Social Behavior of Pigs

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Abstract

Improper social behavior development brings problems in later social life. Several time points are known to be crucial for the development and in other words, susceptible to interruptions during those time points. In conventional pigs, those time points could be categorized to three interaction periods, the period for piglet-sow interaction (suckling), between littermates interaction (before weaning), social interaction with other littermates (after weaning).

In this research, 4 cages (51 pigs) of pigs were observed for figuring out circadian rhythm and social behavior pattern. In group observation, the circadian rhythm of conventional pigs was established as a pair of active hours in early morning and early evening. Over three recordings of three different time points of day 10, 14 and 24, the behavior status 'active' increased with their physical developmental status and this is suggesting increase in potential social behaviors. In individual observation, the environmental change induced by maternal separation and mixing of other littermates resulted change in specific social behavioral pattern. Additional second individual observation also showed changed social behavioral pattern.

The results in this research could suggest the needs for proper social behavioral development according to the critical time points and social environmental changes so that prevent existing behavioral problems and improve the welfare of conventional farm pigs.

Introduction

Social behavior

Social behavior in animals can be easily differentiated from other behaviors by its distinguishing features. The most distinguishing features are involvements of two or more animals during the behavior and existence of communication between the animals to initiate the behavior. This communication does not necessarily need to be the form of verbal languages like in human animals, but it should be a signal which is enough to affect the intention of reciprocal body to provoke any response such as, change in facial expression or ongoing behavior (Deag 1980). By following currently used definition, social behavior is limited in the boundary of 'within the same species (Robinson 2008) but, it needs to be reconsidered if the behavior also can involve the behaviors between two or more different species. In this context, not like the usage in describing human behavior, 'social' does not mean the meaning of the context talking about being 'social' versus 'anti-social'. For example, fighting is a social behavior as well as play behavior.

Behavior, environment, gene and the brain

Behavior is the final phenotype that is expressed as the result of the orchestrated work among inherited and environmental influences and the brain acting on the same substrates, the genome (Robinson 2004). From evolutionary to contemporary history, the environment has been a major trigger to make variations in the social behavior of the animals. Some of the variations became to be adaptive traits and conserved through evolutionary time. The hormones playing important role in social behavior expression such as, vasopressin and oxytocin and their neural circuits can be the examples. Also, in the life time of individuals, the environment influences gene expression in the brain to bring behavioral change in shorter time scale. Although, there have been still discussions about 'nature-versus-nurture' to decide which factor is having more control on social behavior, it is currently generalized that DNA itself, is both inherited and

environmentally responsive, after all, working in a continuous gene-environment-behavior circle (Chakravarti et al, 2003). There are some results supporting the generalization in some species such as song birds (Mello et al, 1992), cichlid fish (S. S. Burmeister, E. D. Jarvis, R. D. Fernald, *PloS Biol. 3, e363 2005) and* honey bee (C. W. Whitfield, A.-M. Cziko, G. E. Robinson*, Science 302, 296 2003).*

Development of social behavior

In development of social behavior, the very first social encounter for an animal is with its mother. The importance of maternal care for the development of social behavior has been one of the major study subjects among researchers. There are several striking results proving that improper maternal care can bring negative alteration in the animal's later social life. Harlow's classic experiments in infant monkeys showed several associated examples. The infant monkeys isolated from, especially physical contact with their mothers and other monkeys for the first eight months, had severe problem in developing affectional tie or relationship with others in their later lives (Harry F. Harlow*, 1959*). In rats, females that give attention to their pups extensively have offspring that are less responsive to stress and more responsive to their own pups. This means maternal care pattern can even have an effect on the genetic potential of the next generation in epigenetic scale (F. A. Champagne, D. D. Francis, A. Mar, M. 2003).

After or overlapping the critical period of maternal care, the infant animals become curious about the outside world of their mothers and they start to explore it. So they naturally encounter the objects around them, their littermates or peers of other groups. During this another critical period for behavior development, they show unique behavior pattern of play behavior. This play pattern is highly influenced by the previous maternal care period. Following one of the Harlow's classic experiment results, the monkeys deprived from all the physical contact during the first eight months showed far less assurance and activity to explore the outside world other than their own shelters. Naturally, there was debases and delays in appearance of the play behaviour (Harlow, H.F. & Zimmemann, R.R., 1958).

Play behavior and social play behavior

Play behavior can be categorized to several specific play behaviors with patterns of object, locomotor and social play (Marc Bekoff and John A., 1998). Among these patterns, social play behaviour is considered to be most involved in the development of social behavior. Similar to the definition of social behavior, social play behaviour is defined as all the play activities that involve two or more players simultaneously. However, defining play behavior itself through mere observation has been considered not clear enough to do so because play behaviors do not remarkably differ from the motor patterns in other contexts. For example, even though play fighting behavior is not supposed to harm the relationship between the animals involved in the movement, it is not easy to differentiate from fighting behavior which is meant to attack the reciprocal body in aggressive contexts. Nevertheless, there are some criteria to specify this unique behavior pattern, social play behavior.

Play behaviour, neural substrates and function

Social play behavior, like other play behaviors occurs majorly during the animal's juvenility (Byers, J. A., and C., 1995). The neural basis of social play behavior is relatively remained unexplored though, there are some results suggesting related neural basis of social play behavior. Among the reported researches, two of the main brain areas involved in social play behavior is the neocortex and cerebellum. In the research results about relationship between the neocortex and social play behavior, only social play frequency was significantly and positively related to the neocortex ratio (Lewis, K. P., 2000). Also, the increase in the neocortex size was parallel to the increase in group network sizes in primates and carnivores (Dunbar, R.I.M. , 1995). Another focused brain area is the cerebellum. The similarity of social play behavior with social behavior in other contexts can actually risk the animal into dangerous situation to get injured. To avoid this risk, the movement or cues should be clear and specific enough to indicate 'play' mood to the reciprocal animals. To control accurate and fine movement with the motor coordination and balance, the role of the cerebellum is crucial (Bloedel, J.R., 1992). It is suggested that the development of the cerebellum tend to be together with the development of the neocortex (Barton R.A., and P. H. Harvey, 2000) and developmental period of these brain areas coincides with the general time for appearance of social play behavior (Fairbanks, L. A.,2000). The research about the synaptogenesis in the

cerebellum and play behavior in mice(locomotor play), cats(social play), and rats(locomotor play and social play) showed that one of the main effects of all play behaviors is cerebellar synaptogenesis and all these play behavior patterns might be scheduled to actively modify or terminate synapse formation in the cerebellum. This result characterizes another sensitive period of mammalian social behavior development (Byers, J. A., and C. Walker, 1995).

Through the studies about social play behavior, the function of this behavior has been drawn. It had been speculated for a long time that the behavior has no actual function for adaptation but now common conclusion has been made among researchers. The potential conclusion is that social play behavior is working as a no-planned rehearsal event before the actual social event is occurred so that the animals can learn how to deal with actual social situations from the practice in relatively safe and playful mood before their adult life. Even though not all the social behavior can be practiced and prepared during the play, social play behavior can be work as a medium for enhancing and promoting some adult social skills, such as fighting, social interactions, and dominance relationships (Martain, P., and T. M. Caro, 1985). There is a research about the relationship between the extended juvenile period and the relative neocortex size in primates. Although having a longer juvenile period before having full reproductive capacity can be considered maladaptive trait in most animals, in primates, especially extended juvenility is observed., This pattern in primates is considered as a highly selective and adaptive trait because of their complex social system and consequential needs for practicing to learn more complex social skills drawn from the system. (Joffe, T.H., 1997). Preventing social play behavior at critical juvenile period showed negative effect on adult social relationships in rats (Hol, T., C.L. Van den Berg, J.M. Van Ree, and B.M. Spruijt, 1999). In humans, social play in childhood is considered essential part of the child's life. Rough-and-tumble play is considered to have a crucial role in developing social and emotional self-regulation and also social competence especially in boys (Pellegrini, A. Rough, 1987). Children with autism are known to have difficulty to get involved especially in social play with other children. With the fact that the nature of autism is characterized with impairment of social interaction and communication, the deprived social play in these children seems absolute and completely irreversible. Especially, the difficulty initiating and engaging in social play in these children make them more socially deprived and inactive. However, the attempt to teach social play skills in sophisticated way and help initiation of social play in these children have worked on exhibiting social play behavior. This work suggests that

helping these children to exhibit social play behavior can decrease the secondary effect of deficiency in social behavior (Oke, N. J. & Schreibman L., 2003).

By the previous works explained above, the general concept of the function of social play behavior is known as a vital facilitator of social skills which will be utilized in later adulthood, facilitating social relationship with others.

Social behavior in pigs

Social behavior of pigs is not well known among people in general however, people who have ever kept eyes on them can easily recognize their rich social behavior repertoires. Wild boars which are known to be the ancestors of domestic pigs in contemporary farms show diverse social behaviors in natural environment. In a study with domesticated pigs released in natural environment showed that the pigs can easily express their social behaviors like their ancestors (Stolba A & Wood-Gush D., 1989).

At birth, piglets become to set hierarchies by setting teat order. The first pair of teats is usually considered to have more milk and the piglets suckling those teats become the largest ones among the group. This order is formed within the first 48 hours and change in the order is rare (The Merck veterinary manual, 2008). During the period of suckling, piglets show social repertoires with their sows and littermates. Around the age of weaning in domesticated pigs, pigs start to express more diverse and broad behavior pattern such as, exploring the pens, manipulating materials around them and nuzzling each other. Each can be recognized as one type of the play behaviors. Therefore, it can be supposed that conventional pigs also have similar social behavior developmental patterns of other mammals. However, the current conventional environment is not preferable and thought to be the cause of behavioral problems in domestic pigs. The suggested causes are the conventional raring cage depriving mother-child interaction, early weaning age preventing social interactions between littermates and enforced mixing of different litter mates. These can bring interruptions to natural social behavior developmental phases and have serial and continuous effect to the following next phases.

There are not many researches about the direct cause-effect relationship of those factors but, by sudden mixing of litter groups, enforced hierarchy setting and following aggressive behavior is common problem in current farms. Easily observable tail and ear biting in juvenile pigs is also considered as one of the side effects of the

conventional farming. Preventing expression of natural behavior and forced stereotypic behaviors are apparently harming the welfare of pigs. With those concerns above, to know better about social repertoires of conventional pigs and to study their social behavior development, the following research project was conducted with several research questions and related goals.

Research questions

Can we distinguish social play behavior from other forms of behavior in pigs?
Do we see changes in frequency of social interactions according to developmental stage and environmental changes?

Project goals

1. Establishing ethogram of social play behaviors in pigs
2. Finding circadian rhythm of piglets
3. Studying change in the behavioral pattern according to the developmental stages
4. Studying the effect of environmental change on specific behavior frequency

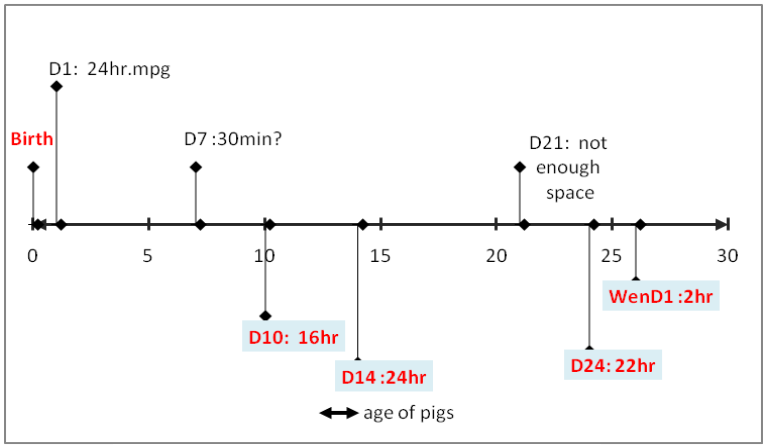


Figure 1. Timeline of recordings

Materials and method

Subjects

Overall, 57 pigs were observed. There were 51 pigs of 4 litter groups born on the same week and caged in 4 cages of 2,3,8,9. With 51 pigs, group observation was conducted and among the 51 pigs, 6 pigs were specifically chosen for individual observation. The litter sizes of 4 cages were 13,12,13,13 ~~pigs~~ in cage 2,3,8,9 respectively and their gender distribution was 41% female and 59% male in general. Average weights of the pigs were 6.2kg, 7.3kg, 6.8kg and 6.8kg in four litters.

For individual observation, 6 randomly chosen pigs were observed. They were pig number 6, 9 in cage3, number 1, 6 in cage8 and number 7, 12 in cage9 with gender portions of 50%and 50%. In the second individual observation, with semi-natural environment, 6 female pigs living in previous pony stable were observed.

The pigs observed in group observation were marked with color spray for farm animal indication using the international Braille alphabet (Figure.2) method. The pigs in semi-natural stable were also marked to in different way to identify individuals. The pigs were periodically remarked in the same way. All the pigs were under standard management protocol of Tolakker farm at Utrecht University, the Netherlands.

Picture 1

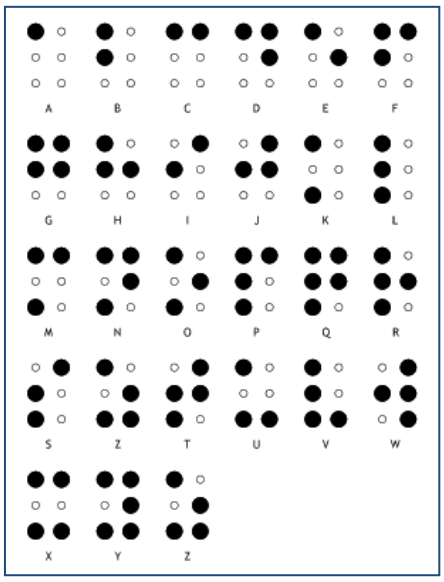


Figure 2

Recording and scoring materials

MPEG recorder and Observer XT 8 from the Noldus:

To record the behavior of pigs, the program MPEG recorder was used with accessory devices of 4 CCD (charge coupled device) video cameras, microphones for audio recording, 8 infrared (IR) lights and a desktop computer. The cameras were attached on the ceilings of each cage to have the whole pigs with their sows in one screen (Pic.1).

The program Observer XT8 was used for scoring behaviors watching recorded videos (Fig.5). With this program basic behavioral analysis such as descriptive statistics, time bin analysis and visualizations of the results are also possible. Recordings were conducted following the schedule of the observation timeline however, not all the recordings were successful due to practical problems (Fig.1).

Observation plan

Observation plan was set to fulfil the research goals. It was in 4 categories; prior observation, group observation, first individual observation and second individual observation. Prior observation was for recognizing and differentiating social behaviors to establish ethogram for further behavioral scoring. Group observation was the observation of several litter groups to figure out the general behavioral pattern shaping their circadian rhythm and change in their behavioral pattern. Individual observation was observation of several individual pigs, scoring the frequencies of their specific behaviors. In individual observation2, the pigs living in semi-natural environment were observed for especially the effect of changed physical environment.

To know the circadian rhythm of activity and compare the change in their behavioral pattern, several 24 hours observations of each critical time point were planned. Individual observation was planned according to the result of group observation demonstrating specific two hours with active social behavior exhibition. The second individual observation was observing pigs housed in the previous pony stable resembling semi-natural environment during the same time amount and schedule of the first individual observation. According to the observation plan, the timeline of observation could be drawn (Fig.1).

Group observation

In the program observer, coding scheme setting was done before behavior scoring. It is briefly composed of three components, subjects, behaviors and modifiers. In the category of 'subject' the numbers of cages were input implying four subjects in total. For group observation, to get the activity pattern of conventional farm pigs, the behavior states of active and inactive were investigated. In modifiers panel, specifying each behavior state, 'suckling', 'other activity', 'manipulating sow's body part' or 'peer's body part' and 'interaction with sow or peer' were set for active state and for inactive state, 'lying' and 'sleeping' were set. All the behaviors and modifiers were state event and mutually exclusive so that only one behavior and modifier could be scored without overlapping.

The criteria to score each behavior were defined. If two or more pigs were suckling then it was scored as 'suckling'. A state engaging 1 or more pig in other activity then it was scored other activity and if all the pigs except for one pig, those state were scored as 'inactive'.

Group observation	Behaviors	Modifiers	Reciprocal body	Number of piglets
	Active	Suckling		2≤
		other activity	with sow	1≤
			with a peer	
	Inactive	lying		n-1≤
		sleeping		n-1≤

Figure.3 Coding scheme and criteria for group

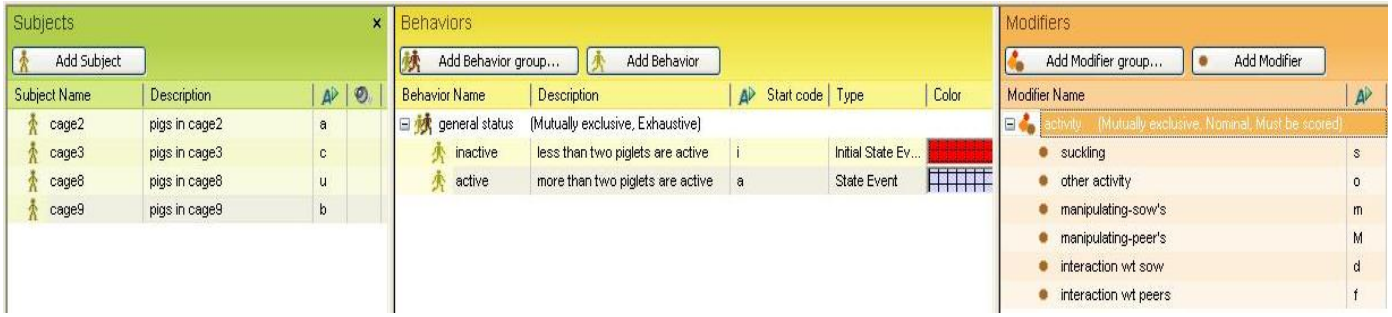


Figure.4 Coding scheme of group observation

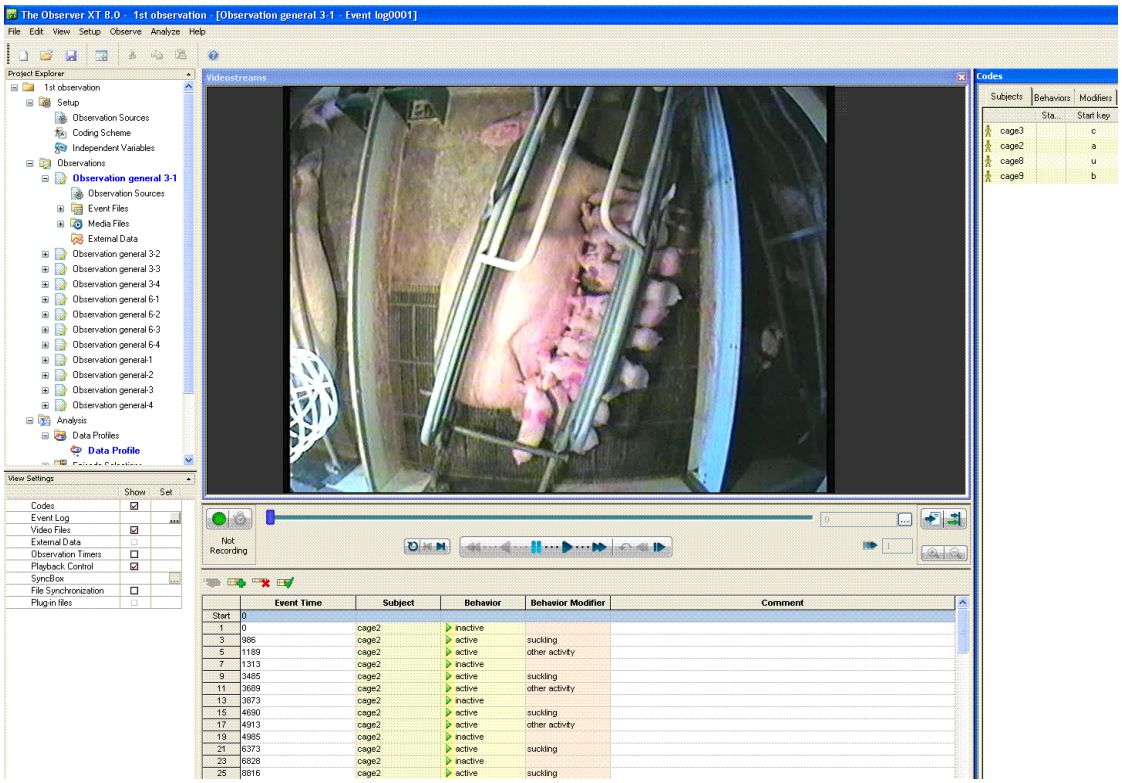


Figure.5 Screen shot of the Observer XT8

Individual observation

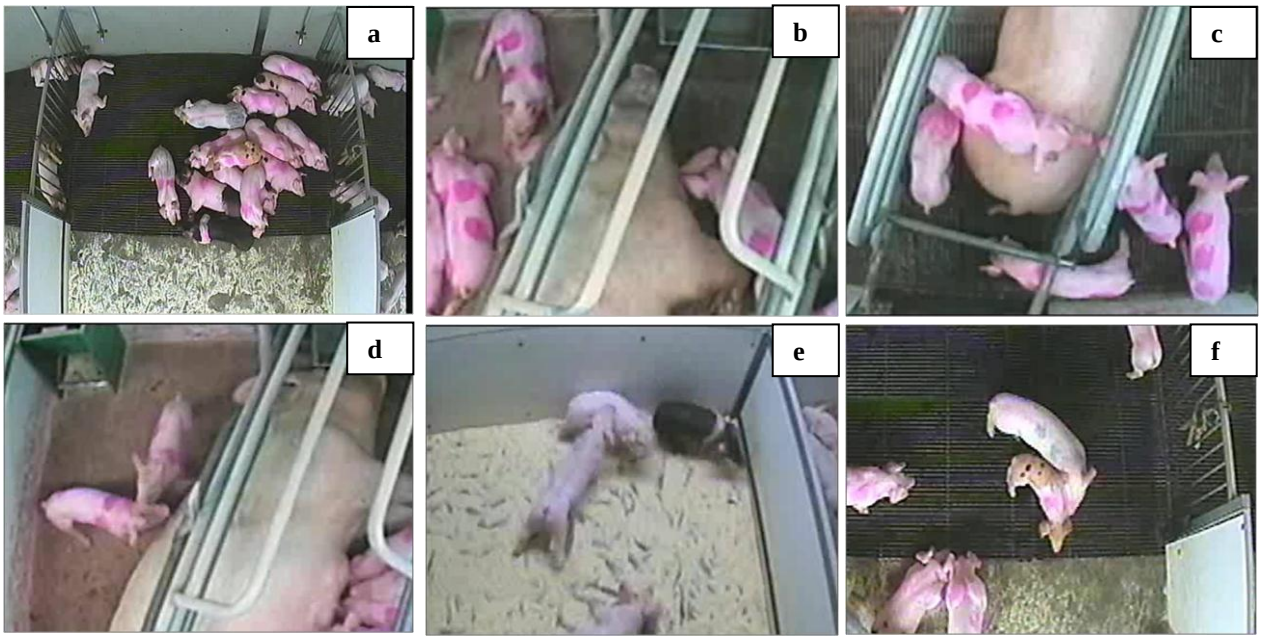
Individual observation was for observing specific behaviors of six pigs individually. Therefore, the coding scheme of individual observation was composed of subjects of 6 pigs, 8 behaviors of 'nuzzling', 'body contact', 'climbing', 'being climbed', 'chasing', 'being chased', 'chain-stick (enrichment) manipulation', 'other behavior'. The descriptions of the behavior and criteria are shown on the figure 6 below. By describing each specific behavior, ethogram of specific behaviors was established.

Behavior	Criteria/ Description	detail
Nuzzling	To rub or push against gently with the nose or snout	Littermates / others
Body contact	Touching by part of the body except for nose	≥ 5 sec
Climbing	Stepping and lining on top of one or more pigs	On peers / sow / a peer
Being climbed	Being stepped or lined by a pig	
Chasing	Walking or running after a pig	
Being chased	Being followed by a pig	
Chain-stick manipulation	Nosing the attached enrichment materials	
Eating	Drinking and consumption of food	
Other behavior	Any other behaviors than above	

Figure 6 Specific behaviors and criteria for scoring

To score specific behaviors, coding scheme of the program the Observer XT8 was set. The subjects for the first individual observation were 3-6 (pig number 6 in cage 3), 9, 8-1, 6 and 9-7, 12. In behavior category, 'inactive', 'nosing (nuzzling)', 'body contact', 'chasing', 'being chased', 'climbing', 'being climbed', 'chain stick (enrichment)' and 'other behavior' were coded. The behaviors conducted with reciprocal bodies in the list were connected to the modifier, which is an additional category specifying which cage group the reciprocal bodies are from. Also, for the behaviors of 'nuzzling' and 'body contact', the modifiers specifying body parts were connected. The behaviors of 'inactive' and 'other behavior' were state events and other behaviors like 'nuzzling' having without continuity were scored as point events. So point events (behaviors) could be scored as frequencies than time amount. All the point behaviors were mutually exclusive so that each behavior could be scored independently (Fig.7). The same coding scheme and scoring criteria were used for the second individual observation.

Figure.7 Coding scheme of individual observation



Picture2. Specific behaviors
a) inactive, b) nuzzling ears of sow, c)climbing on sow, d)nuzzling littermates, e) chasing, f) body contact

Results

Group observation

Change in activity pattern and within subjects contrast: Relatively regular activity pattern was observed and visualized (fig.8). Generally they showed 'active' pattern in the early morning and early evening. After finishing observation and scoring of three different time points, day10, day14 and day24, the percentages of active state during the recording hours could be analyzed (Fig.9). The active state percentage was increased in all 4 cages according to their ages (day) (Fig.10).

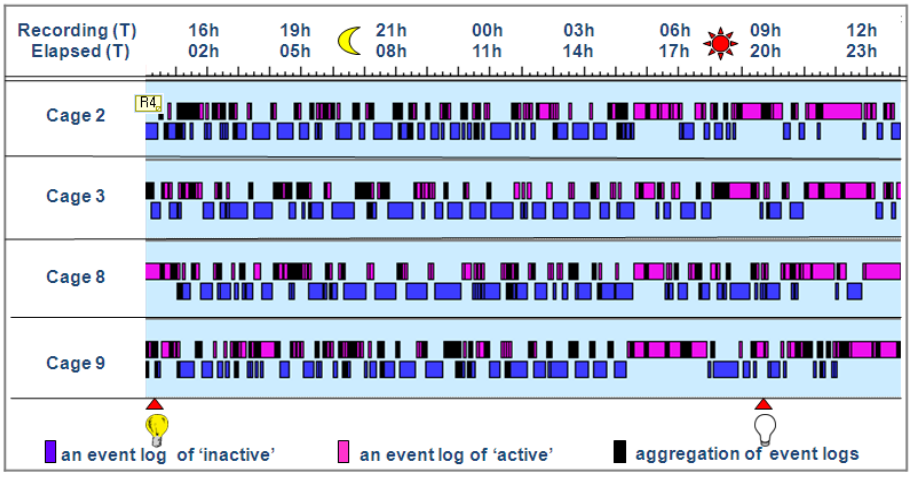


Figure 8 Visualization of activity pattern of group observation at day 14

Cage \ Day	D10(16hr)	D14(24hr)	D24(22hr)
2	33.50	47.70	50.50
3	41.70	49.30	54.50
8	42.70	53.60	60.10
9	43.50	56.50	60.20

Figure 9 Activity (%)

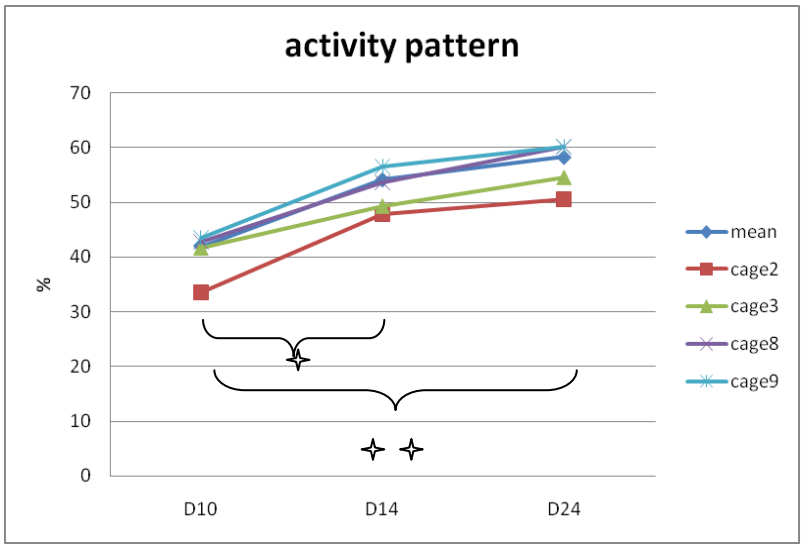


Figure.10 Change in activity pattern according to the age of pigs

The result of test of within subjects contrast in general linear model repeated measures of ANOVA showed more significant contrast between day10 and day24 (p-value: 0.004, f-value: 62.436) than the contrast of day10 and day14 (p-value:0.001, f-value:223.738).

Time bin analysis

Time bin analysis is done to know the behavioral results within specific interval. The whole scored results can be chopped into several or many short observations with chosen specific time amount or the observation can be divided into chosen numbers of intervals of specific time amount. The time bin results can be used to compare the behavior pattern of a specific time point to other time points in one observation. In this research, we divided the group observations results into from 16 to 24 intervals of one hour (Fig. 11).

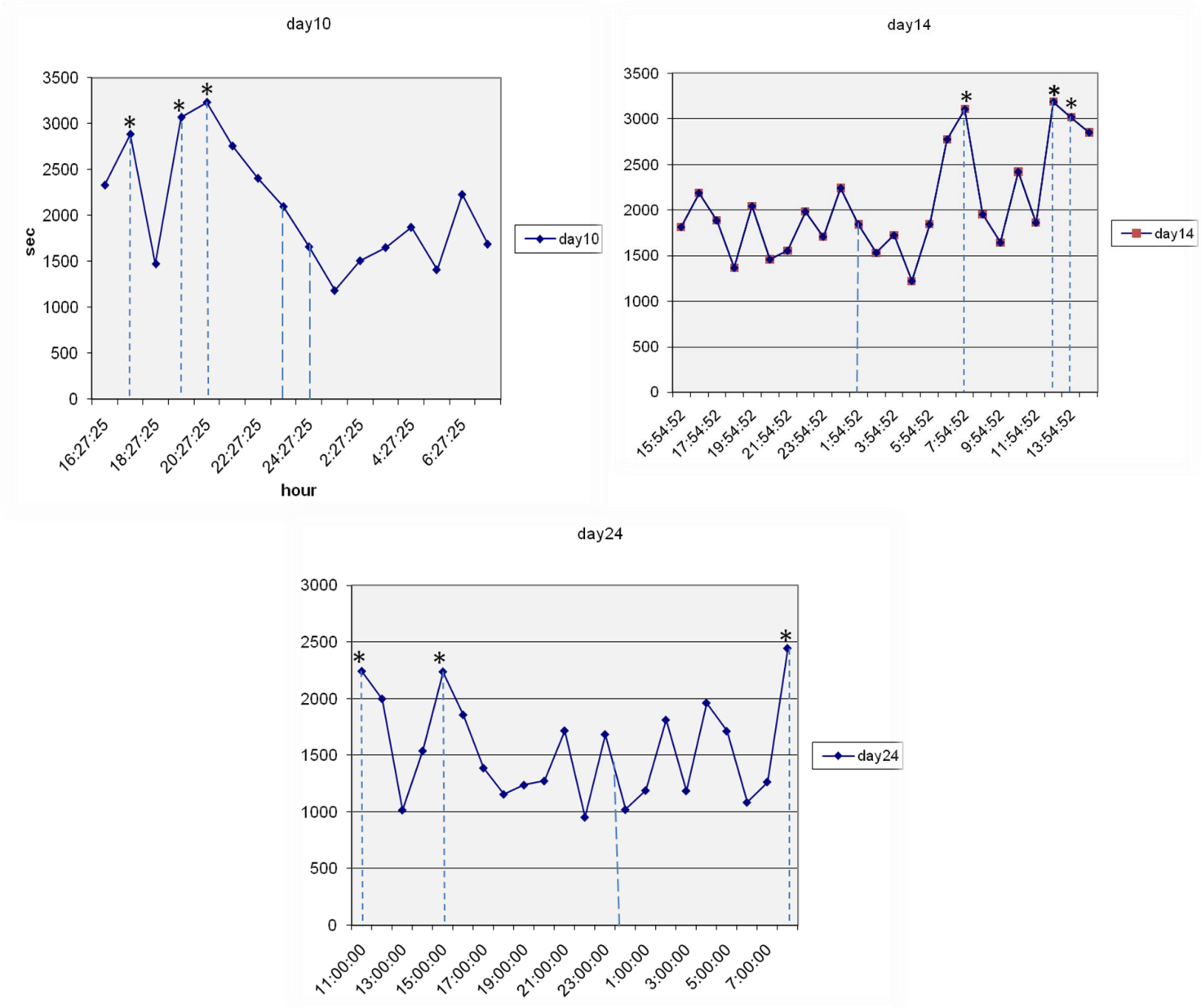


Figure 11 Time bin results of day10, 14 and 24

With time bin results, simple contrast analysis was possible to compare activity during other hours to the activity during a specific hour. From 00:00 to 01:00 was chosen for the specific hour and compared to every hour. Several hours showed significant contrast to the activity of the hour from 00:00 to 01:00. At day 10, in the hours, at around from 20:30 to 21:30, from 19:30 to 20:30 and from 17:30 to 18:30 most contrast was observed in descending order. Here some hours from 08:27 till 16:27 were missed in recording due to practical problem. At day14, the hours between 1 and 2 and 2 and 3 in the afternoon, between 8 and 9 in the morning showed more contrast then other hours. At day 24, in the time bin result of 9 and 11 in the morning and 3 in the afternoon, there were more significant contrasts to the specific hour of midnight than other hours.

Individual observation

The results of individual observation of two different time points were compared by paired sample t-test. At day 24, the 6 subjects were in the cage with their sows and littermates. At day 25 they were separated from their mothers and mixed with other littermates. The change in cage group members brought changes to specific behavior frequencies. The behaviors with more significant differences were behavior 'nuzzling' and 'being climbed'. The behavior 'chain stick' was not be able to happen because there was no enrichment material in the cage of day 24.
(Fig. 12)

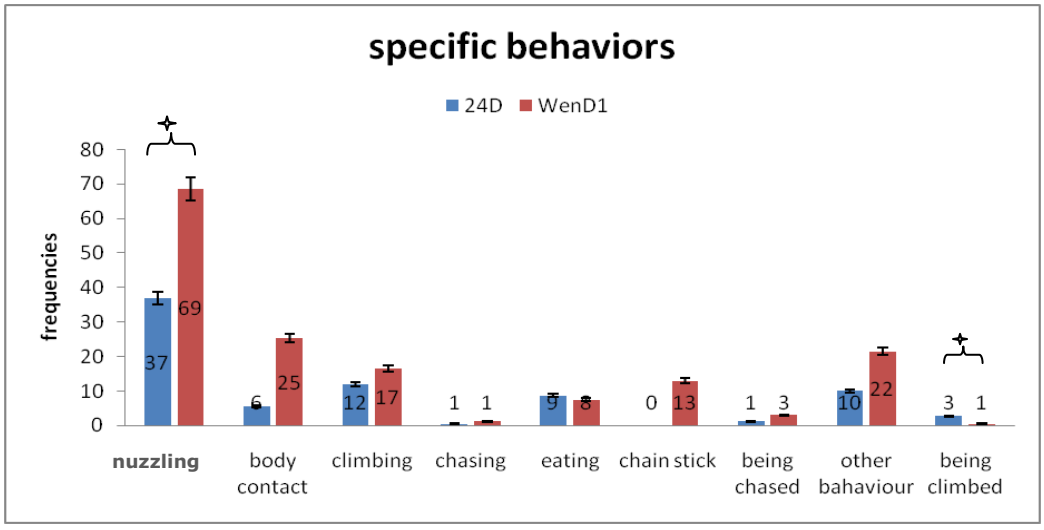


Figure12. Paired sample t-test result of specific behaviors on day24 and weaned day1

Detailed 'nuzzling' and 'climbing' pattern of one representative subject pig 3-9 is being shown in the graph. 'Nuzzling littermates' were the most frequent however the pigs nuzzled their sows as well as their littermates with the rate at around one third of the rate 'nuzzling littermates'. They also climbed onto their sows with relatively low frequency. 'Climbing on group' was more frequent than 'climbing on one' and this happened just before sleeping on the group followed behavior 'sleeping' (Fig.13).

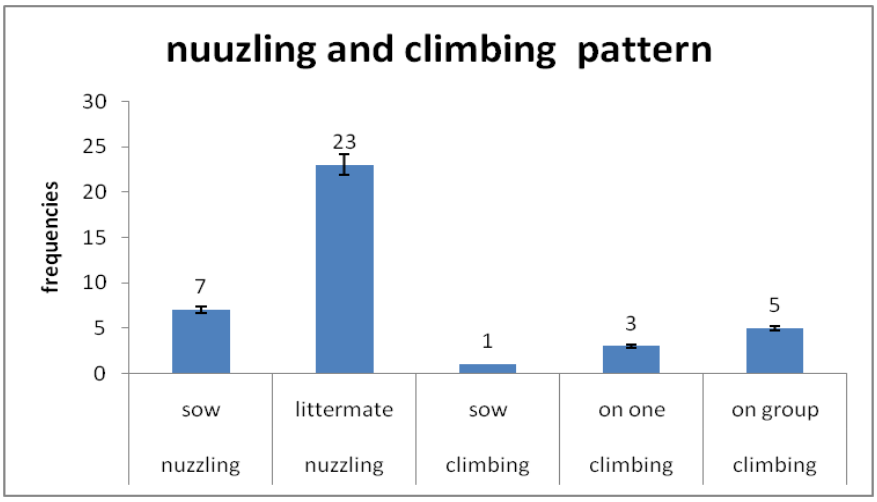


Figure13. Nuzzling and climbing pattern of 3-9 at day24

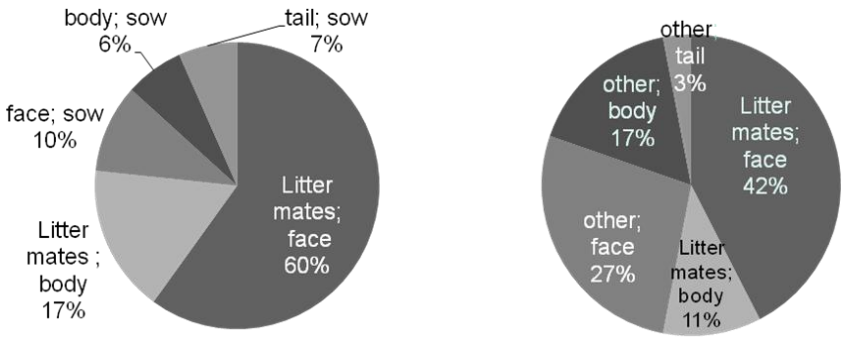


Figure 14. 'Nuzzling' pattern of 3-9 on day24 (L) and weaned day1(R)

Looking into the behavior 'nuzzling', on day24 and weaned day1 of pig 3-9, on day24 the body part nuzzling sow were face (10%), body (6%) and tail(7%). Nuzzling among littermates was mainly to face of the pigs. On weaned day 1, 47 percent of nuzzling frequency was to other litter group, face (27%), body (17%) and tail (3%)(Fig. 14).

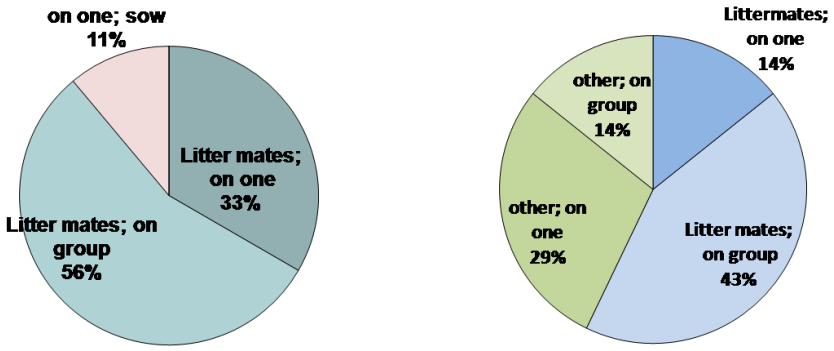


Figure 15 'Climbing' pattern of 3-9 on day24 (L) and weaned day1(R)

In climbing pattern of two days of the subject pig 3-9, comparing the results on day24 to the results weaned day 1, 'climbing on the same litter group' was the most frequent climbing pattern in both days,56% and 43% respectively, but on weaned day1 'climbing on the other littermate(29%)' followed the behavior(43%). In the average of 6 pigs, the frequency of nuzzling other littermates (53%) was higher than nuzzling the same littermates (47%) on weaned day1 and climbing on other littermates had lower frequency(45%) than climbing on the same littermates had(55%).

Second individual observation

Similar behavior pattern could be observed but it showed much lower frequencies in each behavior compared to the frequencies in the first individual observation. However, obviously nuzzling was the most frequent behavior like in other observations.

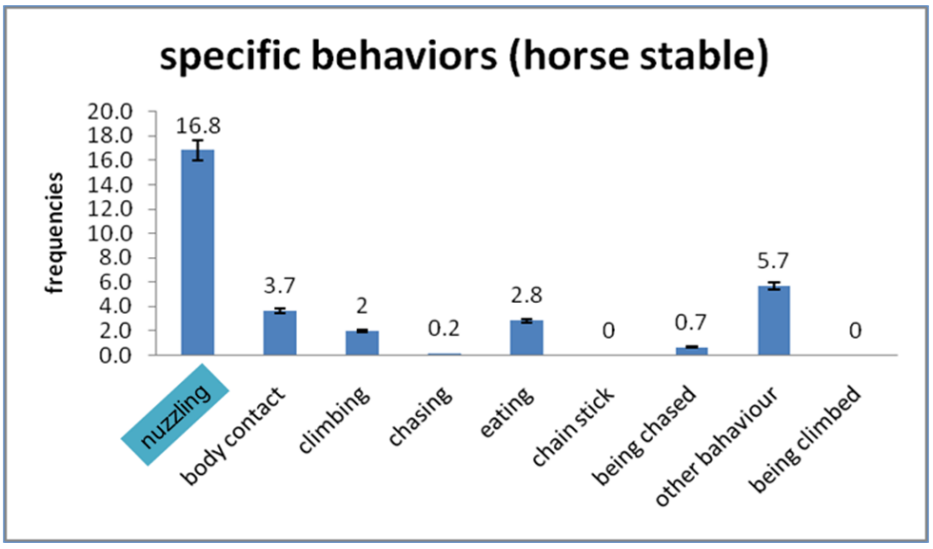


Figure 16. Specific behavior pattern in semi-natural pigs

Conclusion and discussion

During group observation, there were results showing clear circadian rhythm in conventional pigs in contemporary farming. They exhibited unique activity pattern while wild boars are known to have nocturnal activity. There were two distinctive active hours during 24 hours, early morning and early evening. It is known that in wild boars, depending on their environmental condition such as, food shortage there could be change in circadian rhythm into diurnal activity pattern. Therefore, the two separated active hours are considered to be the change brought by environmental condition of current farm management protocol, such as feeding time of sows.

In group observation results, pigs showed increase in their activity parallel to the increase in their passed life time. This reflects the possibility that social behavior exhibiting is increasing with their physical development in their early age. The increased chance for social behavior would be crucial to develop social behavior to adapt to social environmental changes in later life. Precisely, the neural circuit in the brain responding to the social environmental change would be formed through the process during the chances.

In individual observation, the specific social behaviors could be observed and the ethogram was obtained. Comparing the frequencies at two different time points revealed that the environmental change could affect the specific behavior pattern. The behavior 'nuzzling' which is a very representative social behavior in pigs was the most significant behavior during the whole observation. In detail, piglets nuzzled its mother repeatedly while suckling and this could suggest the necessity for piglets to have sows in order to have mother-infant interaction for social behaviour development as well as milk for associated physiological and neurological development.

Separating the pigs from their sows and mixing with other littermates make pigs to show more social behavior, especially 'nuzzling'. Almost double-increased frequency of 'nuzzling' and larger frequency of 'nuzzling other littermates' than 'nuzzling the same littermates' can be considered as an adaptive traits according to social environmental change.

Specific identification of social play behavior was not practically possible due to lack of generalized detailed ethogram of social play behavior and social play cues in pigs. Also, current insufficient recording protocols hindered behaviour observation in

individual behaviour level. For example, 'play fighting' and 'fighting' could not be identified with enough demonstration.

In the second individual observation, there was not much social behavior among pigs in semi-natural horse stable. The reasons are suggested that due to the colder temperature of outside stable and their age. The age of the pigs was more than 8 weeks and this can mean that this time point is not as crucial as the time points of the first individual observation during the first few weeks.

Suggestion and future studies

To observe and differentiate social play behavior from other social behaviors, more detailed recording and scoring approach is recommended. With the new approach, detailed ethogram for social play behavior could be obtained and it would bring more objective demonstrations for studying social play behavior. Considerate change in management protocol for appropriate social behavior development in conventional farm could prevent behavior problems and bring welfare improvement.

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