Investigating the reward cycle for play in young pigs

Undersökning av belöningscykeln för lek hos unga grisar

Negar Farhadi

Master in Animal Science

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Supervisor: Lena Lidfors, Department of Animal Environment and Health, SLU
Co-supervisor: Manja Zupan, Department of Animal Environment and Health, SLU
Examiner: Linda Keeling, Department of Animal Environment and Health, SLU

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Sveriges lantbruksuniversitet
Fakulteten för veterinärmedicin och husdjursvetenskap
Institutionen för husdjurens miljö och hälsa
Box 234, 532 23 SKARA
E-post: hmh@slu.se, **Hemsida:** www.slu.se/husdjurmiljohalsa

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1. Summary

A reward cycle for investigating the emotional status in animals has been developed and it requires that animals go through three main phases, i.e. anticipation, consumption and relaxation. The reward cycle has not been tested previously for access to play in pigs. Therefore, the aim of this Master thesis was to investigate if growing pigs showed more behaviours indicative of excitement than pigs that were not allowed to play, performed play in a play arena and showed more behaviours indicative of relaxation after play when they were back to their home pen than pigs that were in their home pen the whole time.

Forty undocked piglets (10 litters of Specific Pathogen Free half pure-bred Yorkshire and half hybrids of Yorkshire x Landrace balanced for breed between two treatments were used. From 44 days of age the selected pigs were housed in a weaner stable with four per pen, two castrated males and two females with the most average weights, in their original litter in pens with a size of 6.5 m^2 called "home pen". Within each litter two non-play and two play pigs were randomly selected. Focal animals were individually marked by pig marking spray. After five days of acclimatization to the new environment, four days of training started during which two pigs were allowed to walk to the holding pen (2.0 m^2) where they were kept for three minutes. After that the mesh gate opened and the pigs walked in freely to the play arena (5.8 m^2) where they stayed for 15 minutes. Two of each of the following objects were used as toys in the play arena: wellingtons, brush, traffic cone, rubber pipe, ball and knotted rope. Half of the piglets had previous experience of objects (i.e. knotted rope, ball and tire) around weaning. Play pigs were observed (instantaneously at 30 s intervals and continuously within each 30 s) 3 min. in the holding pen and 15 min. in the play arena. Non-play pigs were only taken to the holding pen (3 min.) and brought back to their home pen. Play pigs were directly after coming back to the home pen observed for 10 min. and non-play pigs were observed on days without play sessions for 10 min. Statistical analysis was done with Generalized Linear Model for Mixed procedures that tested effect of treatment, time, week, sex and previous toy experience.

In the holding pen play pigs performed significantly more locomotor play ($P<0.01$), play fight ($P<0.05$), elimination ($P<0.01$) and had more curled tail position ($P<0.01$) than non-play pigs. However, non-play pigs performed significantly more explore bar than play pigs ($P<0.05$) in the holding pen. Pigs of both treatments were numerically more often recorded in zone 1 and orient 1 (i.e. closest proximity to the play arena). In the play arena object play was the most performed play type and then locomotor play which both decreased over time ($P<0.001$). Social play was the least performed play behaviour but even if it stayed close to zero it showed a slight gradual increase over time ($P<0.001$). Thus, as predicted they performed all three types of play. The most and the least preferred toys were numerically the brush and the ball respectively. In the home pen play pigs performed significantly more social contact ($P<0.001$), moving ($P<0.001$) and exploring ($P<0.001$), a tendency for drinking more ($P<0.1$) and significantly less locomotor play ($P<0.05$) than non-play pigs. In the home pen, non-play pigs performed significantly more lying ($P<0.001$) and had the tail in a hanging position more ($P<0.001$). Those behaviours expected to be relaxation-related, such as drinking, eating and rubbing against pen structures, were not significantly higher in play pigs.

In conclusion, play pigs showed some behaviours indicative of anticipation in the holding pen, they performed all three types of play in the play arena. However, play pigs did not show behaviours expected to indicate relaxation in the home pen.

1. Sammanfattning

En belöningscykel för att undersöka det emotionella tillståndet hos djur har utvecklats och den kräver att djur går igenom tre faser, dvs. förväntan, konsumtion och avkoppling. Belöningscykeln har inte testats tidigare för tillgång till lek hos grisar. Syftet med detta examensarbete var att undersöka om växande grisar visade fler beteenden som tyder på förväntan att leka än grisar som inte fick möjlighet att leka, om de utförde lekbeteenden i en lekarena och om de visade flera beteenden som tyder på avkoppling efter lek när de var tillbaka i sin hembox än grisar som var i sin hembox hela tiden.

Fyrtio ej svanskuperade smågrisar (10 kullar) av specifikt patogenfria halvt renrasiga Yorkshire och halvt hybrider av Yorkshire x Lantras som balanserades för ras mellan två behandlingar användes. Från 44 dagars ålder hölls de utvalda grisarna i ett avväjningsstall med fyra per box, två kastrerade hanar och två honor med de mest genomsnittliga vikterna, i sin ursprungliga kull i boxar med en storlek på 6,5 m^2 kallade "hembox". Inom varje kull valdes slumpmässigt två lekgrisar och två icke-lekgrisar ut. Fokaldjuren märktes individuellt med grismärkspray. Efter fem dagars acklimatisering till den nya miljön, började fyra dagars träning under vilka två grisar fick gå till förväntansboxen (2,0 m^2) där de hölls under tre min. Efter att gallergrinden öppnades fick grisarna gå fritt i lekarenan (5,8 m^2) där de stannade i 15 min. Två av vart och ett av följande objekt användes som leksaker i lekarenan: stövel, borste, trafikkon, gummirör, boll och knutet rep. Hälften av smågrisarna hade tidigare erfarenhet av objekt (dvs. knutet rep, boll och däck) runt avvänjningen. Lekgrisar observerades (momentant med 30 s intervall och kontinuerligt inom varje 30 s intervall) 3 min. i förväntansboxen och 15 min. i lekarenan. Icke-lek grisar togs endast till förväntansboxen (3 min.) och togs sedan tillbaka till sin hembox. Lekgrisarna observerades 10 min. direkt efter det att de kom tillbaka till hemboxen och icke-lek grisar observerades under 10 min. på dagar utan lek. Statistisk analys gjordes med generaliserad linjär modell för blandade förfaranden och testade effekten av behandling, tid, vecka, kön och tidigare leksakserfarenhet.

I förväntansboxen utförde grisarna signifikant mer rörelselek ($P<0,01$), kamplek ($P<0,05$), eliminering ($P<0,01$) och hade mer knorr på svansen ($P <0,01$) än icke-lek grisar. Men, icke-lek grisar utförde signifikant mer undersökande av gallergrinden än lekgrisarna ($P<0,05$) i förväntansboxen. Grisar av båda behandlingarna var numeriskt oftare i zon 1 och orientering 1 (dvs. närmast lekarenan). I lekarenan var objektetlek den mest utförda lektypen och sedan rörelselek som båda minskade över tid ($P<0,001$). Social lek var det minst utförda lekbeteendet, men även om det stannade nära noll visade det en svag successiv ökning över tid ($P<0,001$). Som förväntat utförde de alla tre typer av lek. De mest och de minst föredragna leksakerna var numeriskt borsten respektive bollen. I hemboxen utförde lekgrisarna signifikant mer social kontakt ($P<0,001$), förflyttning ($P<0,001$) och undersökning ($P<0,001$), en tendens till att dricka mer ($P<0,1$) och signifikant mindre rörelselek ($P<0,05$) än icke-lek grisar. I hemboxen utförde icke-lek grisar signifikant mer liggande ($P <0,001$) och hade svansen mer i en hängande position ($P<0,001$). De beteenden som ansågs vara

avkopplingsrelaterade, såsom dricka, äta och stryka kroppen mot inredningen, var inte signifikant högre hos lekgrisar.

Sammanfattningsvis visade lekgrisarna vissa beteenden som indikerar förväntan i förväntansboxen, utförde alla tre typer av lek i lekarenan. Däremot visade lekgrisarna inte beteenden som ansågs indikera avkoppling i hemboxen.

2. Introduction

2.1 Background

Much of the research in animal welfare has been done on negative aspects of animal well-being such as stress, pain and hunger (e.g. Yeates & Main, 2008). Therefore it might be important to focus more on positive aspects of animal well-being when talking about animal welfare in general (Boissy *et al.*, 2007). Generally, most people agree on that animal welfare is not defined simply as the absence of negative factors in animal life, but also the presence of positive and joyful experiences (e.g. Boissy *et al.*, 2007; Yeates & Main, 2008). According to Yeates & Main (2008) focusing more on negative aspects and less on positive parts of animal welfare result in ignorance of ethological and physiological points in animal life. One way to induce positive experience in animals have been suggested by Boissy *et al.*, (2007) as providing animals with the opportunity to play. Play is a measurable tool of positive welfare since animals will not play if their basic needs are not fulfilled or if they face fitness threats or detrimental conditions (e.g. Held & Spinka, 2011). Further, they wrote about the role of play as both a sign and a creator of good welfare as a result of its both short and/or long-term advantages. Therefore, to assess play as an indicator of welfare in young farm mammals the crucial task for scientists is to form an approved and a feasible index to measure play (Boissy *et al.*, 2007). One model that has been presented for measuring positive emotions in animals is the reward cycle (Keeling *et al.*, 2008). It has been tested on lambs allowed to play in a play arena (Chapagain, 2012), but it has not been tested previously on play behaviour in growing pigs.

2.2 Reward cycle

Boissy *et al.* (2007) presented a classification of positive emotion based on its occurrence in relation to time i.e. “past”, “present” and “future” and describes them as “post-consummatory satisfaction”, “pleasant activity” and “positive anticipation” respectively. Building from that Keeling *et al.* (2008) suggested a reward cycle model for investigating the emotional status in animals, where they combined functional and phenomenological aspects of emotions. The idea is that animals go through three main phases, i.e. appetitive, consummatory and post-consummatory, for different activities such as eating, drinking, sexual activity, play, etc. (Figure 1). It is important that the animals pass through all three phases in order to achieve the full positive emotion.

The first phase of the reward cycle model consists of high emotional arousal such as “excitement”, “anticipation” and “desire” which is linked with an appetitive motivational state and “high arousal” affective emotional states (Keeling *et al.*, 2008). Previous research on anticipation before this model was developed provides some knowledge about anticipation in animals. Behaviours indicating anticipation can be measured in the period between declaration of a reward and appearance of the reward itself i.e. the time during which the animal knows the reward will arrive and expect it (Van der Harst & Spruijt, 2007). Anticipatory-related behaviours are known to be dopamine and endorphins related (Spruijt *et al.*, 2001; Boissy *et al.*, 2007). Some examples of anticipation of food in horses are reported as spending more time in a standing position, increased locomotion and arousal and

investigatory behaviours (Peters *et al.*, 2012). Moreover, the announcement of an oncoming reward to pigs increased their activity level and play behaviour as a result of expectation, which is mediated via the "mesolimbic dopaminergic system", and decreased weaning-related stress and aggression (Dudink *et al.*, 2006). In farmed mink (*Mustela vison)* anticipation was expressed as "more nose pokes around the feeding area" and switching more often from one behaviour to another (Vinke *et al.*, 2006). In another study by Luuk *et al.* (2012) mice showed anticipation for food by increasing their "behavioural activity". Rats became more active and performed higher level of exploration during anticipation to different types of rewards (Spruijt *et al.*, 2001) and there was a higher level of sensitiveness to rewarding stimuli in rats in "standard" caging systems than rats reared under "enriched" housing (Van der Harst *et al.*, 2003). In domestic fowl more head movements and locomotion were recorded when they expected negative stimuli and more comfort behaviour were recorded when they expected positive reinforcement (Zimmerman *et al.*, 2011). In summary, the anticipatory-related behaviours vary among species and they alter based on the characteristics of the oncoming stimuli (Van der Harst & Spruijt, 2007). Also, the period of anticipation varies in duration and it can last from one minute to several minutes (Spruijt *et al.*, 2001).

The next phase of the reward cycle is linked with a consummatory motivational state and is related to "pleasure" and "liking" states e.g. pleasant taste or touch (Keeling *et al.*, 2008). The anticipation and consumption phases are distinguishable by means of their different neurobiological-mediated brain activities (Spruijt *et al.*, 2001). This phase is activated by the arrival of a reward or a positive reinforcement and leads to consumption of the reward and it is believed to be opioid mediated (Boissy *et al.*, 2007). Consummatory-related behaviours are expressed in many different forms and more probably are controlled by a variety of complex brain systems (Berridge & Robinson, 1998).

The reward cycle's last phase, post-consummatory phase, is involved with "satisfaction", "relaxation" and "relief" and is attached with "low arousal positive emotions" (Keeling *et al.*, 2008). Regarding post-consummatory related behaviours very little investigation has been done (Burman *et al.*, 2011).

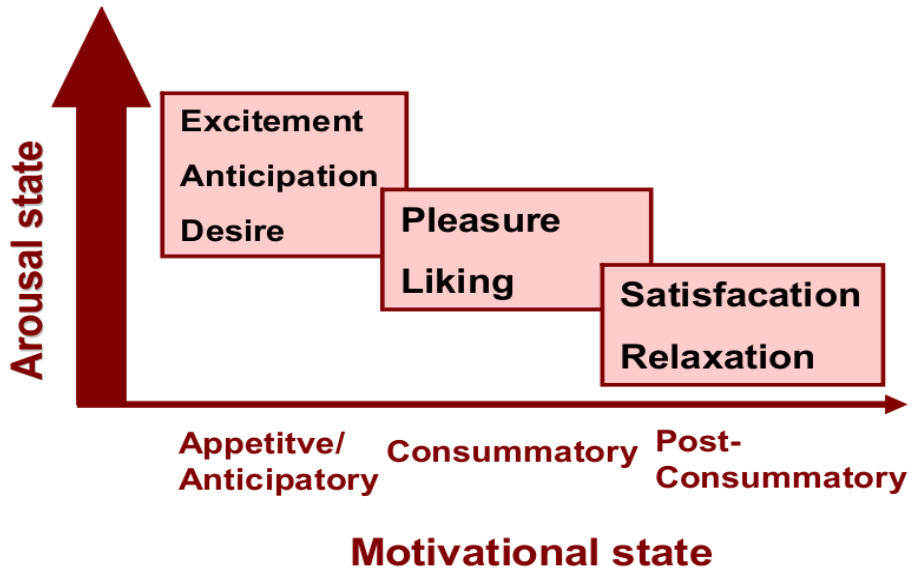

Figure 1. Schematic explanation of the reward cycle (adopted after Keeling et al., 2008).

When it comes to testing the reward cycle it has mainly been investigated in humans and for sexual acts and food pleasure cycles (e.g Georgiadis & Kringelbach, 2012; Kringelbach *et al.*, 2012). According to their findings in the sexual cycle, the three phases are "wanting", "liking" and the "satiety" phase respectively (Georgiadis & Kringelbach, 2012). The wanting phase includes forming a desire to acquire a particular reward. Thus it is generated partly by sensory activators or learnt experiences (Georgiadis & Kringelbach, 2012). Liking phases covers sexual arousal and consumption parts and the final phase is the satiety phase which is called "post-ejaculatory (orgasmic) refractory period" (PERT) in sexual cycles (Georgiadis & Kringelbach, 2012). Studies have shown that pleasure cycles function in the same way for other reward cycles such as food in humans (Georgiadis & Kringelbach, 2012; Kringelbach *et al.*, 2012).

Boissy *et al.* (2007) suggests that the "reward system" can act as a scale to measure the difference between costs and benefits and where benefits exceed costs it can be perceived as experiencing joy. In addition, Held & Spinka (2011) pinpoints that cost of play for captive animals is negligible since in industrial farming animals unlike in nature are never going to face life hazards such as "predators" and "food shortages".

2.3 Evolution and function of play in mammals

2.3.1 Definition of play

Play occurs in many animal species with emphasis in the young animal. The belief that play only is seen in sophisticated species e.g. primates is not valid any longer since it has been observed even in turtles (Dugatkin, 2009). Definition of play varies within the animal science literature. In one definition by Martin & Caro (1985) play is described as behavioural patterns that are without any external clear purposes. The main types of play are most often addressed as "object", "locomotor" and "social" play in the literature (Dugatkin, 2009).

The Oxford dictionary of animal behaviour has the following definition of "play":

> "An aspect of juvenile behaviour, in which the (usually) young animal spends time in apparently pointless activity, such as friendly fighting, sex without coition, hunting without prey, etc. Play is often accompanied by a characteristic facial expression and characteristically energetic movements. It is a type of leisure activity, in that it disappears from animal's repertoire when demands upon the animal's time are very severe. Although play seems to be functionless, it may be a type of rehearsal or practice for activities that will become important later in life. It may also be a form of exploration of both the physical and the social environment."

Oxford dictionary of animal behaviour (2006).

2.3.2 Function of play

According to Bekoff (2004) play functions differently based on inter- and intra-species differences, sex and age. Held & Spinka (2011) define the functions of play in two main levels of "long-term" and "immediate" advantages of play. By "immediate" they mean those functions that animals have a use of in the present time but would not last for other future occasions. Some examples of long-term functions of play are described as all kinds of improved "skills and competencies". Playing at young age helps animals to handle unpredictable events that they may face later in life and might be stressful as well. This learning is accomplished through play via increased physical reactivity and mental capacity to deal with stressful occasions (Donaldson *et al.*, 2002).

Play behaviour can be blocked in undesirable situations such as rough environments, and Newberry *et al.* (1988) observed that domestic pigs in a semi-natural environment did not play during periods of cold weather. Therefore, having interest for play could be perceived as existence of good well-being and a sign of being satisfied with basic vital demands (Boissy *et al.*, 2007).

2.3.3 Play and positive emotions

The persistency of emotional development goes back to Darwin's evolutionary theory (Darwin, 1872 cited in Desire *et al.*, 2002). It has been suggested that we and most animals are sharing similar "behaviour", "structure" and "brain chemistry" so there is a possibility that animals feel the same as human (Boissy *et al.*, 2007). According to Held & Spinka (2011) play is contagious i.e. watching playing animals stimulate play in others; so if we provide animals with play opportunity even in little amount or for few animals this contagiousness brings positive welfare effect in all individuals in that group.

Farm animals with play motivation are often facing limitations to express play behaviour as a result of lack of space, play partners and play objects (Jensen *et al.*, 1998). According to Boissy *et al.* (2007) three of the main future candidates for assessing positive emotional states in farm and laboratory animals are "play", "affiliative behaviour" and "some vocalizations". In addition, play in animals conveys the concept that they are both experiencing "rewarding and relaxing" experiences during play (Held & Spinka, 2011). Further they pinpoint that play can benefit animals both psychologically and socially. Opioids are underlying the

psychological achievement and social advantage which has to do with the social facilitation of play that can be contributed positively to all members in a group. For instance, in rats access to a social partner during play has a crucial role in facilitating play (Spruijt *et al.,* 2001). Social play, maternal care and sexual interaction are addressed as "social rewards" and are the most important examples of social interactions with crucial roles in survival, provision of a sense of security and removing stress and anxiety in mammals (Trezza *et al.,* 2011).

One of the methods that most researcher recommend to improve positive experiences in both farm and laboratory animals is environmental enrichment. This can be accomplished via providing a condition in which an anticipation to a positive event exists including giving a larger space allowance to stimulate play (Boissy *et al.,* 2007).

2.4 Play in Pigs

2.4.1 Access to play as a form of enrichment

Pigs are usually raised under restricted living conditions which limit the expression of locomotor play. There is a risk when play is suppressed by physical limitations that the animals experience frustration (Newberry *et al.,* 1988). The current pig farming practices are also lacking stimulations for those behaviours that pigs are highly motivated to do such as novelty seeking and exploratory behaviours (Rodríguez-Estévez *et al.,* 2010). There are housing factors that affect the pigs play behaviour e.g. different types of farrowing crates placed in pens of equal space (Blackshaw *et al.,* 1997). Raising pigs under intensive housing impedes them from performing their behavioural repertoire especially expression of play behaviour. This limitation is caused by lack of space, social companions and novel objects. (Newberry *et al.,* 1988). In a study Jensen & Kyhn (2000) found that play behaviour was encouraged by access to larger space. Bolhuis *et al.* (2005) reported that environmental enrichments such as access to straw as litter bedding improve pigs welfare. This is due to an increase in play behaviour and decline in oral manipulatory behaviour towards pen mates, which was compared with non-enriched housing i.e. barren conventional environment (Bolhuis et *al.,* 2005). Oostindjer *et al.* (2011) reported higher play behaviour in piglets that were housed in enriched housing than piglets in barren housing. Their results show that higher levels of exploration and play was observed in those piglets moved from a barren to an enriched environment, while higher occurrence of belly nosing and lower play levels were observed in pigs moved from an enriched to a barren environment. The beneficial effects of environmental enrichment on handling stress are stronger if the provision of enrichment happens in a novel and sudden way (Oostindjer *et al.,* 2011). Dudink *et al.* (2006) reported that when pigs were offered positive stimuli e.g. extra space, food, or straw their activity, orientation towards the reward location, behavioural transition (mostly combined with play markers e.g. hopping, pivoting) increased. An important factor for behavioural expression during anticipation is the predictability of the rewarding stimulus (Dudink *et al.,* 2006). The importance of provisioning pigs with some sort of environmental enrichments (e.g. wooden block or rope) is emphasized by Trickett *et al.,* (2009).

2.4.2 Play during natural and free-ranging conditions

In free-ranging pigs the initiation of play most often occurred as a response to unexpected events like for example a wind and novelty (Newberry *et al.,* 1988). The authors also showed a preference to play with play mates in similar age. For instance, weaned free-ranging pigs were rarely observed to scamper with younger piglets, and it seems they preferred to play with similar aged pigs (Newberry *et al.,* 1988). The same authors also observed that there was no encouragement from the sow's side for play in her offspring. It has been found that social development of piglets relationships was influenced by their mothers' social relationships (Newberry & Wood-Gush, 1986).

2.4.3 Social play

Play among pigs may be released by social facilitation i.e. seeing others play stimulates play in the rest of the pigs (Bolhuis *et al.,* 2005). This can be seen when usually a group of piglets run together (Bolhuis *et al.,* 2005). Another form of play in pigs is referred to as sex play i.e. mating patterns which is perform by piglets and observed more in males (Berry & Signoret, 1984).

2.4.4 Object play and exploration

In pigs object play has been found to increase in rate by age while there was no difference in morning and afternoon rates (Blackshaw *et al.,* 1997). They counted object exploration as part of object play since they believed that in young pigs both object exploration and play is part of object play. Van de Weerd *et al.* (2003) reported that pigs showed preference for objects that were "deformable", "destructible", "chewable", "odorous" and "ingestible" and when suspended rather than objects provided loosely.

2.5 Aim

The aim of this study was to investigate if growing pigs showed behaviours indicative of excitement, performed play in a play arena and showed behaviours indicative of relaxation after play when they were back to their home pen. Play pigs that were taken to a holding pen and thereafter released in a play arena were compared with non-play pigs that were only taken to the holding pen and brought back to their home pen. Behaviour of play pigs was recorded as soon as the animals came back to the home pen and compared with the behaviour of non-play pigs that was recorded on days when no play sessions with play pigs were carried out. The questions addressed and the predictions are as follows:

1. Do pigs allowed to play in a play arena show more moving, exploring, playing and being oriented towards the play arena than pigs not allowed to play in the play arena?

   Play pigs will show a higher number of recordings of moving, exploring, playing and being oriented towards the play arena in a holding pen outside the play arena than non-play pigs.

2. Will pigs perform locomotor play, social play and object play in the play arena?

   Pigs will perform play behaviours such as locomotor, object and social play in a play arena.

3. Do pigs which have experience with toys play more in a play arena (all 3 types of play) compared to pigs without experience?

Pigs with previous experience of toys will have a higher number of recordings of play in a play arena.

4. Do pigs show behaviours indicative of relaxation after having been in a play arena by showing lying, closing their eyes within the first 10 minutes, eating, drinking and rubbing themselves?

Play pigs will after coming back to their home pen have a higher number of recordings of behaviours indicative of relaxation, such as lying, eating, drinking and rubbing, than non-play pigs that had not been away from their pen.

5. Will pigs who are not allowed to visit a play arena (non-play pigs) perform more aggression towards other pigs and be less active in their home pen than play pigs?

Non-play pigs will perform more aggression and will be less active in their home pen on days with no play in the stable than play pigs when coming back after having been in a play arena.

3. Material and Methods

3.1 Animals, housing and management

This study was carried out at the Swedish National Livestock Research Center, Lövsta-Uppsala. A pilot study was performed for two weeks in April (Section 3.2.1) and the main study was done during four weeks between 30th of April and 25th of May 2012 (Section 3.2.2). The study was approved by the Swedish Ethical Committee of Experimental Animals in Uppsala (Drn: C 34/12) before starting the study.

In the main study ten litters of the second farrowing batch of Specific Pathogen Free (SPF) from first-parity Yorkshire pure bred sows were used. Five sows were inseminated with Yorkshire boars and five sows with Landrace boars, which mean that piglets from five litters consisted of pure-bred Yorkshire and five litters of half Yorkshire and half Landrace. The pigs in this study were balanced for breed in both treatments in a previous study from which we selected the pigs (Hultman, 2013) and therefore they were equally distributed between treatments in this study. Half of the litters in the previous study were given one enrichment object per week during the three last weeks before weaning, and three enrichment objects together directly after weaning (Hultman, 2013). This means that half of the piglets had a previous experience of enrichment objects (i.e. knotted rope, ball and tire) for the first time at the age of 13 days, and the other half were not provided with any objects.

Weaning was carried out by taking away the sow from her piglets at the mean age of 33 days. After 11 days, 40 selected undocked piglets were moved to the weaner stable and were housed 4 per pen in their original litter in 10 separate pens. Piglets were placed in their new pens by the staff according to the management routines of the facility. The pens had a total area of 6.5 m^2 (3.25 m x 2 m) and were constructed of galvanized steel bars. The pen floor was made of two different types: concrete solid floor and slatted floor. These identical pens where pigs were kept when not tested are called “home pen” in this report. The temperature in

the stable was adjusted thermostatically but it varied from 21.3 – 27.3°C with a humidity which was adjusted at 80%.

The feeding was done manually three times a day at 8:00, 12:00 and 15:00 o'clock, one hour before starting the recordings, during lunch time and one hour after finishing the observations. They were fed with the commercial piglet feed in a common open stainless steel feeder trough. The feed type was “SOLO 331 P BK” from Lantmännen. The feeding at 8:00 and 15:00 o'clock was done by the staff and at 12:00 by the main researcher to avoid having the staff disturbing animals during observations. The amount given each day to each pen was recorded by both the staff and the main observer. The access to water was ad lib. and water was provided in one water nipple above the slatted floor area in the home pen. Normally, they got chopped straw (wheat straw, ca. 5 cm long) by a straw machine (JH miniStrø, Jørgen Hyldgård Staldservice A/S, Denmark) which distributed 0.5 to 1 kilo equally among pens. The machine moved through the railed roof that made noise and disturbances and pigs got excited at the time of straw giving. Therefore pigs received 0.5 to 1 kg long straw (wheat straw, ca. 30 cm long) in their pens manually two times a day during the study. This modification from chopped straw to long straw was done because of two reasons; first, to maintain the same substrate in the home pen and the play arena and second, to avoid disturbance from the moving straw machine on the rail above the pens. Removal of feaces was done in the morning at 8:00 by the staff and at 12:00 o’clock by the observer to avoid disturbance from staff during observation time.

3.2 Experimental Design

3.2.1 Pilot study

In order to test which objects would be preferred most by the pigs to interact with and to develop the protocols a pilot study was performed. In this study 8 pigs from the first batch were used. They were housed in the same weaner stable with 4 pigs per pen (2 males and 2 females) with their litter mates.

In order to find suitable objects for pigs internet pages were searched for available objects that could be used for pigs as toys. Ten different objects, one or two of each, which were possible to buy from shops in Uppsala were purchased (Grizzly zoo, Biltema and Bauhaus). The objects bought were wellingtons (wellies), traffic cone, brush, rubber pipe (pipe), ball, knotted rope (rope), chain, hose pipe, bicycle tire and marine plastic floating buoy. All objects were washed and desinfected with Vircone before they were given to the pigs. During the pilot study all objects were placed in a large pen (1.3 x 4.5 m) and pairs of pigs were moved to the pen and left there 15 minutes (Appendix 1). During this time two observers noted down which objects the pigs interacted the most with. Over the 5 days objects that pigs did not interact with were removed step wise until five objects were left.

During the last five days of the pilot study (Appendix 1) protocols and behaviour definitions (i.e. ethogram) were developed by the two observers. A holding pen was also developed (1.3 x 1.55 m), built and tested. Moreover, the optimal duration was estimated for how long the

pigs could be kept in the holding pen without trying to jump out of it and in the play arena before they lost interest in the objects.

3.2.2 Main study

For the main study, 40 piglets were selected 11 days after weaning (four individuals from each litter, two males and two females). Within each litter of four siblings, two non-play and two play pigs were randomly selected. Focal animals were individually marked in the morning of each observation day with pig marking spray (Porcimark,, KRUUSE Co.) using two colours and two patterns distinguishing all four littermates. The observers were blind to the previous experience with toys of the piglets. Non-play pigs did not visit the play arena, but were kept in the same pens and had identical environmental factors as the play pigs (e.g. housing, feeding, etc.). The selection of focal individuals in each litter was based on the weight and sex. The heaviest and lightest litter mates were removed from the selection and an effort was made to select two males and two females in each litter with the most average weights (Appendix 2). The remaining pigs of the litter stayed in the farrowing pen until they reached approximately 30 kg (around 12 weeks of age) and were then moved to a slaughter pig unit. In the weaner stable, they got five days of acclimatization/familiarization to the new environment.

An arena for testing pigs was built by gates at the end of the weaner stable closest to the entrance door and was named “play arena”. The total size of the play arena was 1.3 x 4.5 m (Figure 2). The floor was covered by long-cut straw in order to make it more comfortable for the pigs to perform play behaviours and particularly locomotor play. The first two pens next to the play arena remained empty to avoid pigs in that pen to disturb the pigs in the play arena. A smaller compartment at the entrance of the play arena was constructed and called “holding pen” (1.3 x 1.55 m). The holding pen was moved from one side to the other side of the play arena based on the location of pens on which side of the stable that were going to be observed on that day. A mesh gate was used in order to enable pigs to have visual contact with the play arena and to separate the play arena from the holding pen (Figure 2).

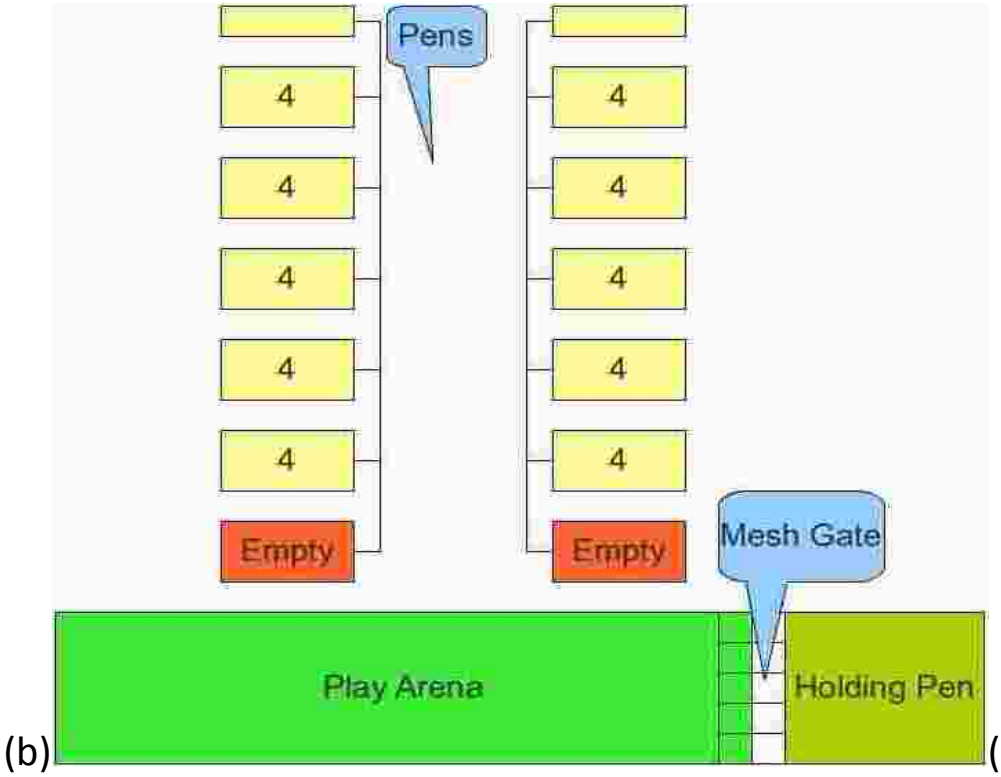

Figure 2. Drawing of the stable with the 10 home pens, a play arena and the holding pen for testing the pigs behaviour. The holding pen was moved between the (a) and (b) positions.

In the play arena two of each of the following objects were used as toys: wellingtons (wellies), brush, traffic cone, rubber pipe (pipe), ball and knotted rope (rope) (Figure 3). Pigs were introduced to the ball and the rope already around weaning (Hultman, 2013). Five of the toys were placed on the floor (always in the same location) and one hanged from the roof of the play arena (i.e. knotted rope) (Figure3). Toys were washed regularly at the end of each week. After each play bout the play arena was cleaned and manure from previous play pigs was removed. Thereafter, toys were organized on their spot and the play arena was prepared in the same way for the next play round.

Figure 3. Play arena with the toys used in the main experiment (Photo: Negar Farhadi).

After acclimatization four days of training started during which two pigs were allowed to walk to the holding pen where they were kept for three minutes. Afterwards, the gate to the play arena opened and the pigs walked in freely to the play arena where they stayed for 15 minutes. During these days the pigs were expected to learn to use the play arena and the objects that were placed in it.

3.3 Behavioural recordings

Behavioural observations were recorded by two observers at the same time observing one pig each. In total three observers were involved with the third person observing four sessions. The definitions of behaviours were standardized among the observers before the observations started by recording a sample video clip and filling in the protocols separately by all three individuals while watching it.

The behavioural observations were done during the training period both in the holding pen and in the play arena. During the training period pigs from all 10 pens were tested four days (Appendix 1). For the following three weeks play bouts were carried out in the following order: five pairs played each day during Monday-Tuesday and Thursday-Friday from 9:00 to 14:00, which means that two play sessions per week were carried out (Appendix 1). Pigs played in a randomized order based on which side of the stable their pens were located to facilitate the movement of the holding pen between each side (Figure 2). This means that five pens located on one side of the stable were tested each day. A lottery was carried out at the first day of the experiment for if the pen closest to the play arena should be tested first or last. Once that was decided pens were tested in order of placement.

Non-play pigs were also moved to the holding pen and left there for 3 minutes where after they were taken back to their home pen again. They were observed in the holding pen by using the same protocol as for the experimental pigs to find out if there were any differences in their behaviour compared to play pigs. Home pen observations were done following play sessions for the play pigs and for non-play pigs on days with no play bout (i.e. Wednesdays) with the same protocols.

Each pair of pigs was observed for 3 minutes in the holding pen before entering the play arena, or going back to their home pen for non-play pigs. Observations were done on behaviours in the play arena for 15 minutes followed by 10 minutes home pen observation. Non-play pigs were also observed for 10 minutes in their home pen on Wednesdays.

Three protocols were prepared for each phase of the test i.e. holding pen, play arena and home pen observation. For all three protocols the pigs were observed by using two different recording methods. Instantaneous recordings were done on behaviours with long duration at every 30 seconds. Continuous recordings were done on behaviours with short duration within every 30 seconds. A watch that counted down and gave a sound signal at every 30 seconds was used to record behaviours exactly at each 30 seconds. The behaviours recorded by instantaneous sampling are listed and defined in Table 1, and the behaviours recorded by continuous sampling is listed and defined in Table 2.

In the play arena continuous sampling was performed of the three types of play (i.e. object play, locomotor play and social play). Additionally recordings were made of latency to close the eyes for play pigs after they came back to their home pen. It was recorded as first time (minute of observation) the focal pig closed its eyes with no external pressure (such as biting or social touch from other pen mates).

Table 1. Behaviour and their definitions used for instantaneous sampling with observation place (Holding pen: hp, Play arena: p and Home pen: h)

Behaviour	Description	Place
Zone (Figure 4)		hp
Zone 1	Most of the body is within zone 1	
Zone 2	Most of the body is within zone 2	
Body posture		hp, p, h
Standing [b]	Standing on all four legs with eyes open and not doing anything else (kneeling was included)	
Sitting [b]	Putting hind part of the body (i.e. hind legs and hip) completely on the floor while having hind legs bent and front legs stretched	
Lying [a]	Lying on belly or side of the body	
Moving	Walking or running	
Orientation		hp
Orientation 1	Head and snout facing play arena	
Orientation 2	Head and snout facing exit	
Orientation 3	Head and snout facing other directions	

Tail position		hp, p, h
Curled	Tail in an upward posture with the characteristic spiral form	
Hanging	Straight hanging tail in vertical position with no motion	
Wagging	Moving tail from side to side on a successive basis	
Between legs	Tail hidden between hind legs	
Exploring	Moving snout over the floor, sniffing, rooting or licking the floor or pen fittings. Chewing or eating straw is also recorded within this category	hp, p, h
Explore bar	Touching/contacting the play arena bars successively using the snout, or licking, or putting snout between bars, biting sniffing, chewing and pulling the bars	hp
Eating [b]	Placing snout inside the feeder and chewing food	h

(a): Newberry *et al.,* 1988
(b): Adopted after Scott *et al.,* 2006, 2007 & 2009

Table 2. Behaviour definitions for continuous sampling with observation place (Holding pen: hp, Play arena: p and Home pen: h)

Behaviour	Description	Place
Comfort behaviour[a]	Rub or scratch part of the body by using the hoof or pen fixture	hp,h
Drinking	Having snout in touch with drinker and push it successively to make water flow and ingest water	h
Eliminate	Assuming the characteristic elimination position. Discharge of urine or faeces is visible	hp,h
Social contact	When the focal piglet makes a relatively short snout (or oral) contact to any parts of the body of another piglet. Only the initiator was recorded	hp,p,h
Play fight [i]	Social interactions between piglets including shove (i.e. push/butt/lever pen mate). The behaviours were perform in a way that no pig get damaged, or being chased or running away. At the end of each bout both stop around the same time and continue doing ordinary activities eg. looking around or sniffing floor etc.	hp,p,h
Aggression [a, j, l]	Any social interaction which signals conflict among participants such as chasing, biting, parallel pressing, head-to-head knocks or levering. The interaction may result in with one chased away or get damaged and never accompanied with a play marker (such as pivot, scamper etc.).	hp,p,h
Mount pen mate[b]	Placing front legs and/or chin on the back of another piglet	hp,p,h
Snout/Nose/Root object	Any manipulation of objects with using snout only such as sniff, root, exploring, levering, shoveling up the object by	p

	using snout. Or any rotational object touch by snout	
Shake object	Shaking of head while holding object which protrudes from mouth	
Carry object	Move (forward) carrying object or material which protrudes from mouth	
Bite or chew object	Grip with the teeth. Also unsuccessful attempts will be recorded in this category; i.e. opening the mouth and trying to grip the object but failing to catch it	
Lick object	Draw tongue across over a surface of the object	
Pull object	Grab and draw away the object which protrudes from the mouth	
Paw object	Touching, moving or pushing the object using front paws	p
Running	All sorts of galloping including gamboling, scamper and any fast moving forward apart from walking	p
Pivot [g]	A jump in the air on the spot and facing different directions each time	p
Head movement	All quick and successive movements of head, including both vertical and horizontal movements	
Hop [a, l]	Jumping up and down on the spot	p

(a): Newberry *et al.*, 1988
(g): Held & Spinka, 2011
(l): Donaldson *et al.*, 2002
(i): Pearce *et al.*, 1989
(j): Dudink *et al.*, 2006

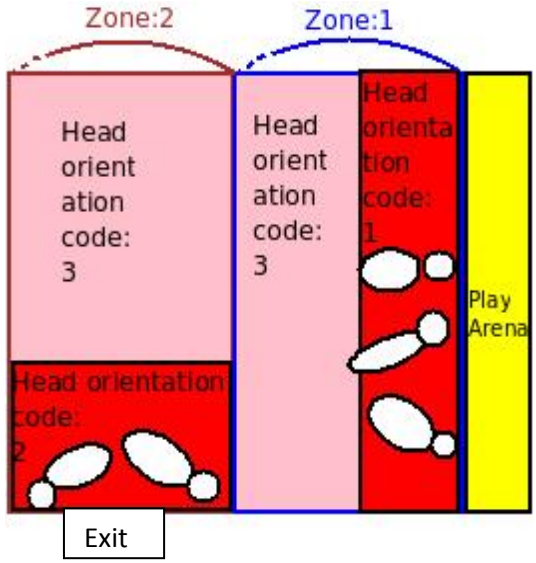

Figure 4. The distribution of different zones and head orientations in the holding pen.

3.4 Experimental challenges

This study was the first research performed at the new facility. Since the installation of equipment and constructions were not done completely, we had quite often disturbances throughout the study period, namely loud and/or sudden noises, commuting of carpenters and unfamiliar people in the stable and especially some complications with adjusting temperature and humidity. For instance, in some sessions of the study we had quite high temperature in the

weaner stable (minimum= 21.1° C and maximum=27.3°C). The slippery floor very often caused pigs to fall while performing locomotor play in the play arena. We avoided using the first born litters (first batch) in the main study to minimize the risk of technical uncertainties in the new facility. However, the pilot study was performed on 8 piglets from the first batch.

3.5 Weight gain

Pigs were weighed three times in total; first time at weaning, second time two weeks after weaning and third time four weeks after weaning (Appendix 2). The mean body weights at weaning were 15.47 kg (±0.64 SE) for play pigs and 16.09 kg (±0.68 SE) for non-play pigs. Mean body weights at the second weighing were 28.12 kg (±0.93 SE) and 29.25 kg (±0.97 SE) for play and non-play pigs respectively. At the third weighing the pigs had a mean body weight of 42.95 kg (±1.26 SE) and 45.02 kg (±1.1 SE) for play and non-play pigs respectively. Weights were not included in statistical analysis due to the management problems mentioned above.

3.6 Statistical analysis

Statistical analysis has been done separately for the holding pen, the play arena and the home pen. For the holding pen and home pen observations data from both treatments i.e., play and non-play pigs were used. Before statistical analysis some behaviours were grouped in the following way. All snout/nose/root object, object in the mouth and paw object were grouped as object play. Locomotor play covered running, pivoting, head movements and hops. Social contact, play fight and mount pen mate were grouped as social play. Total play was defined as locomotor, object and social play.

Statistical analysis was performed in SAS Software version 9.3 (Statistical Analysis Systems, SAS Institute, Cary, NC, USA). The residuals of the dataset did not follow a normal distribution (Univariate procedure). The Generealized Linear Model for Mixed procedures (GLIMMIX procedure) was utilized taking into account either Binomial (instantaneous recordings) or Poisson (continuous recordings) distributed data. The tested models included the effects of treatment (play or non-play), sex (female or castrated male), previous toy experience (experience) (i.e. if pigs had toys around weaning or not), time (holding pen 3 minutes, play arena 3x5 minutes and home pen 2x5 minutes) as fixed effects, and pen as random effect. The fixed effects previous toy experience and sex were not included in the model for the behaviour “standing” in the home pen due to problems with the convergence of data. The significance level was set at 0.05 while tendencies towards significance at 0.10. Results are presented as median number of recordings per minute and 95% confidence limits (CL) based on mean pen values.

For practical handling reasons, the number of sessions with non-play pigs was lower than with play pigs, i.e. 2 versus 10 (4 training and 6 testing) sessions. Therefore, the two sessions for the play pigs that were closest to the dates when non-play pigs were tested were selected for data analysis in the holding pen and the home pen. This means that statistical analysis was done on sessions 5 and 6 for the play pigs in the holding pen and on sessions 7 and 9 in the home pen (see Appendix 1). In order to create a stronger statistical model for the analysis of effect of

time in the play arena week of observation (i.e. 4 weeks) instead of session of observation (i.e. 10 sessions) were used.

4. Results

4.1 Holding pen

4.1.1 Comparison between play and non-play pigs

The most common continuously recorded behaviour in the holding pen was "locomotor play" (Figure 5). Play pigs performed significantly more "locomotor play" (P=0.0036, F=8.58), "play fight" (P=0.0103, F=6.64) and "elimination" (P=0.0039, F=8.42) than non-play pigs in the holding pen (Figure 5). The total number of recordings of "elimination" was 21 (18 recordings for play pigs and 3 recordings for non-play pigs). The occurrence of "social contact" looks as if it is higher in play pigs than non-play pigs (Figure 5), but no significant difference between treatments was found (P=0.29, F=0.59).

There were too few recordings of "comfort behaviour" (4 recordings) and "mount pen mate" (one recording), to run the statistical analysis. Also too few recordings of "aggression" (two and four recordings for play and non-play pigs respectively) was performed during the observations in the holding pen which was not enough to get a higher median value than 0.

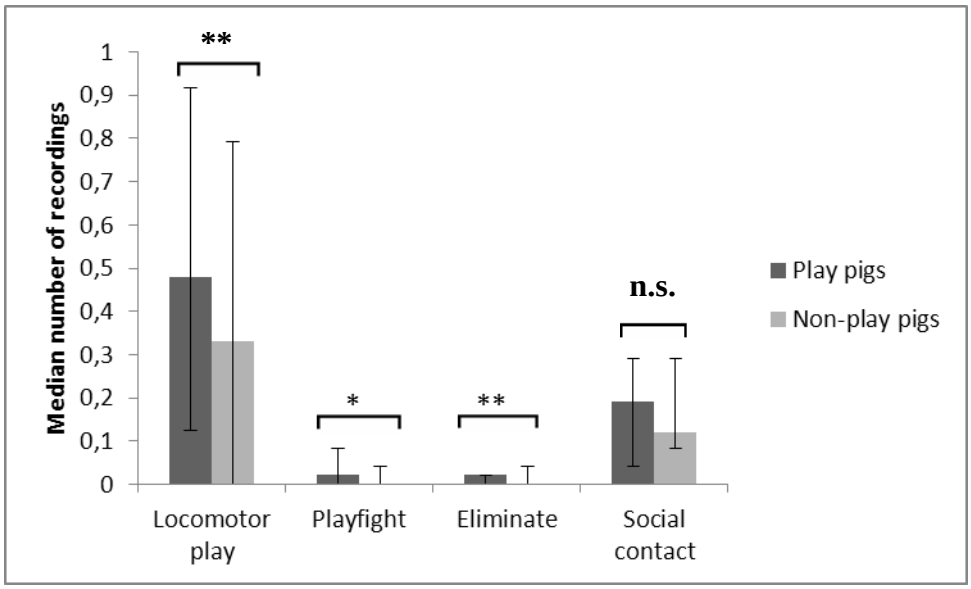

Figure 5. Median (95% Confidence Limits) number of recordings per minute for behaviours recorded in pairs of pigs when kept three minutes in a holding pen during two sessions where they were either allowed to go in and play afterwards (play) or were taken back to their home pen (non-play) (n=10 pairs/treatment)(P<0.05, ** P<0.01, n.s. P>0.1).*

Non-play pigs had significantly higher number of recordings of "explore bar" and significantly fewer recordings of "curled tail" than play pigs (Table 3). Pigs of both treatments were numerically more often recorded in "zone 1" (closest zone to the play arena) than "zone 2" and numerically more often in "orientation 3" and "orientation 1" than in "orientation 2" (Table 3). The pigs in both treatments were mostly "standing" and "moving" about ¼ of the

recordings, but never recorded “lying” or “sitting” in the holding pen (Table 3). “Exploring” in the holding pen was recorded quite frequently, but there were no significant differences between treatments (Table 3). The tail positions “curled” was recorded most times (Table 3) whereas “hanging” occurred on only ten occasions, “wagging” on four and “between legs” on no occasion, therefore these behaviours were not considered in the analysis.

Table 3. Median (95% Confidence Limits) number of recordings per minute for behaviours recorded in pairs of pigs when kept three minutes in a holding pen during two sessions where they were either allowed to go in and play afterwards (play) or were taken back to their home pen (non-play) with F-values and exact p-values (n=10 pairs/treatment)

Behaviour	Play	Non-play	F value	P value
Zone 1	0.625 (0.46 - 0.75)	0.69 (0.542 - 0.792)	1.54	0.2158
Zone 2	0.37 (0.25 - 0.54)	0.31 (0.21 - 0.46)	1.54	0.2158
Orientation 1	0.44 (0.375 - 0.583)	0.44 (0.333 - 0.583)	0.15	0.6967
Orientation 2	0.042 (0 - 0.125)	0.083(0.042- 0.167)	0.65	0.4205
Orientation 3	0.50 (0.333 - 0.542)	0.42 (0.333 - 0.583)	0.00	0.96
Standing	0.75 (0.708 - 0.833)	0.79 (0.5 - 0.917)	0.30	0.5833
Moving	0.25 (0.167 - 0.292)	0.21 (0.083 - 0.375)	0.01	0.9363
Curled tail	1 (0.917-1)	1 (0.75-1)	7.41	0.0067
Exploring	0.54 (0.375 - 0.833)	0.52 (0.375 - 0.792)	0.15	0.7003
Explore bar	0.27 (0.125 - 0.417)	0.37 (0.125 - 0.459)	4.40	0.0365

4.1.2 Effects of time, sex and previous experience

The only behaviour which was significantly affected by time in the holding pen was “locomotor play” (P=0.02, F=3.84). The play pigs performance of “locomotor play” decreased over time (i.e. three minutes of observation) with the highest number of recordings in the first minute. Median (95% Confidence Limits) number of recordings per minute for play pigs were 0.69 (0-1), 0.44 (0-1.5) and 0.37 (0–0.62) for the first, second and third minutes of observation respectively. Corresponding numbers for non-play pigs were 0.19 (0–1.12), 0.25 (0-1) and 0.12 (0–0.62). There were no significant effects of sex on the observed behaviours. Pigs with previous experience of toys had a higher number of recordings of “eliminate” than pigs without that experience (P=0.04, F=4.24). There were no other behaviours in the holding pen that were affected by the pigs previous experience with toys.

4.1.3 Behavioural changes over sessions

Based on descriptive analysis all the ten sessions for play pigs and the two sessions for non-play pigs in the holding pen were calculated for their medians and confidence limits to show how behaviours changed over the sessions (Figure 6).

In play pigs, based on descriptive analysis, “explore bar” increased from session one to session two and having the highest number of recordings during session two and ten and the lowest in session five (Figure 6A). In the play pigs “moving” was highest during the first session and then declined until the 4^{th} session thereafter it was relatively constant but with the lowest level in the last two sessions (Figure 6B). Play pigs showed no ”social contact” during the first two sessions, but the behaviour increased from sessions two to four and was stable from session four to ten with a dip in session seven (Figure 6C). The non-play pigs showed a

higher number of recordings of "social contact" during the first session than play pigs and an increase until session two (Figure 6C). The performance of "locomotor play" in play pigs was zero in the first session with an increase to session 3 and thereafter it was a relatively steady level (Figure 6D). Non-play pigs showed a higher number of "locomotor play" in the first session compared to play pigs and no clear change until session 2 (Figure 6D).

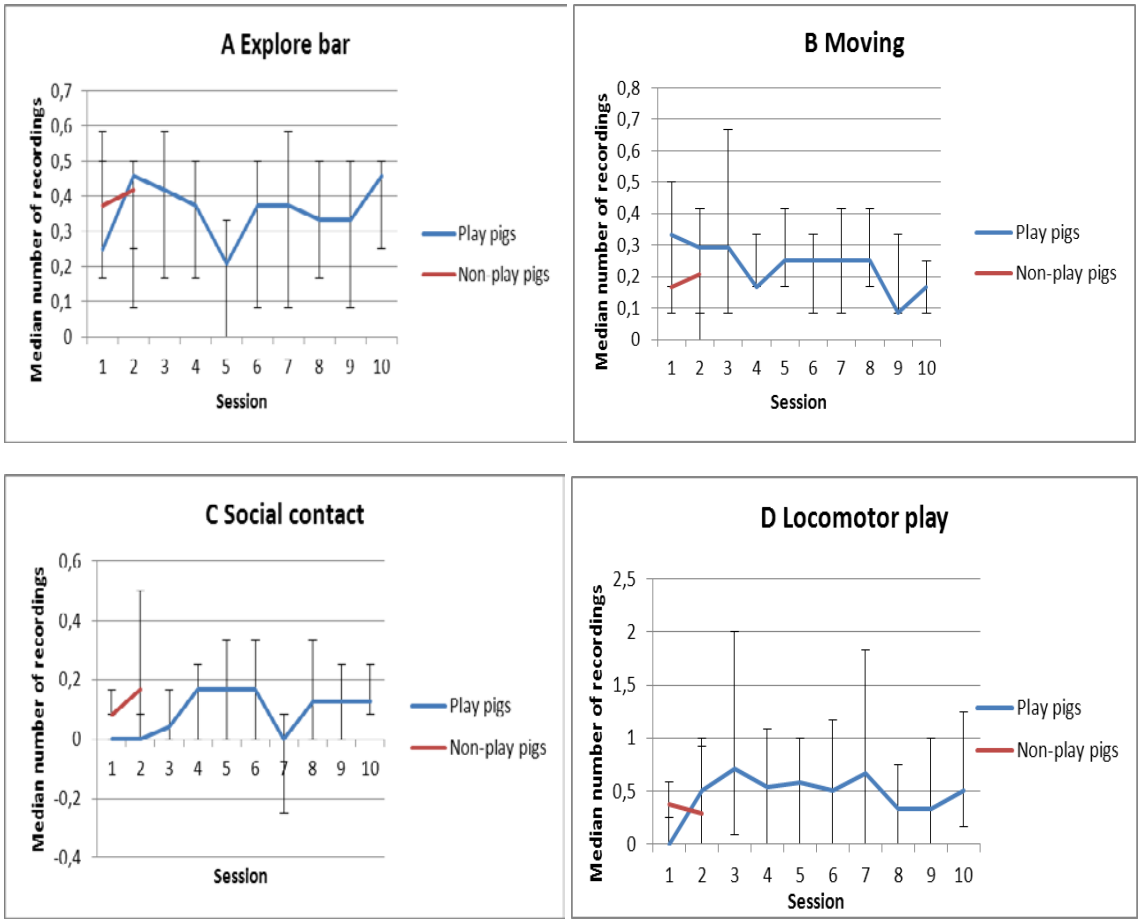

Figure 6. Median number of recordings (± 95% CL) for the behaviour "A Explore bar" , " B Moving", "C Social contact", and "D Locomotor play" during 10 sessions for play pigs and two sessions for non-play pigs during 3 minutes observations in the holding pen (n=10 pairs/treatment). (Note that non-play pigs in their sessions 1 and 2 were statistically compared with play pigs in their sessions 5 and 6 when they had experienced going to the play arena after having been in the holding pen for four training sessions).

4.2 Play arena

The statistical model tested for effects of time, week, sex and previous experience of toys. The overall medians, CL, P-values and F-values are presented in Tables 4 and 5, but the results are presented under separate sub-headings. "Wagging tail" (i.e. totally 45 recordings) and "tail between legs" (no recordings) were observed too few times to be analyzed.

Table 4. Median (95% Confidence Limits) number of recordings per minute for behaviours recorded continuously in pairs of pigs when kept fifteen minutes in a play arena with F-values and p-values (n=10 pairs)

Behaviour	Med (CL^- - CL^+)	Time (3x5min)		Week		Sex	
		Pvalue	Fvalue	Pvalue	Fvalue	Pvalue	Fvalue
Locomotor play	0.40 (0.25 – 0.47)	P<0.001	123.65	P<0.001	8.21	P<0.1	2.94
Object play	1.73 (1.50 – 1.85)	P<0.001	316.87	P<0.001	17	P<0.05	4.08
Social play	0.10 (0.08– 0.13)	P<0.001	12.77	P<0.1	2.19	n.s.	0.40
Total play	2.21 (1.81 – 2.4)	P<0.001	383.6	P<0.001	19.82	P<0.01	6.95

Table 5. Median (95% Confidence Limits) number of recordings per minute for behaviours recorded instantaneously in pairs of pigs when kept 15 minutes in a play arena with F-values and exact p-values (n=10 pairs)

Behaviour	Med (CL^- - CL^+)	Time (3x5min)		Week		Sex		Experience	
		Pvalue	Fvalue	Pvalue	Fvalue	Pvalue	Fvalue	Pvalue	Fvalue
Standing	0.74 (0.709 – 0.808)	P<0.05	3.35	P<0.05	3.45	n.s.	1.2	P<0.05	5.27
Moving	0.20 (0.16 – 0.247)	n.s.	1.37	P<0.001	26.45	P<0.1	3.17	P<0.1	2.88
Curled tail	0.96 (0.919 – 0.992)	n.s.	2.02	n.s.	0.15	n.s.	0.39	n.s.	0
Hanging tail	0.02 (0.007 – 0.054)	P<0.001	8.41	P<0.05	3.07	n.s.	1.59	n.s.	0.39
Exploring	0.43 (0.346 – 0.458)	P<0.001	41.50	P< 0.01	4.53	n.s.	0	n.s.	0.29

4.2.1 Effect of time

During 15 minutes of observation the most performed play type was “object play” and then “locomotor play”, whereas “social play” was the least performed play type in the play arena (Table 4). There was a significant effect of time in the play arena on “locomotor play”, “object play”, “social play” and “total play” (Table 4). “Locomotor play”, “object play” and “total play were highest in the first five minutes of the observation (i.e. 0-5 min) and “social play” was highest in the third five minutes of the observation (i.e. 10-15 min) (Figure 7). The differences between times did not show clear trends for the other behaviours (i.e. “sitting”, “lying”, “eliminate” and “aggression”) and are thus not presented in this report.

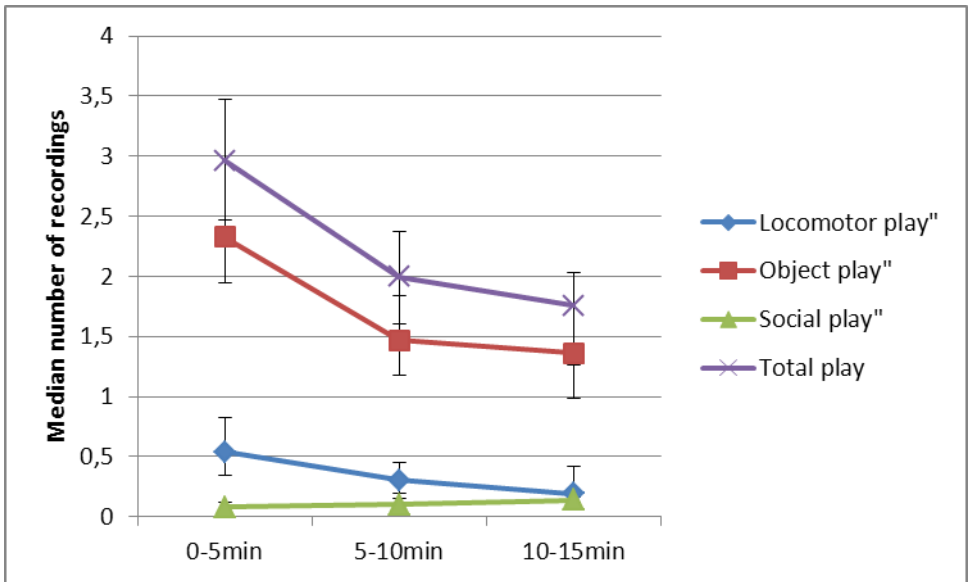

Figure 7. Median (± 95% Confidence Limits) number of recordings per minute of different play types during 15 minutes access to a play arena during 10 sessions of observation divided by time intervals of 5 minutes (n=10 pairs).

There was a significant effect of time (i.e. 3x5 min) on "standing", "hanging tail" and "exploring" (Figure 8). "Standing" showed a gradual decrease over time while "exploring" increased over 15 minutes. "Hanging tail" stayed close to zero during 15 minutes and showed similar values in the first and second five minutes but slightly increased in the last five minutes of the observation (Figure 8). The differences in time for other behaviours (i.e. "moving" and "curled tail") are not further presented in this report since they were not significant

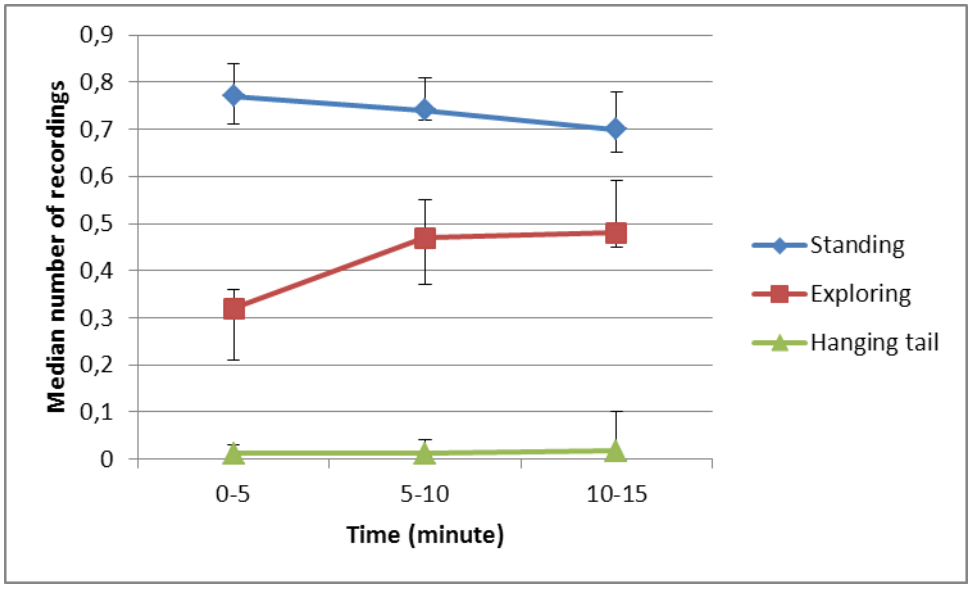

Figure 8. Median (± 95% Confidence Limits) number of recordings per minute of "standing", exploring" and "hanging tail" position observed during 15 minutes access to a play arena during 10 sessions of observation divided by time intervals of 5 minutes (n=10 pairs).

4.2.2 Effect of week

Week of observation significantly affected “locomotor play”, “object play” and “total play” (Table 4). “Object play” was performed the most, then “locomotor play”, whereas “social play” was performed the least during the four weeks of observation (Figure 9). “Object play” was performed the most in the first week and the least during the last week and fluctuated between these weeks (Figure 9). “Locomotor play” was performed the most in the first week and did not change so much throughout weeks. “Social play” showed a tendency for week effect (Table 4) and was performed the most in the second week and stayed close to zero during the other weeks (Figure 9). Median (95% confidence limits) number of recordings for “total play” were for week 1 2.27 (2.07 - 2.64), week two 1.92 (1.7 - 2.36), week three 2.22 (1.73 - 2.55) and week four 2.10 (1.62 - 2.36).

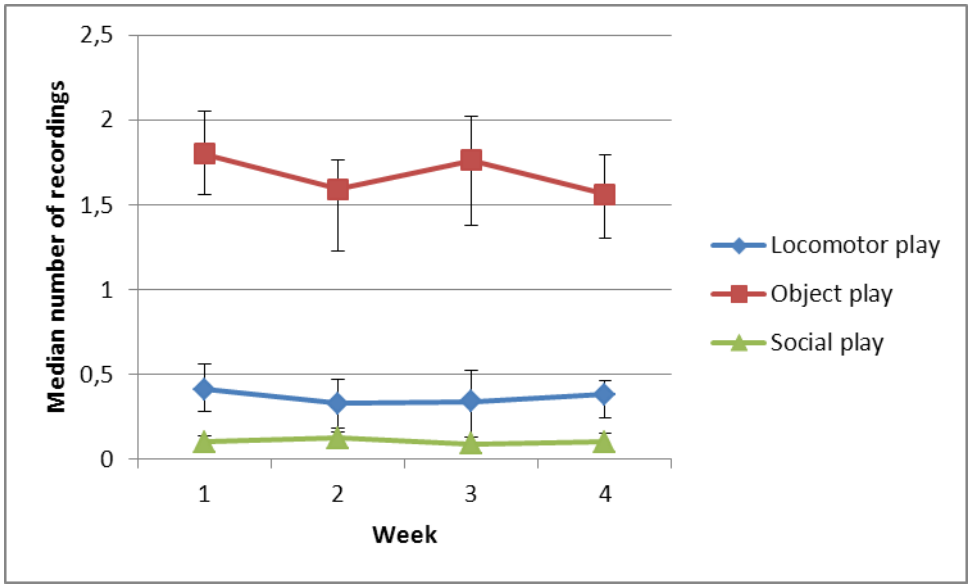

Figure 9. Median (± 95% Confidence Limits) number of recordings per minute of different play types during4 weeks of 15 minutes access to a play arena during 10 sessions of observation (n=10 pairs).

There was a significant effect of week of observation on “standing”, “moving”, “exploring” and “hanging tail” (Table 5). “Standing” and “exploring” showed an overall rise during weeks with an exception of week three for “standing” (Figure 10). However, “moving” showed a decrease over weeks of observation and “hanging tail” was close to zero mostly with a slight increase in week three (Figure 10). The differences between weeks for other behaviours are not further presented in this report.

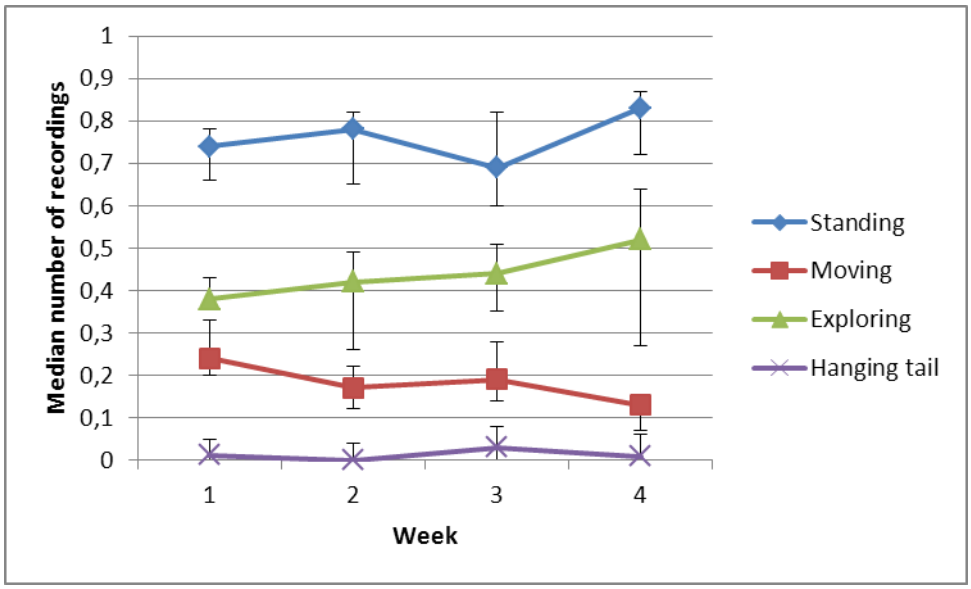

Figure 10. Median (± 95% Confidence Limits) number of recordings per minute of "standing", "moving" "exploring" and "hanging tail" position observed during4 weeks of 15 minutes access to a play arena during 10 sessions of observation (n=10 pairs).

4.2.3 Effects of sex and previous experience

A significant effect of sex was found in "object play" and "total play" (Table 4). Females performed significantly higher "object play" and "total play" than males (P=0.04) and (P=0.008) respectively. Moreover, a significant effect of previous toy experience was found in "standing" (Table 5) where pigs showed higher number of recordings with previous experience (P=0.02).

4.2.4 Preferred objects and type of interactions

Numerically the most preferred object to interact with was the brush (Figure 11). Similar interest was shown for the traffic cone, the pipe and the rope (Figure 11). The second least interesting object was the wellies and the lowest interest was directed towards the ball (Figure 11).

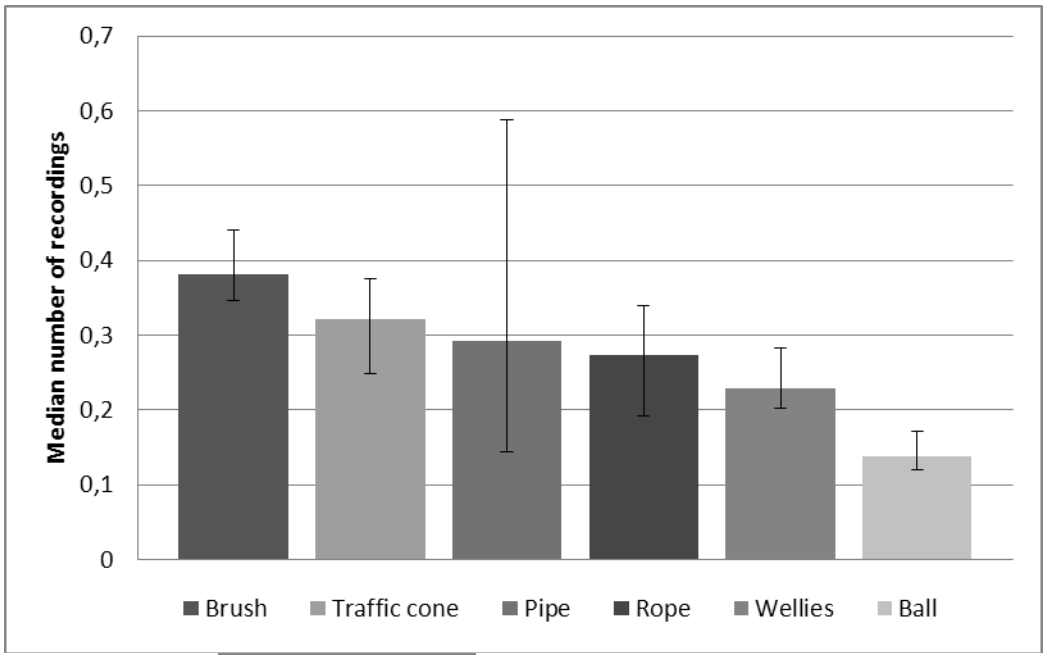

Figure 11. Median (95% Confidence Limits) number of recordings per minute that pigs had interaction with each object in the play arena (n=10 pairs).

When splitting up interactions with the objects into snout contact, paw and mouth manipulation, the brush was mostly explored by the pigs' snout (Figure 12). The traffic cone and pipe was slightly more manipulated by the mouth than the snout. The rope had a slightly higher number of recordings of mouth manipulation than snout. The wellies and the ball had a higher recording rate of snout manipulation. Pawing objects was observed too few times to be able to be visible in figure 12.

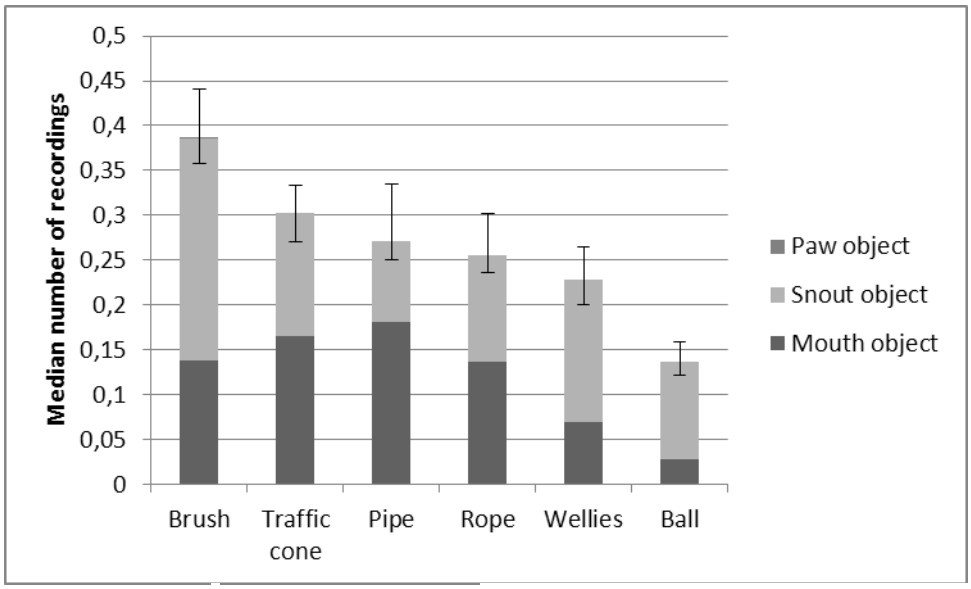

Figure 12. Median (95% Confidence Limits) number of recordings per minute that pigs had mouth, snout or paw interaction with six different objects during 15 minutes observation in the play arena during 10 sessions (n=10 pairs).

4.3 Home pen

4.3.1 Comparison between play and non-play pigs, sex and previous experience

Play pigs tended to "drink" more and performed significantly higher number of recordings of "social contact" and significantly less "locomotor play" than non-play pigs (Table 6). "Drinking" was recorded significantly more during the first five minutes of observation (median 0.04, CL 0.02–0.15) than during the last five minutes (median 0.03, CL 0–0.07). "Social contact" was recorded significantly more during the last five minutes (median 0.30, CL 0.22–0.57) than during the first five minutes (median 0.32, CL 0.10–0.41) in the home pen. Pigs with no previous toy experience performed a significantly higher frequency of "eliminate" (median 0.04, CL 0.02–0.06) than pigs with previous toy experience (median 0.01, CL 0.006-0.02). "Play fight" was performed too few times to be able to do statistical testing on (i.e. six and zero recordings for play and non-play pigs respectively). In addition, the statistical analysis gave no significant differences in "aggression" when looking at treatment, previous experience with toys and time. There was no significant effect of week in any behaviours observed continuously in the home pen.

Table 6. Median (95% Confidence Limits) number of recordings per minute for behaviours recorded continuously for 10 minutes in pairs of pigs during two sessions when moved back to home pen after fifteen minutes in a play arena (play pigs) or not allowed to go to play arena (non-play pigs) with F-values and p-values (n=10 pairs/treatment)

Behaviour	Play	Non-play	Treatment		Time (2x5 min)		Experience	
	Med (CL^- - CL^+)	Med (CL^- - CL^+)	Pvalue	Fvalue	Pvalue	Fvalue	Pvalue	Fvalue
Drinking	0.044 (0.025 - 0.15)	0.037 (0 - 0.075)	P<0.1	3.65	P<0.001	14.63	n.s.	0.23
Eliminate	0.006 (0 - 0.0625)	0.025 (0 - 0.05)	n.s.	1.23	n.s.	1.23	P< 0.01	9.98
Locomotor play	0 (0 - 0.0125)	0.0125 (0 - 0.0375)	P<0.05	4.07	n.s.	0.29	n.s.	0.76
Social contact	0.49 (0.34 - 0.56)	0.12 (0.037-0.4)	P<0.001	51.07	P<0.001	12.6	n.s.	1.14
Playfight*	0.0125(0 - 0.0125)	0 (0 – 0)	-	-	-	-	-	-
Aggression	0.019 (0 - 0.075)	0.006 (0 – 0.1)	n.s.	0.02	n.s.	0.28	n.s.	2.27

(*) not tested due to too few recordings

Treatment and time had a significant effected on "standing", "lying", "moving", "eating", "exploring" and "hanging tail" in the home pen (Table 7). Play pigs showed significantly higher number of recordings of "standing", "moving", "exploring", and less "lying", "eating" and "hanging tails" than non-play pigs (Table 7). Moreover, "standing", "moving" and "exploring" was significantly higher in the first five minutes (i.e. 0-5 min) and "lying", "eating" and "hanging tail" was significantly higher during the second five minutes (i.e. 5-10 min) (Table 8).

Table 7. Median (95% Confidence Limits) number of recordings per minute for behaviours recorded instantaneously for 10 minutes in pairs of pigs during two sessions when moved back to home pen after fifteen minutes in a play arena (play pigs) or not allowed to go to play arena (non-play pigs) with F-values and p-values (n=10 pairs/treatment)

Behaviour	Play	Non-play	Treatment		Experience		Time (2x5 min)	
	Med (CL^- - CL^+)	Med (CL^- - CL^+)	Pvalue	Fvalue	Pvalue	Fvalue	Pvalue	Fvalue
Standing	0.33 (0.21 - 0.37)	0.2 (0.05 – 0.36)	P<0.001	21.21	-	-	P<0.01	9.09
Sitting	0.025 (0 – 0.0625)	0 (0 – 0.5)	P<0.1	3.64	n.s.	0.01	n.s.	0.93
Lying	0.6 (0.5 – 0.712)	0.781(0.59 – 0.95)	P<0.001	53.14	n.s.	0.45	P<0.001	17.03
Moving	0.056 (0.037 – 0.087)	0 (0 – 0.025)	P<0.001	25.54	n.s.	0.07	P<0.05	5.59
Eating	0.006 (0– 0.0625)	0.00625 (0–0.25)	P<0.001	18.38	n.s.	0.17	P<0.05	6.38
Exploring	0.275(0.2–0.34)	0.056(0.0125–0.2625)	P<0.001	71.08	n.s.	0.22	P<0.05	5.53
Hanging tail	0.566 (0.44 – 0.73)	0.762 (0.525–0.96)	P<0.001	52.44	n.s.	2.1	P<0.001	11.75

Table 8. Median (95% Confidence Limits) number of recordings per minute of behaviours during 0-5 min and 5-10 min after play sessions in a play arena and then coming back to the home pen in pairs of pigs during two sessions in the home pen

Behaviour	0-5 min	5-10 min
	Median (CL- CL+)	Median (CL- CL+)
Standing	0.27 (0.15 – 0.42)	0.21 (0.11 – 0.34)
Lying	0.62 (0.5 – 0.76)	0.74 (0.56 – 0.85)
Moving	0.05 (0.02 – 0.06)	0.02 (0.01 – 0.04)
Eating	0.01 (0 – 0.11)	0.07 (0 – 0.125)
Exploring	0.2 (0.15 – 0.3)	0.19 (0.06 – 0.25)
Hanging tail	0.62 (0.46 – 0.77)	0.69 (0.56 – 0.85)

4.3.2 Behavioural changes over time for all sessions

Descriptive data for all the ten sessions for play pigs and the two sessions for non-play pigs in the home pen were calculated for their medians and confidence limits to show how behaviours changed over the ten minutes of observation (Figure 13). Non-play pigs were not observed at the time when play pigs came back to home pen; instead they were observed in days of the week when no play session was carried out. Non-play pigs were not “drinking” during the ten minutes whereas play pigs “drank” during the first seven minutes of the observation with a peak in the second minute (Figure 13A). Play pigs performed a high

number of recordings of "social contact" in the first minute and thereafter it declined throughout the ten minutes of observation (Figure 13B). Non-play pigs had a quite low and constant number of recordings of social contact with a dip to level zero in the 7th minute of observation (Figure 13B). There were no clear trends or patterns of changes over time which would be interesting to show in graphs for any of the other behaviours. The data for changes over sessions are not presented in this report since we did not find any clear trends in any of the observed behaviours.

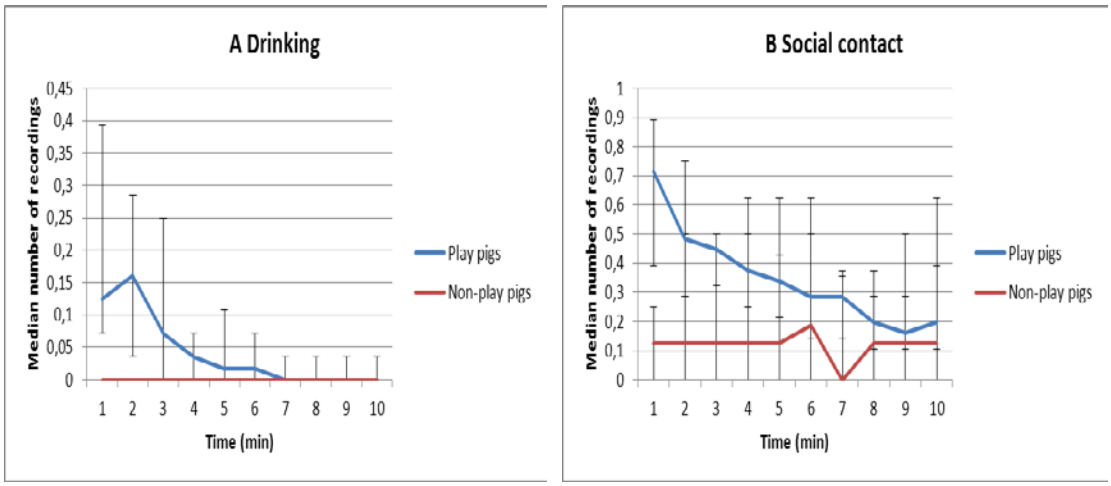

Figure 13. Median number of recordings (± 95% CL) per minute over ten minutes observation in "A Drinking" and " B Social contact" for play pigs (10 sessions) and for non-play pigs (2 sessions).

4.3.3 Latency to close eyes

The latency to close the eyes in the play pigs after coming back to the home pen after being tested in the play arena is illustrated in Table 9. The highest mean value for latency until the eyes were closed was recorded in sessions three, six and ten (i.e. 6.9 min) with the highest number of pigs that closed their eyes in sessions three, seven and ten (i.e. 12, 11 and 12 out of 20 pigs respectively).

Table 9. Latency to close the eyes in the home pen within 10 minutes observation after coming back from the play arena in 10 pairs of pigs (n=20).

Session	No. of pigs recorded	No. of pigs eyes closed	Mean latency until eyes closed (min)
1	20	8	6.7
2	20	9	6.8
3	19	12	6.9
4	20	8	4.5
5	20	10	5.9
6	20	7	6.9
7	20	11	5.7
8	20	8	6.7
9	20	9	6.8
10	19	12	6.9
Mean	-	9.4	6.38

5. Discussion

Regarding the investigating of the reward cycle i.e. anticipatory, consummatory and relaxation phases the main finding in this study was that play pigs showed significantly more locomotor play, play fight, elimination and had more curled tail than non-play pigs in the holding pen. In the play arena, object play was the most performed play behaviour whereas social play was the least. Moreover, locomotor play and object play was significantly higher in the first week and the first five minutes of the observation. The only gender effect found was for object play and total play with females performing more than males. In the home pen, play pigs performed significantly more social contact, moving, eating and exploring while non-play pigs were lying significantly more and performed more locomotor play.

5.1 Appetitive phase in the holding pen

In the holding pen, the most frequently observed play was locomotor play. Play pigs performed significantly more locomotor play, play fight and elimination than non-play pigs. It may be that play pigs have learned that they were going to be given the opportunity to play. Showing an increase in play can be an indicator of anticipation (Dudink *et al.,* 2006). Higher locomotor play and play fight in play pigs are forms of play behaviours, therefore one may speculate that they were preparing themselves for the coming play (i.e. anticipating to play) which can also be a sign of finding play a rewarding experience. These results are in agreement with a part of our first prediction, i.e. play pigs would show more play than non-play pigs. Similar results have been found in pigs (i.e. higher activity level and play behaviour) when anticipating environmental enrichment (Dudink *et al.,* 2006) and increased level of activity and running while anticipating food reward (Haskell *et al.,* 1996). For other species, behaviours indicative of anticipation for some form of reward, are for example increased locomotor behaviour (Van de Bos *et al.,* 2003) and higher levels of exploration (Spruijt *et al.,* 2001) in rats and more standing and increased locomotion in horses when anticipating food (Peters *et al.,* 2012). Similar findings have been reported in silver foxes and mice (i.e. increased activity) when anticipation both feed and non-feed related rewards (Moe *et al.,* 2006; Luuk *et al.,* 2012). However, these findings of our study are in contrast with findings on cats since the animals decreased their activity level when anticipating food (Vad de Bos *et al.,* 2003).

The higher number of eliminations (urination and defecation) is much harder to interpret. Jones & Nicol (1998) reported that higher occurrence of defecation is an indication of "porcine arousal" and Fraser (1974) claimed that pigs defecated more the first time they were in a novel environment. In this study the arousal can be interpreted as being of a positive nature.

During the three minutes in the holding pen both play and non-play pigs spent most of their time in zone 1 which was the closest zone to the play arena. Similar findings have been reported in Dudink *et al.* (2006) when pigs were offered positive stimuli, e.g. extra space, food, or straw, they were orientated more often towards the location in which the reward was offered. Also silver foxes spent more time in the front of their cages where reward was offered by a person (Moe *et al.,* 2006). Since the play pigs were supposed to have learned that they would be released in the play arena after some time being in close proximity to the play

arena could be an indication of anticipation. However, as this did not differ between non-play and play pigs this behaviour cannot be interpreted as anticipatory behaviour. One reason that may explain the similarity in time spent in zone 1 between play and non-play pigs could be the possibility of visual contact with the play arena through the mesh gate for both groups. Pigs are known for their exploratory and foraging nature (Van de Weerd *et al.*, 2003). Therefore, it is likely that spending most time in zone 1 has something to do with the exploratory nature of pigs which has a crucial role in pigs' "survival" (Studnitz *et al.*, 2007). So this part of our prediction that play pigs would be more observed in zone 1 than non-play pigs, was not supported by these results. It is also possible that a phase of anticipation that becomes too long can lead to inactivity or frustration in animals (Bloomsmith & Lambeth, 1995). It was noted during the pilot study that when pigs spent longer time in the holding pen (e.g. 4-6 minutes), they attempted to jump over the exit gate.

Both play and non-play pigs were mostly recorded in standing position and then moving, but never sitting or lying. One can relate this to anticipation, which is reported by Peters *et al.* (2012) when horses increased their time spent in standing position as a result of food anticipation. But it is difficult to draw any conclusions based on this especially when there was no significant difference between the treatments. When it comes to exploration, non-play pigs showed significantly more exploring the play arena bars than play pigs. It could be due to that non-play pigs that had no previous experience of the play arena had a stronger motivation for exploration than play pigs that already had been in the play arena and learned that the play arena gate was opened after three minutes. The same discussion points can be applied to the result with significantly more recordings of curled tail in play pigs than in non-play pigs. Since play pigs had been in the holding pen and play arena before the holding pen was more familiar and they knew what would happen afterwards compared with non-play pigs that did not know what would happen next. According to Kleinbeck & McGlone (1993) pigs had their tails hanging down in stressful situations such as heat stress and had the tail more in an upright posture (similar to curled tail in this study) when touched by a familiar person.

5.2 Consummatory phase in the play arena

As predicted the pigs performed all three types of play (i.e. object, locomotor and social play) in the play arena. Object play was the most performed type of play during the play arena observation. This may be due to that toys were the objects that pigs had the least experience with compared with other substrates in the environment (i.e. straw, play partners, etc.). Since pigs have a curious, exploratory and foraging nature (Van de Weerd *et al.*, 2003) they investigate objects in their environment. Object play was performed the most during the first week of the study (i.e. training week) which can be due to the novelty effect of toys. It is highly likely that pigs would lose their interest in the same repeated objects with time if they would have continuous access to them. This was reported by Trickett *et al.* (1995) where pigs with continuous access to rope interacted more with it the first week and at the time after changing it to a fresh one. Van de Weerd *et al.* (2003) reported similar results when within five days a significant habituation to most objects occurred and object interaction decreased significantly by time.

In contrast to Van de Weerd *et al.* (2003) who reported that pigs interacted more with suspended toys than loose toys, the most numerically preferred object in this study was the brush which was provided loosely on the floor. Moreover, according to Van de Weerd *et al.* (2003) pigs showed preference for objects that were "deformable", "destructible", "chewable", "odorous" and "ingestible". In our study, a brush cannot be considered as any of these suggestions. Finding the brush interesting might be due to that the hairs of the brush felt interesting on the snout or the unpredictability of moving the hairs of the brush. The least interesting object based on descriptive statistical analysis was the ball which was one of the two objects that they had experience with around weaning (Hultman, 2013). In this study play performance was not higher based on previous experience with toys which was opposite to our prediction. The toys pigs had experienced before were the rope and the ball out of the tested six toys in this study. However, due to the risk that the sow or piglets would be injured by the toys in the previous study, the piglets were not allowed to have continuous access to the toys when the observer was not in the stable (Hultman, 2013). This may partly explain why there was no effect of previous toy experience on the play level in this study. One can also speculate if the pigs curiosity in the toys only last for a short time and/or if pigs have a short memory of the individual toys.

When it comes to locomotor play it was significantly higher in the first week and in the first five minutes. Higher occurrence of locomotor play in the first week can be a result of lower weight in the pigs at that age that made it easier to move faster or perform physically active behaviours such as running, pivoting etc. One can assume that this has an even larger effect on pigs of older ages (i.e. week three and four) as a result of higher metabolic activity and weight gain. The pigs in this study were the second batch of Specific Pathogen Free (SPF) pigs in a new barn and had a larger weight gain than had been expected at the start of the study. This may further have influenced their heat balance. Moreover, a previous study found a strong effect of temperature on activity and behaviours in growing pigs e.g. they decreased their heat producing activities at temperatures above 24.2°C (Huynh *et al.*, 2005). We may speculate that the significantly higher occurrence of hanging tail in week three could have something to do with this phenomenon as well. During the study we found that the floor of the stable was very slippery, even after covering the floor in the play arena with long straw. This led to frequent falling of pigs while performing locomotor play which may explain why they performed less locomotor play over time. One explanation for locomotor play being highest in the first five minutes can be the access to a bigger space that induced locomotor activity during the first minutes after entrance to the larger space (i.e. play arena). These results are in agreement with Jensen and Kyhn (2000) who found that dairy calves performed more locomotor play after they were introduced to a larger space and the performance was even higher in those calves that were housed in smaller pens previously. This phenomenon is called a rebound effect and is a response of animals to having been kept in a space that did not allow for locomotor activity (Jensen & Kyhn, 2000). Blackshaw *et al.* (1997) noted that even if locomotor play increased by age it reached a constant level at the age of 26-30 days. Pigs in this study were observed when their mean age was 49 days in the beginning and 77 days at the end.

Social play was the least performed play type in the play arena and it increased over 15 minutes of observation and was significantly higher during the last five minutes of the observation. According to Jensen *et al.* (1998) social play and locomotor play usually are connected to each other. However, in this study we noted that sometimes when one pig started to run the other pig started to follow but this locomotor play did not lead to play fight or social interaction; rather they ended it by going back to pen exploration or object interaction. That social play was performed the least of all three types of play during all sessions, can have to do with the novelty effect. By that we mean that the play partners were the pen mates and siblings, so they were not new to each other and therefore no novelty effect was involved in social interactions. However, in the final part of the observations (i.e. last five minutes) they might have lost interest in other substrates available in the play arena, and were maybe exhausted enough to avoid further locomotor play. Therefore, the pigs turned to their pen mates.

Females performed more object and total play than males. There are different findings reported with different animal species which do not support our results. For instance, no significant gender effect was found in performing social play in free-range pigs (Newberry & Wood-Gush, 1986) and locomotor play in piglets (Newberry *et al.*, 1988).

The most observed body posture in the play arena was standing. Moving was the second most recorded body posture in the play arena. Both standing and moving can mean that animals were alert/active and curios to explore the arena. Moving occurred significantly more in the first week (i.e. training) and one can interpret this as an attempt to discover the new environment and higher level of activity and responsiveness. However, exploration was significantly higher during the last week and last five minutes of the observation. Spinka *et al.* (2001) meant that exploration has associations with play in many ways and Blackshaw *et al.* (1997) believed exploration can be the first movement towards play initiation. Therefore, higher exploration during both the last week and the last five minutes of the observations can be interpreted as habituation and decrease the novelty effect of toys. So, it could be that they compensated their novelty seeking motivation with higher performance of exploratory behaviours instead. Pigs had mostly curled tails in the play arena which according to Kleinbeck & McGlone (1993) can be associated with positive experience.

5.3 Post-consummatory phase in the home pen

Play pigs performed significantly higher number of recordings of social contact, significantly less locomotor play and tended to drink more than non-play pigs. Higher social contact in play pigs might be performed as a form of reunion-related behaviours with non-play littermates especially since it occurred more often in the first five minutes of the observation. As reported by Boissy & Le Neindre, (1997) heifers initiated licking and sniffing conspecifics at reunion with them following a period of separation. However, non-play pigs performed significantly higher locomotor play than play pigs. According to Held & Spinka (2011) social facilitation is one characteristic of play. Performing higher locomotor play in non-play pigs can be related to social facilitation of play. In other words, one may speculate that play pigs going out to play every other day could affect non-play pigs positively. In a study by Haskell *et al.* (1996), investigating the persistence of foraging behaviour during the post-

consummatory phase of a feed reward, the pigs with larger reward had more persistent feeding motivation which disappeared over time and by learning. Performing significantly higher locomotor play in non-play pigs than play pigs in this study therefore is contradictory to findings by Haskell *et al.* (1996). Moreover, we found no significant effect of week on locomotor play in the home pen. This is contradicting with findings of Jensen & Kyhn (2000) who tested effects of space allowance on play behaviour in dairy calves during which calves showed a decrease in locomotor play over weeks. Play pigs showed a tendency to drink more and it may be explained in terms of the physiological needs of play pigs after having been very active for almost 20 minutes. Also, the temperature in the pig stable was at times higher than normal (e.g. 27.3°C).

According to Zimmerman *et al.* (2011), comfort behaviour in domestic fowl was reported as an indicator of relaxation and positive emotional states. We expected to find significantly more comfort behaviour in play pigs than non-play pigs as a behavioural indicator of relaxation. Unfortunately there were too few recordings on this behaviour to be able to do any statistics on.

The results of this study are in agreement with our prediction that non-play pigs would be less active than play pigs in the home pen (i.e. non-play pigs performed more lying, less moving, less exploring and less social contact). However, non-play pigs ate significantly more than play pigs which does not support our prediction that play pigs would eat more (i.e. counting eating as an indicator of relaxation).

Hanging tail was observed significantly more in non-play pigs than in play pigs. According to Kleinbeck and McGlone (1993) pigs showed more hanging tail position when they were in contact with a familiar person. Therefore, one can argue that non-play pigs were more relaxed than play pigs in the home pen. But in this case more hanging tail occurrence could simply be a result of significantly higher performance of lying in non-play pigs because during this study pigs showed hanging tail when lying. In addition, it is important to bear in mind that due to practical handling reasons, home pen observation sessions for non-play pigs was performed in days with no play bouts. This lead to that we obtained a base-line of behavioural patterns for non-play pigs in the home pen. This could have been different if we had observed them simultaneously with play pigs, i.e. when play pigs came back to their home pen after having been in the play arena. Moreover, almost half of the play pigs in each session after play closed their eyes while lying within ten minutes of observation in home pen. This can be an indication of showing relaxation after play in the home pen. Whether this relaxation was expressed as a result of experiencing a rewarding effect or physical exhaustion after play is difficult to speculate in. Also it might take a bit longer time to relax at both mental and physical level and perform behaviours connected to that. Therefore, we think 10 minutes observation immediately after play might not be enough time for relaxation-related behaviours to appear. During the study we noticed that play pigs were not lying down immediately in the home pen after play. Thus, it is likely that pigs performed relaxation-related behaviours in a longer time span after coming back to their home pen which we did not observe. Moreover, there were disturbances from non-play pigs that might have affected the relaxation phase of play pigs. Further investigation is needed regarding this phase.

Pigs with no previous toy experience performed higher frequency of elimination (including both urination and defecation). Pigs with or without previous toy experience were assigned randomly between both play and non-play pigs. One speculation is that pigs with no previous toy experience appeared to be more "excited". In other words, they showed higher "arousal" by performing significantly more occurrence of elimination according to Jones & Nicol (1998). Furthermore, there was no significant difference in performing aggression between treatments, due to previous toy experience or time. This indicates that non-play pigs did not show higher occurrence of aggression than play pigs which does not support our prediction.

5.4 Suggestions for future research

Due to practical handling reasons non-play pigs were tested on days of the week when no play sessions were running. This makes it difficult to compare data obtained from the non-play pigs with those from play pigs in the home pen and in the holding pen. Therefore, testing non-play pigs every day in the same way as play pigs would have given us data for a better comparison between the two treatments. Home pen observations of non-play pigs gave us a base-line for behavioural patterns in the home pen on calm days rather than a scale for comparison with the play pigs. Also having both play and non-play pigs in the same pen affected them in several ways. For instance, disturbance from play pigs commuting back and forth to the play arena could have an impact on non-play pigs, and especially the non-play pigs disturbed the behaviour of the play pigs performance of relaxation-related behaviours. In most other novelty tests the arena size was either 5-10 m^2 (for the age of maximum 8 weeks) or 5-10 m^2 (for the age of 3-16 weeks) and it was recommended to adjust the arena size to animal's body size (Forkman *et al.,* 2007). In the current study we used an arena with the size 1.3 x 4.5 m (i.e. 5.85 m^2) which could be too small at this age (mean age of 7 weeks at the training week). Forkman *et al.* (2007) further mentioned the risk of methodological problems when testing pigs in repeatedly for a long period of time without adjusting the arena size following their body size. Moreover, pigs were switching so often between different behaviours; therefore using video recording could have been beneficial for behavioural observations. Further investigation in this area would be beneficial to find out the behaviours connected to each phase of the reward cycle namely appetitive/anticipatory, consummatory and post-consummatory phases.

6. Conclusions

The conclusions of this study are that:

- Play pigs showed higher locomotor play and play fight in the holding pen. Both play and non-play pigs spent most of the time in zone 1. However, non-play pigs performed higher exploration of play arena bars.

- In play arena pigs performed all three types of play. Object play was performed the most and social play the least. In addition, object play and total play was performed significantly more in females than males. Based on descriptive data brush was the most preferred and ball was the least preferred object to interact with.

- No effect of previous toy experience was found on play. The only significant effects of previous toy experience in the entire study was: pigs with toy experience eliminated more in holding pen, less in home pen and stood more in play arena.

- Play pigs did not show those behaviours that we expected as indicators of relaxation in home pen (i.e. lying, drinking, eating and rubbing). However, almost half of the play pigs closed their eyes after playing within 10 minutes of observation in the home pen.

- On days with no play sessions non-play pigs seemed to be less active in their home pen. Play pigs performed significantly more moving, exploring, and social contact. On the other hand, non-play pigs were longer in lying position, performed more locomotor play and had tail more often in hanging position. Aggression was observed too few occasions to be able to do any statistics on.

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Appendix 1

Time plan for the pilot and main study (Play pigs Mon-Tues & Thurs-Fri).

Week no.	**Monday**	**Tuesday**	**Wednesday**	**Thursday**	**Friday**
1	Pilot study Object test	Pilot study	Pilot study	Pilot study	Pilot study
2	Pilot study Holding pen built	Pilot study Protocol test	Pilot study	Pilot study	Pilot study
3	Moving to weaner stable and weighing	Acclimatization	Acclimatization	Acclimatization	Acclimatization
4	Training Session1	Training Session:2	Non-play holding pen Session:1	Training Session:3	Training Session:4
5	Play obs. Session:5	Play obs. Session:5	Non-play holding pen Weighing Session:2	Play obs. Session:6	Play obs. Session:6
6	Play obs. Session:7	Play obs. Session:7	Non-play home pen Session:1	Play obs. Session:8	Play obs. Session:8
7	Play obs. Session:9	Play obs. Session:9	Non-play home pen Session:2	Play obs. Session:10	Play obs. + Weighing Session:10

Appendix 2

Information about the pigs used in the study (Weight1=weight at weaning, weight2=weight at 2 weeks after weaning and weight3=weight at 4 weeks after weaning)

Pen no.	Pig no.	Sex	Treatment	Breed	Weigh1(kg)	Wejght2(kg)	Weight3(kg)
902	138	M	Play	YxL	19.2	35,1	52,8
902	139	M	Non-play	YxL	17.7	33,4	48,5
902	88	F	Non-play	Y	24.7	41,3	60,0
902	143	F	Play	YxL	16.2	33,2	48,1
903	177	M	Non-play	Y	15.9	29,1	44,4
903	178	M	PLay	Y	12.5	23,4	36,7
903	183	F	Non-play	Y	13.6	24,2	41,2
903	184	F	PLay	Y	13.2	23,6	37,1
904	151	M	Play	YxL	10.6	24,1	38,7
904	152	M	Non-play	YxL	13.0	30,2	47,2
904	155	F	Play	YxL	13.5	28,9	45,6
904	157	F	Non-play	YxL	12.0	25,8	43,1
905	166	M	Play	Y	17.5	28,0	40,5
905	168	M	Non-play	Y	16.2	30,5	45,9
905	171	F	Play	Y	17.2	29,4	43,3
905	173	F	Non-play	Y	17.1	29,6	44,0
906	216	M	Non-play	Y	12.9	23,5	38,4
906	217	M	Play	Y	16.0	29,5	46,6

906	220	F	Play	Y	12.7	21,2	33,3
906	221	F	Non-play	Y	14.8	26,1	41,8
909	248	M	Play	Y	14.4	26,3	40,6
909	242	M	Non-play	Y	15.1	26,5	42,3
909	246	F	Play	Y	14.7	27,6	44,4
909	247	F	Non-play	Y	13.1	25,3	40,7
910	160	M	Non-play	YxL	19.2	36,8	54,0
910	161	M	Play	YxL	11.4	23,4	37,8
910	162	F	Non-play	YxL	14.4	30,5	46,2
910	163	F	Play	YxL	15.9	32,6	48,0
911	204	M	Non-play	YxL	19.8	31,2	46,4
911	205	M	Play	YxL	22.7	35,2	53,1
911	208	F	Non-play	YxL	19.2	28,4	41,6
911	210	F	Play	YxL	18.0	29,1	41,6
912	255	M	Play	Y	16.8	29,9	45,3
912	257	M	Non-play	Y	16.5	29,7	44,0
912	250	F	Play	Y	18.0	32,4	49,6
912	251	F	Non-play	Y	17.4	30,7	46,5
913	227	M	Play	YxL	14.6	26,3	39,7
913	235	M	Non-play	YxL	14.0	24,4	41,3
913	231	F	Non-play	YxL	15.3	27,9	42,9
913	232	F	Play	YxL	14.3	23,3	36,3

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E-post: hmh@slu.se
Hemsida:
www.slu.se/husdjurmiljohalsa

Swedish University of Agricultural Sciences
Faculty of Veterinary Medicine and Animal Science
Department of Animal Environment and Health
P.O.B. 234
SE-532 23 Skara, Sweden
Phone: +46 (0)511 67000
E-mail: hmh@slu.se
Homepage:
www.slu.se/animalenvironmenthealth