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Skillnader i generella beteenden och sociala interaktioner hos unga Yorkshire gyltor i olika sociala miljöer

Linda Marie Hannius

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Linda Marie Hannius

Supervisor:	Anna Wallenbeck, Swedish University of Agricultural Sciences, Department of Animal Environment and Health
Assistant supervisor:	Linda Keeling, Swedish University of Agricultural Sciences, Department of Animal Environment and Health
Examiner:	Else Verbeek, Swedish University of Agricultural Sciences, Department of Animal Environment and Health

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Swedish University of Agricultural Sciences
Faculty of Veterinary Medicine and Animal Science
Department of Animal Environment and Health

Abstract

In Sweden, there was a switch of breeding material for pigs in year 2012 where Swedish producers were introduced to the Dutch Yorkshire (DY) instead of the Swedish Yorkshire (SY). Gestating sows have, in Sweden, been kept in group housing since the 1980s while DY gilts on the contrary have been kept in individual stalls. Consequently, the genetic selection of these lines of Yorkshire pigs was conducted in different environments and are thus indirectly selected for behaviours beneficial for each respective environment. This may induce behavioural differences between them, which may be of importance in group housing systems. In the wild, piglets usually have the opportunity to socialise with other pigs outside the litter and piglets that can socialise outside the litter have better social skills later in life. Piglets that do not have the opportunity to engage in social interactions outside the litter may behave differently than piglets that have that opportunity.

This Master thesis is a part of an ongoing project "Improving sow welfare in group housing systems" which aims to develop commercially relevant and sustainable breeding and rearing strategies for sows in group housing systems. The aims of this MSc thesis were to investigate if there is a difference in behaviours and social interactions between young gilts with two different lines of Yorkshire breeds and if the behaviours and social interactions are affected if they have the opportunity to socialise outside the litter during an early socialisation period. Direct observations where performed on 118 gilts where half were of the breed SY (49 gilts) and the other half DY (56 gilts). Approximately half of both breeds had access to the neighbouring pen during the last four weeks of the nursing period. Scan sampling was used to record different variables for body position, location in pen and activity. Continuous observations were performed for two minutes per animal on each observation occasion to record social interactions and stereotypes.

Overall, the results displayed some behavioural differences between both breeds and treatments. In general behaviour, SY gilts were more active than DY gilts. In addition, gilts of the breed SY performed more social nosing and nosing belly region then DY gilts. Regarding receiving pig behaviour, gilts of the breed SY responds to a performing pigs' social interaction with no reaction in a larger proportion of the observation occasions in comparison with gilts with the breed DY. Regarding different treatments, gilts held in an access pen (AP) slept less and were more active directly after weaning (when the pop holes were closed). It was also found that AP stimulates the gilts to perform a larger variation in social behaviours and showing different types of behaviours to a larger extent. The largest differences in behaviours occurred around weaning. This study includes the first steps of mapping differences in behaviours during early socialisation between these breeds and treatments, but further studies need to be done on the long-term effects.

Keywords: Swedish Yorkshire, Dutch Yorkshire, behaviour, social interactions, social environment

Sammanfattning

Under 2012 skedde det i Sverige en ändring av avelsmaterial hos grisar där svenska producenter introducerades till den holländska Yorkshiren (DY) istället för den tidigare använda svenska Yorkshiren (SY). Dräktiga suggor har i Sverige hållits i grupp sedan 1980-talet till skillnad från grisar av rasen DY som hållits i individuella spiltor. Således har den genetiska selektionen av dessa två linjer av Yorkshireraser skett i olika miljöer. Detta skulle kunna orsaka skillnader i beteende hos dem vilket skulle kunna vara viktiga att ta i beaktning i grupphållningssystem. I det vilda så har kultingarna ofta möjligheten att kunna socialisera med andra grisar än de som finns i kullen och det har visats att kultingar som får möjlighet att socialisera utanför sin kull är mer socialt kompetenta när de blir äldre i jämförelse med kultingar som inte haft denna möjlighet. Således skulle kultingar som inte har möjlighet att engagera sig i sociala interaktioner utanför sin kull kunna ha annorlunda beteenden än kultingar som haft denna möjlighet.

Denna masteruppsats är en del av ett pågående projekt vid namn ” Förbättrad välfärd för suggor i grupphållningssystem” vars syfte är att utveckla kommersiellt relevanta och hållbara avels- och uppfödningsstrategier för suggor i grupphållningssystem. Syftet med detta examensarbete var att undersöka om det finns en skillnad i beteende och sociala interaktioner mellan gyltor av två olika linjer av Yorkshireraser och hur beteenden och sociala interaktioner påverkas av behandlingar där de har möjlighet att vara sociala med grisar utanför sin egen kull (AP). Direkta observationer utövades på 118 gyltor där hälften var av rasen SY (49 gyltor) och den andra häften DY (56 gyltor). Ungefär hälften av båda raserna hade även tillgång till grannboxen under fyra veckor. Scan sampling användes för att registrera variabler för kroppsposition, positionering i boxen samt aktivitet. Kontinuerliga observationer utfördes under två minuter per djur och observationstillfälle för att registrera sociala interaktioner och stereotypier.

Generellt visade resultaten vissa beteendeskillnader mellan både raser och behandlingar. Gällande generellt beteende så verkade SY-gyltor vara mer aktiva än DY-gyltor. Dessutom så utförde SY-gyltor mer social nosningar och nosningar mot magregionen än DY-gyltor. Angående beteende från den mottagande grisen i en social interaktion så reagerade SY-gyltor oftare med ”ingen reaktion” i en större proportion av observationstillfällena i jämförelse med DY-gyltor. Rörande olika behandlingar så var gyltorna som hölls i en AP mer aktiva och sov dessutom mindre direkt efter avvänjning (då luckan mellan boxarna stängts). Resultaten visade även att AP stimulerade gyltorna till en större variation av sociala beteenden och visade olika sorters beteenden mer frekvent. De största variationerna i beteenden skedde runt avvänjning. Denna studie var en början till att kartlägga skillnader i beteenden när grisar växer upp i en social miljö med hänsyn till raser och behandlingar, men fortsatta studier behövs för att undersöka de långsiktiga effekterna.

Nyckelord: Svensk Yorkshire, Holländsk Yorkshire, beteende, sociala interaktioner, social miljö

Raser och social uppväxtmiljö kan påverka både gyltors generella och sociala beteende

Resultaten i detta examensarbete pekade på att det finns skillnader mellan raserna svensk Yorkshire och holländsk Yorkshire och mellan de gyltor som haft en utökad social miljö eller inte när de varit små. Gynnsamma sociala beteenden hos gyltor skulle på ett positivt sätt kunna öka djurvälfärden och ge förbättrad lönsamhet för grisproducenter.

Gyltor av rasen svensk Yorkshire var mer aktiva (exempelvis sov mindre och gick mer) än gyltorna av rasen holländsk Yorkshire. Gyltorna med rasen svensk Yorkshire verkade även nosa mer på andra grisar och de reagerade inte lika starkt när en annan gris initierade en social interaktion med dem i jämförelse med gyltor av rasen holländsk Yorkshire. Resultaten visade att gyltor som fått umgåtts med kultingar från grannboxen var mer aktiva och sov mindre vid tiden då kultingarna blir avvanda jämfört med grisar som hölls i kontrollmiljön. Efter avvänjning stängdes också luckan som skapade den utökade sociala miljön. Den ökade aktivitetsnivån hos kultingar som haft tillgång till grannboxen skulle kunna bero på att kultingarna förlorat både sin mamma och nu även bytt levnadsmiljö vilket skapar en ökad oro. Grisarna som levt i den utökade sociala miljön visade också flera beteenden och dessutom flera olika sorters beteenden än grisar i kontrollmiljön.

I Sverige hålls suggor i grupp i enlighet med den svenska lagstiftningen. Den rasen vi idag ofta använder, holländsk Yorkshire, är dock inte selekterad för att leva i en sådan miljö till skillnad från den svenska Yorkshiren, som använts tidigare. Det har även visat sig i forskning att kultingar som får umgås med andra grisar än kullsyskonen har flera gynnsamma sociala beteenden när de är äldre och blandas med andra grisar de inte känner sedan innan. Gynnsamma sociala beteenden kan möjligtvis minska antalet skador och liknande som minskar djurens välfärd och producentens lönsamhet, vilket idag kan vara ett stort problem när gyltor och suggor blandas.

I studien ingick 118 gyltor där ungefär hälften var av rasen holländsk Yorkshire och andra hälften av svensk Yorkshire. Hälften av gyltorna av båda raserna hölls i en box där det fanns en lucka som öppnades till grannboxen och denna lucka var öppen i fyra veckor innan avvänjning. Den andra hälften av gyltorna hölls i vanliga grisnings och digivningsboxar utan lucka.

Fortsatt forskning behövs för att verifiera hur raserna skiljer sig åt och hur den sociala miljön påverkar gyltorna senare i livet. Genom mer forskning i detta ämne skulle bättre och hållbarare avels- och uppfödningsstrategier för suggor i grupphållningssystem kunna skapas som i sin tur skulle kunna leda till bättre djurvälfärd och förbättrad lönsamhet för grisproducenter.

Preface

This Master thesis was conducted at the Department of Animal Environment and Health at the Swedish University of Agricultural Sciences. This thesis is a culmination of my time at the Animal Science master programme. Since my bachelor in Ethology and Animal welfare, animal behaviour and welfare has been topics that constantly occupies my mind. During my education, my interest in pigs has escalated quickly and I am so glad that I had the possibility to be a part of this study which includes both behaviour and welfare of pigs.

In truth, I could not have achieved this MSc thesis study without help and support, and I would like to thank some of the people who helped me during this process:

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Abbreviations

DY	Dutch Yorkshire
H	Hampshire
IOR	Inter Observer Reliability
LS-mean	Least square mean
SE	Standard error
Std	Standard deviation
SY	Swedish Yorkshire

1 Introduction

In 2008, an EU council directive came with a legislative initiative for improving the welfare of sows (EU Council Directive 2008/120/EC). Due to this, the direction of the management of sows in the European Union (EU) has altered and there is an ongoing change from housing both gilts and dry sows in individual stalls to instead housing them in groups during the major part of the gestation period.

When comparing individual housing with loose housing of sows, there are both disadvantages and advantages with both systems from production and animal welfare perspectives. Stalls allow both sows and gilts to be housed individually (McGlone *et al*., 2004). This in turn have the disadvantage of restricting sows and gilts to perform several species specific behaviours such as exploration and foraging (Rhodes *et al*., 2005). This form of housing also gives the animal limited possibilities to social interactions with other individuals and restriction of movement (McGlone *et al*., 2004; Anil *et al*., 2005). The absence of movements and exercise in individual stalls leads to sows with reduction in bone strength and muscle weight in comparison with sows that are housed in groups (Marchant & Broom, 1996). There has also been found that stereotypes are more often observed in individual housing systems than in group housing systems for sows (Arellano *et al*., 1992). In contrast, the advantages with individual housing of sows is that the system allows for monitoring feed intake on an individual level as well as reducing the labour for producers (Anil *et al*., 2002). Individual housing of sows also have the benefit of allowing protection of sows from agonistic encounters between one another, which have been seen in studies where sows housed in groups had higher injury scores than sows kept in individual stalls (Anil *et al*., 2005).

The advantages of group housing of sows is that it allows sows to express natural behaviours and to perform social behaviours with other individuals (Rhodes *et al*., 2005), it also offers the sow freedom to move and exercise (Anil *et al*., 2005) which has been seen to improve their health (Marchant & Broom, 1996). In contrast, there are disadvantages with group housing as well. In group housing systems, the proportion of culled and removed sows, for the most part due to lameness, has been

seen to be greater than in comparison with individual stalls (Anil *et al*., 2005). This could be an outcome of the fact that in group housing systems, aggressive interactions are commonly seen after mixing of unfamiliar sows (Arey & Edwards, 1998), something that is inevitable in group hosing systems. These aggressive encounters often result in injuries and stress which in turn will lead to concerns about the animal welfare (Chapinal *et al*., 2010). Group housing also makes it hard for the producer to individually monitor the feed intake of the sows (Anil *et al*., 2003; Chapinal *et al*., 2010).

As a consequence of the terminated collaboration between Norsvin and Nordic Genetics, Nordic Genetics announced that they would discontinue with the breeding of the Swedish Yorkshire (SY) in year 2012 (Lundheim & Hansson, 2012). Consequently, Norsvin decided to import Yorkshire from the Netherlands by collaborating with the Dutch company Topigs (Brink, 2012). The reason for the switch in breeding material, according to Norsvin, is that the Dutch Yorkshire (DY) will increase the number of piglets weaned per litter (Brink, 2013). The Dutch Yorkshire line is by the breeding company Topigs called the Z-line and therefore is the abbreviation ZY used by them, but in this study this breed will be called DY. Housing sows in individual stalls have been the most common housing system for both gilts and sows in the EU over the years (European Food Safety Authority (EFSA), 2007a). Accordingly, sows have been selected in accordance with their performance and suitability in individual stalls which may result in sows that are less suitable for group housing systems (Horback & Parsons, 2016). In contrast, sows in Sweden has been group housed during gestation since the late 1980-ies (Regeringskansliet, 1988; Einarsson *et al*., 2014) and since the genetic selection has taken place under group conditions, the SY sows are have been indirectly selected for behaviour beneficial in that environment. This may imply possible behavioural differences in group housing systems between the SY breed and DY breed.

There are evidence that pigs held in stimulating rearing environments shows less damaging behaviours and more explorative behaviours than pigs held in barren environments (Greenwood *et al*., 2014). In addition, gilts social skills improve if they are exposed to social experiences during rearing which also improves their social skills at mixing later in life (van Putten & Bure, 1997). Likewise, evidence is found that piglets that can socialise with piglets from other litters during the suckling period are more socially skilled at mixing after weaning in comparison to piglets that did not have the same opportunity to socialise outside the litter (D'Eath, 2005). This may indicate behavioural differences between gilts that have the possibility to access the neighbouring pen in an access pen (AP) and the gilts that stay in a conventional, control pen (CP).

This Master Thesis is a part of a larger Formas project with the name; “Improving sow welfare in group housing systems - Effects of genotype and rearing strategy on gilts’ social ability, productivity and reproduction later in life.” The aim of the larger project is to develop commercially relevant and sustainable breeding and rearing strategies aiming for gilts that are well adapted for group housing systems. In this master thesis study, protocols developed for registering behaviour, social interactions and stereotypes were used to record and compare behaviour in 118 gilts on eight different occasions when the gilts were between the ages of 0-10 weeks old. The study was performed at the Swedish University of Agricultural Sciences (SLU) Research centre at Lövsta, Uppsala. Gilts of two different Yorkshire breed crosses (SY and DY) with two different treatments (CP and AP) for social environment were included in the study.

The general aim of this master thesis study is to investigate if there are any differences in behaviour and social interactions between the breeds and social environment treatments during early socialisation. This study will also contribute to the larger Formas project with knowledge of how breed and early socialisation could affect gilts early in life.

The specific questions investigated in this MSc thesis are:

- Is there a difference in behaviours and social interactions between SY and DY gilts, and if so, how do they differ?
- Does the behaviours and social interactions differ between gilts in different social environments?

2 Literature review

2.1 Pig behaviour

The modern domesticated pig (*Sus scrofa domestica)* possess a lot of behavioural and physiological characteristics that can be traced back to their ancestor the wild boar *(Sus scrofa)* despite modern rearing conditions and domestication (Graves, 1984; Jensen, 1986; Stolba & Wood-Gush, 1989; Gustafsson *et al*., 1999 ; Jensen, 2006; Špinka, 2009). This has been proved in several studies where domesticated pigs have been allowed to return to more natural conditions (Graves, 1984; Jensen, 1986; Stolba & Wood-Gush, 1989; Gustafsson *et al*., 1999). Stolba & Wood-Gush (1989) showed that a group of pigs which has been reared under intense conditions, showed a rich repertoire of natural behaviours after just one to six month after being released into a park which was providing the pigs with a semi-natural environment. It has however been shown that domestic pigs are both less aggressive, less active and less cautious against possible predators compared to wild boars, indicating that the behaviour repertoire is the same but that the quantity of behaviours has been affected through domestication and modern breeding (Špinka, 2009). These changes in behaviour from the wild boar to the modern domestic pig can be explained as a consequence of the human protection that the domestic pig are adopted to and the environment close to humans (domestication) (Gustafsson *et al*., 1999).

2.1.1 Social behaviours

Under natural conditions, pigs live in family groups (Jensen, 2006). These groups typically consist of two-four sows and their young (Graves, 1984). Boars commonly live solitary lives except during mating season (Graves, 1984), boars may however sometimes congregate in bachelor groups (Špinka, 2009). Around one or two days before farrowing, the pregnant sow will move herself away from the group in order to find a private nest site (Jensen, 1986). When the pregnant sow has found a secluded place, nest-building begins instantly by creating a hollow

hole filled with tufts of grass and other materials suitable for nesting, and farrowing usually occurs shortly after the nest is finished (Jensen, 1986). The sow and her piglets stay near or in the nest until the piglets are around eight to ten days old, in which they return to the rest of the group and abandon the old nest (Jensen, 1986). Evolution has pushed piglets to stand within minutes after birth and they start to form relationships and forming a social hierarchy within the litter already after a few hours (Graves, 1984). Due to that parental duties often is shared within the family group and may be combined between several sows, piglets often come in contact and share social interaction with piglets from other litters early in life (Graves, 1984). Thus, the social integration take place gradually with the rest of the group (Jensen, 1986). The relationships piglets create early in life will, especially among gilt and sows, remain the same throughout their life (Graves, 1984). Under natural conditions, the piglets are weaned around an age of 14 to 17 weeks but they do however gradually distance themselves earlier in line with their increasing age (Jensen, 1986).

Because of pigs highly social nature (Graves, 1984), it is unavoidable for domestic pigs kept in group housing to form a dominance hierarchy (Meese & Ewbank, 1973). A strict dominance relationship is established between each pair of pigs within a group (Špinka, 2009). When a steady hierarchy is formed in the group, aggression within the group is generally uncommon and mild if it occurs (Graves, 1984). It is however found that subordinate-dominant relationships between individuals often are maintained and achieved by agonistic behaviours (Price, 2008). Subordinate animals often uses avoidance behaviours in order to reduce the intensity and frequency of social encounters with dominant animals (Price, 2008). The social ranking and especially the dominance relationships between the pigs plays a major role for both domesticated and wild pigs when it comes to settling disputes over access to resources (Graves, 1984). Social stability in a group is often a result of a stable hierarchy of dominance, where the low-ranking pigs usually get worse access to resources in comparison to the high-ranked pigs (Price, 2008). In the purpose of maintaining a stable hierarchy of dominance, recognition between the individuals is an important factor (Price, 2008) which mostly occur through smell (Špinka, 2009). Besides recognising and communicating with smell, vocalisation with a wide range of different vocal signals is also used (Špinka, 2009). In addition to remembering individuals and recognizing both unfamiliar and familiar pigs, smell is also important in to generally gather information from their surroundings (Špinka, 2009).

Under natural conditions, the group sizes are usually smaller than they are in modern production systems which affect pigs' social environment (Gonyou, 2001). Harmful social behaviours are directed to other individuals and can result in decreased profitability for the producer and can adversely affect the animal welfare (Turner, 2011). Common harmful social behaviours in modern production systems

is aggression and oral manipulation of pen mates which can be seen in form of tail biting, ear biting and belly nosing (Turner, 2011). Weng *et al.* (1998) showed that the frequency of both aggressive behaviours and social interactions increased in relation to decreasing space allowance which indicate the importance of sufficient space for the animals.

2.1.2 Exploratory and foraging behaviours

As pigs are omnivorous opportunist, it is not surprising that the pig is well adapted for exploratory behaviour (Arey, 1993). Pigs explore their surroundings by sniffing, rooting, chewing and biting (Studnitz *et al*., 2007). When pigs are performing exploration behaviour, the snout is mainly used and is commonly directed against objects on floor level (Arey, 1993). Pigs are curious and it is therefore assumed that performing exploratory behaviours can be linked to this curiosity (Studnitz *et al*., 2007). Exploratory behaviours are important for the survival of wild animals which makes it deeply rooted even in our domesticated pigs (Wood-Gush & Vestergaard, 1989).

It is possible to divide exploratory behaviour into two types: intrinsic exploration or extrinsic exploration (Wood-Gush & Vestergaard, 1989). The intrinsic exploration can be driven by general purposes, for example boredom (Studnitz *et al*., 2007) or curiosity about their surroundings (Wood-Gush & Vestergaard, 1989), while extrinsic behaviours could be motivated by a distinct purpose, for example for searching for food (Wood-Gush & Vestergaard, 1989). Due to pigs exploratory nature, pigs spend a large part of their awaken time on exploratory behaviours (Stolba & Wood-Gush, 1989; Bolhuis *et al*., 2005). Stolba and Wood-Gush (1989) found in a study of pigs that under semi-natural conditions, foraging and exploration behaviours took the main part of their active time. During that study, the pigs were occupied with locomotion and exploration of their surroundings 23 % of the observations during daylight and engaged with foraging behaviours (grazing and rooting) 52 % of the observations during daylight (Stolba &Wood-Gush, 1989). When pigs are prevented to perform rooting behaviours by the use of nose ring when housed outdoors, it has been found that other exploration behaviours (for instance, manipulation behaviours, sniffing and chewing) increased instead (Studnitz *et al*., 2003a; 2003b). When nose rings are removed from pigs, it has been shown that they instantly started to root again and this may be explained by the authors' explanations of rooting as being the preferred exploratory behaviour (Studnitz *et al*., 2003a; 2003b). This in turn indicates how important exploratory and rooting behaviours are for their survival and thus a behaviour that pigs have a high motivation to perform.

If there is an absence of foraging materials and especially if feed is restricted, the risk of frustration among pigs increases (EFSA, 2007b). If there is a lack of possibilities for exploration behaviours in the pen, abnormal behaviours may arise which have the risk to cause redirected exploratory behaviours against other individuals in the pen or towards pen fitting (Bolhuis *et al*., 2005; Scott *et al*., 2006; Jensen & Pedersen, 2010). To stimulate exploratory behaviours for a longer time period in pigs, the bedding material should be manipulative, edible, changeable and complex (Studnitz *et al*., 2007) and several studies have recommended straw as a good bedding material and positive effects when using it has been showed. Less exploratory behaviours and activity has been shown in growing pigs housed in barren environments in comparison with housing environments where the pigs have access to straw (Bolhuis *et al*., 2005; Scott *et al*., 2006). The availability of straw has been showed to reduce the occurrence of abnormal behaviours such as manipulation of pen mates and pen fitting in growing pigs (Fraser *et al*., 1991; Scott *et al*., 2006). Moreover, a study by Bolhuis *et al*. (2005) indicated that abnormal behaviours which are directed towards pen mates, for instance tail biting, ear biting and belly nosing, are reduced when growing pigs are provided with straw. Other bedding materials such as maize silage (Jensen *et al*., 2010) and wood chips (Jensen & Pedersen, 2010) has also been seen to reduce abnormal behaviours in growing pigs and in some preference tests these bedding materials seems to be more valued then straw (Beattie *et al*., 1998; Pedersen et al., 2005; Jensen and Pedersen, 2010). It has also been shown that providing silage in addition to straw, increase pigs' time performing exploratory behaviours compared to only provision of straw, and thus meet the needs of the pigs to a larger extent (Presto *et al*., 2013). Day *et al*. (2002) provided a study where the amount of bedding material, straw in this case, resulted in increased time spent on exploratory behaviours, which shows that the exploratory behaviours are influenced by the amount of bedding material provided. Furthermore, space allowance has been shown to influence exploratory behaviours among pigs. In sows, exploration behaviours towards bedding materials increased with increasing space allowance (Weng *et al*., 1998) and this has also been seen in growing pigs (Jensen *et al*., 2010).

2.1.3 Abnormal behaviours and stereotypes

In order to determinate abnormal behaviours in pigs, it is necessary to understand their natural (normal) behaviours (Broom & Fraser, 2015). Normal behaviour can be explained as the behaviour which has been developed during evolutionary adaptation, but there will always be a range of behaviours profiles that can be considered normal since adaption and learning will modify the behaviour of any individual (Keeling & Jensen, 2009) which makes the topic complex sometimes. Abnormal behaviours can be described as behaviours that deviate from the norm of behaviours that has evolved in the natural habitat of the species (Keeling & Jensen,

2009). Frequency of occurrence of abnormal behaviours is thus no synonym for normal behaviour and is important to remember when discussing domesticated animals (Keeling & Jensen, 2009). Another definition of abnormal behaviours is that these behaviours are performed out of context for the situation or performed at a significantly high rate (Wood-Gush & Vestergaard, 1989). It has been seen that pigs that live in housing systems where they are restricted to perform natural behaviours have an increased risk of performing abnormal behaviours (Moinard *et al*., 2003). In pigs, the abnormal behaviours expressed are mainly directed towards pen fitting or pen mates (Broom & Fraser, 2015). Tail biting is one of the most common abnormal behaviours (Moinard *et al*., 2003; Brunberg *et al*., 2011). Belly massage, ear biting, mounting and vulva biting are other abnormal behaviours that can be seen among pigs (Brunberg *et al*., 2011). According to several studies, some kind of stress and/or frustration seems to be the motivational background to behaviours such as belly nosing, tail biting and ear biting (van Putten & Dammers, 1976; Dybkjær, 1992; Moinard *et al*., 2003; EFSA, 2007c). However, vulva biting is instead considered to an act of aggression (van Putten & van De Burgwal, 1990). A major reason behind the development of the abnormal behaviour tail biting has been suggested to be because of pigs high motivation to perform exploration and foraging behaviours (EFSA, 2007c), thus the abnormal behaviours are redirected exploratory and/or foraging behaviours. Taylor *et al*. (2010) found evidence for the relationship between access to straw and tail biting, where pigs with access to straw had lower prevalence of tail biting than pigs without straw. Regarding the abnormal behaviour of belly nosing, a study found that pigs living in an enriched environment has decreased amounts of belly nosing than pigs in barren environments (Dybkjær, 1992). There has also been found that weaning age has an impact on the amount of belly nosing observed since belly nosing increases with a decrease in weaning age (Worobec *et al*., 1999). Several studies have also concluded that the development of belly nosing and frequency of the behaviour is linked to weaning age (van Putten & Dammers, 1976; Gonyou *et al*., 1998; Worobec *et al*., 1999). Belly nosing has in several studies being linked to redirected suckling behaviours (van Putten & Dammers, 1976; Gonyou *et al*., 1998; Worobec *et al*., 1999) The affected animal that will be the victim to abnormal behaviours such as vulva biting (van Putten & van De Burgwal, 1990), belly nosing (Dybkjær, 1992) tail biting and ear biting (Taylor *et al*., 2010) often get skin lesions that negatively impact the welfare of the animal and negatively affect the production efficiency.

Stereotypic behaviours is a form of abnormal behaviours (Keeling & Jensen, 2009) and can be defined as a repetitive behaviour that serves no apparent function for the animal itself and is done without an apparent aim (Mason, 1991). The development of stereotypes has been suggested to be a result out of either restrictive environments with a lack of stimulation for the animal or when the animal is forced to be exposed to situations where the animals does not have control over

their situation and feelings like fear, frustration or stress appears (Mason. 1991). The animal may perform stereotypic behaviours during a large part of its awaken time (Keeling & Jensen, 2009) and the behaviour can, once established, become a need itself (Mason, 1991). The performance of stereotypic behaviours have been demonstrated to provide the animal with relief from the stressful environment by releasing endorphins which may explain the need for performing such a behaviour (Cronin *et al*., 1985; Dantzer, 1986). Cronin *et al*. (1985) found that sows cease stereotypic behaviours when admitted naloxone, which blocks receptor sites for endorphin, which support the concept of stereotypic behaviour as a self-medicating form of stress relief. There is a wide range of stereotypic behaviours that may develop among pigs and these stereotypes are most commonly seen after feeding (Terlouw *et al*., 1991). Animals with a high feeding motivation usually develops oral behaviours such as biting, licking and chewing (Keeling & Jensen, 2009) and since pigs in their natural environments spend much of their daytime foraging (Stolba & Wood-Gush, 1989), oral stereotypic behaviours are the most common (Lawrence & Terlouw, 1993). Hence, pigs that cannot perform enough foraging behaviours, for instance by behavioural restrictions and restricted feed intake, commonly develop oral stereotypies (Lawrence & Terlouw, 1993). Dry sows have an increased risk of developing oral stereotypies as their feed usually is restricted in order to control their weight (EFSA, 2007a). In the welfare Quality® Assessment Protocols for pigs (2009), which is used for practical guidance when wanting to assess animal welfare, stereotypes that is evaluated in the protocol is teeth grinding, bar biting, drinker biting, trough biting, tongue rolling, floor licking and sham chewing.

Stereotypes is an important indicator for showing that the animals performing them live in an environment that is not providing them with enough opportunities to perform their natural behaviours and could be an indicator of poor animal welfare (Keeling & Jensen, 2009). Stereotypic behaviour can however also be seen in appropriate environments if the animals have been living in an unsuitable surrounding before and has established a stereotypic behaviour there, assessing animal welfare from abnormal behaviours can therefore be quite complex when animals have changed environments (Keeling & Jensen, 2009). Consequently, stereotypic behaviours should thus be seen as an indication of that the animal has had reduced welfare at some point in their life (Keeling & Jensen, 2009).

2.1.4 Aggressive and agonistic behaviours

Agonistic behaviours involves both aggressive and submissive behaviours which can be seen when pigs interact (Stukenborg *et al*., 2011; Scheffler *et al*., 2016). Characteristic agonistic behaviours seen when pigs are fighting are: biting, pushing (shovelling), chasing, threatening, head knock and avoidance behaviours and they have been mentioned in several studies (Giersing & Andersson, 1998; Colson

et al., 2006; Hwang *et al*., 2016; Špinka, 2009). Fighting usually occurs when mixing unfamiliar pigs but the most vigorous fighting has usually ended within the first twenty-four hours after mixing of pigs (Meese & Ewbank, 1973).

Agonistic behaviors are often seen in commercial farm conditions when pigs are fed in a limited space and when the feed is restricted (Špinka, 2009) or when new groups are formed out of unfamiliar pigs (Stukenborg *et al*., 2011). Aggressive encounters in group housing systems have a negative impact on animal welfare and production (D'Eath *et al*., 2009; Špinka, 2009). These aggressive encounters increases the risk for lameness (EFSA, 2007a) and often lead to skin lesions which affect both the animal and the producer (Turner *et al*., 2006; Stukenborg *et al*., 2011; Li *et al*., 2012; Tönepöhl *et al*., 2013).

When pigs get mixed to form a new group with unfamiliar pigs, the social hierarchy of that group is usually established within the first two days after mixing (Meese & Ewbank, 1973). The agonistic behaviours shown during mixing is necessary for the developing of a social hierarchy in the group (Krauss & Hoy, 2011). If agonistic behaviours between pigs are performed in already established groups, there can significate problems in terms of fighting about resources (Krauss & Hoy, 2011). There are usually more agonistic behaviours shown during daytime then during night time (Stukenborg *et al*., 2011) and there has also been findings that an increasing age of the pigs generally leads to less observed agonistic behaviours (Scheffler *et al*., 2016). When regarding the animal welfare for low-ranking animals in group housing systems, it is important to have an adequate amount of space in the pen to avoid or escape aggressive situations (Weng *et al*., 1998; Špinka, 2009).

The level of aggressiveness among pigs have been discussed in several studies and factors that have been found to influence the behaviour have been: group size, familiarity between individuals (Stukenborg *et al*., 2011), social status (Elmore *et al*., 2011), the animals body weight (Stukenborg *et al*., 2011; Scheffler *et al*., 2016), parity, age (Strawford *et al*., 2008) and space allowance (Weng *et al*., 1998; Stukenborg *et al*., 2011). Among weaning pigs and growing pigs, there has been shown that pigs with a higher body weight were more aggressive then pigs with a lower body weight (Scheffler *et al*., 2016). One factor that may affect the level of aggressive behaviour is the social status (Elmore *et al*., 2011) and since social status is affected by several factors, it makes it a complex matter. Body weight and size has been found to be positively correlated with the social rank in sows (Edwards *et al*., 1994; Martin & Edwards, 1994). In addition, older sows has been found to generally be more dominant in comparison to young sows which usually are subordinate (Li *et al*., 2012) which affects the social rank. Subordinate sows are less aggressive than dominant sows which consequently leads to that the level of aggression is influenced by the social rank (Elmore *et al*., 2011). It has been

found that there is a relationship between the social dominance status of the mother and gilts dominance (Drickamer *et al*., 1999). The social rank of a pregnant sow affects her offspring's behaviour and performance (Kranendonk *et al*., 2007). Piglets from low ranking sows had a longer latency time to investigate a novel objects then piglets from high ranking sows (Kranendonk *et al*., 2007). Piglets from high ranking sows also had a higher procentage of lean meat, and were heavier at both weaning and slaughter in comparison with piglets from low ranking sows (Kranendonk *et al*., 2007).

In a study by Stukenborg *et al*. (2011) there were two different age groups, the first group included weaned piglets at 28 days of age the second group contained pigs with an age of 68 days, and the groups contained both subordinate and dominant pigs which were mixed. They found that subordinate pigs were engaged in fewer agonistic interactions in comparison with dominant pigs in both age groups and that the entire fight time per individual was longer and more fights were initiated by dominant pigs in comparison with subordinate pigs (Stukenborg *et al*., 2011). There has also been a study performed on piglets during the first three days after weaning in relation to agonistic behaviour and social rank where they were given a rank position between 1-12 where rank 1 was the highest and 12 was lowest in rank (Fels *et al*., 2012). It was found that piglets with a lower rank (rank position 4-12) initiated less fights than piglets with a higher rank (rank 1-3) (Fels *et al*., 2012).

There has been found that aggressive behaviour are heritable in both growing pigs (Turner *et al*., 2008; 2009) and sows (Løvendahl *et al*. 2005) after mixing. Heritability of aggression after mixing in sows has been estimated by the behaviour traits "recipient of aggression" and "deliver of aggression" in a study by Løvendahl *et al*. (2005). Heritability for being a recipient of aggression was low (h^2 = 0.04 to 0.06) while being a deliverer of aggressive behaviour had a higher heritability (h^2 = 0.17 to 0.24) (Løvendahl *et al*. 2005). Turner *et al*. (2008; 2009) did instead use behaviour traits associated with aggressive behaviour for the time when the pig was involved in reciprocal aggression and the time when the pig was either receiving or delivering non-reciprocal aggression after mixing in new groups for estimating their heritage. The heritability for the time spent being recipient of non-reciprocal aggression was quite low (h^2 = 0.17 (Turner *et al*., 2008) and h^2 = 0.08 (Turner *et al*., 2009) while the time spent delivering non-reciprocal aggression was higher (h^2 = 0.37 (Turner *et al*., 2008) and h^2 = 0.31(Turner *et al*., 2009)). Heritability for the time involved in reciprocal aggression was however found to be quite high (h^2 = 0.46 (Turner *et al*., 2008) and h^2 = 0.43 (Turner *et al*., 2009). Turner *et al*. (2006) did also find that the correlation between the time spent being recipient of non-reciprocal aggressions and body weight was negative.

Mixing of unfamiliar pigs should be avoided in order to reduce aggressive encounters in group housing systems (EFSA, 2007b). Reduced aggressive behaviours can also be seen if pigs that are similar to one another in terms of size and age and reduces the risk of problems among low ranked pigs (EFSA, 2007b). Since young sows are subordinate to older sows in group housing systems, it is important to prevent harmful behaviours as much as possible and especially since young sows are more vulnerable in group housing systems (Li *et al*., 2012).
In a study by Li *et al*. (2012) results were found that indicates less intensive aggressive interactions if first parity sows are kept with gilts instead of multiparous sows. Consequently, it is suggested that sows should be sorted according to their parity number in order to improve the welfare for young sows at mixing (Li *et al*., 2012).

2.2 Legislation in the European Union and Sweden

In 2018, there were around 42 million piglets (with a weight of less than 20 kgs) in the European Union (EU28) (Eurostat, 2019). The housing and husbandry systems for pigs in European Union (EU) does differ between countries (EFSA, 2007a). When EFSA released their report about housing and husbandry systems for pigs in 2007, they stated that housing systems for sows and her piglets should allow for immediate contact between piglets and the sow after birth, this in order to regulate the piglets thermal comfort and ensure colostrum uptake.

Since January 1st, 2013, within the EU, loose housing of gilts and sows is required in all holdings of more than ten sows in the course of four weeks after service until one week before predicted farrowing (EU Council Directive, 2008/120/EC). This signifies that during the insemination period and during the first month of pregnancy it is still permitted to house sows and gilts individually. Additional demands to the EU Council Directive, 2008/120/EC regarding group housing of pregnant gilts and sows can only be found in the legislation to the United Kingdom, Netherland and Sweden (Mul *et al*., 2010). The legislation in the Netherlands requires sows to be kept loose housed in groups within four days from insemination, hence the whole gestation (Mul *et al*., 2010). The legislation in Sweden does however require pregnant gilts and sows to always be kept loose housed in groups (Mul *et al*., 2010).

In 2019, a new animal welfare law (SFS 2018:1192) took effect in Sweden. To complement the animal welfare law, an animal welfare ordinance (SFS 2019:66) was also publicized. The law states that all pigs in Sweden must be kept loose-housed (SFS 2019:66 12§) where they are kept pairs or groups, gilts and sows are however allowed to be kept individually and without eyesight and reach of other pigs if they are one week before farrowing and during the farrowing and lactation

period (SJVFS 2019:20 Saknr L106 2 Kap. 8 §). Devices for fixating or confine pigs can only be used temporarily, for example if the sow shows aggressive behaviours that can harm other pigs or keepers or when loose-housed sows in groups are being fed (SJVFS 2019:20 10§). Between year 1988 and 1994, routine fixation of sows were phased out of the Swedish pig producing system (Jordbruksverket, 2012). Consequently, housing sows and gilts by fixation or in any type of confinement for longer times has been banned in Sweden since 1994 (Jordbrukvsverket, 2012).

The use of farrowing crates dominates in the EU during both lactating and farrowing periods, and it is stated that these crates severely restricts the free movement of the sow and seriously affect the piglets in form of contact with the sow (EFSA, 2007a). An alternative to farrowing crates during farrowing and lactation is individual pens for the sow and her piglets, which is a common method to use in member states where farrowing crates are banned (EFSA, 2007a). The Swedish legislation however states that confinement is only allowed during the lactation and farrowing period if necessary for a short period of time and that gilts and sows should otherwise be kept loose-housed in the farrowing pen (SJVFS 2019:20 Saknr L106 2 Kap. 8 §). Routine confinement in farrowing crates or in other ways use obstructing objects which prevent the sows freedom to move are not allowed in Sweden (SJVFS 2019:20 Saknr L106 2 Kap. 11 §).

In EU, regulations require that all pigs should always be provided in sufficient quantities with rooting materials (such as hay, straw, sawdust, mushroom compost etcetera that does not compromise the health of the animal) which enables foraging and manipulation activities (EU Council Directive, 2008/120/EC). In the Swedish regulations it is stated that the bedding material provided to the pig should be given in such quantities that their need for comfort and exploration behaviours are met (SJVFS 2019:20 Saknr L106 4 kap. 4 §). Furthermore, it is stated that gilts and sows should be given access to an sufficient quantity of suitable bedding material one week before expected farrowing in order to allow them to perform nesting behaviours (SJVFS 2019:20 Saknr L106 4 Kap. 5 §). This also affect the piglets since lack of nesting material is very likely to cause stress and an impaired welfare for the sow (EFSA 2007a) which may affect her ability to take care of her piglets which impairs their welfare.

2.3 Prior knowledge about the Yorkshire breeds and social treatment

2.3.1 Breeding goals for the Yorkshire breeds

In two- or three-way breeding schemes, the Yorkshire dam breed is commonly found in pig production. They have become popular due to large litter sizes, the gilts durability and the mother abilities of the sow (Brink, 2013).

Because of the Yorkshire breeds meat quality and feed efficiency, Sweden begun to import live Yorkshire pigs at the end of the 19th century (Hansson & Lundheim, 2013). With this, a new breeding plan in Sweden was created and which induced in the Swedish Yorkshire (SY) (Hansson and Lundheim, 2013). In Sweden, the breeding goals for the SY were dams with good maternal abilities, high producing, durable and also produce offspring's with good meat qualities (Hansson and Lundheim, 2013). Thus, were the breeding goals adapted so the pigs were functional in Swedish husbandry systems.

When the breeding of the SY ended in 2012, the use of Dutch Yorkshires (DY) instead begun (Brink, 2013). The breeding goals for the DY are high piglet survival, sows that are easy to handle and durable (Brink, 2013). The DY should also have a high meat percentage, growth and good fat reserves which leads to sustainable gilts (Brink, 2013). DY breeding dams are being selected, produced and evaluated in the Netherlands under circumstances comparable to those in most EU-countries (Brink, 2013).

2.3.2 Social treatment

The development of gilts social abilities during their early life is rather unexplored. The gilts social abilities are trained over time in a group with other females when living in wild conditions (Jensen, 1986). Due to the fact that piglets are returning to the sow group with their mother after just eight to ten days of age in the wild, they get social contact with other pigs early in life (Jensen, 1986). The shared parental duties which are often shared in a family group of pigs automatically lead to piglets which share social interactions with other piglets, gilts and sows quite early in life (Jensen 1986; Jensen, 2006). In the natural habitat of wild pigs, it is therefore usual that piglets get social experience and can develop social abilities during rearing, which is usually not applied in conventional farming systems (Petersen *et al*., 1989; Jensen, 2006). It has been suggested that the natural socialisation period is occurring from around a week after until weaning and that this is the time for when piglets for social relationships (Petersen *et al*., 1989). D'Eath (2005) found evidence that piglets that got to socialize with piglets from

other litters were more socially skilled at the mixing that usually occurs after weening. Access to other pigs is considered a stimulating rearing environment and it has been shown that pigs held in stimulating environments show less damaging behaviours and more explorative behaviours (Greenwood *et al*., 2014). Being able to perform explorative behaviours are connected to their cognitive abilities and to perform such behaviours are considered an important way of enhancing their welfare (Mendl *et al.*, 2010). These increased cognitive abilities could also be connected to better problem solving abilities among pigs (Mendl *et al.*, 2010). Furthermore, social experience during the early life of gilts has been presented to improve their social skills when mixed later in life (van Putten & Bure, 1997). When pigs are reared in barren environments, it has shown to affect the pigs' ability to cope with stressors in general and increased social stress (de Jonge *et al*., 1996). Social experiences early in life could also influence the brain development so that the pigs have better experience and ability to cope with different situations in the future. This is in line with a study by Kanitz *et al*. (2009) that found that a single social isolation in piglets caused behavioural changes and neuroendocrine changes which indicate experienced distress, and thus can social experience have effect on both behaviour and development in pigs.

3 Material and methods

The practical parts of the study was conducted at the Pig Research Centre of the Swedish University of Agricultural Sciences at Funbo Lövsta outside of Uppsala. The data used for this specific master thesis was collected between 19th of January 2018 and 16th of January 2019.

3.1 Animals

For this master thesis, behaviour recording on gilts, from birth until they were moved to the growing-finishing stable at the age of nine weeks, were performed in the farrowing stable. The gilts originate from 28 litters (four gilts per litter) which were divided into seven different batches with a total of 118 gilts, which is further explained in section 3.1.2. All pens contained both females and males, but observations were only made on four focal gilts from each litter. The reason for only using four gilts per litter was because it is highly likely to get at least four gilts in a litter which was very important for the continued project at both breeds and treatments were as evenly distributed as possible. It also has to do with the bigger project were these gilts later will become sows themselves and need to fit in the already existing farrowing batches after first parity. The gilts for the project was chosen by the staff at the farm. The piglets were firstly selected to not being too small or too big, in order to reduce variation in size and weight of the piglets. The staff had beforehand gotten information that the gilts should be randomly selected if there were more than four suitable gilts to choose from each pen. The gilts were therefore selected by chance to the greatest extent possible in order to minimize the potential bias that could become a problem if you intentionally select all animals to a study.

3.1.1 Breeds

In the research herd where this study was carried out, a switch of dam breeding material from SY to DY occurred recently, making it possible to produce gilts of SY and DY breed when using semen from SY and DY sire-boars. The sires used were 100 % SY or DY. The sows used to produce our gilts were 100 % SY or at least 50 % DY. Taken together this means that the gilts investigated in this study is

100 % SY or at least 75 % DY. As explained in section 2.3.1, the breeding goals for these two breeds are generally quite similar. The breeding goals have been typical for mother sows but the breeding has been more effective in the DY breed. Both breeds are bred for favourable behaviours in their environment and thus has indirect selection occurred to get pigs that fit in their current hosing environment.

3.1.2 Excluded animals

During the process of preparing data for analysis, some animals were excluded due to the criteria mentioned in table 1. Three of our focal gilts had sires of the breed Hampshire (H) due to return to estrus for the dam where only H semen was available, resulting in piglets with the breed DY*H. Due to return to estrus for one dam, four piglets had the dam with the breed SY and a sire with the breed DY, resulting in four focal gilts with the breed SY*DY. Hence, a total of seven pigs had a breed combination that were chosen to be excluded from the analyses of this study. One gilt in batch B (at an age of 16 days) were culled due to illness. In batch F, a total of five gilts were excluded due to having a sick sow that hurt the piglets which resulted in several cullings in that litter as they lived in a very different environment in comparison with other litters. Hence six pigs were excluded from the analysis of this study due to culling. Out of the 118 gilts at the beginning of the project, a total of 113 focal gilts underwent the entire early socialisation period but a total of 13 animals were excluded in the analysis, resulting in 105 gilts used for analysis, which is made visible in table 1. Even though these 13 gilts were excluded from the statistical analysis, they were important for having equally sized groups and matched sibling groups between the treatments which were important for the bigger Formas project in which this study is a part of. One gilt in batch C were euthanized at an age of 44 days due to illness and does thus have missing values on the last two observation occasions but the data collected before her culling is used in this study.

For the continuous sampling, the same animals which were excluded for the Scan sampling were excluded for the continuous observations, meaning that cross breeds and gilts which were culled before weaning were excluded from statistical analyses.

Table 1. *List of criteria's for excluded animals*

Criteria	**Affected litters (batch)**	**Amount of pigs**
Crossbreeds (Not SY*SY or DY*DY).	**2** (B, C)	3 + 4 = **7**
Not complete observations until after weening at six weeks of age.	**2** (B, F)	1 + 5 = **6**

3.2 Housing and management

The study was conducted at the Research Centre of the Swedish University of Agricultural Sciences, which is an Specific Pathogen Free (SPF) herd where the herds are closed from bringing in new animals and are regularly controlled for common pig diseases, which leads to thorough infection control routines (The Swedish Livestock Research Centre, 2017).

The gilts included in this study were housed in individual loose-housed farrowing pens together with their mother sow and siblings. In order to easily recognize the four focus gilts in each pen, they got different colored ear tags in order to easily tell the difference between both other siblings but also between different focal gilts. The pen consisted of a dunging area with slatted floor, a lying area in concrete and a piglet corner with a heat lamp, in which only the piglets had access. These pens were manually cleaned by the staff in the morning and were thereafter provided with straw. The cleaning was regularly done at least one hour before the observations began but were at some occasions cleaned after the observations in order to not disrupt the observations. The sows were fed by the automatic feeding system two to three times per day with dry feed. The observations were done between feedings in order to minimize the possible influence of feeding on the sows' behaviour and consequently on piglets' behaviour. Dry feed adapted for piglets where provided through a feed dispenser in the piglet corner when the piglets reached an age of two to three weeks. Water was available from two drinking nipples *ad libitum*.

Four pens in each farrowing stable where dedicated to this experiment. The gilts were provided with two different social housing environments. Between two of the four pens, a pop hole (figure 1) was placed in the piglet corner which created the extended social environment in the access pen (AP), as seen in figure 2 from the master thesis of Andersson (2019).

Figure 1. Picture of the pop hole when closed

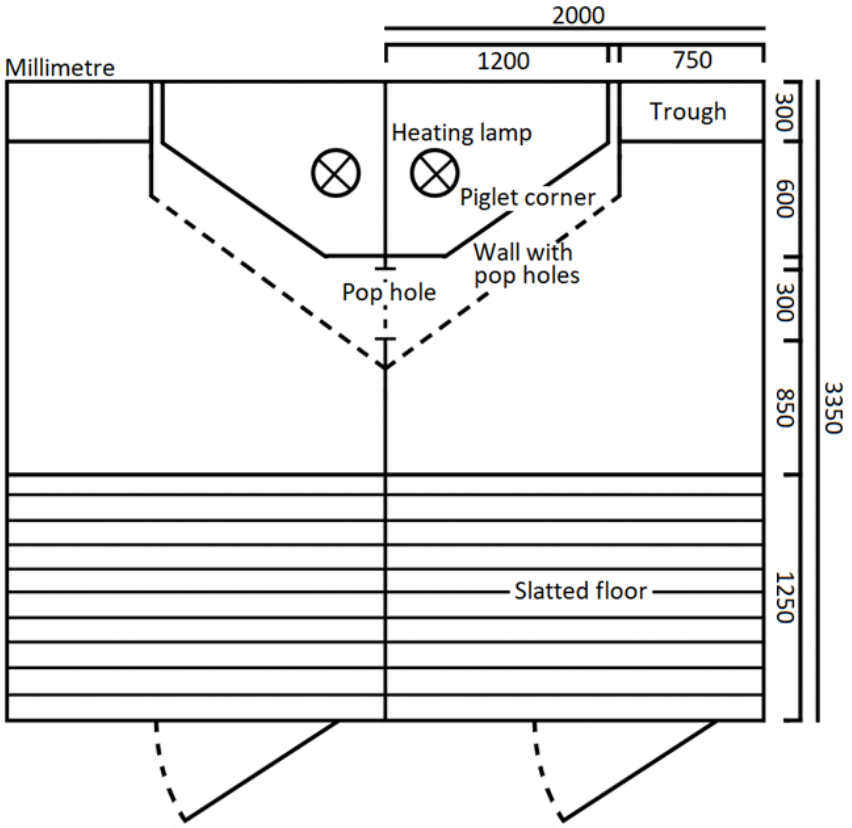

Figure 2. An illustration of two conventional loose housed farrowing pens with a pop hole that was used in this study. The piglets in the access pen had the opportunity to walk between the pens through a pop hole between an age of two to five weeks. The pop hole is located in the piglet corners between two pens. Illustrated by Andersson (2019)

The other two pens were conventional farrowing pens, called control pens (CP) and looked and had the same measurements as the AP illustrated in figure 2, but these pens did not have the pop hole. This was in order to create the two different early life social environments in the gilts life. When the piglets reached an age of two weeks, the pop hole was opened in order for the piglets to roam freely between their own and the neighboring pen. This pop hole was open until weening (at five weeks of age) in which the piglets where placed in their original pens and could thereafter not access the neighboring pen again. Out of the 28 litters where half of the litters where DYs and the other half SYs, the gilts within each breed were divided so one half of the group lived in the AP and the other half in the CP. The distribution between breeds and treatments that are used in the analysis can be seen in table 2.

Table 2. *Distribution between breeds and treatments during early socialisation (when the pop hole is open) in analysis*

	SY	**DY**	**Total/treatment**
Access pen	20	31	51
Control pen	29	25	54
Total/breed	49	56	**105**

The design of the social environment has been selected due to the reason that it can be achieved on commercial farms and will make it possible to collect information on the effect of the gilts social experience early in life and the development of their social abilities. The extended early life social experience is also placed in the same time when the gilts should have socialised with other piglets and sows in the wild. As mentioned before, social experience have a general effect on the behavioural developments in a long-term, this study did however focus on the short-term effects. The long-term effects will later be taken into consideration in the bigger Formas project.

3.3 Study design

In this study 105 gilts, divided over two different breeds (SY and DY) were used from the first week of life until they reach an age of ten weeks. Approximately half of the gilts with the breed SY and DY will, from two weeks of age until weaning at five weeks of age, live in an extended early social environment where they in their pen have access to the neighbouring pen (AP). Each batch were observed eight times during their time in the farrowing stable and the placement of these behavioural observations in relation to the age of the gilts and the early life social environment (pop hole open) can be seen in figure 3.

Event	**Birth**					**Weaning**				**Move from farrowing stable**					
Week of age	0	1	2	3	4	5	6	7	8	9	10	→			
Social environment			Early life social environment									→			
Behaviour observation		**1**	**2**	**3**	**4**	**5**	**6**			**7**	**8**	→			

Figure 3. Placement of behavioural observations in relation to the gilts age and early social environment period

3.3.1 Behavioural protocols

In appendix 1, 2 and 3 the protocols that has been used for the data collection for this study can be found.

The protocols used for behavioural recordings were used on piglets of two different breed crosses, SY and DY. The ethogram for these protocols were developed based on the ethogram by Nihlstrand (2016) and Vahlberg (2019). Additional behaviours were added to the final ethogram with definitions inspired from Xin *et al*., 1989; Loijens *et al*., 1999; de Leeuw & Ekkel, 2004; Welfare Quality®, 2009 and Smith, 2013. From the final ethogram, behavioural protocols were constructed which were used to collect data for behaviours before and after early life social environment (pop hole open) (appendix 1), during early social environment (pop hole open) (appendix 2) and social interactions (appendix 3). Any types of stereotypic behaviours in the pen were also recorded during the observations of social interactions (appendix 1; appendix 2).

The protocols design made it possible to register behaviours on individual level in each home-pen. Scan sampling with direct behaviour observations were performed on each individual of the focal-gilts and were used to register different variables for location in pen, body posture and activity. The social interactions were recorded with direct and continuous observations. The protocols were printed out before each observation occasion and the gilts were randomized beforehand and during the observations the observer filled in the protocols with a regular soft pencil.

3.3.2 Behaviour observations

3.3.1.1 Observation occasions and observers

Direct observations were used for recording the behaviour of the pigs. The observer did not have contact with the animals as the observer was standing outside the pen.

The observations were performed by two observers of which the first observer made 72.8 % of the observations and the second observer did the remaining 27.2 % of the observations used in this study. Because two observers was used, Inter Observer Reliability (IOR) tests were performed in order to see how the two observers differed when registering observations. To asses IOR, both observers made simultaneous observations at six different occasions (112 direct observation minutes and 432 scans).

In each pen, the four focal gilts were observed. The observation time needed for recording the behaviours were approximately two and a half to three hours per observation batch and were performed either on the forenoon or afternoon, between

8:00-12:00 or 13:00-16:00. The behavioural observations were intentionally placed during daytime as pigs are more inactive during evening and night then during the day and it has also been shown that more agonistic behaviours are performed during daytime then during evenings and night (Stukenborg *et al*., 2011). Furthermore, the behaviour recordings were performed after provision of bedding material and between or after feedings for the sow to minimize the disturbance of these events on the pigs' behaviour.

Observations included scan sampling and continuous sampling of behaviours according to the ethogram in table 3.

Table 3. *Ethogram of behaviours*

Category	Variable	Definition
Scan sampling		
Body posture	Lying on the side	Lying on the side, head/legs on the side
	Lying on the belly	Lying on the belly, with head nearly vertical position, front legs not outspread to the side
	Sitting	Front feet on the ground, back legs in lying position
	Standing	Standing or walking on all four feet
Location in pen	Lying area	Pig in the lying area
	Slatted area	Pig in the slatted area
	Piglets corner	Pig in the piglet area
Activity	Eating feed	Snout in feed trough
	Drinking	Snout touching water nipple
	Suckling	Snout touching the sow's teat (only piglets)
	Nosing/rooting pen floor	Snout touching pen floor (also slatted floor)
	Nosing/biting pen fitting	Snout touching pen fitting
	Nosing/biting other pig	Snout touching other pig (also if nosing on other pig in other pen)
	Exploring enrichment material	Pig playing/investigating straw or other enrichment material with snout, enrichment material in the mouth
	Walking	Pig is walking
	Defecating	Pig is urinating and/or defecating
	Sleeping	Pig is lying down with closed eyes
	Inactive	No physical activity (i.e. pig is standing, sitting or lying still), snout in air and eyes are open

Continuous sampling		
Social interactions performing pig	Nosing	Snout touching other pig
	Nibbling/biting	A pig nibbles or bites another pig
	Tail biting	Having another pig's tail in the mouth
	Vulva biting	Snout touching/biting other pig's vulva
	Ear biting	Having another pig's ear in the mouth
	Head knock	Approaching other pig with rapid head movement and open mouth
	Climbing	At least one hoof/leg on the top of another pig
	Riding	A pig is mounting another pig
	Lifting	Snout on or under the body of another pig and lifting upwards
	Pushing	Pushing another pig with any part of the body in order to displace it, no biting
	Belly massage	A pig is nosing, sucking and/or massaging another pig's belly or throat with snout (not piglets on sow's teat)
	Nosing teat/suckling	Pigs' snout touching the sows' teat
	Vocalization	Silence is considered as no vocalization
		Grunting are considered as low vocalization
		Barking, screams and squeals are considered as high vocalizations
Social interactions receiving pig	No reaction	No change in body position or activity of the receiving pig
	Avoiding	Pigs' head turning away or pig moving away from the performing pig
	Return approach	Receiving pig approaching the performing pig with head/snout, responding actively against pig
	Other pen	Interaction were the receiving pig is from other pen, no other reaction recorded
	Vocalization	Silence is considered as no vocalization
		Grunting are considered as low vocalizations,
		Barking, screams and squeals are considered as high vocalizations

Stereotypes	Sham chewing	The pig performs chewing without anything in the mouth, sometimes with heavy saliva production
	Bar/trough/drinker biting	Pig bites or chews the pen fitting, trough or manipulates drinkers without apparent drinking.
	Tongue rolling	Pig is rolling its tongue/playing with tongue: exposing the tongue in an unusual fashion while stretching the lower jaw horizontally
	Teeth grinding	Continuous and rhythmical audible grinding of teeth, without actual chewing
	Floor licking	The pig is licking the floor

3.3.1.2 Description of scan sampling and continuous sampling

In order to acclimatize the pigs to the observer, every behavioural observation started with an acclimatization period. This was done by the observer by firstly walking past the pens that was going to be observed and secondly to stand outside each of these pens until the pigs did not give attention to the observer and was then recognized to be accustomed. After the acclimatization period, the behavioral observations started with scan samplings of all four focal groups followed by a continuous observation of the first pair during their first minute. After completing the first continuous observations in the first pen, a new round of scan samplings were performed in all of our four pens in the same order as before. After this the second continuous sampling could start on the first two gilts in the second pen on the left side of the unit. When all four pens have had continuous observations on the first two focal gilts, the same the observations proceeded in the same way but in the following continuous observations focal gilt three and four was observed for one minute with observations proceeded in the same way as before.

The observation order can be seen in figure 4. When all gilts have had continuous observations for one minute, it was repeated again in order to register social interactions for a total of two minutes during each behavioural observation occasion.

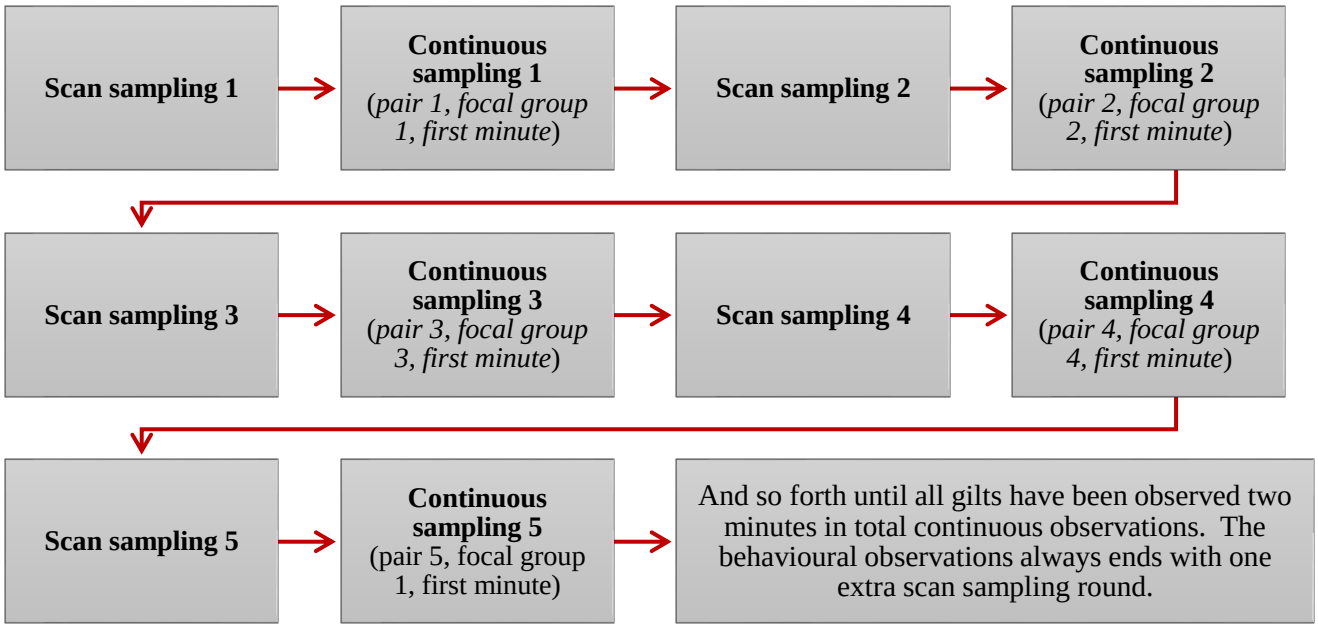

Figure 4. Flow chart over the order in which scan sampling and continuous sampling was performed

The scan samplings always started with the first pen on the left side (focal group one), continued to pen two, pen three and lastly ended on the last pen of the right side of the unit (pen four, focus group four) (figure 5).

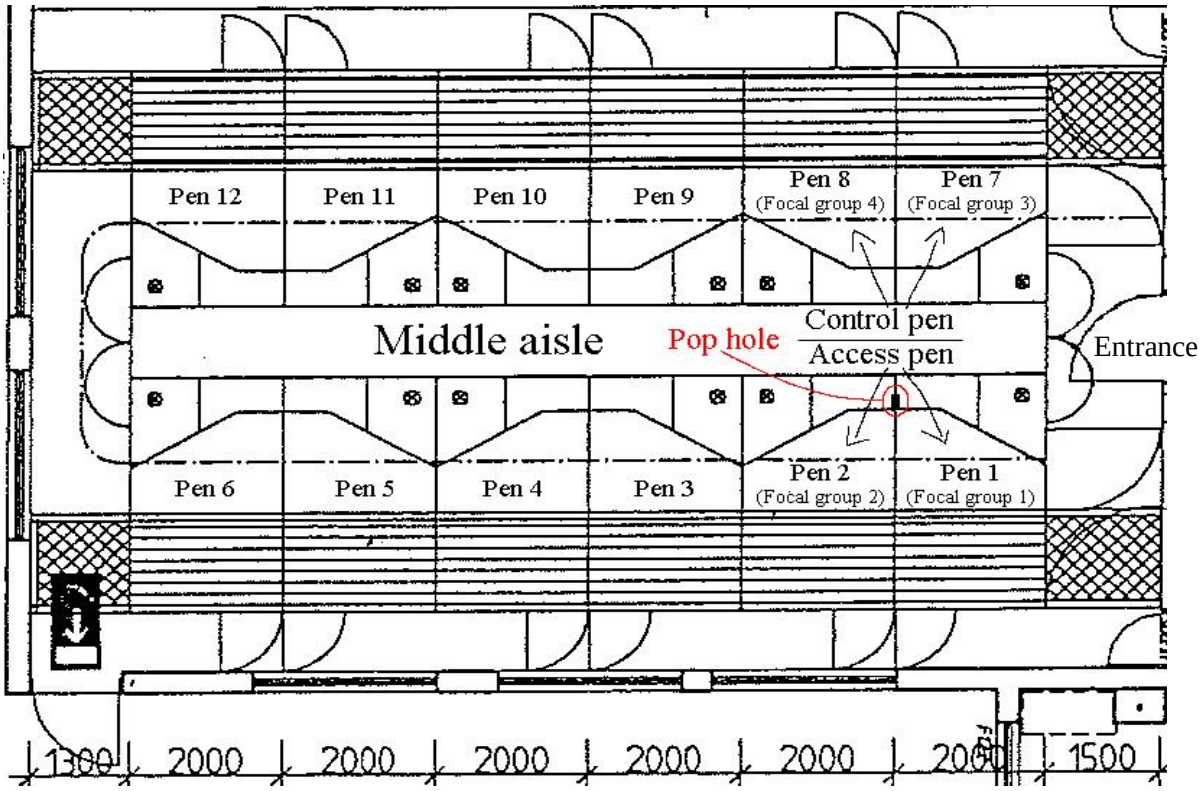

Figure 5. Layout and placement of the focal animals in the stable

After the first round of scan samplings was finished, the first continuous observation started on the two first focal animals in the first pen on the left side of the unit. The continuous observations, which were observed simultaneous and continuously, lasted for one minutes for the first pair of focal animals and the time was measured with help of a digital stopwatch (Pro Touch$_{TM}$ Countdown Timer). During the continuous observations the social interactions concerning our two focal gilts during the time were recorded in each pen. The focal gilt that is initiating a specified social interaction were called performing pig and the focal gilt receiving social interactions were called receiving pig. In the continuous observations, all social interactions involving at least one of our focal gilts for that specific continuous observation, where the focal gilts where either performers or receivers, were registered. Accordingly, the focal gilts where therefore seen as a potential receiving gilt or a potential performing gilt during these observations. Social interactions were considered new when the performing behaviour was changed, either by stopping the behaviour and not performing a social interaction for three seconds and then performing a social interaction again, or by changing one social interaction to another social interaction.

During the continuous observations, two of the four focal gilts in each pen was observed simultaneous and continuously for one minute per observation round and all social interactions were recorded. On each observation day two rounds of observations were performed, thus are the social interactions were continuously recorded for a total of two minutes per focal gilt and observation occasion. The continuous observations were done between the scan samplings (figure 4; appendix 1; appendix 2). The social interactions were registered when the focal animals were involved, either as receiving or performing pigs. For each social interaction, both receiving and performing pig behaviour and vocalization were registered, the definitions for these behaviours are described in table 3. Furthermore, stereotypic behaviours were recorded in case of occurrence during the observations, definitions of stereotypic behaviours are shown in table 3.

The observations were performed on two of the four focal animals in the pen at the same time. The pigs observed were randomized to eliminate possible biases due to the order of observation. Out gilts could have the following colors on their ear tag: blue, green, red, pink or a combination of these where the front piece had one of these colors and the back piece another. They all had their three last numbers of their individual number written on the ear tag for further identification. In accordance with conventional handling of the piglets, the ear tags were given to the pigs at five days of age in combination with their iron injection.

3.4 Statistical analyses

The data was statistically analysed by using SAS version 9.4 (SAS Institute, Inc., 2011). Excel (Microsoft, 2016) was used for displaying the results.

3.4.1 Data editing and changes of variables

In the analyses, the predictor variable/independent variable age at observation (age in weeks when observed) were created and divided into eight different classifications as shown below (table 4).

Table 4. *Classification of the predictor variable age at observation (age in weeks when observed) with the given week and a description of the new predictor variables*

Age in days	Age in weeks	Description
$x \leq 8$	1	If "age in days" is less or equal to 8 = gilts are 1 week of age at observation.
$8 < x \leq 15$	2	If "age in days" is greater than 8 but less or equal to 15 = gilts are 2 weeks of age at observation.
$15 < x \leq 22$	3	If "age in days" is greater than 15 but less or equal to 22 = gilts are 3 weeks of age at observation.
$22 < x \leq 29$	4	If "age in days" is greater than 22 but less or equal to 29 = gilts are 4 weeks of age at observation.
$29 < x \leq 36$	5	If "age in days" is greater than 29 but less or equal to 36 = gilts are 5 weeks of age at observation.
$36 < x \leq 43$	6	If "age in days" is greater than 36 but less or equal to 43 = gilts are 5 weeks of age at observation.
$57 < x \leq 64$	9	If "age in days" is greater than 57 but less or equal to 64 = gilts are 9 weeks of age at observation.
$64 < x \leq 71$	10	If "age in days" is greater than 64 but less or equal to 71 = gilts are 10 weeks of age at observation.

x = age in days at observation occasion.

For some of the gilts, the division of observations weeks resulted in that the interval between observations week five and six were not seven days long. This affected 27 gilts out of 105, where the gilts got zero observations at week five but instead got two observations at week six.

3.4.1.1 Scan sampling

The response variable lying side and lying belly were converted into the new variable lying which together reflects the behaviour “lying down” independently from body position when laying down.

3.4.1.2 Continuous sampling

Some of the variables (behaviours) investigated in the continuous observations (table 3) had few observations and were due to this edited. Some variables under the category "performing pig behaviour" were merged together to form new variables that included the same type of behaviours. A new variable "biting" was created by merging the variables for nibbling/biting, tail biting, vulva biting and ear biting, which created a variable that included all biting behaviours. The new variable "moving pig" was created by adding the content from the variables riding, lifting and pushing which included all behaviour that could be considered performed when a pig wanted to move another pig. A new variable "nosing belly region" was created by merging the original variables for belly massage and nosing teat/suckling, this in order to create a variable that included behaviours related to suckling.

3.4.2 Inter observer reliability

To test the inter observer reliability, simultaneous direct observations were performed by the two observers in 24 pen observations for continuous and scan sampling. The degree of agreement between the two observers were assessed using the kappa method in procedure FREQ in SAS.

3.4.3 Scan sampling

3.4.3.1 Descriptive statistics

The scan sampling data was measuring the variables for location in pen, body posture and activity (table 3). Data from individual scan samplings were converted into proportion of scan samplings the behaviour was performed at each observation day, thus a time budget on the proportion of time that the animal performs a certain behaviour. The procedure MEANS was thereafter used to estimate means and standard variations of the continuous and normally distributed variables. Descriptive statistics (mean and standard deviations) were estimated by breed, treatment and age in weeks at observation.

3.4.3.2 Statistical analysis and model

The effect of breed, treatment and age at observation was statistically analysed by using SAS. When in the process of building the model to analyse differences in behaviour, each response variable was tested against potential predictor variables using univariate models in procedure GLM for fixed effects and procedure MIXED for random effects. The initial effects tested were Breed ,Treatment, Age at observation, observer, batch, farrowing pen, month, weight at birth, weight at five weeks, weight at nine weeks, litter ID, breed*treatment, breed*age at observa-

tion, treatment*age at observation, breed*batch and breed*treatment*age at observation. The final model used, based on the significance of the effects and biological relevance, is given below (model 1). The effect of observer was included in the effect of batch, the effect of physical farrowing pen was included in the effect of litter ID and the effect of month (season) was included in batch. The weights of the pigs at birth, five weeks and nine weeks did not have significant effect on the behavioural response variables. Least square means (LS-means) and standard errors (SE) were estimated for the significant three way interactions in order to investigate the direction of difference, and pairwise comparisons.

The final model were:

MODEL 1: Y = Breed + Treatment + Age at observation + Batch + Breed*Batch + Breed*Treatment*Age at observation+ e.

Where Breed (SY or DY), Treatment (AP or CP), Batch (A, B, C, D, E, F, G) and Age at observation (1, 2, 3, 4, 5, 6, 9, 10) were fixed effects and Litter ID (N=27) was a random effect.
Y is the different response variables and e represents the residual error.

Level of significance for the effects included in the model is given in table 5.

Table 5. *Level of significance for the different effects in the statistical model for scan sampling*

Response variable	Breed	Treatment	Age at observation	Batch	Breed*batch	Breed * Treatment * age at observation	Litter
Body posture							
Lying	*	N.S.	***	N.S.	N.S.	***	ɣ
Sitting	*	N.S.	***	N.S.	N.S.	***	N.S.
Standing	**	N.S.	***	N.S.	N.S.	***	ɣ
Location in pen							
Lying Area	N.S.	N.S.	***	ɣ	N.S.	***	*
Slattered area	*	N.S.	***	**	N.S.	*	N.S.
Piglet corner	N.S.	N.S.	***	***	N.S.	***	ɣ
Sow feed stall	N.S.	N.S.	***	N.S.	N.S.	***	ɣ
Activity							
Eating	N.S.	N.S.	***	N.S.	N.S.	*	N.S.
Drinking	N.S.	N.S.	***	N.S.	N.S.	N.S.	ɣ
Suckling	ɣ	N.S.	***	ɣ	N.S.	***	*
Noosing rooting floor	N.S.	N.S.	***	*	N.S.	**	N.S.
Noosing rooting fitting	N.S.	N.S.	***	*	N.S.	N.S.	Conversion criteria not met.
Nosing rooting other pig	*	N.S.	***	**	*	N.S.	N.S.
Exploring enrichment	N.S.	N.S.	***	N.S.	N.S.	N.S.	*
Walking	N.S.	**	***	ɣ	N.S.	***	N.S.
Defecating	N.S.	N.S.	**	ɣ	N.S.	ɣ	N.S.
Sleeping	*	*	***	*	N.S.	***	*
Inactive	N.S.	N.S.	***	**	ɣ	N.S.	N.S.

**** = p < 0.001* *** = p < 0,01* ** = p < 0.05* *ɣ = p < 0.1 (tendency to significance)* *N.S. = Not Significant*

3.4.4 Continuous sampling

3.4.3.3 Descriptive statistics

The continuous observation data was measuring the variables for performing pig behaviour, the performing pig vocalisation, the focal gilts role in the interaction, the receiving pig behaviour and the receiving pig vocalisation (table 3). For the descriptive statistics, SAS was used with the procedure FREQ with tables over performing pig behaviours, receiving pig behaviours and vocalisation of the receiving pigs in an interaction. The procedure FREQ was also used for getting frequency tables for performing pig behaviours in relation to breed, treatment and the gilts week of age at the observation occasion. After this, the procedure MEANS was used in SAS. In comparison with the descriptive statistics in the scan sampling, the output was instead how big the proportion of observed behaviours was instead of mean values of the scan samplings. The variables in the continuous observations were then converted to binary variables and analysed with generalized linear models.

3.4.3.4 Statistical analysis and model

The effect of breed, treatment and age at observation was statistically analysed by using SAS. When building the model for analysing the continuous observations, each response variable was tested against potential predictor variables by using the GLIMMIX procedure for generalized linear models. The final model used was based on the significance of the effects and biological relevance (model 2), and the same model was used for both performing pig behaviour and receiving pig behaviour, this in order to be comparable (table 6; table 7). Other interactions were also tested but were not significant or the analyse convergence criterion were not met and was thus not presented since they could not be used in the model. Least square means and standard errors were estimated for the significant effects in order to investigate the direction of difference for all significant effects.

Level of significance for the relevant and significant effects which are included in the model is given in table 6 for the performing pigs and in table 7 for receiving pigs.

Model 2: Y = Breed + Treatment + Age of observation + Batch + e.

Where Breed (SY or DY, Treatment (AP or CP), Age of observation (1 2 3 4 5 6 9 10) and batch (A B C D E F G) were fixed effects. Y is the different response variables and e represents the random residual.

Table 6. *Level of significance for the different effects in the statistical model for performing pig behaviour in continuous sampling*

Response variable	Breed	Treatment	Age at observation	Batch
Nosing	**	N.S.	***	N.S.
Biting	N.S.	*	***	*
Head knock	N.S.	N.S.	N.S.	N.S.
Climbing	N.S.	N.S.	***	*
Moving pig	N.S.	N.S.	N.S.	**
Nosing belly	*	N.S.	***	**

*** = p < 0.001 ** = p < 0.01 * = p < 0.05 N.S. = Not Significant

Table 7. *Level of significance for the different effects in the statistical model for receiving pig behaviour in continuous sampling*

Response variable	Breed	Treatment	Age at observation	Batch
No reaction	***	N.S.	N.S.	**
Avoiding	N.S.	N.S.	***	*
Return approach	N.S.	N.S.	*	**
Other pen	N.S.	N.S.	N.S.	N.S.

*** = p <0.001 ** = p<0.01 * = p<0.05 N.S. = Not Significant

4 Results

4.1 Inter observer reliability

The degree of agreement between the two observers were strong with kappa values for all observation types above 0.95 (table 8). A kappa value of one means total agreement and values above 0.9 indicates very high agreement. Kappa and P-values for the agree of agreement between the two observers in body position (variables: lying on side, lying on belly, sitting, standing), location in pen (variables: lying area, slattered area, piglet corner, sow feeding stall) and activity (variables: eating, drinking, suckling, nosing/rooting pen floor, nosing/rooting pen fitting, nosing/biting other pig, exploring enrichment material, walking, defecating, sleeping or inactive), performing pig behaviour (variables: nosing, nibbling/biting, tail biting, vulva biting, ear biting, head knock, climbing, riding, lifting, pushing, belly massage, nosing teat/suckling), performing pig vocalization (variables: no, low, high) receiving pig behaviour (variables: no reaction, avoiding, return approach, other pen) and receiving pig vocalization (variables: no, low high) and stereotypes are shown in table 8.

Table 8. *Kappa and P-values for the agree of agreement between the two observers in scan sampling: body position, location in pen, activity and continuous sampling: performing pig behaviour, performing pig vocalization, receiving pig behaviour, receiving pig vocalization and stereotypes*

Registration	Kappa	P
Scan samplings		
Body position	0.9787	<0.001
Location in pen	0.9936	<0.001
Activity	0.9710	<0.001
Continuous observations		
Performing pig behaviour	0.9961	<0.001
Performing pig vocalisation	0.9582	<0.001
Receiving pig behaviour	0.9728	<0.001
Receiving pig vocalisation	0.9904	<0.001
Stereotype yes/no	1.0000	<0.001

4.2 Scan sampling

4.2.1 Descriptive statistics

The mean and standard deviation (std) for the time spent in different body postures, location in pen and activities were estimated per breed (table 9), treatment (table 10) and the gilts age in weeks at observation (table 11). The level of significance for the effects included in the model are presented in table 5.

The SY gilts spent less time lying and sitting but more time standing compared to DY gilts (table 9). DY gilts spent more time in the lying area but less time in the piglet corner in comparison with SY gilts (table 9). Regarding activities, the SY gilts spent more time suckling, walking and nosing /rooting floor in comparison with DY gilts (table 9). DY gilts did however spend more time sleeping then SY gilts (table 9). Gilts with the treatment AP spent more time walking and less time sleeping in comparison with gilts with the treatment CP (table 10).

Table 9. *Frequency table for scan sampling by breed. Mean and standard deviation (Std) of proportion (%) of scans (and time) spent in different body postures, location in pens and activities within each breed*

	SY		**DY**	
Number of observations	392		446	
	Mean (%)	**Std (%)**	**Mean (%)**	**Std (%)**
Body posture				
Lying	61.9	21.30	66.9	18.31
Sitting	2.3	3.93	3.7	6.02
Standing	35.8	21.25	29.3	17.10
Location in pen				
Lying area	39.8	23.28	43.9	23.32
Slattered area	17.9	19.33	15.7	17.97
Piglet corner	40.9	27.05	39.2	26.82
Sow feed stall	1.3	3.90	1.2	3.82
Activity				
Eating	4.4	7.39	4.4	6.96
Drinking	0.8	2.26	0.7	2.28
Suckling	10.4	13.06	9.5	12.01
Nosing/rooting floor	9.7	11.79	8.6	10.81
Nosing/rooting fitting	1.7	3.65	1.7	3.91
Nosing/rooting other pig	7.5	7.85	6.2	7.00
Exploring enrichment	3.2	5.36	3.4	5.45
Walking	5.8	6.72	5.2	6.24
Defecating	0.5	1.54	0.6	1.76
Sleeping	35.8	23.07	40.6	23.12
Inactive	20.2	15.16	19.0	15.47

Table 10. *Frequency table for scan sampling by treatment. Mean and standard deviation (Std) of proportion (%) of scans (and time) spent in different body postures, location in pens and activities within each treatment*

	Access pen		**Control pen**	
Number of observations	408		430	
	Mean (%)	**Std (%)**	**Mean (%)**	**Std (%)**
Body posture				
Lying	64.1	19.72	65.0	20.09
Sitting	2.9	4.63	3.2	5.69
Standing	32.9	19.22	31.8	19.59
Location in pen				
Lying area	41.2	22.23	42.8	24.41
Slattered area	17.4	18.96	16.1	18.34
Piglet corner	40.2	26.00	39.8	27.81
Sow feed stall	1.2	3.82	1.3	3.89
Activity				
Eating	4.6	7.34	4.2	6.99
Drinking	0.7	2.17	0.8	2.36
Suckling	9.5	12.39	10.3	12.63
Nosing/rooting floor	8.7	10.41	9.5	12.06
Nosing/rooting fitting	1.9	4.22	1.5	3.33
Nosing/rooting other pig	6.6	7.18	7.0	7.66
Exploring enrichment	3.4	5.35	3.1	5.45
Walking	6.2	6.65	4.8	6.23
Defecating	0.6	1.74	0.5	1.59
Sleeping	37.7	22.50	39.0	23.88
Inactive	20.1	15.31	19.1	15.35

Table 11. *Frequency table for scan sampling by the age in weeks at observation. Mean and standard deviation (Std) of proportion (%) of scans (and time) spent in different body postures, location in pens and activities over total number of animals observed within each age in weeks*

	Week 1		**Week 2**		**Week 3**		**Week 4**		**Week 5**		**Week 6**		**Week 9**		**Week 10**	
Number of observations	105		105		105		105		78		132		104		104	
	Mean (%)	**Std (%)**	**Mean (%)**	**Std (%)**	**Mean (%)**	**Std (%)**	**Mean (%)**	**Std (%)**	**Mean (%)**	**Std (%)**	**Mean (%)**	**Std (%)**	**Mean (%)**	**Std (%)**	**Mean (%)**	**Std (%)**
Body posture																
Lying	74.2	13.85	71.3	14.81	66.1	16.87	67.5	16.37	62.7	25.35	55.4	23.70	57.4	16.57	63.9	21.57
Sitting	2.9	4.61	3.1	4.50	1.9	2.91	2.3	3.57	2.1	4.02	2.0	3.83	4.6	6.79	5.7	8.11
Standing	22.9	13.15	25.6	13.76	32.1	16.20	30.2	16.76	35.2	25.07	42.6	23.61	38.0	16.33	30.5	19.60
Location in pen																
Lying area	46.3	25.23	39.8	22.80	42.5	21.46	49.5	23.30	27.4	19.72	36.3	21.30	43.9	20.80	48.2	25.13
Slattered area	15.0	21.07	19.3	20.26	16.6	17.81	22.6	15.48	4.1	5.04	5.9	7.27	29.0	20.32	20.9	20.38
Piglet corner	38.6	27.78	40.7	25.51	40.3	25.90	27.2	21.13	65.8	21.65	54.2	24.01	26.0	18.39	29.9	25.94
Sow feed stall	0.0	0.00	0.1	0.81	0.6	2.06	0.7	2.26	2.8	5.75	3.6	6.49	1.1	3.58	1.0	2.65
Activity																
Eating	0.5	1.73	0.3	1.20	0.4	1.88	1.2	3.20	5.5	8.65	8.3	8.06	11.0	8.56	7.6	7.22
Drinking	0.1	0.74	0.1	0.74	0.3	1.26	0.2	0.94	1.1	2.46	0.9	2.35	1.9	3.31	1.8	3.47
Suckling	19.7	11.30	18.1	11.80	19.8	9.54	21.5	10.48	0.0	0.00	0.0	0.00	0.0	0.00	0.1	0.81
Nosing/rooting floor	1.3	2.62	2.4	3.83	5.5	5.75	5.4	5.63	14.3	14.40	16.8	13.59	13.3	10.69	13.5	13.24
Nosing/rooting fitting	0.3	1.27	0.4	1.50	0.7	1.86	0.4	1.61	1.6	3.75	3.2	5.16	2.7	4.09	3.8	5.55
Nosing/rooting other pig	5.8	6.51	5.7	7.20	6.7	7.61	5.8	6.37	5.0	5.93	7.3	8.48	9.4	7.76	8.2	7.84
Exploring enrichment	1.5	3.20	2.7	5.31	4.2	5.70	3.2	4.46	3.3	5.73	5.2	7.23	2.3	4.20	3.3	5.17
Walking	3.6	4.25	5.3	5.78	7.3	7.41	4.5	4.76	5.6	7.15	5.4	7.41	7.5	7.31	4.6	5.91
Defecating	0.9	2.27	0.6	1.74	0.7	1.67	0.3	1.10	0.1	0.67	0.4	1.56	0.8	2.02	0.4	1.48
Sleeping	59.0	14.47	50.9	14.81	42.5	16.27	43.6	15.46	39.8	25.51	30.0	24.14	16.7	16.17	26.9	24.71
Inactive	7.3	7.03	13.6	9.43	11.9	8.54	14.0	10.92	23.8	17.36	22.5	14.82	34.2	14.17	29.9	15.42

4.2.2 Body posture

There was a significant three-way interaction between breed, treatment and age at observation for lying (p = 0.001) (table 5). The trend was that the proportion of time lying down decreased over time (figure 6). The major differences between breeds and treatments were found between week three, four and five (figure 6). In accordance to this, time spent sitting, standing and walking increased over time and time spent sleeping decreased over time (p = 0.001 for all) (table 5).

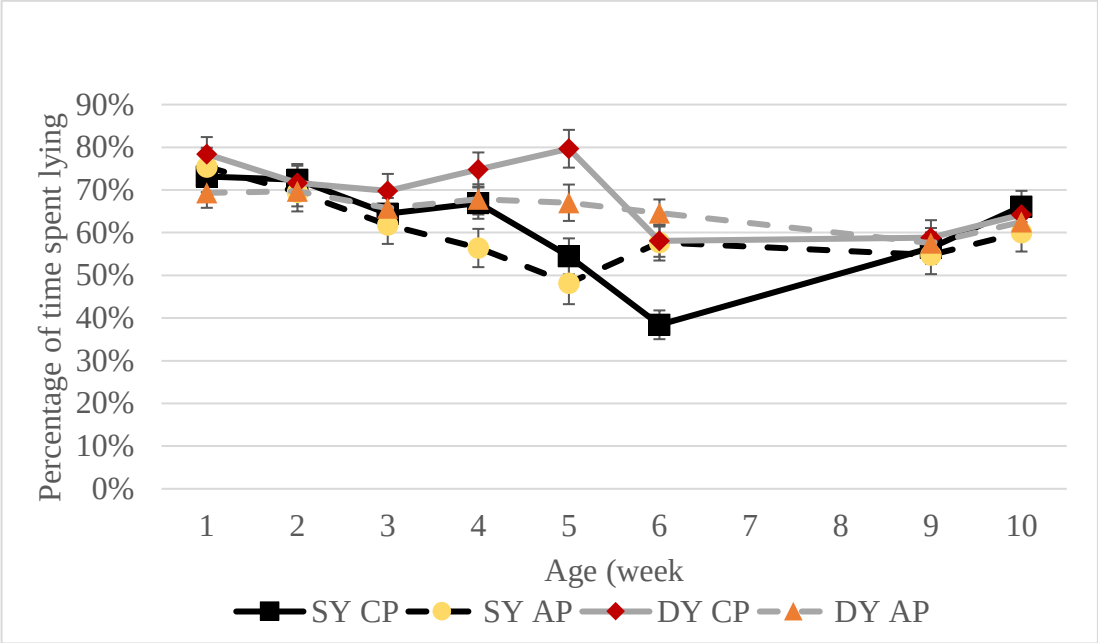

Figure 6. Percentage of time spent lying down over time (LS-mean ± *SE)*

4.2.3 Location in pen

For the location in pen, a significant three-way interaction between breed, treatment and age at observation was found for time spent in the lying area and the piglet corner (P=0.001 for both) (table 5). Gilts with the breed SY and access to an AP spent significantly less time in the lying area in week four then the other gilts (figure 7). All gilts spent less time in the lying area before weaning (figure 7). The major differences between breed and treatment groups were found week two to four (figure 7).

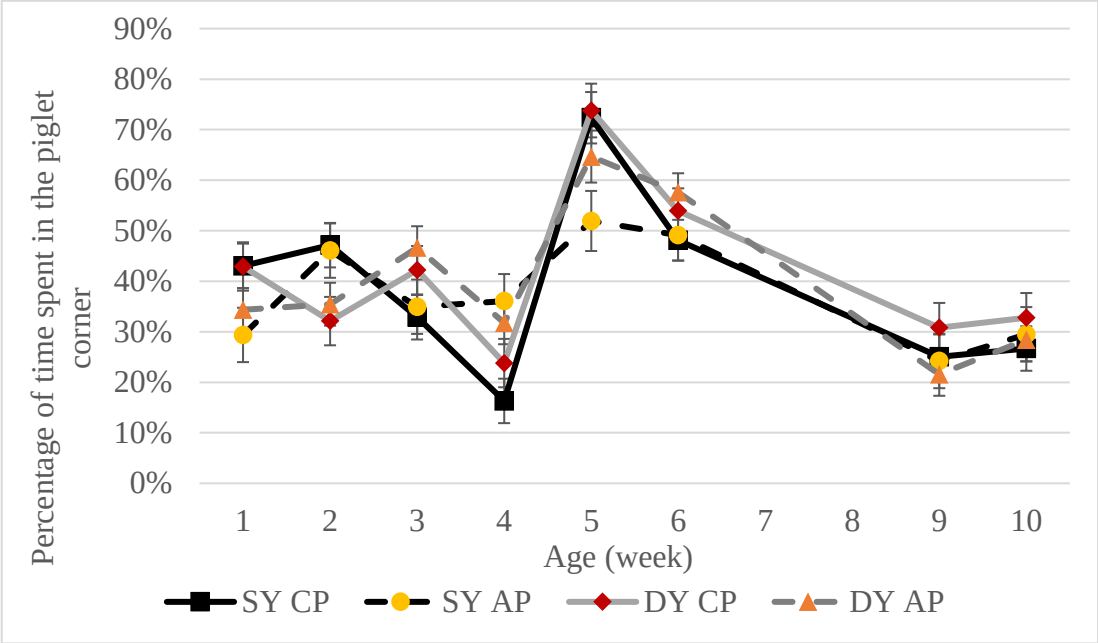

Figure 8. Percentage of time spent in the piglet corner over time (LS-mean ± SE)

Regarding the location piglet corner, the trend was that all gilts spent more time in the piglet corner around weening, which decreased after weaning (five weeks) (figure 8). The major differences that were found in week five were that the gilts with the breed SY and treatment AP spent less time in the piglet corner than the other gilts in the study (figure 8).

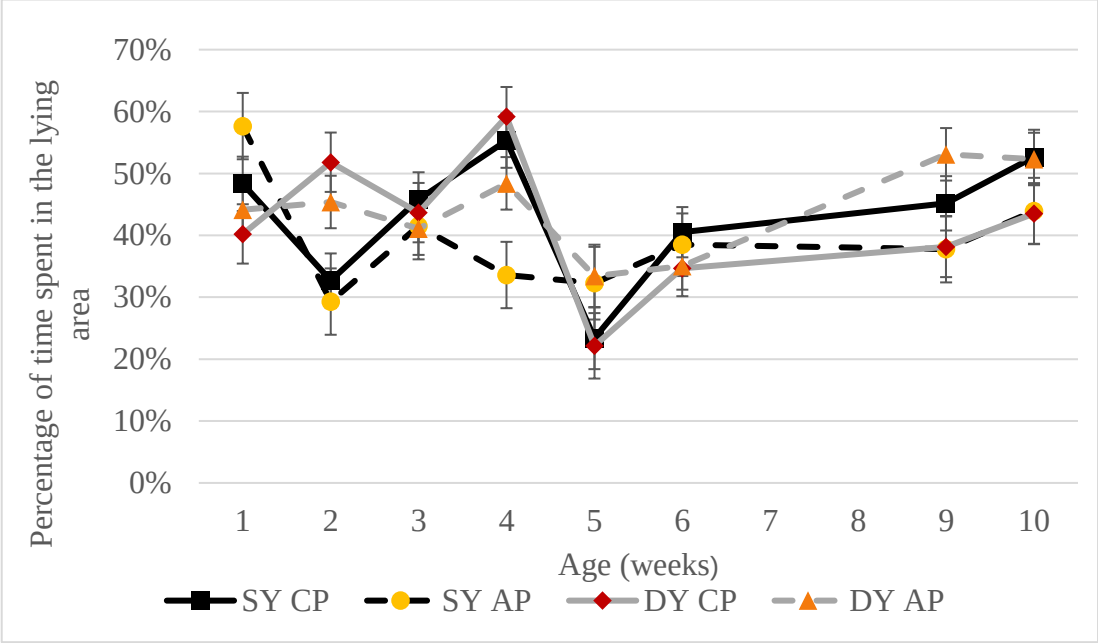

Figure 7. Percentage of time spent in the lying area over time (LS-mean ± SE)

4.2.4 Activity

There was a significant three-way interaction between breed, treatment and age at observation for the behaviour eating (p = 0.006) and suckling (p = 0.001). The trend for eating was that the behaviour increased at weaning (figure 9). In accordance to this, the trend for suckling indicated that the behaviour drastically decreased after weaning (figure 10). The major differences for eating were found in week five, six, nine and ten (figure 9), while the major difference in suckling were to be found in week two (figure 10).

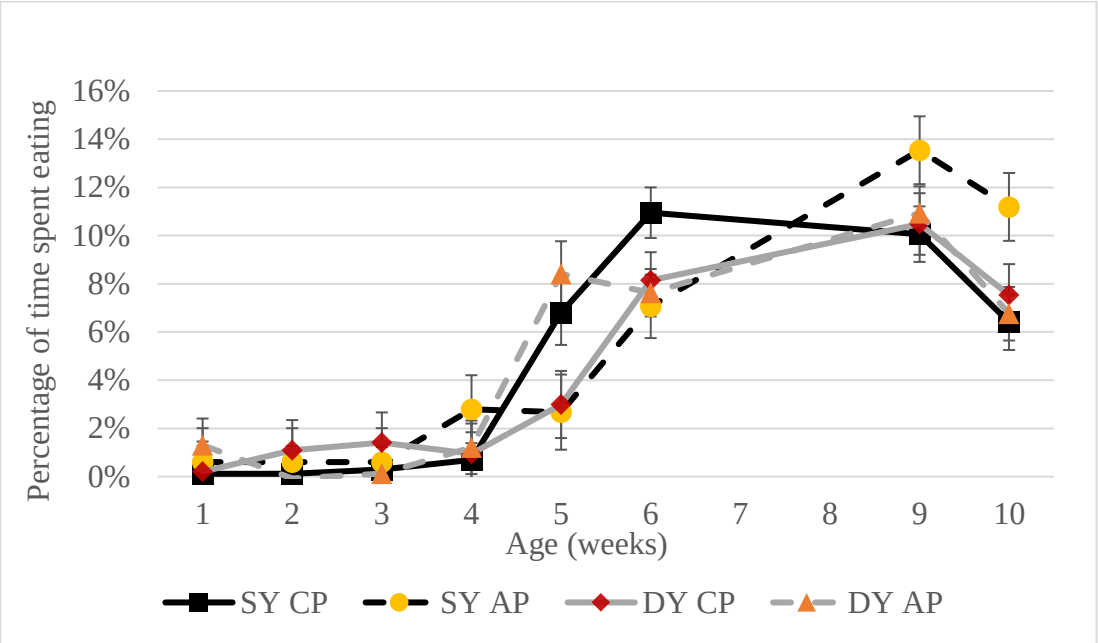

Figure 9. Percentage of time spent performing the activity eating over time (LS-mean ± SE)

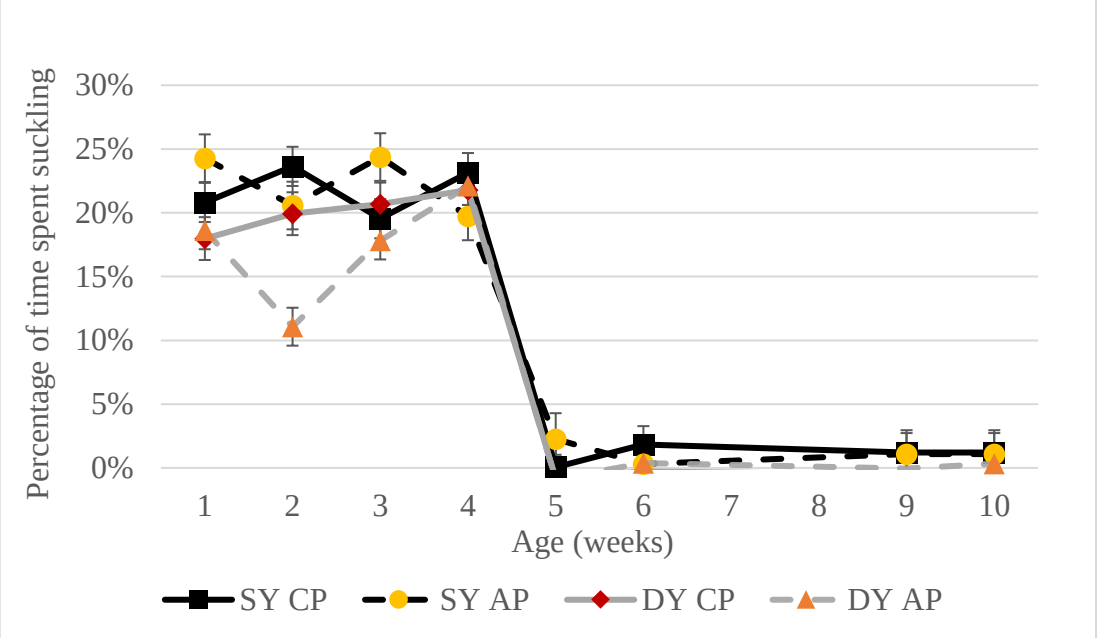

Figure 10. Percentage of time spent performing the activity suckling over time (LS-mean ± SE)

Regarding the behaviour walking, a significant three-way interaction between breed, treatment and age at observation was found (p = 0.001). Gilt with the breed DY with access to the AP differs significantly in week two compared to the other gilts (figure 11). Gilts with the breed SY and treatment AP differs significantly in week four and five where they spend more time walking than other gilts in this study (figure 11).

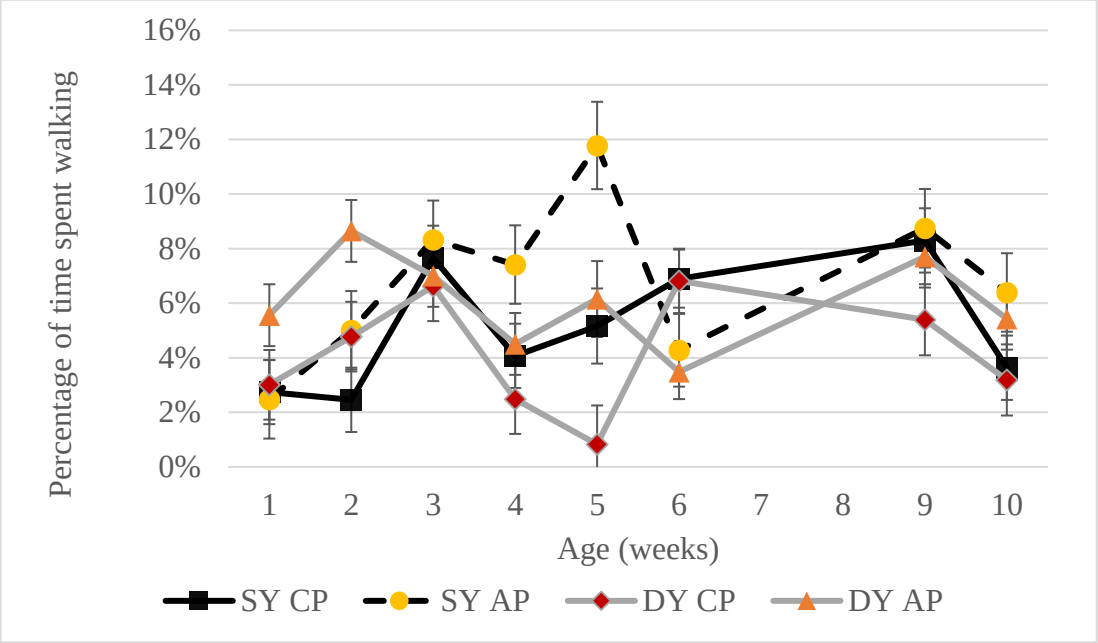

Figure 11. Percentage of time spent performing the activity walking over time (LS-mean ± SE)

There was a significant three-way interaction between breed, treatment and age at observation for the behaviour sleeping (p = 0.001). The trend was that the proportion decreased over time (figure 12). The major difference were found between four and five (figure 12). In accordance to this time spent noosing/rooting floor (p = 0.005) increased over time. So did also time spent inactive, even though this increase was not significant (p =0.158).

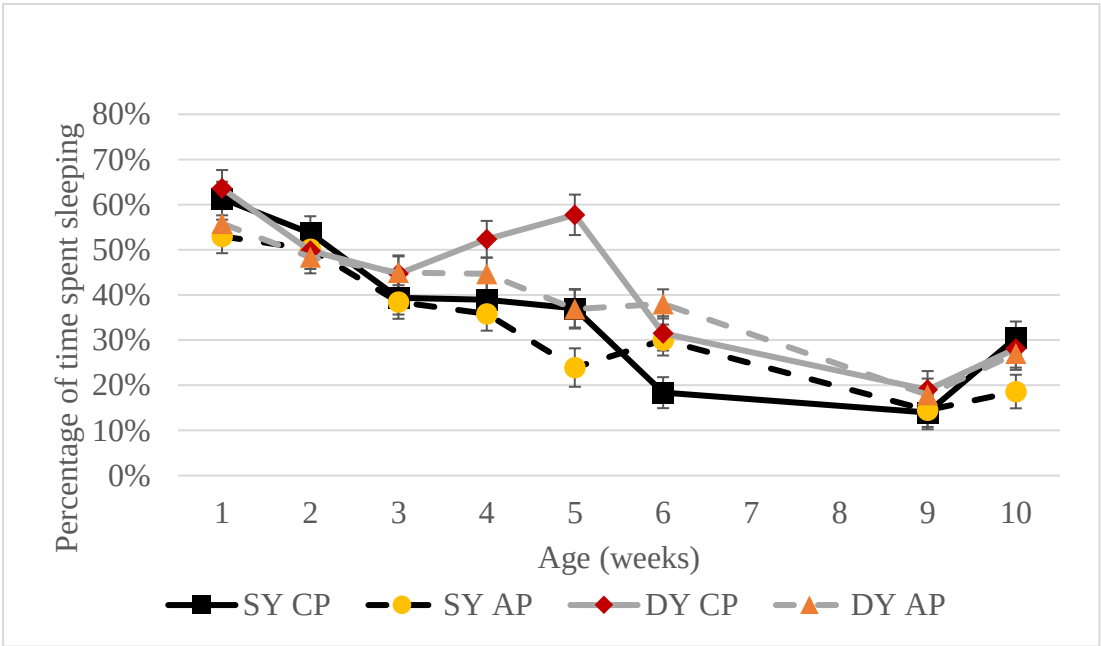

Figure 12. Percentage of time spent performing the activity sleeping over time (LS-mean ± SE)

4.3 Continuous observations

4.3.1 Descriptive statistics

4.3.1.1 General descriptive statistics for continuous observations

The reaction of receiving pigs towards behaviours performed by the performing pig is presented in table 12.

Table 12. *Percentage of performing pig behaviour in relation to the behavioural response from the receiving pig. N=number of observations*

	Receiving pig behaviour				
Performing pig behaviour	***No reaction (%)***	***Avoiding reaction (%)***	***Return approach (%)***	***Other pen (%)***	***N***
Nosing	81.2	4.2	14.4	0.2	920
Biting	50.9	23.1	26.1	0.0	295
Head knock	20.0	40.0	40.0	0.0	10
Climbing	79.0	20.1	1.0	0.0	418
Moving pig	61.3	21.1	17.6	0.0	703
Nosing belly region	97.7	1.9	0.4	0.0	261

The vocalisation of receiving pigs towards behaviours performed by the performing pig is shown in table 13.

Table 13. *Percentage of performing pig behaviour in relation to the vocal response from the receiving pig. N=number of observations*

	Receiving pig vocalisation			
Performing pig behaviour	***Quiet (%)***	***Low (%)***	***High (%)***	***N***
Nosing	93.0	7.0	0.0	918
Biting	84.1	15.6	0.3	295
Head knock	100.0	0.0	0.0	10
Climbing	77.3	21.5	1.2	418
Moving pig	84.0	15.0	1.0	700
Nosing belly region	72.8	27.2	0.0	261

The vocalisation of receiving pigs in relation to the behaviour response performed by receiving pig is presented in table 14.

Table 14. *Percentage of receiving pig behaviour in relation to the vocal response from the receiving pig. N=number of observations*

	Receiving pig vocalisation			
Receiving pig behaviour	**Quiet (%)**	**Low (%)**	**High (%)**	**N**
No reaction	90.7	9.2	0.2	1910
Avoiding	59.8	38.2	2.0	348
Return approach	79.2	19.9	0.9	342
Other pen	100.0	0.0	0.0	2

4.2.1.1 Performing pig behaviour

Differences in proportion of gilts which were the performing pig with a certain behaviour between breeds is presented in table 15.

Table 15. *Frequency table over the proportion of observation occasions that the behaviour of the performing pig in the social interaction has been observed at least once in relation to breed. N= 838 observations*

	Breeds	
Performing pig behaviour	**SY (%)**	**DY (%)**
Nosing	61.0	53.1
Biting	25.0	22.9
Head knock	1.0	0.9
Climbing	36.2	35.4
Moving pig	51.8	46.9
Nosing belly region	27.3	23.1

The proportion of gilts within each treatment when being the performing pig in a social interaction is shown in table 16.

Table 16. *Frequency table over the proportion of observation occasions that the behaviour of the performing pig in the social interaction has been observed at least once in relation to treatment. N= 838 observations*

	Treatments	
Performing pig behaviour	**Access pen (%)**	**Control pen (%)**
Nosing	59.1	54.7
Biting	26.5	21.4
Head knock	1.0	0.9
Climbing	36.5	35.1
Moving pig	51.7	46.7
Nosing belly region	25.7	24.4

Frequencies in performing pig behaviour over time is presented in table 17, indicating an increase in nosing and biting behaviours and decrease in climbing behaviours over time.

Table 17. *Frequency table over the proportion of observation occasions that the behaviour of the performing pig in the social interaction has been observed at least once in relation to the age of the pig in weeks. N= 838 observations*

	Week of age (%)							
Performing pig behaviour	***1***	***2***	***3***	***4***	***5***	***6***	***9***	***10***
Nosing	27.6	44.8	47.6	42.9	65.4	76.5	78.9	68.3
Biting	8.6	11.4	18.1	21.9	25.6	28.0	36.5	40.4
Head knock	0.0	0.0	0.0	1.9	0.0	3.0	1.0	1.0
Climbing	50.5	45.7	38.1	36.2	39.7	30.3	32.7	15.4
Moving pig	40.0	46.7	42.9	46.7	47.4	60.6	53.9	51.9
Nosing belly region	44.8	33.3	35.2	54.3	3.9	3.0	12.5	13.5

4.2.1.2 Receiving pig behaviours

Differences in proportion of gilts which were the receiving pig with a certain behaviour between breeds is presented in table 18.

Table 18. *Frequency table over the proportion of observation occasions that the behaviour of the receiving pig in the social interaction has been observed at least once in relation to breed. N= 838 observations*

	Breeds	
Receiving pig behaviour	**SY (%)**	**DY (%)**
No reaction	85.7	77.4
Avoiding	29.6	25.3
Return approach	27.8	25.8
Other pen	0.0	0.2

The proportion of gilts within each treatment when being the receiving pig in a social interaction is shown in table 19.

Table 19. *Frequency table over the proportion of observation occasions that the behaviour of the receiving pig in the social interaction has been observed at least once in relation to treatment. N= 838 observations*

	Treatments	
Receiving pig behaviour	**Access pen (%)**	**Control pen (%)**
No reaction	81.6	80.9
Avoiding	27.9	26.7
Return approach	27.7	25.8
Other pen	0.3	0.0

Frequencies in receiving pig behaviour over time is presented in table 20, indicating an increase in social interactions leading to that the receiving pig avoids or returns approach over time.

Table 20. *Frequency table over the proportion of observation occasions that the behaviour of the receiving pig in the social interaction has been observed at least once in relation to age in weeks. N= 838 observations*

	Week of age (%)							
Receiving pig behaviour	***1***	***2***	***3***	***4***	***5***	***6***	***9***	***10***
No reaction	80.0	79.1	83.8	75.2	79.5	82.6	90.4	78.9
Avoiding	15.2	20.0	21.0	21.0	33.3	34.9	37.5	35.6
Return approach	17.1	22.9	24.8	22.9	25.6	35.6	32.7	29.8
Other pen	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0

4.3.1.2 Stereotypic behaviours

Stereotypic behaviour was only shown in a low proportion of the observation occasions, (4.6 %). There was a significant difference (chisq P = 0.001) between the two breeds where SY showed stereotypic behaviours 7.4 % and DY showed stereotypic behaviours 2.3 % of the observations occasions. Consequently gilts with the breed SY showed stereotypic behaviours more often than gilts with the breed DY.

4.3.2 Analysis of differences between breeds and treatments

4.3.2.1 Performing pig behaviour

A significant difference between breeds was found for the behaviour nosing (table 6) indicating that gilts with the breed SY performed social nosing behaviour at least once during the observation at a larger proportion of the observation occasions compared with the breed DY (SY: 62 ± 2.7 compared with DY: 52 ± 2.7 % of the observation occasions (LS-mean ± SE), P = 0.008). In addition, a significant interaction was found between breeds for the behaviour nosing belly (table 6) indicating that gilts with the breed SY spent more time nosing belly than gilts with the breed DY (22 ± 2.67 and 15 ± 2.0 % of observation occasions respectively (LS-mean ± SE), P = 0.015).

There were a significant difference found between treatments for the behaviour biting (table 6) indicating that gilts that had access to the AP showed more behaviour including biting than pigs that lived in CPs (AP: 25 ± 2.4 compared to CP: 19 ± 2.0 % of observation occasions (LS-mean ± SE), P = 0.036). In addition AP stimulates the gilts to a bigger variation in behaviours and showing behaviours of different kind more frequently in comparison with gilts reared in CPs (table 16; table 19). The gilts in the AP did numerically show behaviours more often than the gilts in control pens (table 16; table 19).

Significant interactions were found for the predictor variable for age at observation for the response variables for the performing behaviours nosing, biting, climbing and nosing belly (P = < 0.001 for all) (table 6).

For the behaviour nosing, the percentage of observations spent nosing increased with age of the gilt besides on week four of the observations where it slightly decreased from the week before (figure 13). There were a significant difference between week one and two (P=0.010), between week four and five (P=0.003) and a tendency for significance between week five and six (P=0.073) and week nine and ten (P=0.083) (figure 13).

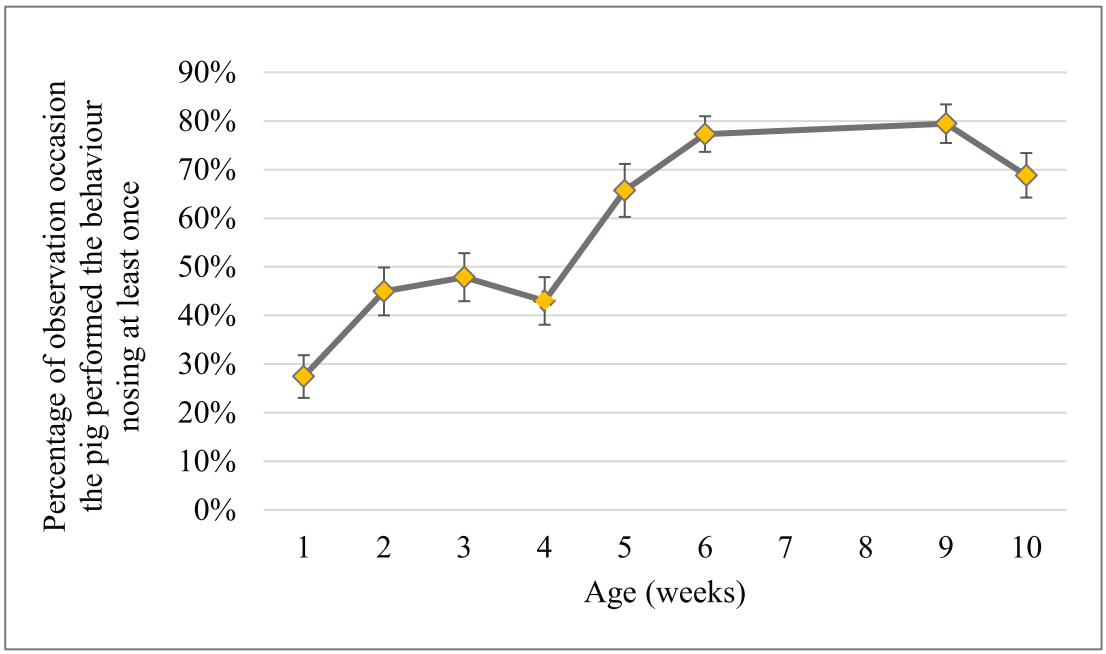

Figure 13. Percentage of observation occasions where nosing was performed at least once as a performing pig behaviour over the age of the gilts (LS-mean ± SE)

For the behaviour biting, the percentage of proportion spent biting increased with age of the gilts, but there were no significant difference between consecutive weeks (figure 14).

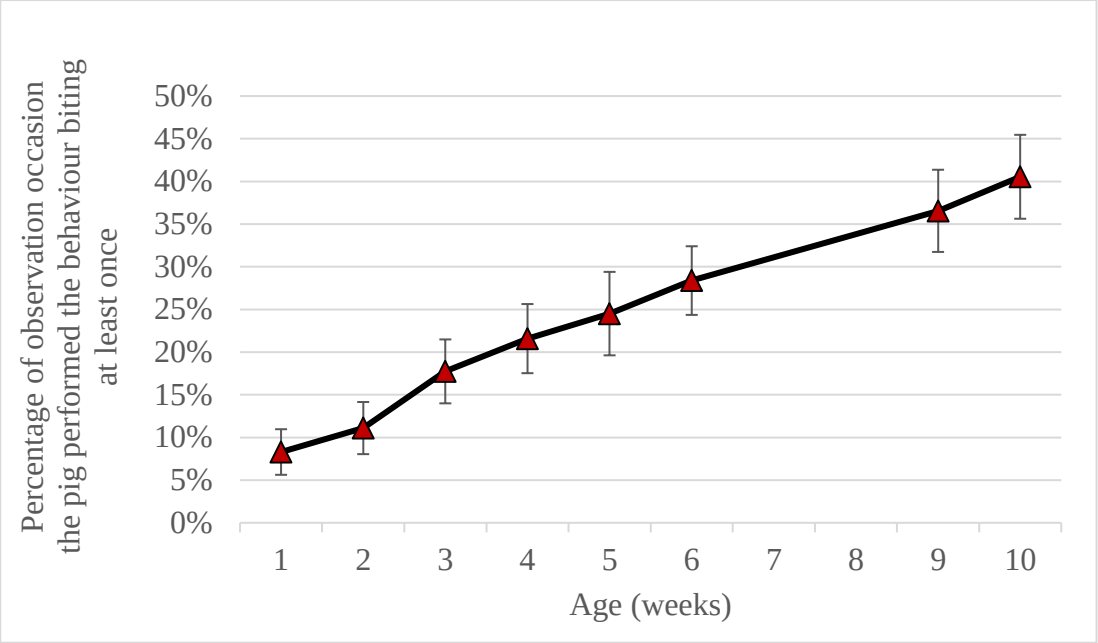

Figure 14. Percentage of observation occasion where biting was performed at least once as a performing pig behaviour over the age of the gilts (LS-mean ± SE)

Regarding the behaviour climbing, there were a significant difference between week nine and ten (P=0.004) and a tendency to significance between week five and six (p=0.087) (figure 15).

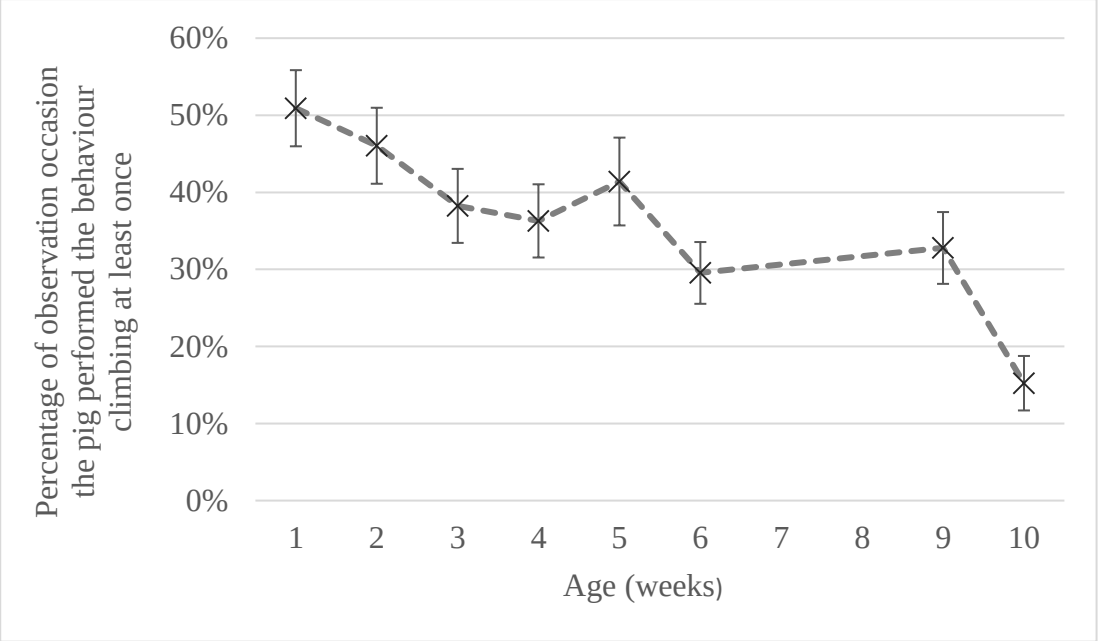

Figure 15. Percentage of observation occasion where climbing was performed at least once as a performing pig behaviour over the age of the gilts (LS-mean ± SE)

For the behaviour nosing belly region, a significant difference were found between week three and four (p = 0.005), week four and five (p=0.001) and between week six and nine (p=0.009) (figure 16).

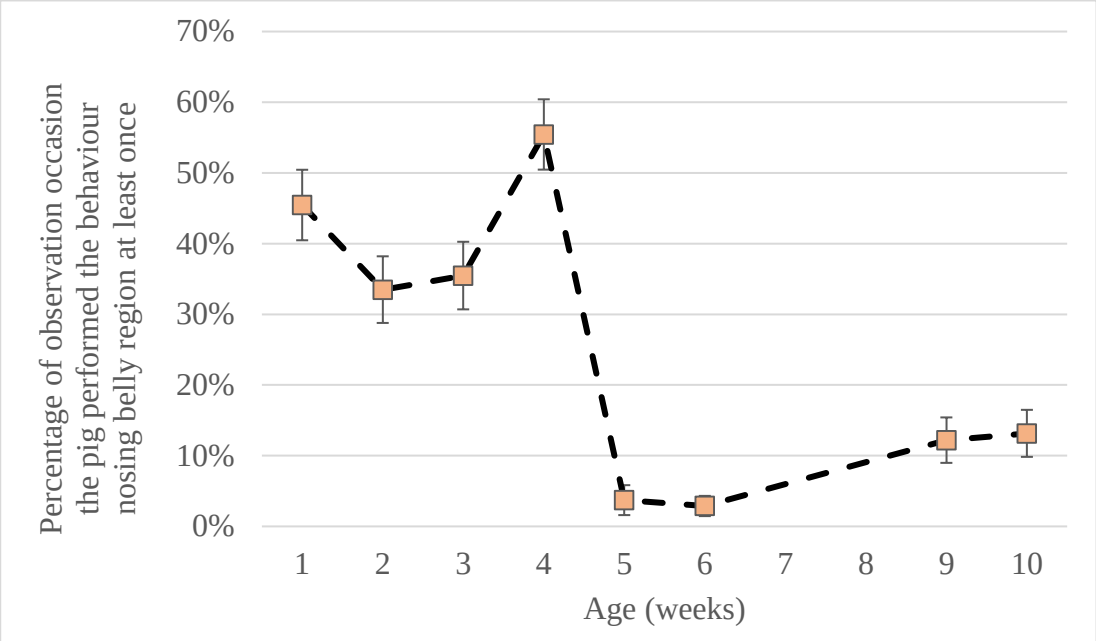

Figure 16. Percentage of observation occasion where nosing belly region was performed at least once as a performing pig behaviour over the age of the gilts (LS-mean ± SE)

4.3.2.2 Receiving pig behaviour

A significant difference between breeds was found for the receiving pig behaviour no reaction (table 7) indicating that SY reacted with no reaction to social interactions at least once during a larger proportion of the observations occasions than DY gilts (SY: 88 ± 1.7 compared with DY: 77 ± 2.1 % of observation occasions (LS-mean ± SE), P = 0.001).

5 Discussion

The general aim for this master thesis was to investigate if there are any differences in general behaviour and social interactions between two lines of Yorkshire pigs in two different social environments during early socialisation. Behaviours were recorded by direct observations and was performed by two observers. The agreement in observation between the two observers were very strong and thus the observer is not believed to affect the results. The different variables for body posture, location in pen and activity was recorded by scan sampling. Continuous observations were used for recording social behaviours and interactions. The registration of behaviours was done on an individual level in the gilts own home pen. In this study, a total of 118 gilts were included (105 gilts were used for analysis), where 49 gilts were of the breed SY and 56 gilts were of the breed DY. In addition, these pigs were divided into two different social environments where 51 of the gilts had access to AP and 54 gilts were kept in a CP. The results from this study will contribute to a bigger Formas project with knowledge of how breed and early socialisation could affect gilts early in life.

5.1 Body posture, location in pen and activity

5.1.1 Body posture

The proportion of time spent lying down decreased with time and the pattern is the same for both breeds and treatments (table 11), there is however no general distinct difference between treatments but it was found for breeds (table 5). The reason that the proportion of time spent lying down decreases with age may be because they become more active with age as suggested by Newberry *et al*. (1988). Newberry *et al*. (1988) reported that activity behaviours increases with age, especially during week two to six after birth. In accordance to this, it is not surprising that the pigs in this study increased their time spent sitting and standing over time while time spent sleeping decreased. This increased inactivity could also be connected to the biology of the piglets as the piglets, in the wild, from about 10-14 days of age would return to the family group from the nest in which they were born (Jensen, 2006). When they return to the group, intensive social activities start

where they become more active, in order to fit in the social structure and to start practising behaviours of importance such as foraging which increase with age (Stolba and Wood-Gush, 1989; Jensen, 2006). The behaviours of the domestic pig have not changed much from the wild pig during the domestication (Jensen, 2006; Jensen *et al*., 2010) and this increase in activity with age regardless of breed or treatment can be connected to the natural behaviours of the pig.

5.1.2 Location in pen and activities

Regarding location in pen, there was larger variation in time spent in the lying area (figure 7) and piglet corner (figure 8) before weaning compared to after weaning, but there was not a distinct difference between treatments or breeds (table 5). However, gilts with the breed SY and treatment AP spent less time in the piglet corner directly after weaning and when the pop hole was closed then the other gilts in the study (figure 8). At the same time there was a general big difference in location in pen for all gilts between the week before weaning (week four) and after weaning (week five) for both time spent in lying area and piglet corner (figure 8). After weaning the gilts spend less time in the lying area and more time in the piglet corner. This could be a result of the loss of thermal heat from the sow, which is important when the piglets are young (Cox and Cooper, 2001), and the piglet corner with the heating lamp could work as a replacement for the sow in terms of thermal comfort. Regarding the activities, eating (figure 9) and suckling (figure 10), there was a distinct and logic effect of weaning that can be observed. There was no distinct general difference between breeds or treatments but there was a large difference before and after weaning as also described regarding location in pen. The percentage of time spent eating (figure 9) increased after weaning as well as the behaviour suckling (figure 10) decreased after weaning. Both changes in eating and suckling could be an effect of weaning and thus be associated with each other, considering the fact that the piglets cannot suckle when the sow is gone and needs to start eating food instead. When discussing natural weaning in pigs, it is usually defined as a gradual process which cannot be described as a specific time but is rather a change from reliance of other food than the sows' milk (Worobec *et al*., 1999; Jensen, 2006). In semi-natural environments the weaning age of the piglets have been suggested to be 12.5 weeks (Stolba and Wood-Gush, 1989), 17.2 weeks (Jensen and Recen, 1989) and in enriched pens 11-12 weeks (Bøe , 1991). The entire litter does not necessarily have to be weaned at the same time (Worobec *et al*., 1999) although unweaned piglets at an age of six weeks of age receive less than half of their dry-matter intake from the sows' milk (English *et al*., 1988). Behavioural implications of abrupt artificial weaning has been studied several times. Piglets weaned at three weeks of age showed more aggressive behaviours and an increase in overall activity and they seemed to have difficulties in lying comfortably together with other littermates in comparison with piglets weaned at six weeks of age (Fraser, 1978). On the other hand, piglets weaned in an age of four weeks performed more redirected oral behaviours such as belly nosing and other oral manipulations of littermates tails, ears and other body parts, and this was suggested to

be potential indicators of stress (Dybkjaer, 1992). It is however, interesting that DY gilts with access to an AP quite drastically decreased their suckling at week two as seen in figure 10. DY gilts with access to an AP also spends more time walking during the same period in comparison with the other breed and treatments (figure 11). This could be interpreted as that the gilts with the breed DY are more affected of the extended social environment than the gilts with the breed SY, which do not change their suckling or walking behaviour as much in the beginning of the early socialisation period. Increased activity in terms of walking and overall being active was interpreted as stress that could imply a possible decrease in welfare in the study of Fraser (1978). Likewise, the increased walking and reduced suckling among DY gilts with treatment AP, in beginning of the social period seen in this master thesis, could imply stress and a possible decrease in welfare during that time. It could be that these piglets with AP get erupted of the other gilts when suckling or resting and thus become more active. As suckling is an important behaviour during piglets early life (Jensen, 2006), disruption of this behaviour could potentially result in stress in these piglets, which could affect their welfare.

Regarding the activity walking, there was not an obvious pattern in time spent walking between breeds or treatments. SY gilts with access to an AP spent more time walking before weaning and when the pop hole was opened. The gilts that had access to an AP spent more time being active (move more/walk more) the weeks before weaning (figure 11). This could be because these gilts hade an area double the size to a conventional pen and thus had the ability to move more than gilts in CP and since the pop hole is closed after weaning they get the same space to move freely as the gilts have in the CP. In the weeks around weaning the SY gilts were more active than the DY gilts if you compare between treatments (figure 11). This may indicate that the SY gilts are more daring than DY gilts. This is in line with the fact that SY gilts are indirectly selected for loose housing (Brink, 2012) and thus can perform active behaviours more than DY gilts which are indirectly selected for individual housing (Brink, 2013). The findings that gilts in AP are being more active could however also indicate that these gilts are stressed and have difficulties to calm down due to possible interference with more piglets. This is also in line with the study of Fraser (1978) where increased activity could be signs of stress. If considering the natural behaviours of the piglets, the increased independence from the sow with age in natural conditions leads to an increase in activity and in interactions with the environment (Worobec *et al*., 1999). Thus could this increased activity seen among gilts in AP be a natural effect of being able to perform natural behaviour. In the bigger Formas project, tests have been done to see if there is a difference between stress between both breeds and treatments, these could however not fit in this master thesis. Findings about the potential stress and pressure from the social treatment can therefore be found in the following research from this project.

Regarding the activity sleeping, there was an apparent trend that the gilts spend less time sleeping with an older age which can be seen among all gilts besides

those with the breed DY who spent a little more time sleeping, especially around weaning (figure 12). This is in line with the before mentioned possibility that SY gilts indirectly are bred for living in loose housing and thus are more active, and therefore sleep less, than DY gilts and that these differences are shown when they are stressed during the weeks around weaning. That DY gilts in CP sleep more could also be due to the environment as these gilts can be considered to live in a less stimulating environment. Different environments have been seen to effect piglet behaviour differently (Cox and Cooper, 2001). Gilts in AP had the opportunity to use more space to move around and also engage in more social activities and it may be so that the DY gilts in CP sleep as a reaction to lack of ability to be active. Restriction in space and a lack of enrichment results to changes in behaviour which leads to psychological distress such as anxiety and depression (Wemelsfelder and McMillan, 2005). The piglets should according to their biology sleep less due to their increased activity level (Jensen, 2006) and more space has been seen to enhance piglet activity level which suggests a welfare improvement (Petersen *et al*., 1995). The increase in sleep among gilts with the breed DY and treatment CP directly after weaning could indicate a potential welfare problem among these gilts. Increased activity has, however, also been seen to be connected with stress (Fraser, 1978) which could indicate that gilts with in an AP reacts more and are more stressed, when experiencing weaning and when the pop hole is closed, than gilts which were only weaned in the CP. This is logical since the pigs in the AP not only lose their mother but also social contact to other piglets and the neighbouring sow which they might have formed social relationships with. Closing of the pop holes could in itself also be a stressor as it results in removal of space and environmental enrichment for the piglets which has been seen to result in distress in other studies (Wemelsfelder and McMillan, 2005). It has been shown that piglets can exhibited stronger relationships with other piglets than with their natural littermates (Newberry & Wood-Gush. 1986). This loss of sleep and more active behaviour among gilts in the AP could also be an effect of that they are more cognitionally developed and therefore are more active and perform more behaviours due to that they are reared in a more stimulating environment than gilts in CP (Greenough and Juraska, 1979; Black, 1998). If they get improved cognitive abilities due to this social environment the increased activity could also be an indication on problem solving abilities since being able to express themselves and performing wanted behaviours can result in animals with a better welfare than animals that cannot express wanted behaviours (Jensen, 2006).

It is, however, interesting that a pattern in behavioural change of the gilts regarding both body posture, location in pen and activities in the majority of significant interactions could be seen in the piglets around weaning, but that the behaviour seems quite stable when the piglets are not in a period that is demanding. This indicates that the piglets are sensitive during this period. There are numerous studies that have found that weaning can be considered as a stressful period for piglets (Weary & Fraser, 1997; Dybkjær, 1992; Fels *et al*., 2012; Campbell *et al*., 2013; de Ruyter *et al*., 2017).

5.2 Social interactions

The descriptive statistics regarding performing and receiving behaviour indicates that nosing and nosing belly region can be classified to not be a severe social interactions from the performing pig, as a large percentage of the receiving gilts behaviour was no reaction (table 12).

The severity of the social interaction cannot be determined (or defined) by only the behaviour of the performing pig, but the severity is defined by the behaviour of the receiving pig. For instance, nosing is less severe (81 % of the social interaction nosing with the performing pig was returned with no reaction) and biting is a more severe social interaction (23 % responded with avoiding reaction and 26 % with return approach) (table 12). This is in accordance to the vocal response of the receiving pig (table 14). As a result of biting the receiving gilt more often performed avoiding reactions or returned approach than when the performing pig was nosing (table 12). Biting is more commonly connected with vocalisations among the receiving pigs (table 13) which is in line with the study by Horn (2009) that shows that vocalisations can be a sign of stress. Climbing and moving pig were behaviours that had a quite high number of avoiding reactions as a response by the receiving pig (table 12). For the performing behaviour moving pig, there were 17,6 % of the receiving pigs that were returning the approach (table 12) and this was responded with a low vocalisation response in 15 % of the occasions (table 13). For the performing pig behaviour climbing, the receiving gilts responded in 20.1 % of the observation occasions with an avoiding reaction (table 12) and the receiving pig responded with a low vocalisation in 21.5 % of the observation occasions and high vocalisation in 1.2 % of the observed social interactions (table 13). The behaviour biting, climbing and moving pigs did thus create quite high frequencies in vocalisations in comparison with the other behaviours observed (table 13). This could indicate that these behaviours were stressful for the receiving pig since vocalisations is connected to stress (Horn, 2009). The results from this study indicates that vocalisation from the gilts may describe the severity of the interaction. Vocalisation has been discussed to be an indication of negative states of welfare in numerous studies of piglets in different stressful situations. High call rate, duration and amplitude has been seen in environment that is known to be stressful for piglets, for instance when socially isolated (Fraser, 1975a; Fraser 1975b; Weary *et al*., 1997), when male pigs are being castrated (White *et al*., 1995; Horn *et al*., 1999; Taylor and Weary, 2000; Schön *et al*., 2001) and at weaning (Weary and Fraser, 1997; Weary *et al*., 1999). The vocal response in all these procedures has been seen to be stronger with experienced strength of the stressor such as pain (Taylor and Weary, 2000) or the level of need in the piglet (Weary and Fraser, 1995; Weary *et al*., 1996). The results also indicates that it is important to study social interactions from both the performing pig and the receiving pig in order to determine the severity of the reaction. This has also been mentioned to be important in other studies (McGlone, 1985; Newberry and Wood-Gush, 1986).

A significant difference between breeds was found for the behaviours nosing and nosing belly region (table 6) indicating that gilts with the breed SY performed social nosing or nosing belly region behaviour at least once during the observation at a larger proportion of the observation occasions compared with the breed DY (table 15). Social nosing can however be considered as a wanted behaviour while nosing belly region usually is an unwanted behaviour. Regarding the larger proportion of social nosing among SY gilts, it may be because the reason that SY gilts are more adapted for performing social interactions due to the fact that they have been selected to environments and housing systems where they have the possibility to be social. Nosing is also a behaviour which could be connected to their behavioural biology as they become more active and perform more social behaviours including nosing to fit in the family group of pigs which they return to when they are around two weeks of age in the wild (Jensen, 2006). An increase in the behaviour nosing can thus indicate a possibility for the piglets to perform behaviours which they would perform in the wild. There are slightly higher frequencies of biting behaviours in gilts in the treatment AP (table 16), this is however logical as they meet unknown pigs and have a higher social pressure than pigs that live in the CP. The higher frequencies of biting behaviours could also be an effect of the changing space allowances that the gilts in the AP experiences during this period of observations. This has also been seen in a study by Weng *et al*. (1998) which showed that the frequency of aggressive behaviours and social interactions increases in relation to decreasing space allowance. In a study by Cox and Cooper (2001) it was found that piglets in both stimulating outside environments and conventional inside pens slept less and performed more rooting and oral activities with age. The difference between AP and CP in consideration to biting behaviours were only 5.1 percentage points (table 16) and the increase occurrence of biting with age among all gilts (table 17) could thus be a result of their increased natural behaviour of oral manipulation (Jensen, 2006). This increase in biting could also be a result of increased aggression with age in order to maintain subordinate-dominant relationships which is in agreement with the study of Price (2008) who found that subordinate-dominant relationships between pigs are achieved and maintained by agonistic behaviours.

Regarding receiving pig behaviour, gilts with the breed SY responded to a performing pigs' social interaction with no reaction in a larger proportion of the observation occasions in comparison with gilts with the breed DY (table 18). This may be because SY gilts are bred for a more adequate social behaviour (Brink, 2012). If these behaviours remain when they get older, it could be possible that fewer social interactions results in fighting which could improve the welfare of the pigs since less fighting could result in less injuries. This would also be good for the producer since less injuries when mixed could increase the profitability.

The AP gives the piglets another experience than the CP as they have more space than piglets in the CP and that the piglets in the AP can socialise with piglets outside the litter and form relationships with them as they would do with other pigs in

the family group when living in the wild (Jensen, 2006). It has been seen that early experience can significantly affect animal behavioural responses and hence their ability to adapt to challenges which they face later in life (Harlow and Harlow, 1962; Heyes and Galef, 1996; Healy and Tovee, 1999). This has been shown to be a result of that the piglets learn behavioural responses which are useful later in life (Fagan, 1981). It has also been discussed to be a result of the fact that the animal has enhanced cognitive abilities and greater behavioural flexibility which consequently leads to greater capacity in adapting to new challenges (Greenough and Juraska, 1979; Black, 1998) or a more robust coping strategies (Walsh and Cummins, 1975; Anisman *et al.*, 1998). The AP could lead to behaviours in gilts that is wanted when the gilts get older and are mixed with other sows in intensive pig production. Stimulating environments have been seen to allow pigs to carry out a richer behavioural repertoire (Hötzel *et al*., 2004). A richer behavioural repertoire are seen among gilts in this study in social interactions if they were held in an AP instead of a CP. Gilts with AP in general performed a higher percentage point of the performing pig behaviours nosing, biting, head knocks, climbing, moving pig and nosing belly region (table 16), although only biting was significant (table 6). Tendencies to a richer behavioural repertoire, which can be seen in gilts that has been kept in an AP, could lead to the pigs developing skills that will be important for coping with stress (Hötzel *et al*., 2004). Tendencies to a richer behavioural repertoire in the performing pig behaviours nosing, biting, head knocks, climbing, moving pig and nosing belly region was also seen between breeds where SY had a higher percentage point of these behaviours in comparison with the breed DY (table 15). This could mean that richer behavioural repertoires could be of importance when the gilts get older and encounter new stressful moments such as mixing with other sows (Hötzel *et al*., 2004).

5.3 Methods

In the research herd where this study was carried out, a switch of dam breeding material from SY to DY occurred recently, making it possible to produce gilts of SY and DY breed when using semen from SY and DY sire-boars. This gave a limited amount of potential SY dams in this project which may have affected the quality of sows used from the SY dams.

During the early social environment period (when the pop hole is open) two pigs were sometimes registered at the same time during the continuous observations. This is always a risk as it is hard to fully observe two things at the same time. However, this was only done when the pigs were calm. If they were active, we did separate the observations and look at the focal animals at two different occasions instead which minimized the risk to miss behaviours. We could have filmed all observations in order maximize the chance of not missing behaviours. We did however chose to do direct observations instead due to the tremendous amount of time needed to watch all video clips of this as well as other parts of the bigger project that is filmed. At the same time, we need to consider the possibility that we may

have missed some social interactions if the performed social behaviours at the same time or if we looked down to write in the protocol and therefor missed behaviours. This was considered when choosing the method and to work without camera, and was thus a risk we chose to take. The behaviour observations where done before, during and after the period of early social environment. The behaviour observations were consequently placed in order to record behaviours before and after events that could affect the piglets (figure 3). This has shown to be useful in the time of weaning for this project were the results have indicated that they are affected during this period.

Due to the fact that we did IOR tests, we could see that the observers did register behaviours very similarly, which is good for getting reliable results. The similarity between the registrations of behaviours could be due to the fact that there was several occasions of training before actual registrations of both observers, and after each occasion the observers discussed the behaviours shown and how they were interpret. The observers also tried to time the scan sampling and continuous samplings with each other which is crucial to get equal results. Pigs can change behaviours quite often and if the observers do not look at the pigs at the same time, it can affect what they register. The few observations that did differ could be an effect of not timing each other perfectly when observing, but due to the low number of differences, we can assume that this did not occur often. Doing an IOR test is important as observers is an important factor that can affect the outcome of a study, the results from the IOR can therefore display the possible bias that can occur.

When considering the methods scan sampling and continuous sampling there is always advantages and disadvantages. Scan sampling gives a good overview of the behaviours which was the aim, but it also leads to missing out behaviours that are not performed often. Continuous sampling is good for registering everything you see during that period, but you also miss behaviour that are not performed during that time, which could be a problem. A total observation period of two minutes per continuous observation is quite short, but it is necessary to consider the practical parts of the study. A longer time would have extended the time needed for each observation occasion and that would have not been possible in the bigger Formas project since that affects other parts of the project. A balance of data needed and practical aspects of the study is necessary for getting a durable project. This setup was reasonable for getting the results wanted for this study but the data sampling methods is always worth to discuss.

During this study the behavioural observations were conducted at different time points. This was due to practical reasons, there were several occasions were these observations were a small part of the information that was needed to be collected for during that specific day. The different time points could potentially have affected the results since pigs can behave differently during different times of the day. All observations were however collected between 08.00 and 16.00 which can

be considered as daytime. This was intentional since pigs are more active during daytime in comparison with evenings or night time (Stukenborg *et al*., 2011). Since pigs are diurnal and mostly sleeps during nights (Stukenborg *et al*., 2011), it is in line with the projects interest to collect data during daytime since this is the time were pigs are supposed to perform social interactions and other behaviours then sleeping. If data instead would have been collected during nighttime that could have been a potential bias since pigs tend to sleep. Differences in activity during forenoon and afternoon or individual differences in behavior during days could potentially effect this study but were difficult to avoid due to practical reasons for the bigger Formas project which this study is a part of.

A problem worth noticing when conducting studies of behavioural data and a subject animal's behaviour repertoire is to be aware of the possible associations that can occur when wanting to interpret behaviours. This could especially be a problem when the behaviours are divided into exclusive behavioural categories as the potential difference between treatments in shown behaviours does not necessarily have to be direct effects of the treatment itself. In the case of this study, it could be so that differences in nosing behaviours can be related to the difference in gross level of general activities, as piglets that are inactive does not have the same opportunity to be engaged in social interactions.

Regarding the ethical aspects of the study, these observations were done to record general behaviours of these pigs and the observer did therefore try to not affect the pigs in any sort of way. The acclimatization period before each observation period was done with the purpose of letting the pigs get used to the observer which hopefully lead to them not being affected by the observer. This is however hard since pigs are very curious animals and with lack of much other enrichment, an observer walking around can be quite interesting. This is however more of a potential bias to the study than an ethical concern. Due to the fact that only visual observations were done for this project, the potential welfare concern due to the sampling method is minimal. A bigger potential ethical problem could be the potential risks the pigs in the AP can experience when meeting other piglets and a new sow. This can lead to more fighting due to the fact that more social hierarchy needs to be determined and more social interactions can occur which can end in harmful experiences for the piglets. There were however no direct serious harmful events with the piglets which is good through both an animal welfare aspect and an ethical aspect. Before this study, ethical aspects were discussed and events that could affect the piglets' welfare were kept as low as possible.

6 Conclusion

From the results, it can be concluded that SY gilts are more active than DY gilts. Gilts of the breed SY performed social nosing or nosing belly region behaviours at a larger proportion of the observation occasions compared with gilts with the breed DY. Regarding receiving pig behaviour, gilts with the breed SY responds to a performing pigs social interaction with no reaction in a larger proportion of the observation occasions in comparison with gilts with the breed DY. This could be results of indirect selection for behaviours beneficial in different environments. The results show that gilts held in an AP slept less and were more active directly after weaning (when the pop holes were closed). It was also found that AP stimulates the gilts to a larger variation in social behaviours and showing social behaviours such as biting more frequently. This master thesis has given indications of how breed and early socialisation could affect gilts early in life and the results will be studied further in the larger Formas project “Improving sow welfare in group housing systems” where more long-term effects of both early social environment and breeds will be studied.

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Appendix 1

The protocol for scan sampling which was created from the ethogram (Table 3) and used in the data collection for behaviour recordings before and after the early social environment (pop hole closed).

Scan sampling

Batch: Date: Technician:

Section: Pen:

Individual 1; Individual 2; Individual 3; Individual 4;
Colour: Colour: Colour: Colour:

Scan	Individual	Body posture				Location in pen				Activity									
		Lying on side	Lying on belly	Sitting	Standing	Lying area	Slatted area	Piglets corner	Sow feed. stall	Eating	Drinking	Suckling	Nosing/ rooting pen floor	Nosing/ biting pen fitting	Nosing/ biting other pig	Exploring enrichm. material	Walking	Def.	Sleeping or inactive
1																			
2																			
3																			

Scan	Individual	Body posture				Location in pen				Activity									
		Lying on side	Lying on belly	Sitting	Standing	Lying area	Slatted area	Piglets corner	Sow feed. stall	Eating	Drinking	Suckling	Nosing/ rooting pen floor	Nosing/ biting pen fitting	Nosing/ biting other pig	Exploring enrichm. material	Walking	Def.	Sleeping or inactive
4																			
5																			
6																			
7																			
8																			

Scan	Individual	Body posture				Location in pen				Activity									
		Lying on side	Lying on belly	Sitting	Standing	Lying area	Slatted area	Piglets corner	Sow feed. stall	Eating	Drinking	Suckling	Nosing/ rooting pen floor	Nosing/ biting pen fitting	Nosing/ biting other pig	Exploring enrichm. material	Walking	Def.	Sleeping or inactive
9																			
10																			
11																			
12																			
13																			

Scan	Individual	Body posture				Location in pen				Activity									
		Lying on side	Lying on belly	Sitting	Standing	Lying area	Slatted area	Piglets corner	Sow feed. stall	Eating	Drinking	Suckling	Nosing/ rooting pen floor	Nosing/ biting pen fitting	Nosing/ biting other pig	Exploring enrichm. material	Walking	Def.	Sleeping or inactive
14																			
15																			
16																			
17																			
18																			

Appendix 2

The protocol for scan sampling which was created from the ethogram (Table 3) and used in the data collection for behaviour recordings during the early social environment (pop hole open) for the groups with the treatment Access pen.

Scan sampling

Batch: Date: Techinician:

Section: Pen:

Individual 1; Individual 2; Individual 3; Individual 4;
Colour: Colour: Colour: Colour:

Order of neighboring pigs:

Scan	Individual		Treatment 1		Body posture				Location in pen				Activity									
	Home pig	Which pen?	Neigh-boring pig	Which pen?	Lying on side	Lying on belly	Sitting	Standing	Lying area	Slatted area	Piglets corner	Sow feed. stall	Eating	Drinking	Suckling	Nosing/ rooting pen floor	Nosing/ biting pen fitting	Nosing/ biting other pig	Exploring enrichm. material	Walking	Def.	Sleeping or inactive
1																						
2																						
3																						

Scan	Individual		Treatment 1		Body posture				Location in pen				Activity									
	Home pig	Which pen?	Neigh-boring pig	Which pen?	Lying on side	Lying on belly	Sitting	Standing	Lying area	Slatted area	Piglets corner	Sow feed. stall	Eating	Drinking	Suckling	Nosing/ rooting pen floor	Nosing/ biting pen fitting	Nosing/ biting other pig	Exploring enrichm. material	Walking	Def.	Sleeping or inactive
4																						
5																						
6																						
7																						
8																						

Scan	Individual		Treatment 1		Body posture				Location in pen				Activity									
	Home pig	Which pen?	Neigh-boring pig	Which pen?	Lying on side	Lying on belly	Sitting	Standing	Lying area	Slatted area	Piglets corner	Sow feed. stall	Eating	Drinking	Suckling	Nosing/ rooting pen floor	Nosing/ biting pen fitting	Nosing/ biting other pig	Exploring enrichm. material	Walking	Def.	Sleeping or inactive
9																						
10																						
11																						
12																						
13																						

Scan	Individual		Treatment 1		Body posture				Location in pen				Activity									
	Home pig	Which pen?	Neigh-boring pig	Which pen?	Lying on side	Lying on belly	Sitting	Standing	Lying area	Slatted area	Piglets corner	Sow feed. stall	Eating	Drinking	Suckling	Nosing/ rooting pen floor	Nosing/ biting pen fitting	Nosing/ biting other pig	Exploring enrichm. material	Walking	Def.	Sleeping or inactive
14																						
15																						
16																						
17																						
18																						

Scan	Individual		Treatment 1		Body posture				Location in pen				Activity									
	Home pig	Which pen?	Neigh-boring pig	Which pen?	Lying on side	Lying on belly	Sitting	Standing	Lying area	Slatted area	Piglets corner	Sow feed. stall	Eating	Drinking	Suckling	Nosing/ rooting pen floor	Nosing/ biting pen fitting	Nosing/ biting other pig	Exploring enrichm. material	Walking	Def.	Sleeping or inactive
19																						
20																						
21																						
22																						
23																						

Scan	Individual		Treatment 1		Body posture				Location in pen				Activity									
	Home pig	Which pen?	Neigh-boring pig	Which pen?	Lying on side	Lying on belly	Sitting	Standing	Lying area	Slatted area	Piglets corner	Sow feed. stall	Eating	Drinking	Suckling	Nosing/ rooting pen floor	Nosing/ biting pen fitting	Nosing/ biting other pig	Exploring enrichm. material	Walking	Def.	Sleeping or inactive
24																						
25																						

Appendix 3

The protocol for the continuous sampling that was created from the ethogram (Table 2) and used in the data collection for behaviour recording on social behaviours and stereotypes during both before, under and after the early socialisation period.

Continuous sampling

Batch: Date: Techinician:

Section: Pen: Start time, min 1: Start time, min 2:

Individual 1; Individual 2;
ID-number: ID-number:
Colour: Colour:

Min	Performing pig behaviour												Vocalisation			Focal animal's role		Receiving pig behaviour				Vocalisation		
	Nosing	Nibbling/ biting	Tail biting	Vulva biting	Ear biting	Head knock	Climbing	Riding	Lifting	Pushing	Belly massage	Nosing teat/ suckling	No	Low	High	Performing pig	Receiving pig	No reaction	Avoiding	Return approach	Other pen	No	Low	High

Comments: Stereotypes No: Yes: Number of pigs:

Sham chewing:
Biting pen fitting:
Tongue rolling:
Teeth grinding:
Floor licking:

Continuous sampling

Batch: Date: Technician:

Section: Pen: Start time, min 1: Start time, min 2:

Individual 3; Individual 4;
ID-number: ID-number:
Colour: Colour:

Min	Performing pig behaviour												Vocalisation			Focal animal's role		Receiving pig behaviour				Vocalisation		
	Nosing	Nibbling/ biting	Tail biting	Vulva biting	Ear biting	Head knock	Climbing	Riding	Lifting	Pushing	Belly massage	Nosing teat/ suckling	No	Low	High	Performing pig	Receiving pig	No reaction	Avoiding	Return approach	Other pen	No	Low	High

Comments: Stereotypes No: Yes: Number of pigs:

Sham chewing:
Biting pen fitting:
Tongue rolling:
Teeth grinding:
Floor licking: