Short-term effects of early social experiences on reactions to unfamiliar pigs

Kortsiktiga effekter av tidig social erfarenhet på reaktion med okända grisar

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Abstract

In Europe, there is an ongoing transition from individual housing to group housing for sows and gilts. The two housing systems will meet some of the needs of the sows but fail in meeting others. Individual housing systems can limit the possibility for aggressive behaviours between animals, whereas it fails in providing possibilities for social interaction and relevant space allowance. On the other hand, sows in group housing systems displays more aggressive behaviours but the sows have more space and the possibility to socially interact with other sows. In 2012, Sweden ended the breeding of Swedish Yorkshire (SY) and genetics from the Dutch Yorkshire (DY) was introduced instead. These two breeds have been selected in different environments (group housing vs. individual housing) which may have caused behavioural differences that may be of importance for group housing systems.

This Master thesis aim was to investigate social behaviours, body posture, solitary play behaviours and exploratory behaviours of five weeks old gilts and see if there were any differences between the two genotypes (SY and DY). The aim was also to see if behaviours changed between groups depending on if the gilts had the opportunity to socially interact with other unfamiliar piglets during nursing (called access pen (AP)) or if they could only socialise with their own litter and mother (called control pen (CP)). Protocols and ethograms were developed for registering the behaviours in a paired interaction test on 102 gilts for a total of three minutes. The practical study was carried out at the Swedish University of Agricultural Sciences (SLU) Research centre at Lövsta, Uppsala. Which was then observed via video recordings.

The results showed some significant differences between genotypes and social treatments, as well as the interaction between genotype and social treatment. Overall, SY gilts were more explorative than DY gilts. SY gilts also initiated the social interaction with more severe behaviours than DY gilts, as well as responding to social interactions with less severe behaviours at a larger proportion of the social interaction. The severity of the interaction was assessed by looking at the responding pigs' proportion of screaming. Regarding the different social treatments, AP gilts explored their surroundings more than CP gilts. The results also showed that AP gilts performed more severe social behaviours than CP gilts, which was also based on that the responding pigs' proportion of screaming. Early socialised pigs exhibited aggressive and severe behaviours quicker, but are also assumed to form dominance hierarchies quicker which will reduce their stress and injuries as well as improve their welfare and production.

Keywords: Swedish Yorkshire, Dutch Yorkshire, behaviour, social interaction, social treatment

Sammanfattning

I Europa pågår det en övergång från individuell hållning till grupphållning av suggor och gyltor. De två inhysningssystemen kommer att tillgodose några av suggornas behov men misslyckas med att möta andra. Systemet med individuell hållning kan begränsa möjligheterna för aggressiva beteenden mellan djuren, medan det inte ger möjlighet till social interaktion och relevant utrymme. Å andra sidan uppvisar suggorna i grupphållningssystem mer aggressiva beteenden, dock har de mer utrymme och möjligheten att socialt interagera med andra suggor. År 2012 avslutade Sverige uppfödningen av svensk Yorkshire (SY) och genetik från holländsk Yorkshire (DY) introducerades istället. Dessa två raser har selekterats i olika miljöer (grupphållning vs. individuell hållning) vilket kan ha orsakat beteendeskillnader som kan vara av betydelse för system med grupphållning.

Denna masteruppsats syftade till att undersöka socialt beteende, kroppsposition, enskilt lekbeteende och utforskande beteende hos fem veckor gamla gyltor och se om det fanns några skillnader mellan de två genotyperna (SY och DY). Målet var också att se om beteendena förändrades mellan grupper beroende på om gyltorna hade möjligheten att socialt interagera med andra okända smågrisar under digivningsperioden (kallad för access pen (AP)) eller om de bara kunde socialisera sig med sin egen kull och modersugga (kallad för control pen (CP)). Protokoll och etogram utvecklades för att registrera beteendena i ett ”paired interaction test” på 102 gyltor under totalt tre minuter. Den praktiska studien genomfördes vid Sveriges lantbruksuniversitets (SLU) forskningscentrum i Lövsta, Uppsala. Vilket sedan observerades via videoinspelningar.

Resultaten visade ett antal signifikanta skillnader mellan genotyper och sociala behandlingar, liksom interaktionen mellan genotyp och social behandling. Sammantaget var SY-gyltorna mer utforskande än DY-gyltorna. SY-gyltorna initierade också den sociala interaktionen med mer allvarliga beteenden än DY-gyltorna, samt svarade på de sociala interaktionerna med mindre allvarliga beteenden vid en större andel av de sociala interaktionerna. Interaktionens allvarlighet bedömdes genom att titta på de mottagande grisarnas andel av skrik. När det gäller de olika sociala behandlingarna utforskade AP-gyltorna sin omgivning mer än CP-gyltorna. Resultaten visade också att AP-gyltorna utförde mer allvarliga sociala beteenden än CP-gyltorna, vilket också baserades på att den mottagande grisen andel av skrik. Tidigt socialiserade grisar uppvisade aggressiva och allvarliga beteenden snabbare, men antas också bilda dominanshierarkier snabbare vilket minskar deras stressnivå och antal skador samt förbättrar deras välbefinnande och produktion.

Nyckelord: Svensk Yorkshire, holländsk Yorkshire, beteende, social interaktion, social behandling

Grisars förmåga att hållas i grupp kan skilja sig åt beroende på ras och tidigare sociala erfarenheter

Detta examensarbete visar på att det finns skillnader i grisarnas beteenden mellan raserna svensk Yorkshire och holländsk Yorkshire. Arbetet visar också på skillnader mellan grisar som när de var unga fått umgås med andra grisar än deras syskon jämfört med om de bara fått umgåtts med deras syskon och modersugga. Fokuset i arbetet ligger på att studera grisarnas sociala beteenden tidigt i livet vilket sedan kan påverka deras förmåga att hållas i grupp när de blir äldre.

I denna studie studerades 102 gyltor där ungefär hälften av gyltorna var från rasen svensk Yorkshire och hälften från holländsk Yorkshire. Hälften av gyltorna hade under digivningsperioden tillgång till grannboxen. Dessa gyltor kunde gå in i grannboxen genom en lucka i väggen under den senare delen av diperioden, medan den andra hälften av gyltorna bara fått vara tillsammans med deras syskon och modersugga.

Under ett test som genomfördes när gyltorna var 5 veckor gamla fick varje gylta träffa en obekant gris under 3 minuter. Gyltorna av rasen svensk Yorkshire utforskade deras omgivning mer än gyltorna från rasen holländsk Yorkshire. Detta kan tyda på att de är mer nyfikna. Gyltorna av svensk Yorkshire initierade interaktionen med mer aggressiva beteenden men reagerade med mindre aggressiva beteenden när en annan gris initierade interaktionen. Däremot utförde de holländska gyltorna mer lekbeteenden. Gyltorna som fått umgåtts med andra grisar än deras egna syskon under digivningsperioden utforskade omgivningen i testboxen mer än de gyltor som bara umgåtts med sina syskon och modersugga.

Resultaten visar också att de gyltor som fått umgås med andra grisar utförde mer aggressiva beteenden och bildade dominans hierarkier snabbare, vilket tidigare studier menar är positivt eftersom aggressionen tidigt i bildandet av en grupp leder till en lugnare gruppdynamik senare och totalt mindre skadliga beteenden. Detta kan innebära att de tidigare socialiserade gyltorna upplever mindre stress och skador.

Preface

This Master thesis was conducted at the Department of Animal Environment and Health at the Swedish University of Agricultural Sciences. I have always been interested in animals and animal welfare which was why I began my studies in the Agricultural Sciences Programme with the focus on Animal Science. During my studies, pigs caught my interest, which made my decision to be a part of this study easy.

I would like to thank and acknowledge some important people who contributed to this process. Without their help and support, this Master thesis would not have been possible to achieve.

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Abbreviations

AP	Access pen
CP	Control pen
DY	Dutch Yorkshire
EU	European Union
SPF	Specific Pathogen Free
Std	Standard deviation
SY	Swedish Yorkshire

1. Introduction

In 2008, initiation of a European Union (EU) directive was formed stating that the sows' welfare must improve (EU Council Directive 2008/120/EU). This led to a transition from individual housing to group housing in the EU. Since the 1st of January 2013, group housing gilts and sows has been compulsory within the EU in all pig holdings with more than ten sows. Sows need to be kept in groups from four weeks after service until one week before expected farrowing (EU Council Directive 2008/120/EU). In Sweden, national legislations have been demanding group housing of sows during gestation since the late 1980-ies (Einarsson et al., 2014).

The main concern with individual housing of gilts and sows is that it fails in providing possibilities for social interaction and relevant space allowance, but it can also limit possibilities for sows to perform aggressive behaviours (Anil et al., 2005). The minimal space, barren environment, restriction of movement and limited social interaction are all thought to negatively impact the pig's welfare (Godyń et al., 2019). Evidence has shown that sows kept in individual stalls have less muscle mass compared to sows housed in groups, as well as having a lower bone breaking strength (Anil et al., 2005). However, advantages with individual stalls are prevention of aggression, individual feeding and ease of management for the producer (McGlone et al., 2004).

The welfare issues with sows in group housed systems, such as aggression, lameness and skin wounds, are mostly amenable with management, whereas the problems in individual housing are more integral to those systems (Anil et al., 2005). Aggression usually occurs during regrouping with unfamiliar pigs due to attempt of establishing dominance or competition over limited resources such as feed (Anil et al., 2005). Clearly, these two systems will meet some of the sows needs but fail in meeting others, thus both systems have advantages and disadvantages regarding animal welfare. Individual stalls meet the needs of controlling feed intake and aggression, whereas it fails in providing relevant space for natural behaviours. Sows in group housing systems exhibit more aggressive behaviours, but also enables the sows to move freely and socially interact with other sows (Anil et al., 2005). Other studies suggest that rearing piglets with the sow in a conventional barren environment such as in individual stalls have lasting effects on the piglets' social development leading to more aggressive pigs (De Jonge et al., 1996, Olsson et al., 1999, Hillmann et al., 2003).

Petersen et al. (1989) implied that the pigs start to form social relationships at one week of age. One way of benefitting the pigs' social behaviour long-term is to mix litters prior to weaning (D'Eath, 2005). When early socialised pigs where mixed with non-socialised pigs the socialised pigs started to show aggression quicker but also formed a stable hierarchy quicker (D'Eath, 2005). This also enabled them to form dominance hierarchy more rapidly in future encounters with unfamiliar pigs. This resulted in a reduction of injuries and stress and ensured immediate welfare benefits without any consequences on production (D'Eath, 2005). This suggest that there is a behavioural difference between gilts that have had early social experiences with unfamiliar pigs through an access pen (AP) and gilts that has stayed in their conventional control pen (CP).

In 2012, the collaboration between Nordic Genetics and Norsvin ended which resulted in the cease of breeding Swedish Yorkshire (SY) (Nordic Genetics, 2012). The collaboration ended due to that Norsvin found their breeding materials worse than the competitors and that the Dutch Yorkshire (DY) would increase the number of weaned piglets per sow (Brink, 2013). This meant that genetics from the Netherlands would be used by collaborating with the Dutch company Topig (Nordic Genetics, 2012). The Dutch Yorkshire (DY) is from the Z-line and therefore has the abbreviation ZY (Brink, 2013), but will in this study be named DY from its initials. Over the last decades DY sows have been selected for individual housing and may therefore not be suited for group housing (Horback & Parson, 2016). Whereas SY sows, was during their breeding period bred for group housing systems (Nordic Genetics, 2012). This may therefore suggest a behavioural difference between the SY and DY when group housed.

This study was conducted as a Master thesis and is part of a larger Formas funded project by 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 larger Formas project focuses on investigating the presence of aggressive behaviour and how it is affected by young gilts social environment during rearing as well as their genetic background. This can then lead to a sustainable and relevant breeding and rearing aimed at gilts adapted to group housing systems.

The overall aim of this Master thesis was to investigate if there were any behavioural differences in relation to social interactions in five weeks old gilts between genotype and social mixing treatments.

The specific questions investigated in this MSc thesis are the following:

- Do behaviours related to social interactions in a paired interaction test with an unfamiliar pig of the same age and size differ if the gilts have had previous social experiences with other unfamiliar pigs?
- Do behaviours related to social interactions in a paired interaction test with an unfamiliar pig of the same age differ between genotypes?
- Is there a significant difference for the interaction between genotype and social treatment?

2. Literature review

2.1. Pig behaviour

When determining the behavioural need of todays domesticated pigs, questions concerning the fundamental difference to their wild ancestors (*Sus scrofa)* arises (Duncan, 1981). Stolba and Wood-Gush (1989) observed that domesticated pigs put into the wild showed behaviours resembling those of the wild pigs. Several other studies also indicates that domesticated pigs released into the wild can express the same behavioural and physiological characteristics as its ancestor (Jensen, 1986; Stolba & Wood-Gush, 1989; Jensen, 2006; Špinka, 2017; Graves, 1984; Gustafsson et al., 1999). Robert et al. (1987) conducted a study with juvenile wild pigs and juvenile domesticated pigs in an intense housing system to evaluate differences in behaviour. Differences in activity where observed, where the wild pigs exhibited a higher frequency in locomotion and activity while the domesticated pigs spent more time resting. The domesticated pigs resting time could illustrate a tendency to conserve energy which have been developed by human selection to maximize productivity (Robert et al., 1987). Ruckebusch (1972) also observed that the time spent active decreases when pigs were kept in a protected environment away from predators and without the need to search for food. In regards to group behaviour, social hierarchy have not changed significantly through human selection (Robert et al., 1987). In domestic as in wild pigs, a constructed pairing test showed a linear hierarchy (Robert et al., 1987). Baxter (1983) states that synchronization of behaviour might even be strengthened in domesticated pigs, which are related to group drives.

A relatively rapid change in pig housing and husbandry environment have occurred in comparison to evolutionary time and the domesticated history (D’Eath & Turner, 2009). Welfare problems can therefore arise due to an imbalance between the pigs’ environment and its behavioural needs (D’Eath & Turner, 2009).

2.1.1. Social Behaviour

Social behaviour is distinguished as an involvement of two or more individuals during communication (Deag, 1980). Communication between pigs is mainly vocal, as well as olfactory signals whereas visual signals are not as developed (Denenberg & Landsberg, 2014). Pigs have a large variety of vocal signals, with approximately 20 different vocalisations which can further be modified with amplitude and frequency (Ekesbo, 2011).

Commercial pigs' social development can be categorized by three interactions (Park et al., 2010); piglet-sow interaction, interactions between littermates and interaction with non-littermates. The first social encounter in a pigs' life is with its mother. Maternal care is therefore important for the piglets' social development (Park et al., 2010). In the wild, the pigs live in groups of approximately eight individuals (Denenberg & Landsberg, 2014). These groups consist of several sows and their piglets, whilst boars live in solitary joining the females only for breeding (Denenberg & Landsberg, 2014). The group sizes are smaller in the wild compared to in today's production systems affecting the pigs' social environments (Gonyou, 2001). The sow separates herself from the group one to two days before farrowing to find a suitable nest site (Stolba and Wood-Gush, 1989). The sow then starts rooting a whole in the ground and isolating it with grass, twigs and leaves to build a comfortable nest (Jensen, 1986). Piglets are well developed at birth, they can see, hear and walk immediately, but they have an undeveloped metabolism and are therefore susceptible to cold (Houpt, 2011). The most distinct group behaviour for piglets in commercial production is therefore to huddle together for warmth (Denenberg & Landsberg, 2014).

Piglets establish dominance quickly within the first week of life by forming teat ranks. The dominant piglets suckle on the first teats where milk flow is at its highest (Denenberg & Landsberg, 2014), making their growth rates higher than subordinates (Dyck et al., 1987). The hierarchy between the piglets remains stable as long as new piglets does not enter (Denenberg & Landsberg, 2014). Aggression and agonistic behaviours then become uncommon or mild if the hierarchy is kept (Graves, 1984) and is necessary for maintaining the hierarchy (Price, 2008). In the wild, pigs are gregarious and therefore keep a close contact with group members (Stolba and Wood-Gush, 1989). The ability to recognise and identify familiar individuals in the group maintains this dominance order and stable relationships (Kristensen et al., 2001). Commercial pigs are today mixed with unfamiliar pigs several times in confined and crowded places which will cause aggressive and agonistic behaviours (Meese and Ewbank, 1973). Today's rearing therefore causes several interruptions in the natural development for social behaviour which effects the pig in future encounters (Meese and Ewbank, 1973). Weng et al. (1998)

observed an increase in the frequency of aggressive behaviour and social interactions in relation to less space allowance, which is an indication of the importance of sufficient space.

The sow stays with the piglets in the nest for approximately one to two weeks, which enables a close bond between sow and piglet (Stangel and Jensen, 1991). Sows in the same group will take care of the piglets equally, for example one sow will stay with the piglets whilst the rest forage (Denenberg & Landsberg, 2014). Piglets therefore often share social interactions with other littermates earlier in life compared to domestic piglets (Graves, 1984). The piglets also share a communal nesting area (Denenberg & Landsberg, 2014). Wild and free-range pigs, wean their piglets at around three to four months after birth, whilst it in commercial production usually occurs abruptly at three to four weeks of age (Denenberg & Landsberg, 2014). However, in Sweden, piglets cannot be weaned before the age of four weeks (SJVFS 2019:20 Saknr L106 3 kap. 2§) and are usually weaned at five weeks of age (Ivarsson, 2007).

2.1.2. Play behaviour

One method of measuring pigs' welfare is to observe its body condition, skin lesions and lameness (Horback, 2014). One other method for assessing pigs' welfare is by observing the frequency of positive behaviours, such as play. Play only occurs when the pigs' primary needs (comfort, food, safety etcetera) are met, which suggests for a welfare indicator (Burghardt, 2005; Fagen, 1981; Oliveira et al., 2010). A decline in play behaviour can therefore indicate a problem with physical or physiological welfare (Horback, 2014). However, the assessment of play behaviour is rarely used due to difficulties with identifying the signals associated with play, such as reciprocal contact that can be seen as either aggression or just rough play (Horback, 2014).

Locomotor play is the most common solitary play behaviour performed mostly by piglets (Horback, 2014). This can be manifested by for example sporadic movement like scampering, jumping, sprinting and head toss (Fagen, 1981). In the wild it is beneficial for survival to be able to react quickly to change in environmental stimuli like with locomotion play behaviours (Horback, 2014). Rauw (2013) noted immediately locomotor play behaviour when releasing six weeks old piglets into a large hallway. The hallways novelty and increase in space resulted in play (Rauw, 2013). This sudden outburst of energy is also seen in sows when released in group housing after her piglets have been weaned (Horback, 2014). Studies have also suggested that locomotor play benefits the piglets' development of skeletal muscles and behavioural flexibility (Byers, 1998; Špinka et al., 2001). Around nursing, piglets must be able to quickly avoid the sow when she lays down to prevent themselves from being crushed (Damm et al., 2005). Locomotor play is therefore important for enhancing the change of piglet survival (Horback, 2014). A restricted environment, such as no relevant space allowance and lack of bedding material may prevent piglets' locomotor play. This can then, due to lack in exercise, cause abnormal physical development such as joint swelling, hock lesions, splay legs and lameness (Barnett et al., 2000; Bonde et al., 2004; Zoric et al., 2008). Adequate stocking density is an important factor for preventing health issues in pigs which is correlated to an increase in locomotor play (Horback, 2014).

Another solitary play behaviour is object play which involves physical manipulation of objects (Burghardt, 2005; Hall, 1998). In commercial farms, enrichment objects are usually indestructible like for example metal chains due to economic reasons. The objects last long but the pigs tend to lose interest quickly (Studnitz et al., 2007; Wood-Gush & Vestergaard, 1991). Objects that continuously change upon manipulation and can be consumed are therefore preferable, such as straw, compost, mushroom peat, stack of paper etcetera. (Horback, 2014). If these objects are not provided the pigs can harm themselves trying to manipulate objects in the pen such as chewing on metal bars (Broom, 1986). They can also start harming other pigs by tail- and ear biting (Broom, 1986). Social play behaviours early in life with the mother and littermates are also important for social development and for determining dominance (Horback, 2014).

Play behaviour provides adaptive and competitive advantages due to rapid responses to novel situations (Bekoff, 1984; Špinka et al., 2001). As well as cognitive development and maintenance of social bonds (Bekoff, 1984). Play behaviours are also affected by the environmental conditions (Newberry et al., 1988). Barnes et al. (1976) saw that nourished pigs spent more time playing than malnourished pigs. Limitation of space, objects and other pigs may unable the pig to express play behaviour (Horback, 2014). Piglets reared in barren environments can therefore develop aggression, poor social skills (Beattie et al., 1995) and poor meat quality (Geverink et al., 1998). Producers can therefore benefit from providing the pigs with environmental stimuli and socialisation with other pigs (Horback, 2014).

2.1.3. Aggressive and agonistic behaviour

Mixing unacquainted pigs with each other and competing for food are the main reasons for agonistic interactions (Scheffler et al., 2016). Agonistic behaviour occurs when pigs interact with continuum behaviours in a conflict situation which includes defence, offence and submissive behaviours (Petherick & Blackshaw, 1987). This interaction results in a winner and a loser, usually involving aggression such as pushing, levering and biting (Petherick & Blackshaw, 1987). Agonistic behaviours are necessary for the pigs to establish a dominance hierarchy among the group (Scheffler et al., 2016). However, fighting in an already established hierarchy influences the pigs' welfare and production negatively (Špinka, 2017), resulting in an increased risk for lameness (EFSA, 2007) and skin lesions (Turner et al., 2006). Arey and Edwards (1998) also reported that fighting amongst sows can influence their reproductive productivity negatively. Furthermore, aggressive behaviour will be seen less in groups with enrichment objects that are static or mobile (Blackshaw et al., 1997), as well as during night time than during daytime (Stukenborg et al., 2011).

Instability in already established dominance hierarchies develop with stocking density (Turner et al., 2000), space allowance, group size, unfamiliar individuals, body weight (Stukenborg et al., 2011), age, parity (Strawford et al., 2008), and social status (Elmore et al., 2011). For social status, dominant sows were more aggressive than submissive sows (Elmore et al., 2011). The sows' size and body weight were found by Edwards et al. (1994) to positively correlate with social status. It has also been seen that older sows are more dominant and have a higher social status than younger sows (Li et al., 2012), making older sows more aggressive (Elmore et al., 2011). A pregnant sows social status affects her offspring's performance and behaviour (Kranendonk et al., 2007). Piglets from a high-ranking sow had a higher body weight at weaning and slaughter, as well as a higher percentage of lean meat than piglets from low-ranking sows. However, piglets from high-ranking sows also had a shorter latency time for investigating novel objects than piglets from low-ranking sows (Kranendonk et al., 2007). D'Eath et al. (2009) reported that aggressive behaviours are moderately heritable and can therefore be reduced by genetic selection. Turner et al. (2008) also found that aggressive behaviours are heritable after mixing in growing pigs, whereas Løvendahl et al. (2005) found the same with sows.

Agonistic and aggressive behaviour amongst piglets decrease if they are mixed pre-weaning compared to if they only socialise with their own siblings and mother during the nursing period (Olsson & Samuelsson, 1993). Scheffler et al. (2016) also stated this due to the fact that cross-fostered piglets showed to be less aggressive than piglets that had only socialised with their own siblings and mother. Early socialisation with unfamiliar pigs might therefore lead to less aggression later in life. However, the cross-fostered pigs might also be less aggressive because of continuous experiences of defeats in conflict situations (Scheffler et al., 2016).

2.1.4. Exploratory and foraging behaviour

Exploratory behaviour, like sniffing, rooting, chewing and biting objects, develop within the first few days of life (Petersen, 1994). Exploring the environment is essential for pigs to be able to evaluate extrinsic values (i.e., food, water, shelter) and intrinsic values (i.e., pen size, social groups) (Studnitz et al., 2007). Intrinsic behaviour keeps the pig informed about their environment and resources in it. Their physic is also designed to root with a wide cartilage disc on the top of the snout for ploughing (Studnitz et al., 2007). In the wild, most time are spent foraging, which they usually do early in the morning and in the evening (Denenberg & Landsberg, 2014). Stolba and Wood-Gush (1989) studied domestic pigs living in a semi-natural environment and found that they spent 52% of daylight foraging and 23% in locomotion and investigation of their surroundings. Although a change in environment has occurred due to domestication, the pigs need to forage has not changed (Wood-Gush et al., 1989). Wood-Gush et al. (1989) released domestic pigs into the wild in southern Sweden and showed that they investigated over a large area within the first few days. Later, they restricted their movement to the area with the best resources and therefore created a cognitive map (Wood-Gush et al., 1989). They usually explore their surroundings with a purpose of either finding food or a place to lie down (Studnitz et al., 2007). Curiosity is also a motivation for exploration, which is termed inquisitive exploration (Day et al., 1995). This exploration reduces uncertainty whilst boredom also can motivate exploration to feel less bored (Studnitz et al., 2007).

One may then ask if it is still important for the pig to perform exploratory behaviour if enough food is fed and nests are already provided (Wood-Gush & Vestergaard, 1989). The domesticated pig has been selected for production of a large litter size and a fast growth rate (Špinka, 2017). These enormous energy outputs need a lot of energy input in the form of food. There is today no need for the pigs to search for food or to forage but they still need to satisfy their exploratory and forage behaviour. Jensen (1986) showed that commercial sows approaching parturition presented exploratory behaviours such as seeking for a safe place. Some of the responses may have been blurred by domestication, but as suggested by Stolba and Wood-Gush (1989), the behaviour is very similar to its ancestor.

If the pig is prevented from exploring and foraging by a barren and restricted environment the behaviour may be redirected towards other pigs, causing injuries (Wood-Gush & Vestergaard, 1989). Denying pigs appetitive behaviour forces it into a state of aversion or frustration (Wood-Gush & Vestergaard, 1989), and it can also lead to stereotypies like bar-biting (Špinka, 2017). Further evidence of the importance of explorative behaviour comes from a study by Wood-Gush et al. (1989) in which piglets would leave their nest and explore the surrounding new area. Evidence was found that piglets reared in a barren environment showed less inquisitive exploratory behaviour than those from an environment enriched with wood shavings and branches. Similar findings were found by Stolba and Wood-

Gush (1980) in growing pigs. Both these studies imply that piglets in barren environments are suffering from less exploratory behaviour. Furthermore, minimal improvements such as adding straw does not alleviate the pig for too long (Špinka, 2017). However, more spacious pens, enough bedding and enrichment objects have a more long-term effect (Špinka, 2017). The best enrichment is materials that can be manipulated and edible (Studnitz et al., 2007). Straw as bedding material has been demonstrated to reduce abnormal oral behaviour and tail-biting towards penmates (Studnitz et al., 2007). Day et al. (2002) showed the importance of the amount of bedding material where the behaviour to explore increased with the amount of bedding material provided, in this case straw. Because pigs in groups tend to synchronise their exploratory behaviours, enrichment materials must allow many pigs to be able to engage with them at the same time (Špinka, 2017). Increase in space allowance has also been found to increase exploratory behaviours in sows (Weng et al., 1998) and with growing pigs (Jensen et al., 2010).

2.2. The use of Yorkshire lines in Swedish pig production

In Sweden, pig breeding started in 1920 with the breeds Swedish Landrace and SY (Lundeheim, 2017). Since 2005, Nordic Genetics (Sweden) and Norsvin (Norway) started cooperating. This cooperation ended in 2012 making Norsvin start a collaborating with Topigs in the Netherlands, creating the joint company Topigs Norsvin. This led to the extinction of the SY and the start of importing DY from the Netherlands. The only breeding remaining in Swedish regime today is for Hampshire (Lundeheim, 2017).

When the breeding of SY was going on, the goals were to have a dam with good maternal abilities that are durable and high producing with offspring's that had good meat quality (Hansson and Lundeheim, 2013). DY, on the other hand, should have a high piglet survival, sows easy to handle, high meat percentage and a high growth rate (Brink, 2013). The change from SY to DY increased litter size in Swedish herds substantially, but also included challenges (Lundeheim, 2017). The increased litter size led to lower piglet birth weights. The sows' number of functional teats did not increase making it hard to feed all piglets. Therefore, taking genes from abroad both has its advantages and disadvantages. DY, coming from a larger breeding organization with larger nucleus population creates a faster genetic progress. However, there is less possibility for Swedish producers to influence the breeding goals of DY pigs. Today, DY genes originates from the Netherlands and are later multiplied in a herd in Norway. DY pigs are therefore selected and evaluated under

Dutch circumstances that are not always comparable to Swedish (Lundeheim, 2017).

2.3. Prior knowledge about social treatment

Weaning causes a number of stressors such as a sudden change in diet, separation from the sow and a change in environment (D'Eath, 2005). To avoid this stress, the piglets can be mixed prior to weaning (D'Eath, 2005). In the natural habitat of wild boars, the piglets experience social interactions much earlier than that of piglets in conventional farming systems (Spitz, 1986). As well as with free-ranging pigs where they experience social interactions with unfamiliar pigs at an age of one to two weeks when leaving the farrowing nest (Jensen et al., 1986). Petersen et al. (1989) therefore states that the natural social period for a pig is at the age of one week after birth until weaning. Jensen (1994) and Pitts et al. (2000) also found that pigs establish relationships of dominance at an age of 5-12 days. After this period the difficulty for pigs to form acceptance of new conspecifics increases with time, suggesting that early socialisation improves the pigs' ability to integrate into new groups (D'Eath, 2005).

D'Eath (2005) conducted a project to study early socialisation with unfamiliar pigs prior to weaning. He saw that early socialised pigs started fighting faster in each specific social situation than those who had not had early socialisation, but the fights where shorter and a hierarchy was therefore formed quicker. Skin lesions was also reduced later in life with early socialised pigs, suggesting that aggressiveness declines (D'Eath, 2005). A similar finding was recorded by Newberry et al. (2000) where skin lesions declined in early socialised pigs. The social development period may not only be pre-weaning but it does provide a more natural, stress- and injury free time for pigs to learn these social skills in comparison to those mixed later in life (D'Eath, 2005). Early mixing of piglets therefore has welfare advantages due to a reduction in stress and injuries (D'Eath, 2005).

2.4. Legislation in the European Union and Sweden

The EU Council Directive 98/58/EC focusses on the producer ensuring the well-being of their animals from suffering from any unnecessary pain. Since the 1st of January 2013, all member states shall ensure group housing of sows and gilts four weeks after service until one week before expected farrowing (EU Council Directive, 2008/120/EC). Sows and gilts raised in holdings of fewer than ten sows can be kept individually, as well as during the period of insemination and the first month of pregnancy. The individual accommodation must be constructed in a way that allows the pig to be able to see other pigs. However, the week before expected farrowing and during farrowing sows and gilts can be kept from seeing other pigs (EU Council Directive, 2008/120/EC). The ban of individual stalls was integrated already in 2001 with a transition period of 12 years (European Commission, 2012). Some of the member states have stricter legislations beyond the EU Council Directive, 2008/120/EC in regards to group housing, these are for example Sweden (Einarsson et al., 2014). Sweden has a legislation demanding that sows and gilts must be kept in groups during pregnancy and can only be held individually one week before farrowing and during farrowing until weaning (SJVFS 2019:20 Saknr L106 2 kap. 8§). Sweden has regulated group housing of sows and gilts for a longer period than in the EU, where Sweden set up national legislations demanding group housing of sows during gestation in the late 1980-ies and EU in early 2013 (Einarsson et al., 2014).

The fixation of sows is still allowed in the EU from one week before farrowing until four weeks after insemination (EU Council Directive, 2008/120/EC). Fixation of sows and gilts have mainly been intended for protection of the piglets from being crushed (Wischner et al., 2009). Fixation is the dominant system throughout lactation in the EU (EFSA, 2007). In Denmark and Germany, 90% of the sows are confined in farrowing crates. This severely restricts their freedom of movement and for expressing their natural behaviours leading to an increased frustration (EFSA, 2007). In Sweden, routine fixation of sows was phased out in 1988 with a transition period until 1994 (Jordbruksverket, 2012). According to current Swedish legislation, a lactating sows’ freedom of movement may only be restricted during the piglets first days of life by using a safety gate or similar device if the sow exhibit aggressive or abnormal behaviours which constitutes an obvious risk for the piglets or caretakers (SJVFS 2019:20 Saknr L106 2 kap. 10§). A pigs’ freedom of movement can neither be restricted by attaching a weight or other obstructing objects to the pig or by tying different parts of the pigs’ body together, unless this is done for treatment purposes where the pig is at risk of being injured (SJVFS 2019:20 Saknr L106 2 kap. 11§).

Maternal behaviours such as nest building are usually strongly restricted in commercially farmed pigs due to farrowing pens being designed to restrict the sows’ movement to reduce piglet losses due to crushing by the sow (Wischner et al., 2009). For the sows’ nestbuilding behaviour as well as the pigs’ exploratory behaviour it is important with sufficient bedding material (Špinka, 2017). The EU Council Directive 2008/120/EC requires sufficient bedding materials for rooting, such as straw, hay and sawdust etcetera. The Swedish legislation also require that all pigs must have bedding material of such properties and be given in such an amount that the pigs need for investigating and comfort are met (SJVFS 2019:20

Saknr L106 4 kap. 4§). The intension of the EU Council Directive 2008/120/EC is to improve pig welfare, but the maternal behaviour of nest building is not adequately considered (Wischner et al., 2009). The Swedish legislation specifies that sows and gilts must have access to bedding materials that gives them the opportunity to perform nesting behaviours one week before farrowing (SJVFS 2019:20 Saknr L106 4 kap. 5§). Allowing the sow to perform nesting behaviours leads to better health and welfare for both the sow and her piglets (Wischner et al., 2009). For instance, mortality rate and litter size are reported to be correlated with better nest-building performance (Westin et al., 2014).

Animal welfare is a growing concern amongst the general public which contributes to a greater demand for more legislations and more specific legislations (Vapnek & Chapman, 2010). Bilchitz (2012) mentions that the EU legislations contain vague concepts which causes different interpretations. Even so, the public seems to favour cheap meat over meat with stricter animal welfare laws (Jordbruksverket, 2012). Since Sweden joined EU in 1995, the pig production has decrease by 17% while import have increase by 332% (Jordbruksverket, 2012).

3. Material and methods

The study took place in the pig facilities of the Swedish Livestock Research Centre of the Swedish University of Agricultural Science at Funbo Lövsta outside of Uppsala. The video recording of the paired interaction test needed for this master thesis was performed between 8th of February 2018 until 13th of December 2018.

3.1. Animals

This master thesis included 102 gilts at the age of five weeks from two different genotypes (SY and DY) and two different social treatments (AP and CP), balanced over genotypes)), further explained in section 3.3.1. During the nursing period, the piglets were divided into 28 litters in seven different batches where four gilts from each litter were chosen at random as focal gilts for a paired interaction test. The paired interaction test is further explained in section 3.3.3. The distribution of focal gilts between genotypes and social treatments are seen in table 1. After weaning at the age of five weeks, the gilts behaviours were observed in a paired interaction test during a total of three minutes. Here, our focal gilts were paired with unfamiliar opponent gilts who grew up with the social treatment CP. The opponent gilt was always an unknown gilt that was paired with the focal gilt based on a similarity in weight.

Table 1. *Distribution of gilts between breeds and treatment during a paired interaction test at five weeks of age*

Breed / **Treatment**	**SY**	**DY**	**Total/treatment**
Access pen	20	31	51
Control pen	27	24	51
Total/breed	**47**	**55**	**102**

3.1.1. Breeds

The sows used to breed the gilts in this study was either 100% SY or at least 50% DY, whilst the sires where either 100% SY or 100% DY. Every SY gilt in this study was therefore 100% SY and every DY gilt was at least 75% DY and 25% SY.

3.1.2. Excluded animals

At the beginning of the study, 118 gilts were included where a total of 112 focal gilts underwent the paired interaction test at an age of five weeks old. As seen in table 2, ten focal gilts were excluded in the statistical analysis resulting in a total of 102 gilts. Reasons for exclusion were crossbred gilts and gilts without completed observations due to one gilt being euthanized and two gilts being born in another farrowing pen and later moved back.

Table 2. *A list of criteria's for excluded gilts*

Criteria's	**Affected batches**	**Number of pigs**
Crossbreeds	B & C	7
Did not complete the observations	C	3

3.2. Housing and management

The pig facilities of the Swedish Livestock Research Centre of the Swedish University of Agricultural Science are Specific Pathogen Free (SPF). This entails that samples are taken regularly to show that the pigs are free from different common pig infections and that the herds do not bring in new animals from outside (The Swedish Livestock Research Centre, 2017).

The housing system include seven farrowing units with 12 pens per unit. In the seven farrowing units, four pens per unit were used in this study making it a total of 28 pens. The pens are individually loose-housed where the gilts in this study lives with their mothers and siblings. The farrowing pen consist of a lying area with concrete floor, a dunging area with slatted floor and a piglet corner with a heat lamp. At birth, the staff weigh and determine the piglets' gender. The piglets are also marked in one ear with a tattoo rod. At an age of five days, the piglets get an ear tag in one ear where the focal gilts were tagged with a different colour in order to be easily detected. The gilts are weighed again before weaning at five weeks of age. The sows receive dry feed two or three times a day by an automatic feeder. When the piglets reach an age of two to three weeks, they have access to dry feed by an automatic feeder. All the pigs have water available in nipples. The staff manually clean the pens in the morning and thereafter a rail suspended robot provide the pen with chopped straw.

3.3. Study design

102 gilts, from two different genotypes (SY and DY) and two different treatments (AP and CP, balanced over genotype), where included in this study. The distribution of gilts over genotype and social treatment are almost equally distributed, as seen in table 1.

3.3.1. Social treatments

As well as genotypes, the study investigates the difference in social interaction from two different social environments, AP and CP. During nursing, the piglets in AP had the opportunity to walk into the neighbouring pen through a pop hole (height 35cm and width 30cm) located in the piglet corner (figure 1) and could thereby socialise with non-littermates. The pop hole was open from two to five weeks of age. The piglets in CP did not have the opportunity to access the neighbouring pen through a pop hole and therefore only socialised with their own litter and mother.

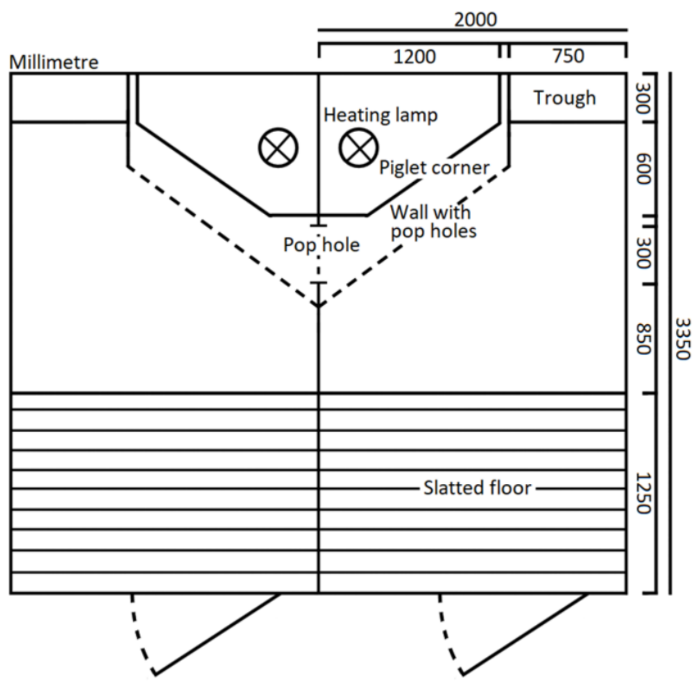

Figure 1. An illustration of two conventional loose housed farrowing pens with a pop hole located in the piglet corners between the two pens. Illustrated by Andersson (2019).

3.3.2. Behavioural protocols

The ethogram in table 3 was firstly developed by studying the focal gilts behaviours in a pilot study prior to this study, based on Hannius (2019) and Vahlberg (2019). The solitary play behaviours were based on Horback (2014). From the final ethogram, protocols where developed, as seen in appendix 1, 2 and 3. These were used to collect data for behaviours in a paired interaction test with gilts at five weeks of age. These appendixes present scan sampling of body posture (appendix 1), as well as continuous sampling of solitary play behaviour, exploratory behaviour (appendix 2), social interaction and vocalisation (appendix 3).

Table 3. *Ethogram of behaviours. Based on Hannius (2019), Vahlberg (2019) and Horback (2014)*

Category	Variable	Definition
Scan sampling		
Body posture	Lying on the belly	Lying on the belly, with head nearly vertical position, front legs not outspread to the side
	Lying on the side	Lying on the side, head/legs on the side
	Sitting	Front feet on the ground, back legs in lying position
	Standing	Standing or walking on all four feet
	Distance (close)	The distance between the pigs' is less than a pigs' length
	Distance (not close)	The distance between the pigs' is greater than a pigs' length
Continuous sampling		
Solitary play behaviours	Hop/spring	Jump up and down in one spot while facing in one direction
	Scamper	A sequence of at least two forward hops in rapid succession and a sudden forward motion
	Sprint	A sudden forward motion either towards or away from conspecific
	Pivot	Jump or whirl around to face in a different direction

	Toss head	Exaggerated lateral displacement of the head and neck in the horizontal plane, involving at least one full movement to each side
Exploratory behaviours	Explore pen fitting	Snout touching pen fitting
	Explore pen floor	Snout touching pen floor
Social interaction performing pig	Nose to body	Snout touching the receiving pigs’ body
	Nose to genital/anal	Snout touching the receiving pigs’ genital or anal region
	Nibbling/biting	The pig nibbles or bite the receiving pig
	Tail biting	Having another pigs’ tail in the mouth
	Vulva biting	Snout touching/biting other pigs’ vulva
	Ear biting	Having another pigs’ ear in the mouth
	Head knock	Approaching other pig with rapid head movement and open mouth
	Climbing	Stepping and lining on top of the receiving pig
	Riding	A pig is mounting another pig
	Levering	The pig puts its snout under the body of the receiving pig and lift the pig up in the air
	Pushing	Displacing the receiving pig by pushing any region of the body
	Chasing	The performing pig is chasing the receiving pig
Performing pig vocalisation	No sound	Either the pig is silent or it is not possible to identify where the sound is coming from
	Grunt	The pig is grunting
	Scream	The pig is screaming, barking or squealing
Social interaction receiving pig	No reaction	No change in body position or activity

	Avoiding	Moving away from the performing pig
	Nose to body	Snout touching the receiving pigs' body
	Nose to genital/anal	Snout touching the receiving pigs' genital or anal region
	Nibbling/biting	The pig nibbles or bite the receiving pig
	Tail biting	Having another pigs' tail in the mouth
	Vulva biting	Snout touching/biting other pigs' vulva
	Ear biting	Having another pigs' ear in the mouth
Receiving pig vocalisation	No sound	Either the pig is silent or it is not possible to identify where the sound is coming from
	Grunt	The pig is grunting
	Scream	The pig is screaming, barking or squealing

3.3.3. Paired interaction test

At the age of five weeks, a paired interaction test took place where the focal gilts were paired with unfamiliar opponent gilts to observe the focal gilts behaviours for a total of three minutes. This test was performed in the farrowing unit in an unfamiliar area (figure 2). The area had a concrete floor and two steel lids on both ends of the area that open to the culvert. For the test to not be affected by other factors, the pen was not enriched.

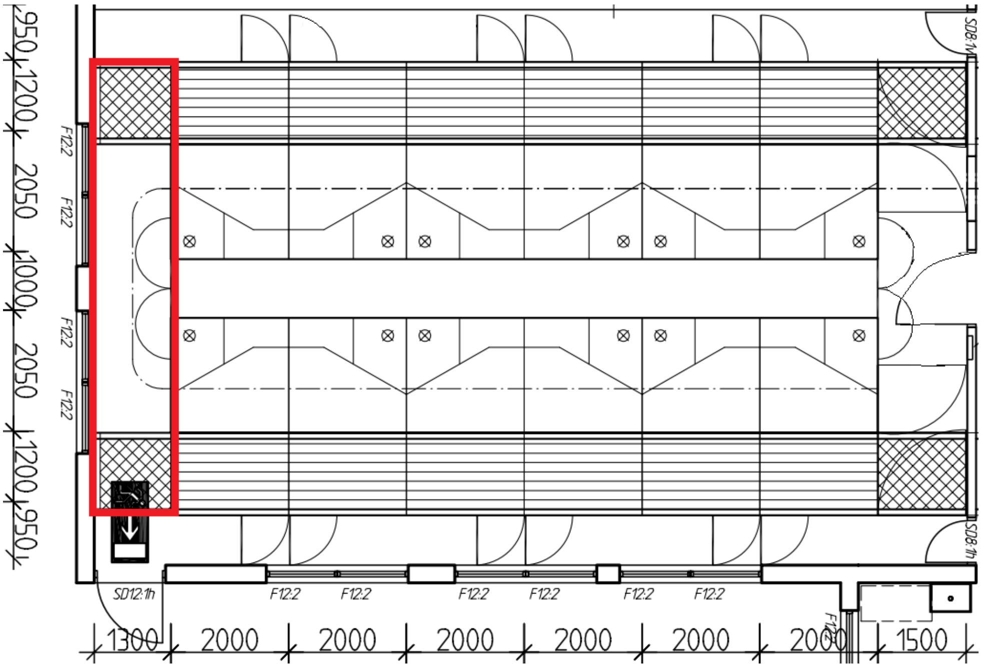

Figure 2. An illustration of the pen used for the paired interaction test at five weeks of age. The measurements are in millimetre.

3.3.3.1. Observation occasion and observers

The behaviours seen in the paired interaction test were registered by one person via video recording (figure 3). One or two people initiated the paired interaction test by recording, moving and choosing the gilts paired together. During the paired interaction test the people initiating the test were standing outside the pen, having no contact with the gilts. However, prior to the test the people initiating the test had to move the focal gilt and opponent gilt from their home pen to the paired interaction test area. After moving the gilts to the paired interaction test area, the gilts were firstly divided by a gate that opened when the test began.

The tests were performed at least one hour after ordinary routines, like for example feeding and cleaning, so that the pigs' behaviour would be less affected by these events. A total of seven batches were observed, approximately two or three hours per batch. The pigs where usually observed at daytime, between 13:00 to 17:00. However, one batch were observed earlier at 07:30 to 08:45 and another later at 16:00 to 18:30.

Figure 3. A screenshot from the video recording of the paired interaction test.

3.3.3.2. Scan sampling and continuous sampling

Continuous sampling was recorded from the start of the paired interaction test during three minutes, according to the ethogram in table 3. For the social interaction, the gilt that was initiating the social interaction was called performing pig, whereas the gilt responding to the interaction was called receiving pig. Both gilts were therefore registered even if they were a focal gilt or an opponent gilt because the roles between performing and receiving pig changed throughout the test. A new behaviour was registered when the behaviour within the interaction changed or if the behaviour stopped for three seconds and then began again. Scan sampling was only made on the focal gilt where its body posture was observed as a freeze frame every 15 seconds for a total of three minutes, according to the ethogram in table 3.

The paired interaction test always started with AP one, on the left side of the unit (figure 4), where all four focal gilts were paired with an opponent gilt and observed one at a time in the paired interaction test area (figure 2). After the observations the gilts were put back into their home pen. Continuing, the next observation was AP two connected to the first observation pen. Lastly, gilts from two CPs were observed. These two CPs could differ in location in the unit because they were regular conventional pens and did not have to be next to each other like APs. The pen order was the same for both scan sampling and continuous sampling.

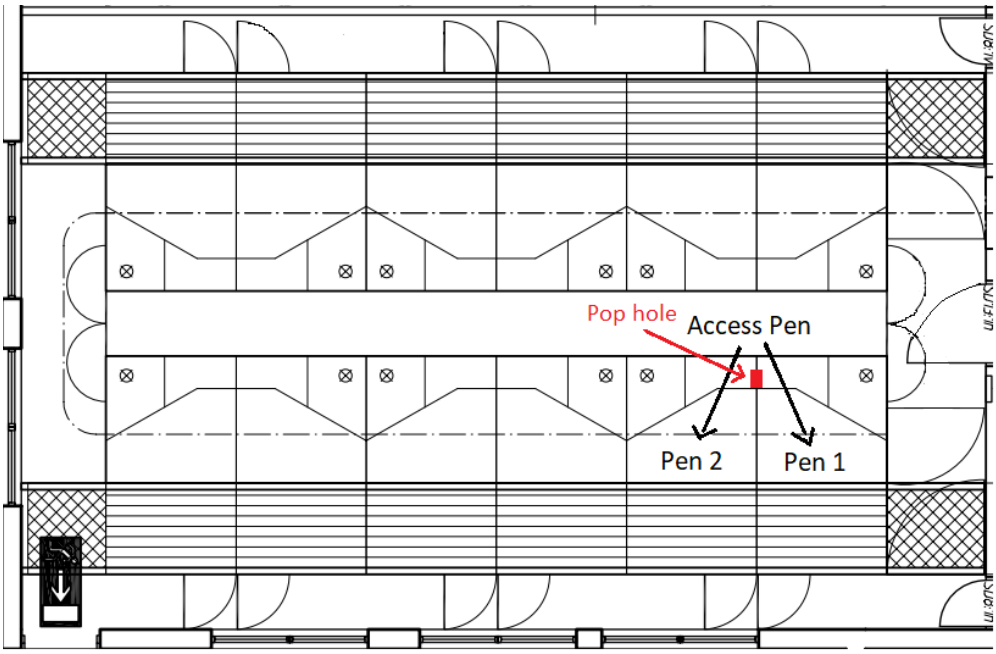

Figure 4. Layout and placement of the pen order in the stable.

3.4. Statistical analyses

The statistical and descriptive analyses were performed by using SAS version 9.4 (SAS Institute, Inc., 2011) and Minitab 18 (Minitab Inc., 2017). Excel (Microsoft, 2019) was used for displaying the results from the statistical analyses.

3.4.1. Data editing and changes of variables

Some of the behaviours (variables) in both scan sampling and continuous sampling was edited prior to the statistical analyses due to different circumstances. Firstly, the variable "distance" was the only analysed body posture variable due to that all gilts except two was performing the variable "standing". Therefore, no analyses were made comparing "lying on the belly", "lying on the side", "sitting" or "standing". The solitary play variable "sprint" was removed due to difficulties distinguishing it from the variable "scamper" during the observations. The definition for "sprint" was therefore merged with the definition for "scamper".

For the social interaction the variable "nose to genital/anal" was removed for both the performing pig and receiving pig and the definition was merged with the variable "nose to body". This was to observe "nose to body" independent of body region. A new variable "nibbling/biting body" was created for both the performing pig and the receiving pig from merging the biting variables "nibbling/biting", "tail biting", "vulva biting" and "ear biting". The performing pig variable "head knock" was removed due to no observations, as well as "riding". The variable "chasing" was also removed because the definition was too vague and too difficult to observe due to the pigs continuously following and chasing each other.

3.4.2. Descriptive statistics

The scan sampling data included body posture and the statistical analyses was only made on the variable “distance”, whilst the continuous sampling included solitary play behaviour, exploratory behaviour and social interaction for the performing pig and the receiving pig, as well as vocalisation (table 3). During the descriptive analyses the scan sampling data was analysed using Minitab, as well as for the social interaction between performing pig behaviour, receiving pig behaviour and their vocalisations. For the continuous sampling data, SAS was mainly used. In SAS, the solitary play behaviours and the social interaction behaviours were made into binary variables before using the procedure MEANS to estimate the means of proportion of observations per gilt spent in different genotype, social treatment and minutes. For the exploratory behaviours, the procedure MEANS estimated the mean number of performed events per gilt and minute spent in different exploratory behaviours within each genotype, social treatment and minutes. The procedure FREQ was also used to get frequency tables of the relations between different variables.

3.4.3. Statistical analysis and model

During the statistical analyses, models was made in SAS to estimate the effect of genotype and social treatment. Prior to making the models, potential predictor variables were tested against each response variable by using the procedure UNIVARIATE to see if it was normally distributed or not considering the Shapiro–Wilks test for normal probability plot and normality. The variables that were normally distributed used the procedure GLM, whereas the other variables used the procedure GLIMMIX. When analysing the variable “distance” between the pigs, the procedure GLM was used, as well as for the exploratory behaviours. For the solitary play behaviours all variables used the procedure GLIMMIX. GLIMMIX was also used for all performing and receiving pig behaviours except for the performing pig behaviour “nose to body” due to it being normally distributed. Both the performing pig vocalisation and receiving pig vocalisation “no sound” was found to be normally distributed and the procedure GLM was therefore used. Other than mean and standard deviations (std), these procedures also presented least square mean (LSMEAN) values, as well as standard error.

The model used in SAS was:

$$\text{Model: Y} = \text{Genotype} + \text{Treatment} + \text{Genotype} * \text{Treatment} + \text{Minute} + \text{Batch} + \text{Weight at 5 weeks} + \text{e}$$

Genotype (SY or DY), treatment (AP or CP), batch (A, B, C, D, E, F, G) and minute (1, 2, 3) were fixed effects.

The Y in the model stands for the different response variables and e stands for the residual error.

4. Results

4.1. Body posture and distance between pigs

4.1.1. Descriptive statistics

The gilts spent more time closer to each other than apart (figure 5). They are furthest apart the first minute and closest the second minute (figure 6).

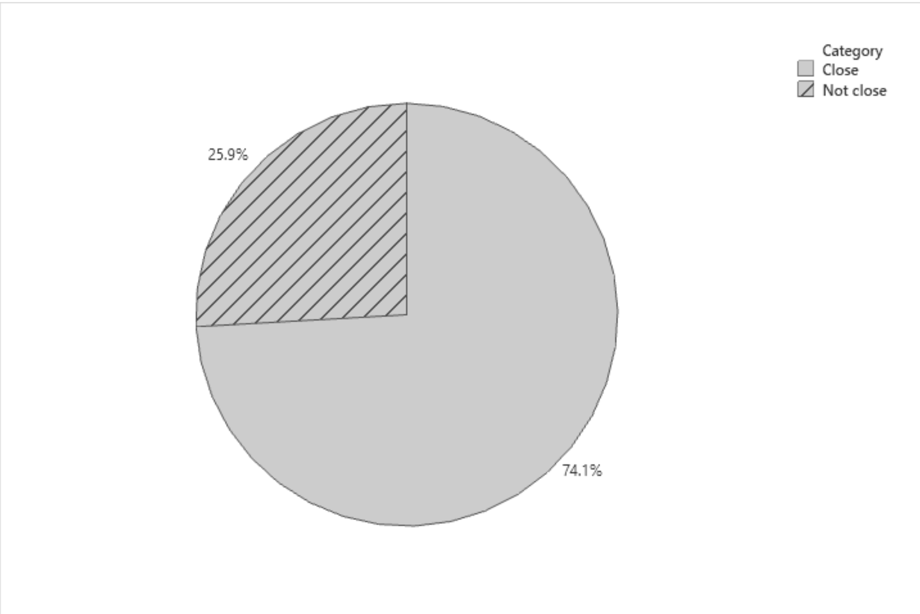

Figure 5. Percentage of time the gilts were closer to each other (close) or further away (not close) from each other than a pigs' length. N = 1224 observations.

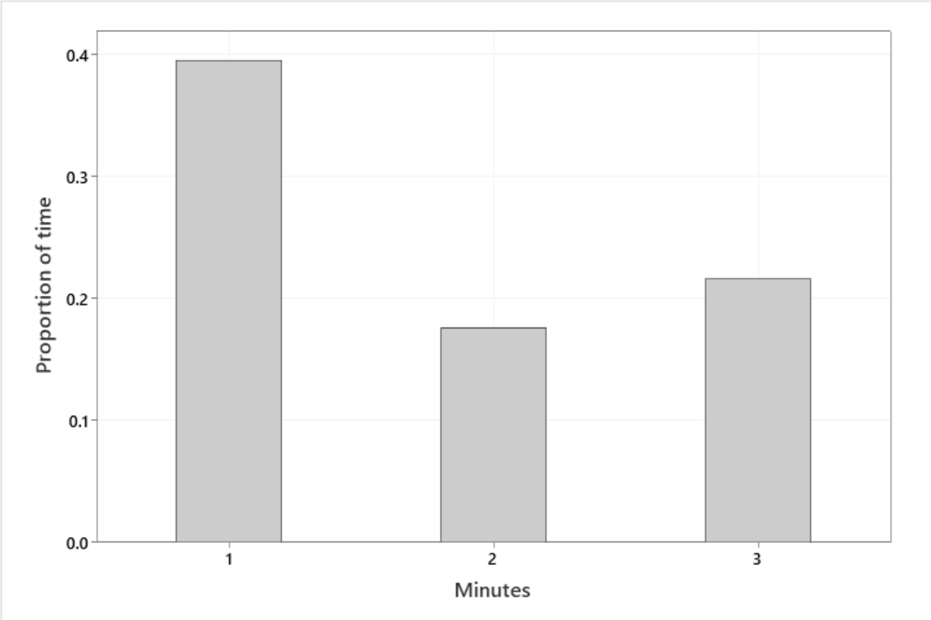

Figure 6. Proportion of time the pigs spent closer to each other than a pig's length per minute.

4.2. Solitary play behaviour

4.2.1. Descriptive statistics

The solitary play behaviour "scamper" was performed most by both genotypes (table 4). DY gilts performed all solitary play behaviours numerically more than SY gilts (table 4). The gilts from CP performed numerically more solitary play behaviours than gilts from AP, except for "toss head" (table 5). The mean of the proportion of "scamper" being performed is seen to increase as time pass (table 6).

Table 4. *Mean of the proportion of observations per gilt and minute spent in different solitary play behaviours within each genotype*

	SY	**DY**
Number of observations	141	165
	Mean (%)	**Mean (%)**
Solitary play behaviours		
Hop/spring	0.0	1.2
Scamper	16.3	17.0
Pivot	7.8	7.9
Toss head	0.0	3.0

Table 5. *Mean of the proportion of observations per gilt and minute spent in different solitary play behaviours within each social treatment*

	AP	**CP**
Number of observations	153	153
	Mean (%)	**Mean (%)**
Solitary play behaviours		
Hop/spring	0.0	1.3
Scamper	15.7	17.6
Pivot	6.5	9.2
Toss head	2.0	1.3

Table 6. *Mean of the proportion of observations per gilt spent in different solitary play behaviours within each minute. Number of observations = 102*

	Minutes (mean %)		
	1	**2**	**3**
Solitary play behaviours			
Hop/spring	1.0	0.0	1.0
Scamper	6.9	18.6	24.5
Pivot	4.9	10.8	7.8
Toss head	1.0	2.0	2.0

4.2.2. Statistical analyses

There was a significant difference for the variable “scamper” on the interaction between genotype and treatment ($p = 0.034$), where the significant difference is seen between SY CP and DY CP (figure 7). A significant difference was also found between minutes ($p = 0.003$), which is seen to increase as time pass (figure 8).

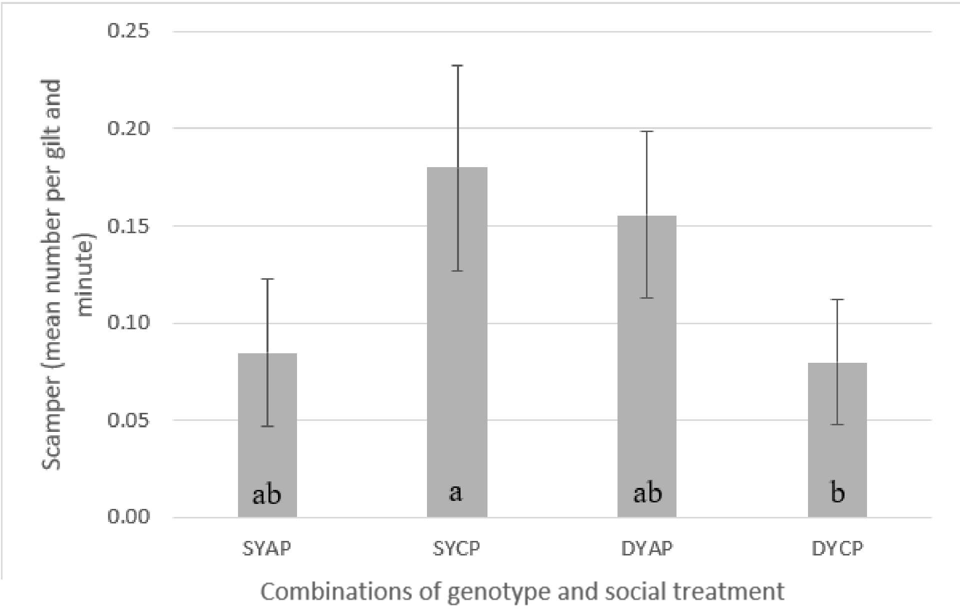

Figure 7. Least square mean ± standard error, number performed events per minute and gilt for the solitary play behaviour scamper in the different combinations of genotypes and social treatments. Different letters (a, b) for different genotypes and social treatments indicate pair-wise differences at p<0.05.

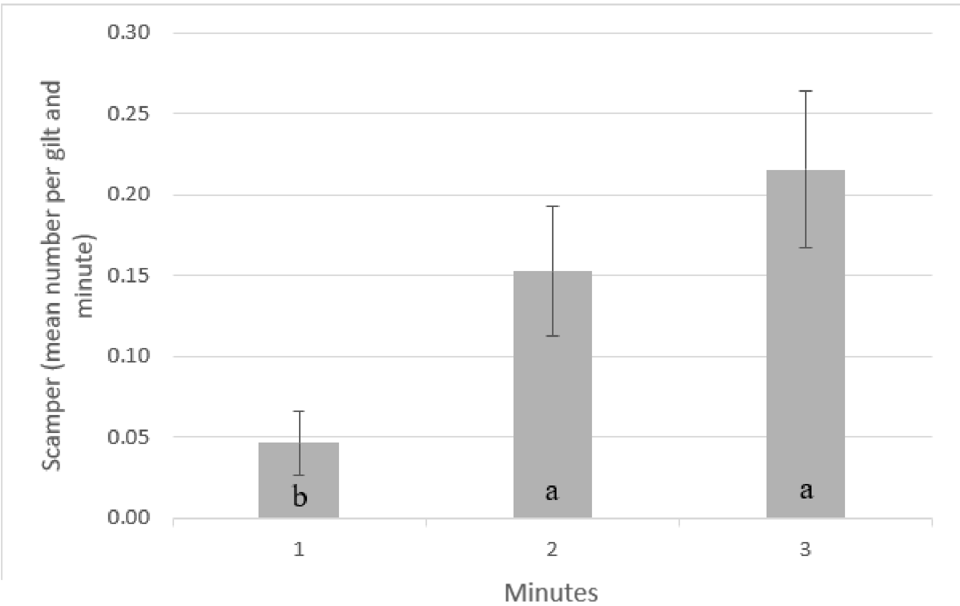

Figure 8. Least square mean ± standard error, number performed events per minute and gilt for the solitary play behaviour scamper per minute 1, 2 and 3. Different letters (a, b) for different minutes indicate pair-wise differences at p<0.05.

4.3. Exploratory behaviour

4.3.1. Descriptive statistics

In total, SY gilts performed more exploratory behaviours than DY gilts (table 7). Gilts from AP also performed more exploratory behaviours than gilts from CP (table 8). Table 9 presents the mean number of exploratory behaviours spent each minute.

Table 7. *Mean and standard deviation (Std) of the mean number of performed events per gilt and minute spent in different exploratory behaviours within each genotype*

	SY		**DY**	
Number of observations	141		165	
	Mean	**Std**	**Mean**	**Std**
Exploratory behaviours				
Explore pen fitting	1.8	1.31	1.3	1.18
Explore pen floor	3.2	1.52	3.5	1.45

Table 8. *Mean and standard deviation (Std) of the mean number of performed events per gilt and minute spent in different exploratory behaviours within each social treatment*

	AP		**CP**	
Number of observations	153		153	
	Mean	**Std**	**Mean**	**Std**
Exploratory behaviours				
Explore pen fitting	1.4	1.19	1.7	1.33
Explore pen floor	3.6	1.38	3.0	1.54

Table 9. *Mean and standard deviation (Std) of the mean number of performed events per gilt and minute spent in different exploratory behaviours within each minute. Number of observations = 102*

	Minutes					
	1		**2**		**3**	
	Mean	**Std**	**Mean**	**Std**	**Mean**	**std**
Exploratory behaviours						
Explore pen fitting	1.3	1.06	1.4	1.20	1.9	1.45
Explore pen floor	3.9	1.38	3.0	1.41	3.1	1.51

4.3.2. Statistical analyses

For “explore pen fitting”, figure 9 presents the interaction between genotypes and social treatments were there was a significant difference between genotypes ($p = 0.002$). SY gilts explored the pen fitting more than DY gilts. There was also a significant difference between minutes ($p = 0.001$), where it is seen that the behaviour increases as time pass (figure 10).

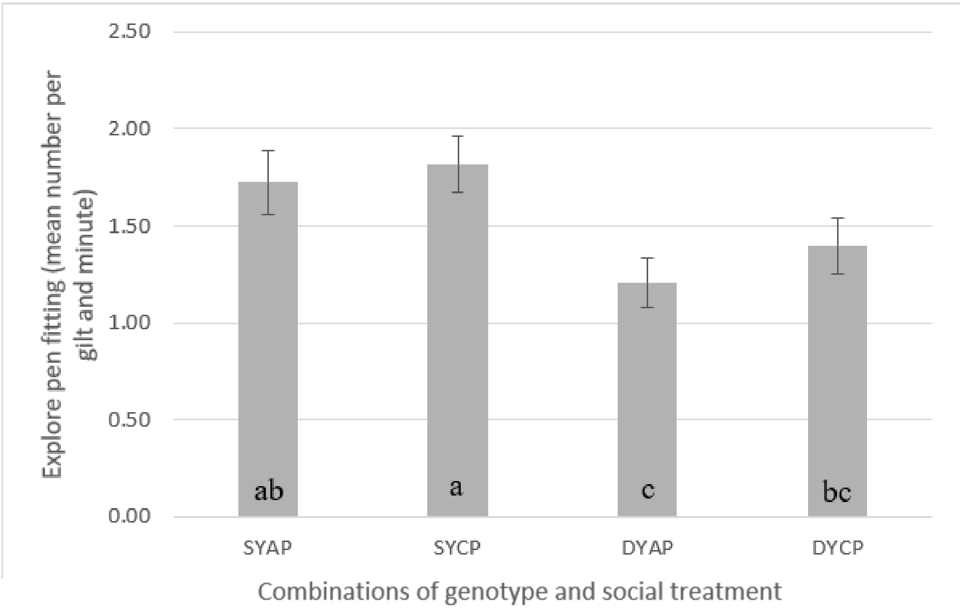

Figure 9. Least square mean ± standard error, number performed events per minute and gilt for explore pen fitting in the different combinations of genotypes and social treatments. Different letters (a, b, c) for different genotypes and social treatments indicate pair-wise differences at $p<0.05$.

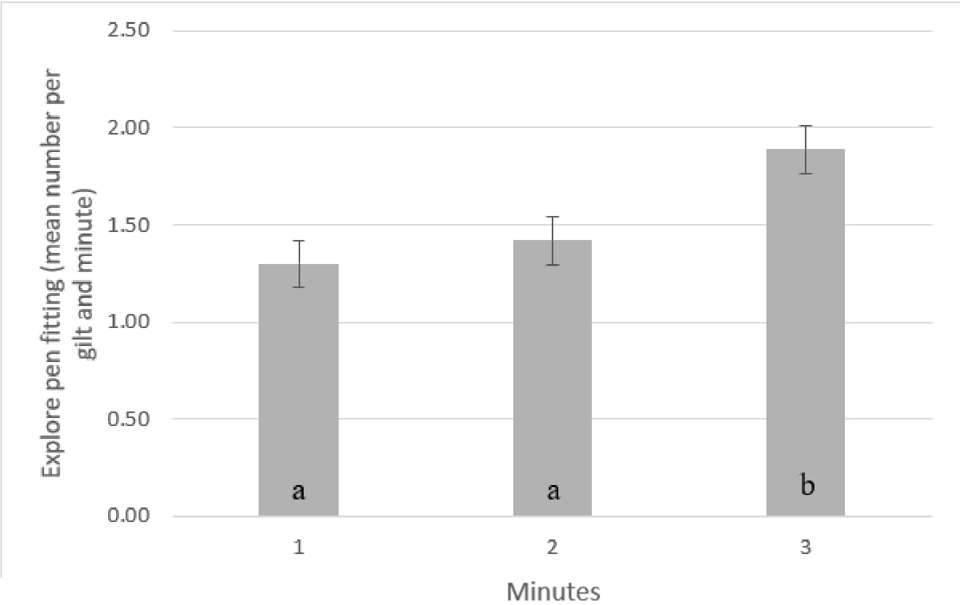

Figure 10. Least square mean ± standard error, number performed events per minute and gilt for explore pen fitting per minute 1, 2 and 3. Different letters (a, b) for different genotypes and social treatments indicate pair-wise differences at p<0.05.

For "explore pen floor", figure 11 presents the interaction between genotypes and social treatments were there was a significant difference between social treatments (p<0.001). Gilts from the social treatment AP explore the pen floor more than gilts from CP. There was also a significant difference between minutes (p<0.001), where it is seen that the behaviour decreases after minute one (figure 12).

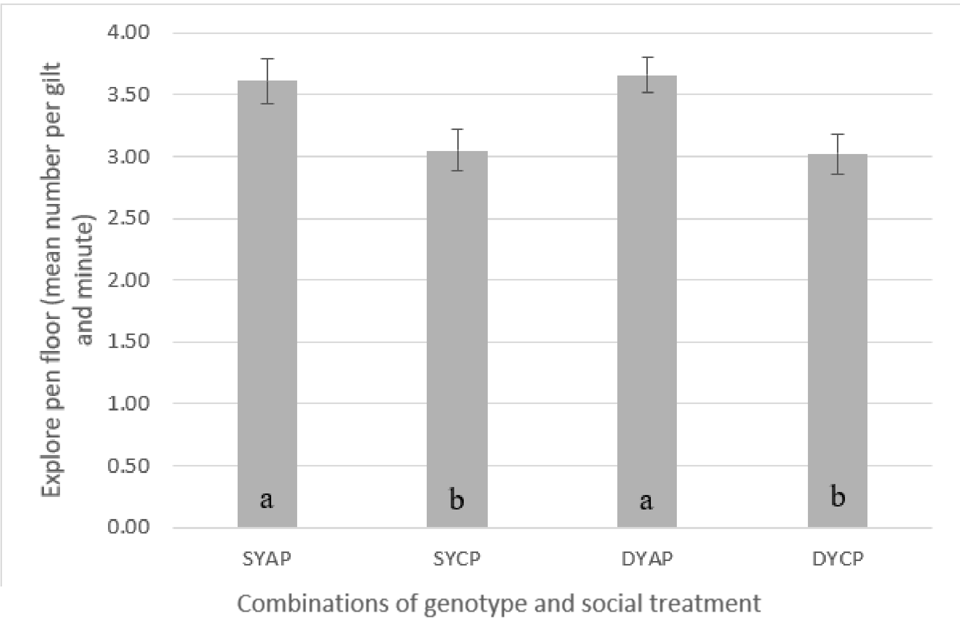

Figure 11. Least square mean ± standard error, number performed events per minute and gilt for explore pen floor in the different combinations of genotypes and social treatments. Different letters (a, b) for different genotypes and social treatments indicate pair-wise differences at p<0.05.

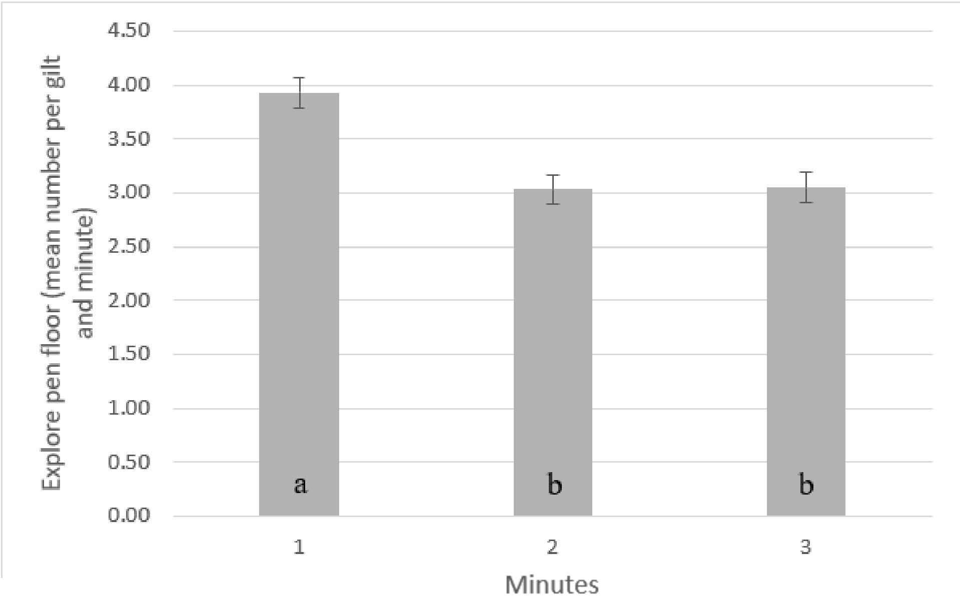

Figure 12. Least square mean ± standard error, number performed events per minute and gilt for explore pen floor per minute 1, 2 and 3. Different letters (a, b) for different genotypes and social treatments indicate pair-wise differences at p<0.05.

4.4. Social interactions

4.4.1. Descriptive statistics

4.4.1.1. General descriptive statistical analysis

The total number of social interactions numerically increased after the first minute (figure 13).

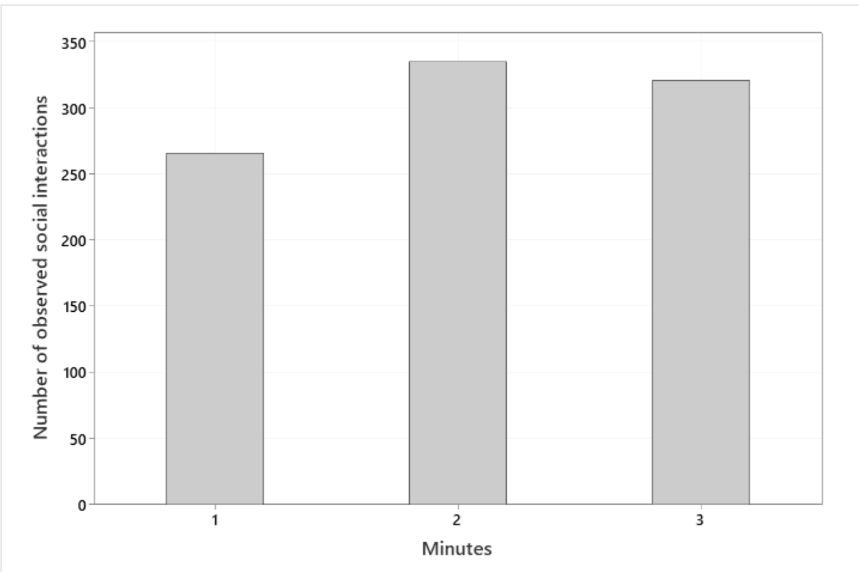

Figure 13. Total number of observed social interactions per minute.

The most commonly performed behaviour of the performing pig was “nose to body”, which was mostly reciprocated with “no reaction” by the receiving pig (table 10). The receiving focal gilts vocalisation in regard to its reaction to the performing pigs’ interaction are presented in table 11. Table 12 shows the receiving gilts vocalisation in regards to its behavioural response.

Table 10. *Percentage of performing pig behaviour in relation to the behavioural response from the receiving focal gilt. N = number of observations*

	Receiving pig vocalisation			
Receiving pig behaviour	**No (%)**	**Grunt (%)**	**Scream (%)**	**N**
No reaction	85.1	14.4	0.5	222
Avoiding	68.8	23.4	7.8	64
Nose to body	67.3	32.7	0.0	104
Pushing	60.0	20.0	20.0	10
Nibbling/biting body	92.0	4.0	4.0	25

Table 11. *Percentage of performing pig behaviour in relation to the vocalisation response from the receiving focal gilt. N = number of observations*

	Receiving pig vocalisation			
Performing pig behaviour	**No (%)**	**Grunt (%)**	**Scream (%)**	**N**
Nose to body	76.8	21.0	2.2	367
Nibbling/biting body	90.3	6.5	3.2	31
Climbing	100.0	0.0	0.0	7
Levering	100.0	0.0	0.0	4
Pushing	68.7	31.3	0.0	16

Table 12. *Percentage of receiving pig behaviour in relation to the vocal response from the receiving focal gilt. N= number of observations*

	Receiving pig behaviour					
Performing pig behaviour	**No reaction (%)**	**Avoiding (%)**	**Nose to body (%)**	**Pushing (%)**	**Nibbling/biting body (%)**	**N**
Nose to body	56.4	13.6	27.3	1.9	0.8	367
Nibbling/biting body	12.9	35.5	9.7	0.0	41.9	31
Climbing	0.0	14.3	0.0	28.6	57.1	7
Levering	50.0	0.0	0.0	0.0	50.0	4
Pushing	56.2	12.5	6.3	6.3	18.7	16

4.4.1.2. *Performing pig behaviour*

In total, SY gilts performed numerically more performing pig behaviours than DY gilts (table 13). Gilts from AP also performed numerically more performing pig behaviours than gilts from CP (table 14). The results in table 15 shows the proportion of gilts performing each performing social behaviour minute 1, 2 and 3 when being the performing pig.

Table 13. *The proportion of gilts performing each performing social behaviour for the two genotypes at least once per minute. N = number of social interactions*

	Breeds	
Performing pig behaviour	**SY (%)**	**DY (%)**
Nose to body	90.6	95.9
Nibbling/biting body	19.8	6.5
Climbing	5.7	0.8
Levering	4.7	3.3
Pushing	13.2	9.8
N	106	123

Table 14. *The proportion of gilts performing each performing social behaviour for the the two social treatments at least once per minute. N = number of social interactions*

	Treatments	
Performing pig behaviour	**AP (%)**	**CP (%)**
Nose to body	94.6	92.4
Nibbling/biting body	16.2	9.3
Climbing	4.5	1.7
Levering	3.6	4.2
Pushing	14.4	8.5
N	111	118

Table 15. *The proportion of gilts performing each performing social behaviour minute 1, 2 and 3 at least once. N = number of social interactions*

		Minutes	
Performing pig behaviour	**1 (%)**	**2 (%)**	**3 (%)**
Nose to body	97.2	91.4	92.2
Nibbling/biting body	7.0	17.3	12.9
Climbing	1.4	3.7	3.9
Levering	0.0	3.7	7.8
Pushing	9.9	14.8	9.1
N	71	81	77

4.4.1.3. Receiving pig behaviour

DY gilts numerically performed almost all receiving pig behaviours at a higher proportion than SY gilts (table 16). The proportion of gilts performing the receiving social behaviours for the two social treatments is presented in table 17. Table 18 shows the proportion of gilts performing the receiving social behaviours minute 1, 2 and 3.

Table 16. *The proportion of gilts performing each receiving social behaviour for the two genotypes at least once per minute. N = number of social interactions*

	Breeds	
Receiving pig behaviour	**SY (%)**	**DY (%)**
No reaction	69.9	64.9
Avoiding	21.4	23.9
Nose to body	33.9	42.7
Pushing	4.9	4.3
Nibbling/biting body	9.7	10.3
N	103	117

Table 17. *The proportion of gilts performing the receiving social behaviours for the two social treatments at least once per minute. N = number of social interactions*

	Treatments	
Receiving pig behaviour	**AP (%)**	**CP (%)**
No reaction	69.7	64.9
Avoiding	20.2	25.2
Nose to body	38.5	38.7
Pushing	4.6	4.5
Nibbling/biting body	10.1	9.9
N	109	111

Table 18. *The proportion of gilts performing the receiving social behaviours minute 1, 2 and 3 at least once. N = number of social interactions*

		Minutes	
Receiving pig behaviour	**1 (%)**	**2 (%)**	**3 (%)**
No reaction	69.0	71.1	61.6
Avoiding	12.7	21.1	34.2
Nose to body	46.5	38.2	31.5
Pushing	0.0	3.9	9.6
Nibbling/biting body	2.8	9.2	17.8
N	71	76	73

4.4.2. Statistical analyses

No significant differences were found for the performing gilts behaviours between genotypes or between social treatments or the interaction between genotype and social treatment. However, a significant difference was found for the receiving gilt behaviour “nose to body” on the interaction between genotype and social treatment ($p = 0.020$) (figure 13). The significant difference is found between SY AP and SY CP.

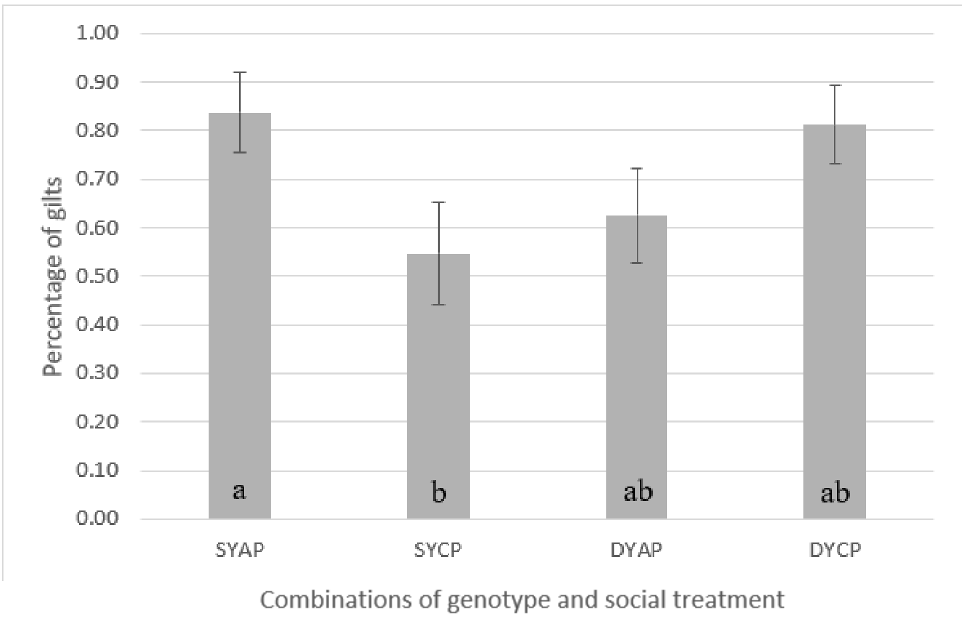

Figure 14. Least square mean ± standard error for the percentage of gilt performing the receiving gilt behaviour nose to body at least one time per observation minute in the different combinations of genotypes and social treatments. Different letters (a, b) for different genotypes and social treatments indicate pair-wise differences at $p<0.05$.

5. Discussion

The aim of this master thesis was to investigate the difference between genotype and social treatment in terms of body posture, solitary play behaviour, exploratory behaviour and social interaction in tests of social interactions performed when the gilts were five weeks old. The tests were executed in a paired interaction test where all interactions were monitored and filmed. The videos were then analysed based on the protocols in appendix 1, 2 and 3. A total of 112 gilts were included in this study, of which 102 were statistically analysed. Out of these 102 gilts, 47 was of the genotype SY and 55 of DY. The social treatments, balanced over genotypes, were equally distributed (51 AP, 51 CP).

5.1. Body posture and distance between pigs

No significant differences were found for genotype and social treatment in relation to body posture which indicate that there is no short-term effect of distance between the pigs. However, numerically the pigs spent 74% of the observation period with a distance closer to each other than an equal size pig (figure 5). The pigs were closest to each other the second minute and furthest apart the first minute (figure 6). This could indicate that the pigs need the first minute to adjust to the new environment before interacting and getting closer to each other.

5.2. Solitary play behaviour

Regarding solitary play behaviours, the behaviour “scamper” was observed most out of all the play behaviours (table 4). This is in line with the results of Horback (2014) on locomotor play behaviours such as “scamper” being most common among piglets. According to the results in table 6, all play behaviours increased as time passed, except for “hop/spring” and “pivot”. As mentioned by Burghardt (2005), Fagen (1981) and Oliveira et al. (2010), more performed play behaviours indicate that the pigs’ welfare increases. The results in table 6 may therefore suggest that the gilts welfare increase as time pass. However, the assessment for play behaviours is lacking which Horback (2014) explains can be due to its difficulties with distinguishing it from certain aggressive behaviours. The results showing that play behaviours increase as time pass (table 6), does not match with the results obtained from Rauw (2013) study. Rauw (2012) showed that the locomotor play behaviours were most direct at admission to the new environment and declined as time passed. This can however be due to the pigs in Rauw (2013) study being from the same litter making only the environment unfamiliar.

A significant difference was found for the behaviour “scamper” for the interaction between genotype and social treatment (figure 7), as well as between minutes (figure 8). Interestingly, solitary play behaviours are in total numerically performed to a higher extent by DY gilts (table 4). This could indicate that DY gilts have a better adaptability to new environments, which can be an advantage later in life. This is in line with studies from Bekoff (1984) and Špinka et al. (2001) where they mean that play behaviours provide adaptive advantages due to the pigs being able to quickly react to novel situations. These behaviours are important for survival in the wild to quickly be able to react to change in environmental stimuli, like for example weather, hunting pressure and food availability (Horback, 2014). Damm et al. (2005) also suggested that play behaviours play an important role in piglet survival during nursing due to them quickly being able to avoid getting crushed by the sow. DY gilts may therefore have a better chance of surviving in the wild and during nursing in commercial situations. Due to play behaviours being an indication for welfare (Burghardt, 2005; Fagen, 1981; Oliveira et al., 2010) it could also be interpreted as DY gilts being less stressed out by the new environment.

The results for the social treatments differ compared to previous studies. Where this study suggests that the gilts from the social treatment CP numerically performed more play behaviours than gilts from the social treatment AP (table 5). Instead, Horback (2014) meant that more space allowance increased the pigs’ welfare, suggesting that pigs from AP should exhibit more play behaviours. However, the differences between social treatments in this study are too small to make any further implications as to why they differ.

5.3. Exploratory behaviour

Regarding “explore pen fitting”, a significant difference was found between the two genotypes. SY gilts spent more time “exploring pen fitting” than DY gilts (figure 9). A significant difference was also found between minutes (figure 10) where the proportion of gilts “exploring pen fitting” increased with time. For “explore pen floor”, a significant difference was found between the two social treatments (figure 11). Here, it is seen that gilts from AP spent more time “exploring pen floor” than gilts from CP. There was also a significant different for minutes (figure 12).

In total, SY gilts explored more than DY gilts (table 7). This may indicate that SY gilts are more inquisitive than DY gilts which is in line with Day et al. (1995) that states that curiosity motivates pigs to explore more. Exploratory behaviours are essential for the pigs to be able to evaluate intrinsic and extrinsic values for survival in the wild (Studnitz et al., 2007). Even though domestication has caused a change in the pigs' environment and need to search for food, it has not changed its need to explore and forage (Wood-Gush, 1989). Interestingly, AP gilts explored more than CP gilts (table 8). Wood-Gush et al. (1989) showed evidence that piglets reared in barren environments showed less inquisitive exploratory behaviours, which can be compared with the CP gilts in this study having less space and enrichment than AP gilts. Jensen et al. (2010) also found that an increase in space allowance increased growing pigs' exploratory behaviours.

5.4. Social interactions

A study conducted by Turner (2011) showed that severe social behaviours between individuals can affect the animals' welfare as well as the producer's profitability. Severe social behaviours include those behaviours that are directed towards other pigs with aggression in the form of for example biting (Turner, 2011). Von Borell et al. (2009) also showed that it is possible to use vocalisation as an indicator for pain and stress when castrating piglets. Knowledge of pig vocalisation can therefore be valuable for assessing animal welfare (Von Borell et al., 2009). The severity of the interaction in this test was therefore assessed by looking at the receiving pigs' proportion of screaming (table 12). Thus, if the receiving pig responds to a social interaction with "avoiding", "pushing" or "nibbling/biting body" the interaction is seen as severe and both gilts welfares are reduced, due to the higher proportion of screaming (table 12). If the receiving pig responds with "no reaction" and "nose to body" the social interaction is seen as less severe (table 12).

The performing pig behaviour "nose to body" is seen as less severe in comparison to the other initiating behaviours due to the fact that 56.4% of the social interaction involving the performing pig behaviour "nose to body" was reciprocated with "no reaction" by the receiving gilt (table 10). The performing pig behaviour "pushing" was also reciprocated with "no reaction" (56.2% of the social interaction). "Nibbling/biting body" is seen as a severe performing pig behaviour due to the receiving pigs' response being 35.5% "avoiding" and 41.9% "nibbling/biting body" (table 10). The vocal response in table 11 corresponds with the behavioural response showing that the performing pig behaviour "nibbling/biting body" was reciprocated with screaming, more in comparison to the other variables. This is also in accordance with table 12 showing that the receiving pig behaviour "no reaction" and “nose to body” are less severe due to the proportion of screaming being less than the other variables.

No significant differences were found for the performing pig behaviour between genotypes, social treatments or the interaction between genotype and social treatment. The findings therefore indicate that there is no short-term effect on genotype or social treatment. However, table 13 shows that SY gilts numerically performed all performing pig behaviours, except for “nose to body”, more than DY gilts. Even though there were no significant differences between AP and CP, numerically AP gilts performed a higher proportion of all performing pig behaviours, except for “levering”, than CP gilts (table 14). These results may indicate that there is a difference that we could not find. If that is the case, it is in line with D’Eath (2005) study on early socialised pigs where the results showed that the socialised pigs performed aggressive behaviours quicker than non-socialised pigs. This also means that early socialised pigs form stable hierarchies quicker which enables them to form hierarchies quicker in future encounters with unfamiliar pigs (D’Eath, 2005). Today’s commercial pigs are mixed in confined places several times with unfamiliar pigs causing aggression and agonistic behaviours (Meese and Ewbank, 1973). It is therefore beneficial to form a stable hierarchy quick so that injuries and stress are reduced. D’Eath (2005) study showed that early socialisation reduced the pigs stress and injuries when mixing with unfamiliar pigs, improving their welfare without any production consequences. We could not see any significant difference in this study but we did see that AP gilts performed numerically more aggressive and severe behaviours than CP gilts. This could mean that AP gilts also form hierarchies quicker than CP gilts which reduces their stress and injuries as well as improves their welfare.

Regarding the receiving gilt behaviour, significant differences was found for the behaviours “nose to body” on the interaction between genotype and social treatment (figure 14). The proportion of SY gilts performing the receiving pig behaviour “no reaction” was higher than for DY gilts (table 16). Table 16 also shows that DY gilts performed all receiving pig behaviours, except “pushing”, at a larger proportion than SY gilts. These results suggest that SY gilts respond with less severe responses at a larger proportion than DY gilts. The proportion of AP gilts performing the receiving pig behaviour “no reaction” was higher than for CP gilts, as well as “pushing” and “nibbling/biting body” (table 17). This is in line with the results from the performing pig behaviour in table 14 and the results from D’Eath (2005) suggesting that early socialised pigs showed aggression quicker but also formed dominance hierarchies quicker than non-socialised pigs. Meaning that early socialisation with unfamiliar pigs prior to weaning might lead to more aggression in the beginning but less later in life. Table 18, which shows that “pushing” and “nibbling/biting body” increased with time, does not necessarily mean that it will continue to increase beyond the three minutes analysed in this study. Scheffler et al. (2016) conclusion that heavier pigs are more aggressive than lighter pigs cannot be drawn in this study because no significant differences were found between weight, genotype and social treatment.

The results on social interaction entails that producers could benefit if their piglets are given the opportunity to socialise with unfamiliar piglets prior to weaning. Due to that both performing gilts and receiving gilts from the social treatment AP probably will form stable dominance hierarchies quicker than gilts from the social treatment CP. This could result in less injuries, less stress and an improved welfare.

5.5. Methods

Few significant differences were found between genotype and social treatment for all behaviours which implies that there is not that much differences between the two genotypes and the two social treatments. More significant differences may have been found if the number of gilts in this study would have been larger. However, the differences between genotypes and social treatments are so small that including more gilts probably would not have changed anything in the results. Something to take into consideration is that behaviours can vary between individuals and not just between different genotypes and social treatments. An observation period longer than three minutes would have been interesting to observe. However, the idea of this study was not to look at the development of the group over a longer period, but to see the gilts’ social ability when introducing it to an unfamiliar gilt. Further studies are done within the bigger Formas project where the development at different ages can be seen.

The results may also be affected by the difficulties with video observations during the paired interaction test. The camera was set up in one corner of the pen, making it hard to distinguish the behaviours happening furthest away from the camera. This may possibly have resulted in behaviours being missed and misinterpreted. Misinterpretation could also have been avoided if the observer would have been physically there and seen the interactions up close from different angles, instead of only looking at the video recordings. However, this also comes with disadvantages in that the observer then can miss behaviours when for example looking down at the protocols and not being able to rewind to see what had been missed, like the observer looking at the videos can. There are always advantages and disadvantages with the observation strategy, but one way of improving the collection of data is to set up one more camera in the other corner so that those behaviours that are hard to see can be analysed from a different angle. The cameras could also be mounted in a better way as the gilts were on a few occasions pressing the door the camera was mounted on, which meant that the camera could be angled incorrectly. To assure no behaviours were missed or misinterpreted every test could have been observed several times. This would however mean that more time would be devoted to video observations, which the time schedule did not accommodate. It is also easy to unintentionally interpret the desired behaviours, which makes it important to be more than one observer who ensures that the behaviour observed is correct. This study was only observed by one observer making this something that has to be taken into consideration.

There were also difficulties with hearing and seeing which gilt vocalised. The difficulties with distinguishing the vocalisation also worsen due to the paired interaction test being done in the same unit as many other pens with other pigs that constantly made different noises. Also, some trials were disturbed by for example feeding machines making noises which affected the gilts in the test. Mechanics working in the stable also disturbed some test by accidentally walking into the farrowing unit where the test was performed. This could have been avoided by clearly telling the mechanics that a test was taking place and that they could not open certain doors and be in certain units at certain times. An alternative is also to have the test area in a separate room where other distractions are excluded as best as possible. However, the gilts then have to be moved and handled for a longer period possibly increasing their stress level. Additionally, the test pen could have been cleaned more thoroughly between each test so that faeces and smells were not left from previous test pigs.

The method for scan sampling on body posture was observed as a freeze frame every 15 seconds for a total of three minutes. Body postures and distance between the pigs could then be missed between these periods so that only a general overview of the body postures was seen in the results. This was the aim of the test to only show an overview of the body posture, but it is still something that can be improved in upcoming tests in the future to represent the whole test period.

Even though these gilts have been apart of several different Master thesis’s, within the bigger Formas project, and therefore been used to people performing other test on them the people in this study could still be a distraction that affected the results. One or two people moved the pigs to the test area and were during the test always standing near the test area monitoring the pigs. During the test some pigs were seen to be affected by the humans whereas some were not. However, this is difficult to completely eliminate as the pigs must be moved and handled before the test, as well as closely monitored during the test. To reduce this influence, the people observing should limit their communication as best as possible as well as not moving as much.

The pigs are mostly active during daytime (Špinka, 2017), which makes daytime a preferable test period that was supposed to be carried out in this study. However, the test period could differ with most of the pigs being observed between 13:00 to 17:00 but some earlier at 07:30 to 08:45 and some later at 16:00 to 18:30. This is due to practical reasons, which in further studies should be minimized due to the possibilities of it affecting the results.

The social treatments (AP and CP) were chosen for this study due to the fact that they can be implemented in commercial farms. However, the farm at Lövsta is an experimental farm that is supposed to represent a real farm, which will make it difficult to limit certain things that represents difficulties with managing this in a real farm. In conclusion, everything does not have to be seen as a disadvantage and there is an understanding that it is difficult to get everything perfect in reality.

6. Conclusion

The results from this study indicate that there is not that much differences between the two genotypes and the two social treatments, due to not that many significant differences. Regarding the solitary play behaviours, “scamper” was observed most and increased as time passed. DY gilts numerically perform more play behaviours than SY gilts which may indicate that DY gilts have a better adaptability. Gilts from the genotype SY explored more than DY gilts, suggesting that SY gilts are more inquisitive.

Regarding the social interactions, if the receiving pig responds with “pushing”, “avoiding” or “nibbling/biting body” the performing pig behaviour initiating the interaction is seen as severe, due to the receiving pig responding with a high proportion of screaming. All results for the performing pig behaviours are numerical. SY gilts performed all performing pig behaviours, except “nose to body”, at a higher proportion compared to DY gilts. SY also responded with less severe responses at a larger proportion than DY gilts. We could also see that AP gilts performed numerically more aggressive and severe behaviours than CP gilts. This could indicate that early socialised pigs prior to weaning shows more aggression in the beginning but less later in life because they form hierarchies quicker than CP gilts. This reduces their stress and injuries as well as improves their welfare. Producers may therefore benefit from giving their piglets the opportunity to socialise with unfamiliar piglets prior to weaning.

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Appendix 1

The protocol for scan sampling of body posture was developed from the ethogram in table 3 and was used for the data collection during the paired interaction test.

Scan sampling

Batch: Genotype: Birth weight:

Focal gilt: Treatment: Weight at 5 weeks:

Test gilt:

Min	Sec	Body posture		
		Lying down	Standing	Distance

Appendix 2

The protocol for continuous sampling of solitary play behaviour and exploratory behaviour was developed from the ethogram in table 3. The protocol was used for the data collection during the paired interaction test.

Continous sampling

Batch: Genotype: Birth weight:

Focal gilt: Treatment: Weight at 5 weeks:

Test gilt:

Min	Solitary play behvaiour			Exploratory behaviour	
	Hop/spring	Scamper	Pivot	Explore pen fitting	Explore pen floor

Appendix 3

The protocol for continuous sampling on social interaction and vocalisation was developed from the ethogram in table 3 and used for the data collection during the paired interaction test.

Continous sampling

Batch: Genotype: Birth weight:

Focal gilt: Treatment: Weight at 5 weeks:

Test gilt:

Min		Performing pig behaviour					Vocalisation				Receiving pig behaviour					Vocalisation		
	Performing pig ID	Nose to body	Nibbling/biting body	Climbing	Levering	Pushing	No	Grunt	Scream	Receiving pig ID	No reaction	Avoiding	Nose to body	Pushing	Nibbling/biting body	No	Grunt	Scream