact*: p = 0.25). However, the correlation analysis did not indicate a relationship at the individual level between the level of social interactions at the young age and the older age (Fig. 3).

Mounting occurred very few times during recording sessions (five, zero and two times in Pen A, B, C, respectively). In both pens the same individual

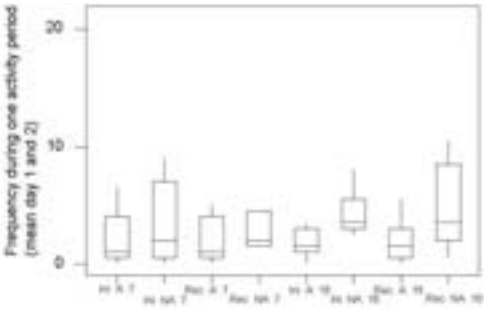

Figure 2. Box plot illustration presenting median values, 25 % and 75 % quartiles, and extreme values regarding behavioural measures of social interaction at two age levels (age 7 and 16 months). The x-axis presents behavioural measures (Ini A: Initiating agonistic contact; Ini NA: Initiating non-agonistic contact; Rec A: Receiving agonistic contact; Rec NA: Receiving non-agonistic contact) for the two age levels (7m and 16m, respectively). The y-axis presents frequencies.

(male) was responsible for all the mounting behaviour. In Pen A, all pen mates (males and females) were subjected to mounting behaviour, whereas in Pen C, the same individual (female) received both incidences of mounting.

The social hierarchy of the pigs in the three groups at seven and 16 months showed a high degree of consistency (Fig. 4) with only two pigs in two groups (Pen A: ID 2 and ID 5; Pen C: ID 5 and ID 6) changing one position during nine months. The two animals climbing to a higher hierarchical level were the same two individuals that performed mounting behaviour at age seven months.

Locomotion and Exploration

Median values for frequencies and durations of behaviours regarding "Locomotion" and "Exploration" at age seven months are presented in Table 2. The animals spent most of their time exploring (median value 1367 sec, i.e., 76 % of the recording period). Obviously, the occurrence of lying was low (median value of Frequency: 0, median value of Duration: 0), as the recording period

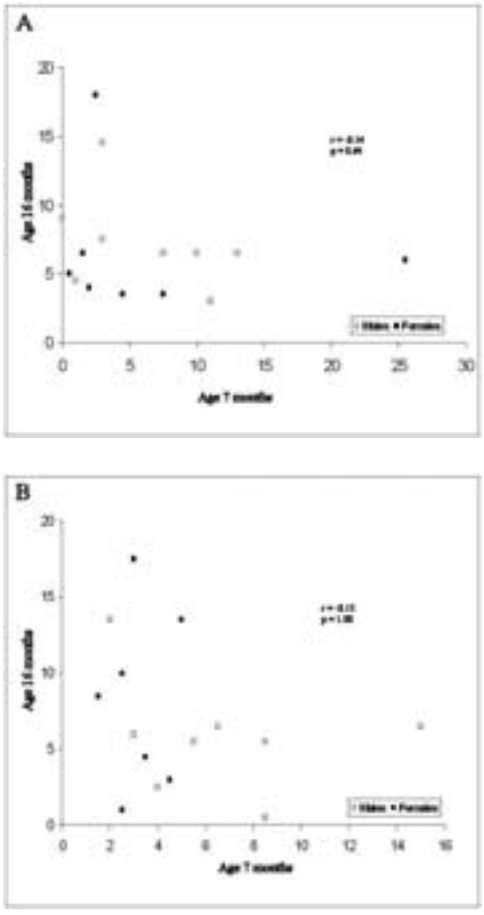

Figure 3. Relationship between individual performance of behavioural measures of social interaction: Frequency of initiating social contact (A) and frequency of receiving social contact (B) at the age of 7 months and at the age of 16 months (Pearson's Partial Correlation Coefficients).

was selected based on activity level.

Resting behaviour

The resting pattern in Pen A, B and C is compared in Fig. 5, where the number of animals *not* resting at a given scanning point (mean day 1 and day 2) is depicted. The data were not subjected to statistical analysis. However, three bouts of activity were conspicuous in all three groups during the six-hours resting period. In all three pens, the most pronounced level of activity was around midnight. At 16 month of age the third period of activity almost disappeared. Comparison of resting pattern at the two age levels is presented in Fig. 6.

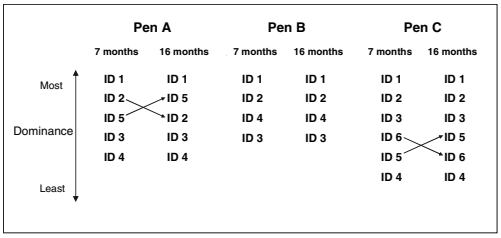

Figure 4. Results from Food Competition Test comparing social hierarchy at the two different age levels (7 and 16 months) for each of the three groups (Pen A, B and C). The animals in each pen are identified by ID numbers (Pen A: five animals, ID 1 – ID 5; Pen B: four animals, ID 1 – ID 4; Pen C: six animals ID 1 – ID 6). The most dominant pig in the pen at each age level is listed at the top, the second most dominant pig underneath and below this, the third most dominant pig, etc. Arrows indicate incidences of dissimilarity between the two age levels.

Effect of light regime

The 24-hours light regime had a statistically significant effect on minipigs' activity pattern on the following day (9.00 am to 4.00 pm): The mean duration per day of *more than three animals active* for the two preceding days with normal illumination (electric light on from 7.30 am to 3.00 pm) was significantly higher than the level recorded on the first day of the 24-hours light regime ($p < 0.05$). However, no statistically significant difference was evident when comparing the mean of two days of normal light provision with the mean of the following two days with 24 hours illumination. Additionally, no difference was found when comparing the mean of two days with normal illumination with the second day of 24 hours artificial lighting.

Table 2. Frequencies and durations (sec.) of behaviours regarding "Locomotion" and "Exploration" (median values, 25 % and 75 % quartiles and extreme values).

Category	Measurement	Behaviour	Median values	Quartiles (25% – 75%)	Extreme values (min. – max.)
Locomotion	Frequency	Standing	11.5	7.0 – 16.8	1.0 – 24.0
		Walking	6.8	4.8 – 9.9	1.0 – 16.0
		Lying	0	0 – 0.1	0 – 1.5
		Running	0	0 – 0.1	0 – 8.0
		Sitting	0	0 – 0	0 – 1.0
	Duration (sec.)	Standing	82.7	37.6 – 185.9	5.0 – 736.2
		Walking	27.5	15.6 – 46.0	2.8 – 62.5
		Lying	0	0 – 0.6	0 – 380.3
		Running	0	0 – 0.3	0 – 34.9
		Sitting	0	0 – 0	0 – 25.1
Exploration	Frequency	Exploring	26	22.3 – 27.8	12,5 – 31.0
		Oral manip.	0.8	0.4 – 1.1	0 – 3.5
	Duration (sec.)	Exploring	1366.5	1094.5 – 1534.3	507.7 – 1631.0
		Oral manip.	2.8	0.8 – 11.6	0 – 44.5

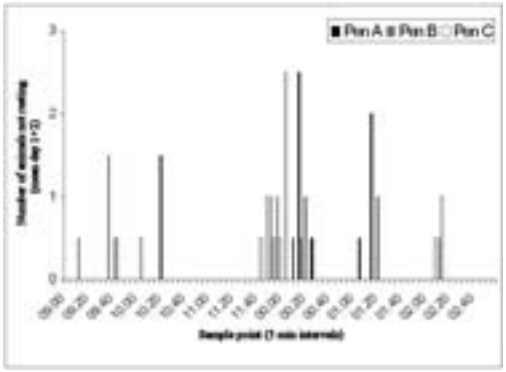

Figure 5. Comparison of the activity pattern between Pen A, B and C when scanning every five min. during the resting period (9.00 pm to 3.00 am). The x-axis illustrates the resting period presented at 15 min intervals; the y-axis shows the average number of animals active (mean pr. day, day 1 and day 2) at the scanning point.

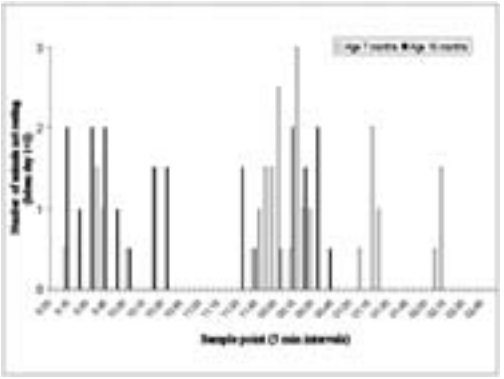

Figure 6. Comparison of activity level during the resting period (9.00 pm to 3.00 am) at two ages (seven and 16 months). Scanning every five minutes. The x-axis illustrates the resting period presented at 15 min intervals; the y-axis shows the average number of animals active (mean pr. day, day 1 and day 2) at the scanning point.

Discussion

Little work has focused on minipig behaviour as compared to other laboratory animal species, many of which have been studied in great detail. Comparison with other social laboratory animal species often entails difficulty, since the behavioural repertoire of the minipig deviates in many aspects from that of non-human primates and rodents. For instance, despite having complex social relationships, pigs spend relatively little time grooming group mates. On the other hand, many

similarities between the behaviour of minipigs and that of production pigs exist, as for instance regarding diurnal rhythm, behavioural patterns as well as time budget. This is supported by the findings of the present study.

Choosing the appropriate time of day at which to observe behaviour is an important practical aspect in behavioural studies. Obviously, animals are not equally active throughout the 24-hours period. The amount of activity seen by the observer will depend on the time of day at which the subjects are monitored. In the present study the pigs showed a period of activity after feeding. These findings are in compliance with the activity pattern typically seen with minipigs as well as production pigs. For instance, Sippel & Oldigs (*1982*) studied the time budgets of Göttingen minipig behaviour and found that the activity level increased around feed allocation, which was once a day. Pigs used for experimental purposes as well as production pigs are typically fed twice a day – in the morning and in the afternoon – thus displaying a period of activity before noon and in the late afternoon. Consistent with studies on production pigs (e.g. *Jensen et al., 1996*) the results of this study indicate that the activity period after afternoon feeding may provide the longest duration of activity in minipigs. Thus, this time window may be the most suitable time of day for recording behaviours related to activity (social interaction, locomotion and exploratory behaviour). The median values for all behavioural measurements of social behaviour are below four events per individual during one activity period of 30 min duration. This level is comparable to the level found in an earlier study of Göttingen behaviour (*Sippel & Oldigs, 1982*). The range of agonistic behaviour observed in the present cohort of pigs seems equivalent to the findings in a study in production pigs where the range of agonistic behaviour was independent of the provision of straw in the morning *(Fraser et al., 1991)*.

The level of social interaction at the two age levels (seven vs. 16 months) in our study was not statistically different regarding the four behavioural measures in question (Frequency of initiating and receiving non-agonistic and agonistic contact). This confirms earlier findings regarding agonistic encounters, but not playing behaviour *(Sippel & Oldigs, 1982)*, which, however, did not include pigs older than nine months.

In the present study it was not possible to demonstrate consistency in the individual level of social behaviour between ages (Frequency of initiating and receiving social contact at age seven and 16 months) (Fig. 3). Nevertheless, in some aspects a uniformity of individual social behaviour between ages was supported by the findings that the social hierarchy was stable between the two age levels (Fig. 4). It is likely that the time window for observation should be larger for a consistency in social behaviour to be reflected in the behavioural registrations. In general, a considerable variation between days may be expected regarding the frequency of social interaction, as social behaviour depends on the motivational states of at least two pigs. For instance, the difference in stages in the ovarian cycle for the female subjects may have influenced the findings, as this has been reported to affect various aspects of behaviour *(Signoret, 1970)*.

The pigs were occupied by exploring for most of the 30 min recording session (median duration > 22 min). These results confirm a well-known fact about pigs: as pigs possess a great explorative and investigative motivation, they will spend relatively much of their active time rooting and exploring the surroundings *(Stolba & Wood-Gush, 1989)*.

The investigative motivation is primarily obvious in connection with food-seeking situations *(Day et al., 1996)*, but even in the absence of suitable external stimuli, pigs appear to be motivated to carry out exploratory behaviour *(Wood-Gush & Vestergaard, 1993; Beattie & O'Connel, 2002)*. The animals in the present study were provided with straw bedding, which has been found to be a suitable item for exploration in pigs, thus having a reducing effect on oral manipulation of pen mates *(Beattie et al., 2001; Fraser et al., 1991)*. As a result, in the home

pen healthy pigs were not expected to spend much time manipulating the pen's contents if a relevant substratum for exploratory behaviour was available, as this is not food-related. This relationship was evident in the present results (oral manipulation less than one sec per 30 min recording session) (Table 2).

In contrast to exploration, standing, as defined in the ethogram (Table 1), is not considered a common behaviour in pigs. In the present study, however, the median duration of standing was 82.7 sec per 30 min during the activity period (Table 2).

The animals in the three groups (Pen A, B and C) showed uniformity in resting pattern, since the activity was clustered in somewhat homogeneous bouts (Fig. 6). So, despite the fact that the three groups were video recorded on different days and that visual contact was not possible between pens, the 16 animals in the study showed a similar resting pattern. This may also have been expected, as social facilitation is a common feature in pig behaviour including resting pattern *(Stolba & Wood-Gush, 1989*).

Comparing the resting pattern of the animals by subjective assessment, it seems that only two of the three bouts conspicuous at age seven months were evident at the age of 16 months, when scanning every five min during the resting period (9.00 - 10.30 pm and 11.30 pm - 00.30 am) (Fig. 6). The activity bout around midnight was more protracted at 16 months of age (from 11.30 pm to 00.40 am) as compared to age seven months (from 11.40 pm to 00.20 am). It may be speculated that this difference is due to the fact that the two data acquisitions took place at two different times a year (February and November). Yet, the length of the day differs only by approximately half an hour (8 h 40 min and 9 h 15 min, respectively). Also, the light and temperature regimes in the research facility were constant so the time of year is not expected to explain this difference. For this, a more thorough analysis would be needed. Although the constant light did not seem to affect the level of activity during daytime, it may have caused bouts of activity instead of sleeping in the evening/night.

In the present study the spontaneous behaviour of Göttingen minipigs was quantified in their home pens. The experimental set-up sought to fulfil this criterion taking into consideration that it should also be possible to carry out the study in a modern experimental animal facility. The home pens offered eight times as much space per animal than legally required according to the revised appendix A of the convention ETS 123 of the Council of Europe (www.coe.int). We did not observe obvious abnormal behaviour in this cohort of pigs, which is essential in laboratory animal science, where animal models are used to study normal biological processes as well as to model abnormal or pathological processes underlying human disorders. Evidence from the literature clearly shows increased occurrence of abnormal behaviour if the animals are not kept in an enriched environment *(Beattie et al., 1996)*, which would imply limitations for evaluation of behaviour deviating from normal standards.

However, it may be argued that many compromises to the norm were taken in the present study. During video recording the sizes of the pens were reduced. This was done about a week prior to video recordings in order to accustom the pigs to the unfamiliar dimension of the pen. It might be expected that the new shape and size of the pen would influence the behaviour of the pigs, as they may have to consider new places for resting and dunging *(Wiegand et al., 1994)*. Nevertheless, the behaviour of the pigs in the present study seemed unaffected, since the animals used the same position in the pen for resting and dunging as before reducing the pen size. In addition unsystematic observation did not reveal obvious changes in behaviour.

During recording periods, natural illumination was kept out of the pens by black curtains covering the windows, whereas electric illumination was provided for the entire recording period – also during the night. This was done due to technical limits of the camera equipment. Since the animals were habituated to a 24-hour light regime two to three days

prior to video recording, the 24-hour light schedule at the time of video recording was thought to have insignificant impact on the behaviour of the animals and thus the results of the study. This was supported by the findings that the pigs showed a significantly elevated activity during daytime only on the first day after 24 hours of illumination, whereas the activity level fell to normal on the second day of 24-hour light provision.

Prior to video recording, the pigs were handled in relation to applying markings for individual recognition on their backs. Handling may be very stressful for pigs, as documented in various studies investigating the effect of handling for instance in relation to slaughter procedures *(Matthews et al., 2001)*. However, since the animals were already accustomed to handling in relation to other behavioural testing, the impact of handling is thought to be of less significance in the present study. This is supported by findings that regularly handled pigs were quicker to approach and physically interact with an experimenter *(Hemsworth et al., 1996)*. Similarly, it is possible to tame Göttingen minipigs and thus artificially control the reaction of minipigs towards humans by habituating the animals to human contact *(Tsutsumi et al., 2001)*.

Preceding data collection, the animals had been exposed to other behavioural experiments (cognitive testing and behavioural tests: Novelty test and Open Field test). Generally, it is desired to avoid using animals that have been exposed to previous experimentation due to possible impact on the results of the study. However, we consider the earlier administration of a single dose of the psychostimulating drug amphetamine to our test animals to have little effect on the results of the present study as the similar treatment of squirrel monkeys *(Sams-Dodd & Newman, 1997)* and rats *(Sams-Dodd, 1995)* produced no consistent effects on social behaviour.

In summary, in this study we have quantified the spontaneous behaviour in the home pen of minipigs, covering various aspects of activity pattern, social behaviour, locomotion, and resting behaviour. Minipigs are diurnal with an increase in activity level after feed allocation in the morning and afternoon. They form a stable social hierarchy, and the level of social behaviour does not seem to differ between seven months old and 16 months old animals. Minipigs spend a considerable amount of their time exploring the surroundings. They show a relatively uniform resting behaviour in nighttime between individuals and different ages. As such, the findings indicate that the behaviour seen in the present study is consistent with the behaviour of production pigs, despite the fact that some modifications regarding the home pen environment were made at the time of data acquisition. Since little was known about the spontaneous behaviour of Göttingen minipigs, this characterisation of normal behaviour may serve as a baseline data for other studies of minipig behaviour.

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