Defining the Behaviour of Different Pig Genotypes

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The candidate confirms that the work submitted is her own and that appropriate credit has been given where reference has been made to the work of others.

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Abstract

Pig production systems can be more beneficial to the farmer than to his stock, with stereotypic behaviour, elevated aggression levels and less freedom all being detrimental. Previous research has shown that the management of pigs within this system can be a major cause of stress to both stock and stockman. However, results are often generalised from the behaviours seen in one breed to others. This research aimed to target this lack of knowledge by comparing the behaviours of three genotypes of pig in their response to several human-interaction tests. These tests were designed to also give indication of management ease.

This research used three crossbred genotypes of pig. All genotypes were of a Large White/Landrace dam line, crossed with one of three sires; Hampshire, Large White or Pietrain.

Several tests were used in this research on various ages of pig, including the human approach test, lesion scoring and movement of pigs in the post-wean period. Management ease through a maze at fifteen weeks of age and the behavioural reaction to being weighed prior to slaughter were also applied here.

The results indicated that differences do exist between genotypes in their behaviour during routine farm handling, and that this has an impact on their subsequent ease of management. Differences in the affliction of aggression were also seen, whereby Hampshire pigs showed significantly less evidence of lesions caused by fighting. Additionally, it was found that the learning ability of the genotypes differed, but that all pigs were capable of forming positive associations with humans.

This research provides encouragement towards the development of genotype-specific management systems, which should be beneficial to both animals and stockmen alike.

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Chapter 1. Introduction

Pig production over the last 100 years has altered dramatically. During this period, there has been increased genetic selection for desirable traits in farm animals (Kyriazakis and Whittemore, 2006), generally via selection for improvement of a single breed for both reproductive and finishing stock. The Large White/Landrace types of pig were introduced in the twentieth century and were considered to have good bacon characteristics, whilst also possessing strong maternal traits. However, the latter half of the century saw a consumer shift towards reduced fat levels in meat and producers required faster growth rates of their stock. This need is still broadly met by Large White/Landrace pigs due to vast genetic improvement.

It is now considered desirable for pigs to have substantial lean growth, accompanied by increased adult lean body mass and final dimensions. However, selection for improved meat characteristics can confer a disadvantage to other traits, such as reproductive capacity. This has led to the use of modern breeding techniques which often use a crossbred dam line and breed different sire lines onto it. This allows the dam line to maintain strong maternal traits, whilst the sire line can be manipulated to provide increased growth rates and feed efficiency, and also beneficial meat characteristics such as increased juiciness, tenderness and lean yield.

When selecting for these traits, geneticists have perhaps overlooked the other characteristics they create. The development of breeds generally occurs within controlled environments, meaning that when these pigs are used on farms, their behavioural traits may be disadvantageous. The behavioural repertoire of breeds is thought to differ, but this is oft ignored when placing these pigs into commercial production.

Large White pigs are the most widespread of the modern breeds. They are known to be superior in growth rate and also provide good litter sizes of around 11-13 piglets. Growth rate can be as much as 750g daily, yielding 60% lean meat (Kyriazakis and Whittemore, 2006). Intensive selection has resulted in a leaner but meaty pig. The Large White pig is often crossed with the Landrace, as this is thought to confer advantageous meat quality and reproductive traits, and is, as previously mentioned the most commonly used sow line in the UK. Meat quality research conducted on the same genotypes used in this project (produced on the same unit) suggests that the Large White type have high eating quality, with good tenderness (Wood, 2008; personal communication).

Hampshire pigs were imported from the USA in 1968 (www.britishpigs.org.uk), and are now considered to be one of the best terminal sire breeds for all purposes, as they have fast growth rates and therefore reach slaughter weight at a younger age, resulting in a meaty carcass. Unfortunately, their poor reproductive performance has led to them primarily being used as a sire line to be crossed onto a dam line with strong maternal characteristics.

The Hampshire types used in this research convey greater tenderness, and have low ultimate pH (Wood, 2008).

Pietrain pigs originated in Belgium and have large hams, large loin muscles and a high percentage of lean meat. However, reproductive efficiency is relatively poor, so these are also best crossed with a good dam line. Pietrain pigs are renowned for their excellent lean meat yield; however this is often coupled with a tendency towards Porcine Stress Syndrome (see Chapter 5). This detrimental trait is strongly associated with the halothane gene. This has led to the Pietrain manly being used in crossbred and terminal sire programmes. However, modern breeds generally claim to now be halothane negative, and indeed the Pietrain type used in this research has been shown to have no classical features of PSE (pale, soft, exudative) pork (Wood, 2008). Pietrain blood is highly valued in sire lines but can be damaging to maternal lines.

The nucleus breeding herd in the UK is now formed from a combination of several breeds selectively bred together to create hybrid breeds. This makes it somewhat harder to define breeds, as the origins of the animal may stem from many sources. Labels are attached to these pigs by breeding companies, but Kyriazakis and Whittemore (2006) still emphasise that it is important to recognise breed origins.

The genotypes used in the current project were from three sire lines types. However, all genotypes were crossed to the same dam line of Large White/Landrace type. The three crossbreds produced are coined as Hampshire, Large White and Pietrain type pigs throughout this thesis.

Production systems in the UK can be more beneficial to the farmer than to his stock, as it can mean cramped living accommodation, elevated aggression levels, the occurrence of stereotypic behaviour, and obviously less freedom. However, the benefits of rapid weight gain, high standards of hygiene, lower pig mortality and great control over the production environment all confer a significant advantage to the producer.

The welfare of production pigs has been extensively researched; however, it generally investigates single breeds. This research aims to target this lack of knowledge, and hopefully provide recommendations for the production system best suited for each of the three genotypes afore mentioned.

Public interest in the welfare of production animals used for their meat is rapidly increasing, suggesting that producers should be concerned over the perception of their husbandry system (Fraser *et al.*, 2001). Any methods jeopardising the welfare of animals is likely to be quickly publicised and create severe repercussions for the industry.

Commercial pig farming frequently exposes animals to potentially aversive conditions. These may include the mixing of unfamiliar pigs (Jensen, 1994), entry into new environments (Beattie *et al.*, 1995) and detrimental handling procedures (Hemsworth, *et al.*, 1987). These conditions can create fearfulness, which in turn can taint meat quality through the release of stress hormones such as cortisol and catecholamine’s (Foury *et al.*, 2005). Fear and anxiety have been defined by Boissy (1995) as “emotional states that are induced by the perception of any actual danger, fear state or potential danger anxiety that threatens the well-being of the individual". It is important to reduce fear in the pig as it can affect welfare, growth and reproductive capacity (Hemsworth and Barnett, 1991).

Repeated exposure to potential stressors has been shown to cause fluctuations in hormonal response (Coutellier *et al.*, 2007). Suppressions in response are seen as pigs habituate to stressors. This is only true however for an acute response (within hours), whilst a mid-term response can still be obvious after several weeks. This would suggest that repeated exposure to stressors dampens the immediate hormonal response, but fails to suppress long term elevated responses.

The strategies for coping with stress divide research opinion, with some suggesting active and passive copers, (Erhard and Mendl, 1999) whilst others feel that there is a continuum (Jensen *et al.*, 1995). Such a continuum provides encouragement for a behavioural test capable of identifying harmful behaviours (Breuer *et al.*, 2003). Pigs can either actively try to remove stressors, or rapidly flee from them (Hotzel, 2004). A third strategy used is to freeze and gradually withdraw. The success and application of this depends on the environment. Active coping tends to be used in stable environmental conditions, whereas passive coping is more often used when the animal is faced with a changing or unfamiliar environment (Hessing *et al.*, 1993).

Individuals generally show preference for one coping strategy. This seems to be predetermined by genetic constitution and early life experience. Different physiological and neuroendocrine mechanisms exist for each of the coping strategies, which leads to different disease susceptibility and stress pathologies (Hessing *et al.*, 1993).

However, other research suggests that behaviour may be guided by instinct. Craig (1981) found that one day old piglets would avoid a sheer drop despite having no prior experience of falling. Rearing conditions can also have influence on behaviour, as shown by Fraser and Broom (1990). Pigs raised in windowless buildings and dim light were affected by bright sunshine and refused to walk into it, suggesting that experience may also affect responses.

Strategies can be explained by the concept of temperament, defined by Mason (1984) as "an individuals' basic stance towards environmental change and challenge". It is the result of undefined characteristics of the neural systems which interact with the environment. The production environment is often responsible for the temperament of pigs. It is however assumed that individuals are consistent in their temperament across situations and contexts. This is debatable as some believe that consistency of response does not occur. Lyons *et al.* (1988) found that juvenile experience affected the response to challenge in later life whilst others found no correlation between early life experience and the behaviour seen in later life, such as Stevenson-Hinde *et al.*'s (1980) work on rhesus monkeys.

However, when considering farm animals, individual variability in response to challenge has been shown. Lawrence *et al.* (1991) raise the question that few studies have considered the consistency of response across time and contexts. Dairy production has received the greatest focus of this type of work, as husbandry procedures are often detrimental to productivity (Kerr and Wood-Gush, 1987; Lyons *et al.*, 1988). This work is still limited to a small number of contexts, and response to social and non-social challenge was not considered in pigs before the work of Lawrence *et al.* (1991). Individual differences in behaviour have been indicated, however the current project focuses on the behaviour of pigs as a genotype, and considers the differences between breeds.

Human beliefs, emotions and behavioural intentions are generally consistent with each other when regarding animals. Waiblinger *et al.* (2006) give the example that if a stockperson has a positive attitude about cows (beliefs) and thinks they are intelligent, then they will enjoy contact with the animals (emotion) and therefore will provide patient management (behavioural intention). This obviously has important implications on the handling of animals, with a knock on effect of attitude resulting in animals which are easier to manage. Farmers tend to show bias towards certain animals, such as anecdotal beliefs that Hampshire pigs are stubborn and therefore difficult to manage. This may have impact upon the way these pigs are subsequently managed, for example, a more forceful approach may be taken when moving Hampshire pigs. This project aims to paint a behavioural picture for each genotype through the use of several tests, therefore providing sound advice for management of each breed.

Measuring the behavioural response of animals can be achieved by many methods. However, in this research, the response of pigs to human intervention is of key interest, so these methods receive focus. Reactions to humans can fall into three categories. These are: reactions to a stationary human, reactions to a moving human and responses to being handled (Waiblinger *et al.*, 2006). Waiblinger notes that observations taking during handling procedures are a particularly valuable evaluation of fearfulness.

One such method of identifying coping strategy is the backtest. This procedure consists of holding a piglet on its back using the thorax and hind leg. The number of escape attempts, grunts and squeals are then recorded to give an indication of the pigs' personality. An alternative restraint to human force can be achieved by placing piglets in wooden cradles and using sandbags to hold the pig in place (Ruis *et al.* 2000). This process separates pigs into high resisting and low resisting groups. This indicator of coping style under stress seems to be able to be applied to various situations, and predicts the coping ability when faced with environmental change at a later age. Pigs which were found to struggle in a backtest were shown by Ruis to be more aggressive in a group feeding test, but second back tests didn't hold this same prediction.

Forkman et al (1995) proposed that those pigs which attempted to escape in the backtest could be considered active copers (high resistance), whilst those which remained calmer could be termed passive copers (low resistance). These passive copers have been suggested to react to new information faster and show levels of being detached from the group and therefore be less dependent upon them. Forkman also showed that active copers would approach novel objects faster later in life, but also lost interest faster.

The backtest has also provided some evidence that there is stability of temperament and coping strategies over time in pigs. High resistant pigs defined using the backtest approach in D'eath and Burns (2002) were later found to be aggressive in a feeding challenge at 10 and 25 weeks of age. This suggests that predictions can be made from preliminary trials regarding later challenges. Low resistant pigs were found to show a greater hypothalamic activation in response to a novel experiment test at 10 weeks and routine weighing at 25 weeks. Low resistant pigs also showed higher inhibition to approaching a novel object at 3 and 8 weeks of age, and had increased latencies to contacting objects at 10 weeks old.

Further ways of determining coping styles include social dependence tests (Forkman et al, 1995). By blocking off an area of the home pen and placing one pig over the divide, piglets' interaction with their contemporaries can be evaluated by how long they spend in contact with the dividing wall and how much they vocalise. However, this test failed to establish active and passive copers, or patterns previously found by Hessing *et al.* (1993), who found that aggression in later life could be predicted this way.

Utilising the results of one test to predict reactions in other situations have been shown to be possible, but to validly and accurately assess behavioural reactions, it is recommended to use a battery of tests on animals over various stages of development (Waiblinger *et al.*, 2006). It was considered in my research that the responses of pigs to humans would give insight into the effects of management systems on behaviour, and whether pigs are able to cope with potentially stressful situations. Therefore, various methods have been used, including the human approach test (Chapter 2), routine handling practices (Chapters 4 and 5) and restraint of animals (Chapter 5) in an attempt to accurately assess whether behavioural differences exist between the three genotypes.

Previously, investigations into the effect of breed on behaviours have been conducted by Breuer *et al.* (2003), whereby differences in Large White, Duroc and Landrace pigs were identified. Duroc pigs were more interested in chewing a suspended rope than Landrace and Large White breeds. There was also a preference for a salty rope, with much greater time spent engaging with this object. Landrace pigs exhibited a lower incidence of escape behaviour, suggesting a more placid nature, or perhaps a greater degree of fearfulness than the other breeds. The motivation to explore and forage has also been identified as having a genetic component. Breuer *et al.* (2003) found that Landrace pigs spent less time ear biting their cohorts, whilst a low degree of belly nosing was found in Duroc pigs. This is also true of locomotive and rest behaviour (Robert *et al.*, 1987).

Genetics are known to determine certain phenotypic traits, with many genes expected to be accountable for variation. Genetic experiments connected with animal learning have shown that strain differences lead to varying sensory capacities, motivation, memory or activity levels

(Olsson *et al*., 2003). However, this has only been shown in a small number of cases. This would suggest that if pig genotypes differ in their behavioural response to situations, it could be explained by underlying genetic capability. For example, if when challenged one breed is capable of retrieving information which could solve the situation, they will instantly be more efficient than others which struggle with memory retrieval (McGaugh, 1966). Indeed, if this genotype had a slower rate of memory consolidation, it would seem to be retarded if challenged at intervals shorter than those required to make the memory imprint. Widely spaced trials would therefore make the pig seem inept, where infact its problem solving ability may be just as proficient as but slower than its counterparts.

These results give cause to believe that temperaments differ between breeds of swine. If this is indeed true then discussion needs to be raised over tailoring production to specific genotype needs. However, the converse of this is also true, whereby the genotype used can be manipulated to specific environments, and indeed this may prove easier.

So, from this we can identify a problem with the application of research findings to all genotypes, and identify the need to assess management systems regarding their suitability to being optimally productive whilst considering welfare needs of both stock and stockmen.

This research therefore investigates three genotypes of pig; Hampshire type, Large White type and Pietrain type. All genotypes were produced from the same dam line type (Large White/Landrace) but were sired from one of the three breed types listed above to create crossbred lines. All pigs used throughout this thesis were of these types, and henceforth will be referred to in chapters as Hampshire, Large White and Pietrain.

Chapter 2. Application of the Human Approach Test as a Means of Measuring Confidence Levels in Three Genotypes

2.1 Introduction

Fearfulness of humans can have detrimental effect on pig welfare and performance (See Chapter 1). The human-animal relationship is thought to have bearing on this (Gross and Siegel, 1979; Hemsworth *et al.*, 1987; Waiblinger *et al.*, 2006), with poor relations resulting in increased stress. The importance of this relationship makes it a necessary area of research, as evaluation of the interactions often reveals areas where welfare can be improved.

Animals are capable of forming associations between stockpersons and their actions. This leads to conditioned approach-avoidance responses, whereby stockpersons are negatively or positively associated with events (Hemsworth *et al.*, 1991). This response may be generalised to all humans or be relative to one human only. Naivety can affect the initial response to stimuli, due to unfamiliarity and novelty. However, with more experience of humans, the response can be caused by various stimuli. There are likely to still be some elements of novelty in any human approach, such as changes in clothing and the location of the test, but the response will mainly be determined by the human approach itself.

The impact of morphological appearance of humans has been studied in some depth. Attributes such as clothing colour, spectacles, height, and posture have all been flagged as important features in many species including pigs and cattle (Rushen *et al.*, 1998). A rather neglected area is that of vocal and olfactory signals, possibly due to difficulty in standardisation. This wealth of stimuli created by the human can make it difficult to quantify what the animal perceives as aversive, or conversely positive. One alternative to this which has previously been explored is the use of dummies (Miura *et al.*, 1996; Bouissou and Vandenheede, 1995), whereby the approach to it can be quantified. Unfortunately, the various body signals omitted by the human are not accounted for when using dummies. This is considered important, as the perception of posture by the animal may affect the behavioural reaction (Grandin, 1987). Threatening or submissive behaviours may be associated with making the body larger or smaller, but this is species specific.

The behavioural patterns of animals when approached by humans can be labelled as fear responses. These include withdrawal from or avoidance of humans (Hemsworth and Barnett, 1987) and freezing (also known as tonic immobility; Erhard and Mendl, 1999). Tonic immobility consists of the animal becoming completely stationary, and appearing frozen to the spot. This is suggested to be indicative of the type of fear response rather than an actual fear reaction. It reflects a predisposition to react more or less strongly to a stressor, and therefore supports the notion of emotionality (Savage and Eysenck, 1964). This display of response to stress can be quantified using the human approach technique, as a high latency to approach may suggest this extreme form of reaction. The responses seen are thought to be a behavioural strategy to protect the animal from harm (Toates, 1980).

There are various ways of measuring the human-animal relationship (and consequently, fear) described in the literature. Generally, measures of avoidance or approach behaviour to objects or human stimuli are used. This is thought to identify fear levels by quantifying the amount of avoidance or, conversely, approach behaviour (Hemsworth and Coleman, 1998). The motivations behind these behaviours are therefore considered as opposite to each other, and whilst both behaviours may be present in an observation, the animals fear will have a major influence on the response towards the human.

Research has been focussed on this relationship as it is thought that negative interactions cause detriment to both animal and stockperson, effectively creating a negative feedback loop. As a way to measure the effect of human interaction on pigs, researchers have commonly used the Human Approach Test.

Hemsworth *et al.* (1996) describe this test, which they coin the 'voluntary animal approach' test (VAA)'. The approach of an individual animal to a stationary test person in a test arena is measured according to the latency to approach. The reverse of this method is the avoidance test (AV), whereby behaviour is categorised by the level of avoidance behaviour of individual animals when approached by a human.

Approach tests have previously been used within purpose built environments. Hemsworth *et al.* (2000) used this method in a validation study of cows approach to humans outside of the home environment. It was found that the milkers' behaviour had a large effect on the response of the animal. So, we know that the approach test works conclusively in purpose built environments, but what about on-farm studies? The human approach test is not always considered a feasible method when used in on-farm studies, as arenas have to be built and animals moved around site (Rousing and Waiblinger, 2004). However, an on-farm version of this has been developed (Waiblinger *et al.*, 2002; Waiblinger *et al.*, 2003). In 2003, Waiblinger *et al.* investigated the approach behaviour of cows in loose housing systems, whilst in 2002 avoidance distances were used to measure fearfulness. These were considered to accurately and validly reflect the human-animal relationship within that farm. Rousing and Waiblinger (2004) have developed this and used the test on individual cows in the home environment, within their home pen group. However, the VAA test has negative effects of familiarity and retesting. The response of cows in the Rousing and Waiblinger (2004) work suggested that animals may be influenced by the motivation to explore or high curiosity rather than the absence of fear. Marchant-Forde (1998) concurred that this was also the case in pigs.

Retesting however is of importance in this research. It has previously been shown that high levels of positive interaction from humans' increases the willingness of the animal to approach this person in future interactions (Hemsworth *et al.*, 1996). Kraemer (1992) argues that animals may begin to perceive humans as co-specifics, therefore changing the nature of the relationship, whilst Jones (2004) takes the approach that humans can be seen as a source of stimulation and therefore a desirable feature of the environment.

Further, a generalisation between stockpersons has been indicated in pigs. This is evidently important in farm practice, as poor relationships stemming from one stockman can be reflected onto all workers, and ultimately results in reduced welfare. Commercial pigs are unlikely to ever have the opportunity to develop strong relationships with humans due to the vast number of animals on one unit and the automated capabilities now available (such as automated feeding systems). Therefore, it is worth investigating whether the human-animal relationship can be positively formed in just one interaction, or if there are significant benefits to repeated contacts.

Recent work also suggests that there may be a genetic influence on the human animal relationship (Boissy *et al.*, 2005). Neophobia is known to exist within populations, whereby different species differ in their fear of unfamiliar stimuli (Price, 1984). The initial responses of naïve animals to stimuli will likely differ between species, as will the extent to which coping strategies are likely to adapt as a result of experience. Studies of two flocks of chickens, ‘flightly’ and ‘docile’, revealed that behavioural responses differed when approached by humans (Murphy and Duncan, 1978).

It is therefore a consideration in this research that certain genotypes of pig may be better suited to a lower level of human interaction, whilst significant benefits of the relationship may be found in other genotypes. This may strongly influence the pig genotype selected for various unit setups.

This concept will be investigated in this research by using three genotypes of pigs, but also staging approach tests over consecutive weeks. This should indicate whether associations of potentially neutral interactions with humans can improve the confidence of piglets with successive trials, and whether this is affected by the genetic constitution of the animal.

2.2 Materials and methods

A Human Approach Test was used consisting of approaching naïve grouped pigs in their home pen and assessing their interaction with stationary humans. 168 piglets were selected for the trial, and were progeny of three different genotype sires (n=56 per genotype). All piglets were born to Large White x Landrace sows served with single sire semen from one of the three genotypes.

Piglets were reared in their litter groups for four weeks post partum in standard farrowing accommodation. This consisted of a sow crate and a creep area for the piglets with an artificial heat supply.

Piglets were weaned at 28 days of age, and were reallocated to genotype specific groups. These were balanced for factors including litter origin, sex and weight, ensuring an even distribution of social and physical status within a pen. Piglets were weighed at weaning by farm staff which involved catching and restraining for a short period of time. Pre-weaning, other interactions with humans such as teeth clipping, tail docking and vaccination occurred. This may have instigated associations between humans and negative events; however, most commercial units perform these tasks. After weaning, pigs were housed in groups of eight; each consisting of 4 females and 4 males. They remained in these groups in the same pen for the duration of the trial.

The piglets were housed in standard weaner accommodation, consisting of rooms of 8 identical pens. These rooms had 4 pens on each side of a central walkway (Figure 2.1). Each pen measured 0.787m (h) by 2.362m (l) by 1.549m (w). Two drinkers were affixed to the back wall of the pen for *ab-libitum* water supply, whilst the food trough was at the front of the pen, forming the frontal barrier. Plastic slats provided flooring in all pens. Pens had a single metal chain suspended from the ceiling reaching to eye level of the pigs to provide environmental enrichment. Room temperature was started at approximately 30ºc, with reductions occurring as live weight increased (<8kg – 30˚c, <10kg – 26˚c, 10-15kg – 22˚c). Fans at the rear of the room provided ventilation. All pens received standard weaner diet into their troughs at around 9am every morning by hand from members of farm staff. This provided extra contact with the pigs than maybe would occur on a commercial farm unit, but interactions were kept to a minimum for the duration of this trial.

Prior to the trial start, four focal pigs were selected from each eight individuals available in a pen by choosing the heaviest and lightest pigs of each sex (Heavy=9.62 ± 1.16kg; Light=7.35 ± 1.14kg). This gave a total of 28 pigs being recorded per genotype (n=84).Three hours before each trial started, these pigs were caught and numbered using a permanent marker pen in the middle of their backs, where 1= large male, 2=small male, 3=large female, 4=small female. As the pigs grew larger, cans of pig ID spray were used to mark 1-4 dots on the back. After marking, pigs were allowed a two hour recovery period where they could resume normal behaviour. The lights were left on.

Four focal pigs from each of seven pens of pigs were used for each of the three genotypes (n = 84). These pens were situated across 3 weaner rooms as described above, with pen position randomised across the rooms for each genotype, in order to balance for any effects of temperature, lighting, viewpoint and proximity to the door. During each trial, pens were visited in a random order, with the restriction that pens in the same room were never visited subsequently.

The method used here has previously been shown to have high inter-observer reliability (Hemsworth *et al.*, 1996), and so two experimenters were confidently used. The approach to the home pen is considered as important as the presence in the pen (Waiblinger *et al.*, 2006), with approach speed, posture and suddenness of entry all affecting response. Therefore, before entry into the room, lights were already on, and the door was opened and closed quietly. The experimenters then proceeded to the pre-designated pen and stood in front silently for 40 seconds to allow pigs across the room to settle. Then experimenter A stepped over the wall of the pen and stood immediately behind the threshold line which was 33” into the pen, and was obvious because of a partition in the floor slats (Figure 2.1). The other experimenter (B) remained outside of the pen a short distance away so as not to influence pig behaviour. Behaviours were recorded once the pigs had crossed the ‘threshold line’ for the four focal pigs (Figure 2.1). Experimenter B then observed each of the four focal pigs at 30 second intervals using a scan sampling approach at each of these intervals and recorded behaviour according to the ethogram shown in Table 2.1.

Behaviour	*Description of Behaviour*	*Confidence Score*	*Behaviour Category*
Chewing	Pig takes overalls of experimenter into mouth and chews methodically	+1	Confident
Rooting	Pig noses under the boots of the experimenter and tips the boot up	+1	Confident
Approach	Pig makes positive movement towards the experimenter	+1	Confident
Biting	Pig purposefully makes contact with the experimenters skin using the teeth in isolated movements	+2	Aggressive
Chew Aggressively	As 'chewing' but with force and persistence	+2	Aggressive
Root Aggressively	As 'rooting' but with force and persistence	+2	Aggressive
Back	Pig bolts to rear of the pen and climbs the wall in an attempt to escape	-1	Unconfident
Avoid	Pig bolts away from the experimenter and appears fearful	-1	Unconfident
Ignore	Pig makes no contact with experimenter or acknowledges their presence	0	Neutral
Sniff	Pig noses the experimenter	0	Neutral
Sleep	Pig lies asleep and doesn't acknowledge the presence of the experimenter	0	Neutral
Lie	Pig lies and watches experimenter but doesn't interact or avoid	0	Neutral
Eat	Pig eats from the food trough	0	Neutral
Drink	Pig drinks from water point	0	Neutral
Fight	Pig engages with another pig in an aggressive way	0	Neutral
Play	Pig engages with another pig in a non-aggressive way	0	Neutral

Table 2.1. Ethogram of Behaviours Observed in the Approach Test

Experimenter A stood upright and remained on the designated spot facing the back wall of the pen for five minutes. The experimenter could gently push a pig away if deemed necessary but otherwise did not move. The experimenter then left the pen, and both experimenters left the room. The process was then repeated according to the pre-arranged schedule until all pens had been entered and recorded. Experimenter A and B altered roles to allow an even distribution across genotype of different experimenters. Tests were repeated, such that eight tests took place in each pen over a period of 32 days. Pigs were sampled as close to 5 day intervals as was possible (Table 2.2). This was thought to reflect farm practice, as pens are often entered at least once a week to test provision supply, such as water.

Test Number	Piglet Age (days)	Time Elapsed Post Weaning (days)	Days between Trials (days)
1	30	2	0
2	35	7	5
3	39	11	4
4	43	15	4
5	46	18	3
6	52	24	6
7	55	27	3
8	60	32	5

Table 2.2. Age of piglets at each trial point, age in relation to weaning and interval between trials.

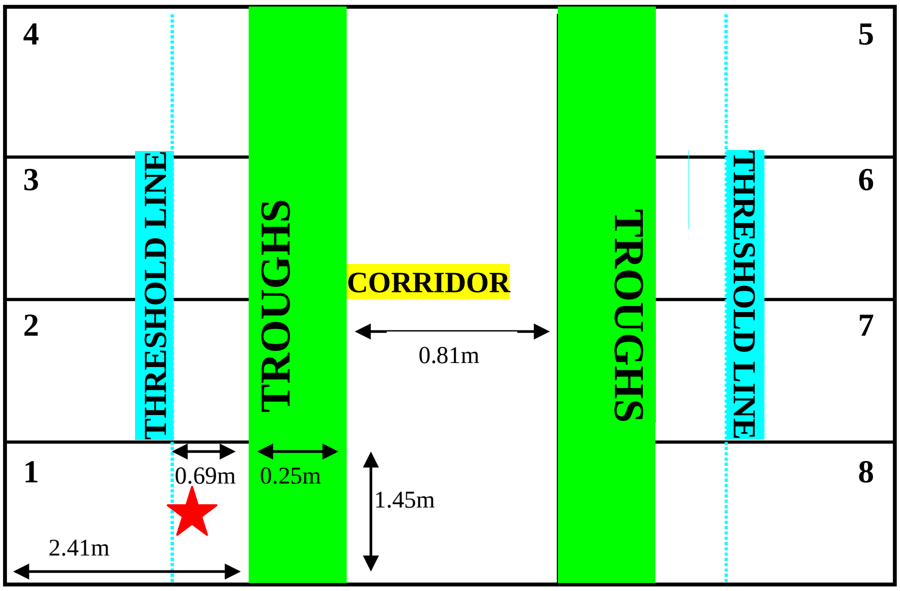

Figure 2.1. Weaner Accommodation Room Layout. The pens were entered by stepping over the trough at the front. The threshold line indicates the point over which pigs had to cross before being recorded as approaching the experimenter. The experimenter stood just behind the threshold line in a central position for the 5 minute trial duration. Pen walls were 0.79m tall.

Statistical Analysis

Data were analysed using Genstat repeated measures ANOVA. The repeated measures design used here required a correction factor to be used when comparing data across time points due to the non-independent characteristic of the data. The repeated measures ANOVA adjusted for this using the Greenhouse Geisser correction (1959). This multiplies the degrees of freedom by a correction factor prior to creating a *P* value, resulting in the appropriate degrees of freedom for the amount of repeated measures. Factors of sex and size were included in the repeated measures ANOVA model, where the main effect being analysed was genotype. Trial comparisons were also included. Fishers Least Significant Differences (LSD) was then applied to this data to identify which means were significantly different. This is then indicated in tables and figures by the use of superscripted letters, where results which do not share the same letter are significantly different.

Due to the high quantity of zero values in some data, the data was non-normal. Where data was non-normal, it was either log-transformed (log^{10}) and analysed using repeated measures ANOVA or converted to 1/0 data (where 0 = no observation of a particular behaviour and 1=occurrence of a behaviour) and analysed using Pearson Chi-Squared (Minitab 15.0). Non-parametric Kruskall-Wallis tests were used on data which remained non-normal.

To accommodate the non-normal distribution seen in some of the data, a confidence score was generated. This accounted for all aspects of the behaviours observed.

Piglets were allocated scores for each behaviour performed within a session (See Table 2.1). Each piglet then had a 'confidence score' for each session, calculated by the sum of the values obtained. These scores were then used to compare the confidence levels of pigs to each other, and across weeks. The use of a confidence score has previously been applied by Andersen *et al.* (2006). They found it to be a valid method of quantifying the approach behaviour of pigs, and have shown it to be as effective as traditional measures such as Voluntary Animal Approach (VAA) and Avoidance scoring (AV) (Hemsworth *et al.*, 1994; Hemsworth *et al.*, 1996). The traditional methods focused on measuring fear response, whilst the more recently used confidence scores attempt to quantify the levels of positive approach behaviour. This was considered more useful here, as the overall aim was to evaluate the ease of managing animals, rather than measuring fearfulness.

2.3 Results

2.3.1 Confidence Score

A significant genotype effect was found when comparing total confidence scores (*Table 2.3* - $F_{2, 78}$ = 5.86, *P*<0.01). A trend was also found for weight to affect confidence ($F_{1, 78}$= 3.13, *P*= 0.08), with large pigs tending to be more confident than small pigs (7.82 ± 0.189; 7.08 ± 0.183).

Genotype	Mean	SE
Hampshire	7.41ab	0.213
Large White	8.35a	0.211
Pietrain	6.60b	0.246

Table 2.3. Genotypic Comparison of Total Confidence Score (P<0.01). Large White pigs were significantly more confident than Pietrain pigs.

Comparisons across Trials

Significant differences were found in Confidence Scores across subsequent trials (Table 2.4, $F_{7, 546}$= 21.41, *P*<0.001). Confidence score increased between Trials 2 and 3 before remaining at a similar level for subsequent trials. Confident Count also differed significantly between trials ($F_{7, 546}$= 10.68, *P*<0.001). A similar progression was seen, with an increase in confident count at Trial 3, which then reached a plateau for subsequent trials. Table 2.5 identifies where significant differences were between Trials.

	Confidence Score		**Confidence Count**	
Trial Number	***Mean***	***SE***	***Mean***	***SE***
1	5.54	0.05	6.43	0.04
2	5.25	0.04	6.32	0.04
3	8.39	0.04	7.83	0.02
4	7.67	0.04	7.29	0.03
5	8.38	0.04	8.30	0.03
6	7.88	0.03	8.04	0.03
7	8.63	0.03	8.64	0.03
8	7.89	0.03	7.99	0.03

Table 2.4. Trial comparisons of Confidence Score and Count (P<0.001). Increases in confidence are seen after Trial 3 and scores remain high throughout the remainder.

Confidence Score	***Differences between Means: t Value=0.79***

Trial	1	2	3	4	5	6	7	8
1	-	n.s	2.85	2.13	2.84	2.34	3.09	2.35
2		-	3.14	2.42	3.13	2.63	3.38	2.64
3			-	n.s	n.s	n.s	n.s	n.s
4				-	n.s	n.s	0.96	n.s
5					-	n.s	n.s	n.s
6						-	n.s	n.s
7							-	n.s
8								-
Confident Count			***Differences between Means: t Value=0.72***					
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1	-	n.s	1.40	0.86	1.87	1.61	2.21	1.56
2		-	1.51	0.97	1.98	1.72	2.32	1.67
3			-	n.s	n.s	n.s	0.82	n.s
4				-	1.01	0.75	1.36	n.s
5					-	n.s	n.s	n.s
6						-	n.s	n.s
7							-	n.s
8								-

Table 2.5. Post Hoc Trial Comparisons for Confidence Score and Confidence Count. Trial 1 and 2 Confidence Scores and Counts were significantly lower than subsequent Trials (P<0.001). Trial 4 also showed a slight decrease in Confident Count before increasing again in Trials 5-8.

Genotypic Comparisons across Trials

Comparisons of confidence score between genotypes across trials also yielded a highly significant result ($F_{14, 546}$= 3.06, *P*<0.001). Figure 2.2 illustrates the changes in confidence over time. It is evident here that in Trial 1, the Large White genotype showed the most confidence. Pietrain and Hampshire pigs were similarly confident. However, as the Trials progressed, Hampshire pigs became more confident than Pietrain pigs and followed a similar pattern to Large White pigs. Both Hampshire and Large White pigs then plateau to some extent, with a slight dip evident in Trial 8. Pietrain pigs however steadily increased in confidence over time and by Trial 6 they were as confident as the other genotypes. All of the genotypes followed a similar pattern between Trials 2-4, with an initial sharp increase in confidence which then plateaus between Trials 3 and 4. Significant genotypic differences occurred in Trials 1-4, and these are detailed in Table 2.6.

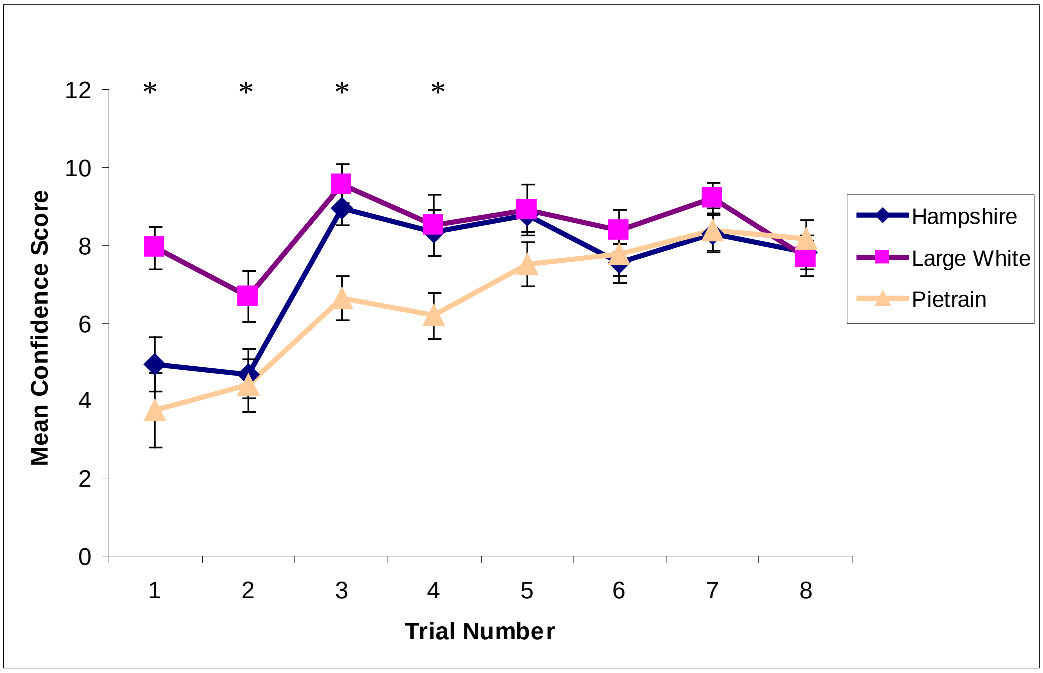

Figure 2.2. Genotypic comparisons of confidence score across subsequent trials (P<0.001). Asterisk indicate where significant differences lie between genotypes. Table 2.5 details these differences. Large Whites were the most confident genotype throughout all Trials, whilst Pietrain pigs started off relatively low in confidence. They then showed a steady incline over time. Hampshires conversely had relatively low confidence at Trial 1 but showed a marked increase between Trials 2 and 3. All genotypes were similar in confidence after Trial 5.

Trial 1: t distribution=1.63	***Differences between means***		
	H	**LW**	**P**
H	-	3.0	n.s
LW		-	4.18
P			-
Trial 2: t distribution=1.63	***Differences between means***		
	H	**LW**	**P**
H	-	2.0	n.s
LW		-	2.29
P			-
Trial 3: t distribution=1.63	***Differences between means***		
	H	**LW**	**P**
H	-	n.s	2.32
LW		-	2.93
P			-
Trial 4: t distribution=1.63	***Differences between means***		
	H	**LW**	**P**
H	-	n.s	2.14
LW		-	2.32
P			-

Table 2.6. Genotypic comparisons by Trial for Trials 1-4 relating to Confidence Score (P<0.001). Large White pigs were significantly the most confident genotype in Trial 1. Trial 2 shows a continuance of this pattern. Trial 3 shows that Large Whites were still most confident

but not significantly so when compared to Hampshire pigs. However, a significant difference was then apparent between Pietrains and Hampshires, with Pietrains being the least confident. Trial 4 also followed this pattern.

Hampshire			***Differences between Means: t Value=1.37***					
Trial	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1	-	n.s	4.03	3.39	3.82	2.61	3.36	2.89
2		-	4.28	3.64	4.07	2.86	3.61	3.14
3			-	n.s	n.s	1.42	n.s	n.s
4				-	n.s	n.s	n.s	n.s
5					-	n.s	n.s	n.s
6						-	n.s	n.s
7							-	n.s
8								-
Large White			***Differences between Means: t Value=1.37***					
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1	-	n.s	1.64	n.s	n.s	n.s	n.s	n.s
2		-	2.89	1.82	2.21	1.68	2.53	n.s
3			-	n.s	n.s	1.61	n.s	1.89
4				-	n.s	n.s	n.s	n.s
5					-	n.s	n.s	n.s
6						-	n.s	n.s
7							-	1.53
8								-
Pietrain			***Differences between Means: t Value=1.37***					
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1	-	n.s	2.89	2.43	3.75	4.0	4.64	4.43
2		-	2.25	1.79	3.11	3.36	4.0	3.79
3			-	n.s	n.s	n.s	1.75	1.54
4				-	n.s	1.57	2.21	2.0
5					-	n.s	n.s	n.s
6						-	n.s	n.s
7							-	n.s
8								-

Table 2.7. Each genotype also showed significant differences between trials ($F_{14, 546}$= 3.06, P<0.001). Hampshire pigs showed a marked increase in confidence score after Trial 2, whilst at Trial 1 their score was significantly lower than in Trials 3-8. There was also a small decrease in confidence at Trial 6, showing significant difference to the score seen at Trial 3. Large White pigs remained relatively stable in confidence score throughout, except at Trial 2 whereby a small decrease was seen. The high score in Trial 3 led to significant differences between Trials 6 and 8. Pietrain pigs started off with the lowest confidence score, leading to significant increases from Trial 3 onwards. No significant changes were apparent from Trial 4 onwards.

2.3.2 Count Confident

Significant genotype/trial interactions were found for confident count (Table 2.8). Confident Count significantly differed in Trial 1 between genotypes, with Large Whites showing the most confident behaviour. This was also seen as a trend in Trial 2. Trial 3 shows Pietrain pigs as least confident, falling behind both other genotypes.

Trial	**Hampshire** Median (LQ-UQ)	**Large White** Median (LQ-UQ)	**Pietrain** Median (LQ-UQ)	**H Statistic (df)**	***P* value**
1	7.00 (0.00-8.75) a	9.00 (7.00-10.00) b	5.50 (3.00-9.00) c	9.52^2	**0.009****
3	9.00 (7.00-9.75) a	9.00 (7.00-10.00) a	7.00 (6.00-8.75) b	7.07^2	**0.029***
7	9.00 (8.00-10.00) a	10.00 (9.00-10.00) b	9.00 (7.00-9.75) a	6.32^2	**0.042***

*Table 2.8. Confident counts per genotype for each of the 8 Trials. Median values are given in addition to the upper and lower quartiles (LQ-UQ). Significant results are marked using *=P<0.05, **=P<0.01.Letters indicate which genotypes differed significantly.*

2.3.3 Neutral Count

Significant differences were apparent between genotypes at Trials 3 and 4 (Table 2.9). From the data, we can see that Pietrains showed more neutral behaviour compared to Hampshire and Large White pigs. This trend was also found in Trials 2 and 7 but was not significant.

Trial	**Hampshire**	**Large White**	**Pietrain**	**$X^{2\ (df)}$**	***P* value**
1	22	22	21	0.136^2	0.934
2	23	22	27	4.083^2	0.130
3	13a	13a	26 b	17.062^2	**0.000*****
4	14a	20 ab	26 b	12.600^2	**0.002****
5	13	17	20	3.656^2	0.161
6	20	20	23	1.143^2	0.565
7	16	15	22	4.397^2	0.111
8	23	26	21	3.257^2	0.196

*Table 2.9. Chi-Square analysis for Neutral Count. Values presented are for sum of occurrences of behaviour (1). Significant results are marked using *=P<0.05, **=P<0.01, ***=P<0.001 Again letters are used to show where significant differences lie.*

2.3.4 Unconfident Count

This yielded significant results in every trial (Table 2.10). The overwhelming trend found here was for Large White pigs to show less unconfident behaviour than both other genotypes in Trials 1-4. Hampshire pigs were most unconfident throughout Trials 2-8.

Trial	Hampshire	Large White	Pietrain	$X^{2\ (df)}$	*P* value
1	13ab	5a	20b	16.243^2	**0.000*** **
2	23a	12b	21ab	11.036^2	**0.004** **
3	27a	16b	20ab	11.810^2	**0.003** **
4	27a	4b	8ab	43.364^2	**0.000*** **
5	27a	17ab	13b	17.029^2	**0.000*** **
6	22a	10b	12ab	11.836^2	**0.003** **
7	21a	16ab	11b	7.292^2	**0.026***
8	15a	5ab	4b	12.950^2	**0.002** **

*Table 2.10. Chi Square analysis for Unconfident Count. Again, the data presented are for positive occurrences of the behaviour (1). Significant results are labelled *=P<0.05, **=P<0.01, ***=P<0.001.*

2.3.5 Aggressive Count

This data was not analysed due to an overwhelming number of zero values, resulting in a non-normal distribution. Instead, this score contributes to the Confidence Score generated, to ensure its inclusion as a measure.

2.4 Conclusions and Discussion

Individual differences have previously been shown to affect the approach of pigs to human stimuli (Hessing *et al.*, 1993; Kerr and Wood-Gush, 1987; Erhard and Mendl, 1999). This research found a trend for size to affect overall confidence score, with heavy pigs tending to be more confident than light pigs. Despite no genotype-size interactions being present, genotypic differences in behaviour were highly significant. This has important implications for management in commercial farms. The stressful response which may have been caused by human presence is detrimental to animal welfare and production (see Chapters 1 and 5) and therefore should be accounted for when interaction such as handling is required.

The total confidence score seen across all eight trials indicates that Large White pigs are more willing to approach humans, whilst Pietrain pigs prefer to remain out of contact. This finding means that Pietrain pigs may require adapted handling regimes to eliminate this negative effect on behaviour. However, it cannot be assumed that a low confidence score reflects a high fearfulness. At Trial 3, Pietrain pigs had twice the incidence of neutral behaviour of both other genotypes. This was also true in Trial 4.

Previous applications of the approach test have also had difficulty with the incidence of neutral behaviours. Pigs on units where there are frequent neutral contacts, or mildly positive ones, but a lack of negative or strongly positive interactions, show higher levels of neutral behaviour (Waiblinger *et al.*, 2003). It is still uncertain whether neutral behaviour is motivated by fear or whether it is a display of indifference. If it is indeed a highly fearful response, the welfare implications are obviously important.

Unsurprisingly, Large White pigs had higher confidence counts than Pietrain and Hampshire pigs. The changes in confidence count over time correlate with the confidence score, suggesting that a large amount of behaviour in the approach test was confident. Whilst it may have been expected to find large amounts of unconfident behaviour in Pietrain pigs, it was instead found that Hampshire pigs consistently showed the most unconfident behaviour. Pietrain pigs initially had high levels of unconfidence but this reduced in Trial 4 and remained relatively low for the following trials.

However, it is more interesting to investigate changes over time here. This reveals that all three genotypes had the capacity to reach the same level of confidence.

This became apparent at Trial 8; the initial response to human approach (Trial 1) indicated a higher level of confident approach behaviour in Large White pigs. Pietrain pigs originally scored low compared to Hampshire and Large White pigs. Russell (1979) suggests that approach to and investigation of novelty will only occur after a period of avoidance. This may indicate an initial reaction of fear to unfamiliar humans in the home pen. However, after Trial 1, the changes over time are most intriguing. Whilst Large White pigs show a high confidence at Trial 3 and remain at this level, Pietrain pigs steadily increase their confidence score across all eight trials, ultimately matching the levels of the other breeds as afore mentioned. Hampshire pigs follow a different pattern again, originally showing low confidence, but with a large increase between Trials 2 and 3. Their further responses then mirror those seen in Large White pigs. This differentiation in response infers that genotype specific behaviour exists in relation to the reaction to humans and should therefore be accounted for in management practice.

Increased approach behaviour over successive trials has previously been shown in Hemsworth *et al.* (1996). They proposed that learning processes can be stimulated during treatments, such as habituation of fear responses and the associated conditioning. For example, humans can be associated with positive interaction, such as petting or the opportunity for manipulation of the experimenter. In this research large amounts of time were spent chewing the overalls of the experimenter or tipping the boots from underneath. These actions may have elicited pleasant oral-nasal sensations, with this emotion then being associated with human interaction.

Further evidence for learnt responses has been presented by Hemsworth *et al.* (1996). They found that pigs receiving regular contact with novel objects were quicker to approach these items when they were presented in a controlled Novel Object Test. However, this was not correlated to behavioural responses to humans, suggesting a specific learnt response to individual stimuli. Despite this, pigs which received regular human contact were quicker to approach novel stimuli. This could mean that reductions of human-associated fear could confer a benefit to other situations, but the reverse is not true.

Regular human contact can therefore elicit responses which can be generalised to other situations, such as movement to different pens, health care related handling and artificial insemination procedures. However, correlations were performed on this data, whereby the same pigs appeared here, and in the finisher pig trial detailed in Chapter 5. No positive relationship was found, so this data has been omitted from this work. This suggests no clear consistency in behaviour over time.

Kooij *et al.* (2002) have previously shown that retested animals generally score low in preliminary tests, suggesting that time is needed for adaptation to the situation. However, Large White pigs reached a stable level of behavioural response in just three trials. This suggests a preferential coping strategy when repeatedly tested in Large White pigs; however, they also had the highest confidence score of the genotypes in Trial 1, which may infer a genetic predisposition for coping with stress.

Despite this, there may be a significant advantage to providing neutral human contact on at least three occasions in the post weaning period, in an effort to reduce management difficulty in future situations, such as moving to different accommodation. The stockperson may then be suitably able to calm the animal in these interactions (Pedersen *et al.*, 1998; Boivin *et al.*, 2000).

The interaction provided could be as simple as entering the pen whilst feeding, checking water supply or performing health checks. However, this study did not discover whether this behavioural response was consistent outside of the trial. Further research may be well directed towards investigating the stability of these traits.

There are several possibilities for inaccurate interpretation of behavioural response to human approach. For example, individual response in the Human Approach Test may have been affected by the group dynamic (Lawrence *et al.*, 1991). If certain pens of pigs were still unsettled due to the weaning process, and hierarchies hadn’t been formed, this may have affected the groups’ ability to cope with the stressor (Tennessen, 1989). It may have therefore been beneficial to conduct aggressiveness scoring on the groups of pigs used prior to the human approach trial to give an indication of whether unsettled groups react differently to the situation. However, conducting lesion scoring by the method detailed in Chapter 3 would have meant handling the pigs, therefore negating the novel effect in Trial 1 of human presence in the pen. Instead, it may have been more beneficial to erect video cameras to record post weaning behaviour, and even to interpret the response of pigs within the human approach trial.

Due to these issues, certain individuals may have been submissive, whilst others may have appeared more confident because they had less social constraint over moving around the pen. Again, this may have been particularly true for the first trials in this research. The hierarchy may still have been unsettled at this juncture, and stress levels may have been elevated compared to what may have been found at a later stage as previously stated (See Chapter 3).

Further justification for the confidence of approach found may be found when considering that the trial was applied within the home pen. It is thought that this reduces fearfulness, due to familiarity with the environment and social support of pen mates (Kooij *et al.*, 2002; Murphy, 1978; Epley, 1974). Therefore, different responses may have been found if the test had been conducted in a novel test arena. Also, the response seen, certainly in Trial 1, may have been more extreme due to the proximity to weaning.

Repeated exposure to potential stressors has been shown to affect hormonal response (Coutellier *et al.*, 2007). Suppressions in response are seen as pigs habituate to stressors. This was only true however for an acute response (within hours), whilst a mid term response was still obvious after several weeks. This would suggest that repeated exposure to stressors dampens the immediate hormonal response, but fails to suppress long term responses. Olsson *et al.* (1999) however found no habituation to social stress presented over a series of 5 weeks, with cortisol increase within 4 hours of stress remaining the same after the first and fifth trials.

Pigs of different genotypes may have been experiencing various physiological responses, and this could have had some effect on their behaviour. For example, elevated stress responses in Pietrain pigs may have created an association between the situation and the ill effects experienced as a result of increased stress hormone concentrations.

In conclusion, differences in the confidence of different genotypes when faced with human interaction have been found. This lends weight to the need for genotype-specific management of pigs, and suggests that certain production systems may be more suited to one genotype than another.

Large White pigs appeared able to cope with frequent interaction, indicated by their willingness to approach humans. This was evident from Trial 1, whereby Large Whites already had the highest confidence levels of the three genotypes. This pattern continued over time, with no negative effects of familiarity becoming apparent. They are therefore likely to be suited to management systems whereby human contact is frequent, for example, units where daily entrance into the pen is required to feed the pigs, or passing through rooms is necessary on a regular basis. This would be beneficial to the stockman as routine tasks could be performed more easily and without upset.

Hampshire pigs however exhibited high levels of unconfident behaviour, suggesting that human interaction is detrimental to their wellbeing. They did however increase in confidence over time, but only after the third entrance into the pen. Therefore, unless regular positive contact can be provided to these pigs in the post-wean period, they are unlikely to become comfortable with human presence. Units with infrequent visitations to rooms/pens may be best suited to this genotype, unless this initial time can be invested.

Pietrain pigs steadily rose in confidence over time. However, large amounts of neutral behaviour were seen, perhaps intimating that although human contact does not disturb the pigs, they receive no great benefit from the interaction. Confidence in Pietrain pigs may well have continued to rise if more trials had been conducted. However, on a farm unit this would require great input, whereas the display of neutral behaviour could perhaps be considered as a satisfactory human-animal relationship.

In conclusion, genotypic differences were apparent regarding the confidence of pigs. This may have repercussions to pig production, as management may be affected by the nature of the human-animal relationship.

Chapter 3 Aggressive Behaviour of Newly Weaned Piglets at Mixing

3.1 Introduction

Aggressiveness in pigs can be a problem. Some of the effects include the infliction of skin lesions, reduced growth rate and lowered feed intake (Boe, 1993; Turner, 2004; Stookey and Gonyou, 1994). Occasionally, vigorous fighting can cause wounds which may ultimately be fatal (Friend *et al.*, 1983). The economic impact of such aggression has been shown by many studies (Arey and Edwards, 1998; McGlone, 1985; Jensen, 1994).

It was therefore considered important in this research to identify aggressive traits in the three genotypes used, since this can affect productive efficacy in many ways. One of the key periods for increased aggressive behaviour is in the post-mixed herd, and one such event experienced by all pigs is mixing following weaning, hence this chapter focuses on the period immediately following weaning.

Mixing at weaning is common practice in commercial farming. The need to house pigs in the most efficient and cost effective way (and to accommodate batch farrowing cycles) means that unfamiliar pigs from various litters are grouped together, and generally have varying sex and weight ratios. The weaning process is a major stressor to piglets due to the abrupt loss of the sow, a shift from milk feeding via the mother to solid food provided in a trough and the introduction of a new social environment (Hötzel *et al.*, 2004; Parratt *et al.*, 2006). By mixing pigs at this already stressful time, profound physiological and behavioural effects can be seen (Coutellier *et al.*, 2007). The injuries sustained at mixing can provide routes for infection, and the physical and psychological stress of weaning can weaken the immune system, facilitating easier infection (Turner, 2004).

Physical activity is also increased as a result of fighting behaviour, which results in stimulation of the sympathetic nervous system. This seems to have a large effect on catecholamine levels, as well as increasing heat production and reducing feed conversion efficiency (Fernandez *et al.*, 1994; Turner, 2004). Colson *et al.* (2006) reported both a glucocorticoid and catecholamine increase in the urine following weaning, both of which decreased notably 4 days later.

The aggressiveness seen in commercial pigs is likely caused by the unnatural mixing of unfamiliar pigs in confined spaces. Conversely, aggressiveness in wild pigs is infrequent and rarely injurious (Turner *et al.*, 2006b). Matriarchal groups are maintained by gradual integration of new members to the group, and threats are generally all that are required to preserve social stability (Mendl, 1995). Wild pigs have the opportunity to disperse once confrontations are resolved, however commercial farming does not provide this opportunity.

Despite the aversive effects of aggression, it is necessary in commercial situations to establish the dominance order in groups of pigs (Meese and Ewbank, 1972). Social relationships within the group become stable and aggressive interactions are regulated with the instigation of a hierarchy. When the group then encounters stressful situations, they are better equipped to cope due to this stable formation (Tennessen, 1989). Challenging situations such as being approached by humans, movement to new accommodation and loading into slaughter transport are likely to be coped with more effectively, due to this group stability. Indeed, the effect of disrupting this group is that reestablishment of the hierarchy occurs. This facilitates more severe fighting events, and is therefore of huge detriment to the welfare of individuals (Tan and Shackleton, 1990).

A major factor affecting aggression levels is genetic variation. Turner *et al.* (2006a, 2008) investigated the heritability of aggressiveness, as many behavioural traits in livestock are known to have a genetic basis. If inheritance does indeed occur, breeding companies have the opportunity to select against the trait in the nucleus herd. Turner confirmed that aggressive traits do have a genetic basis, with heritability also apparent between parents and offspring. He presents scope for selecting against aggressiveness, predicting that aggressiveness of the herd should therefore fall by 5% each year. However, despite selection against aggressive traits appearing positive, Turner also warns that removing aggressive pigs from a population may negatively affect production values. If aggressive pigs also happen to carry beneficial genetic traits such as high meat quality, removing them from the breeding population may have negative effect. Correlations by Turner of growth rate and backfat depth with aggressiveness revealed no such relationship.

This research aimed to identify whether different genotypes of pigs were more susceptible to aggressive traits. This could ultimately aid decisions over genetic selection for traits for reducing aggression whilst avoiding compromising meat quality or growth. Indeed, pigs may be better able to reach their genetic production capacity without hindrance from stress caused by aggression.

Previous studies hoping to quantify aggression have used methods such as deliberate mixing to evoke adverse responses, the use of video cameras to record aggressive behaviours (Janczak *et al.*, 2003; Andersen *et al.*, 2004), resident-intruder tests to measure an individual's aggressive response to an unfamiliar intruder (D'Eath and Pickup, 2002) and skin lesion counting, whereby the number of wounds inflicted after mixing are counted (Turner *et al.*, 2006b).

During fighting, pigs target the head, neck and ears of their opponent and bite and slash at these areas with the canine teeth (McGlone, 1985). Superficial skin lesions can then be found, predominantly to the front third of the body (Fraser and Rushen, 1987). Lesions to the rear are rarer, due to the adoption of a parallel posture by the defendant (Jensen, 1980). The number of lesions accrued per second as a result of being bullied are far greater (six times) than the number received from reciprocal fighting (Turner *et al.*, 2006b).

Lesion scores have thus been shown to be useful as an indicator of the levels of aggression within a group (Barnett *et al.*, 1992), however, they have shown not to correlate with the duration of a fighting bout.

Turner *et al.* (2006b) tested the validity of lesion scoring by both recording aggression using video cameras and performing lesions counts. Carried out at 24 hours post mixing, this information provided a strong indication that lesion scores are an accurate predictor of aggression. They found a correlation between the location and number of lesions with aggressive behaviour caught on videotape. Pigs which initiated fights were shown to accumulate lesions to the front third of the body, whilst those pigs which were subject to bullying showed a higher number of lesions to the rear of the body. A significant benefit of lesion scoring as opposed to video recording or observations is that larger numbers of pigs can be assessed within a short time.

The short duration and latency to start fighting means that dominance hierarchies are quickly formed (Rushen and Pajor, 1987, Meese and Ewbank, 1973). Barnett *et al.* (1992) found that the majority of agonistic interactions fell within the first 90 minutes post mixing, whilst from day two onwards levels reached a lower level and remained at that level. This suggests that lesion counting 24 hours post mixing should incorporate the majority of fighting, with aggression levels after this being vastly reduced.

The approach used in this research therefore focused on selecting individuals from each of the three genotypes available and performing lesion counts. The pigs were counted for several predefined areas of the body, to give an indication of the nature with which the lesions were received, be it through bullying or reciprocal encounters. This data should indicate whether the genotypes vary in their levels of aggression, and therefore highlight potential areas for future research.

3.2 Methods and Materials

Fifty four pigs of each of three genotypes (Hampshire cross, Large White cross, and Pietrain cross; N=162) were used for this trial. Piglets were analysed one day post weaning in their home pens (See Figure 2.1). Due to earlier research suggesting that fighting in adjacent pens can trigger fighting throughout a room; genotypes were equally represented across pens (Stookey and Gonyou, 1998). Piglets were allocated to pens at around 17.00h on weaning day, and lesion counting performed after 14.00h the following day (21-24 hours post mixing). Piglets were mixed at weaning into eighteen groups of nine which were balanced for sex, and weight (mean ± s.d. = 8.51±1.40kg) and each pen also had equal numbers of unfamiliar piglets due to balanced litter origin. Each group of pigs consisted of a single genotype.

Courboulay and Foubert (2007) found that estimating the numbers of lesions from outside of the pen was not accurate; therefore, in this research the pens were entered. Pigs were individually restrained by hand and the total number of lesions accumulated on different areas of the body recorded. During lesion counting, the body is typically divided into three regions to facilitate accurate counting (Turner *et al.*, 2006b): commonly front (head, neck, shoulders and front legs), middle (flanks and back) and rear (rump, hind legs, tail). This approach was also used here, but was modified to include more categories, as shown in Figure 3.1.

A lesion was categorised by a scratch to the skin measuring more than 1cm in length which appeared red (fresh). Areas of many small lesions (under 2cm in length) were given a score of 5 for every 5cm² patch of damaged skin. Pens were considered as six groups of three, with each genotype represented per group, and rotation was made between these groups. In each of these pens, one pig was sampled. Pens were then revisited in order until all pigs had been sampled. Pigs were caught in a random order, and ear tag number recorded for weight and sex records to be compiled.

3.2.1 Statistical Analysis

Results were analysed using Minitab 15.0. A General Linear Model was used to analyse differences between genotypes and additionally genotype/sex interactions. Individual weight was also used as a variable Tukey Post Hoc procedures were used to identify where significant differences lay. These differences are then indicated in figures and tables by the use of superscripted letters. By transforming values into percentages, the distribution of lesions was found for each genotype.

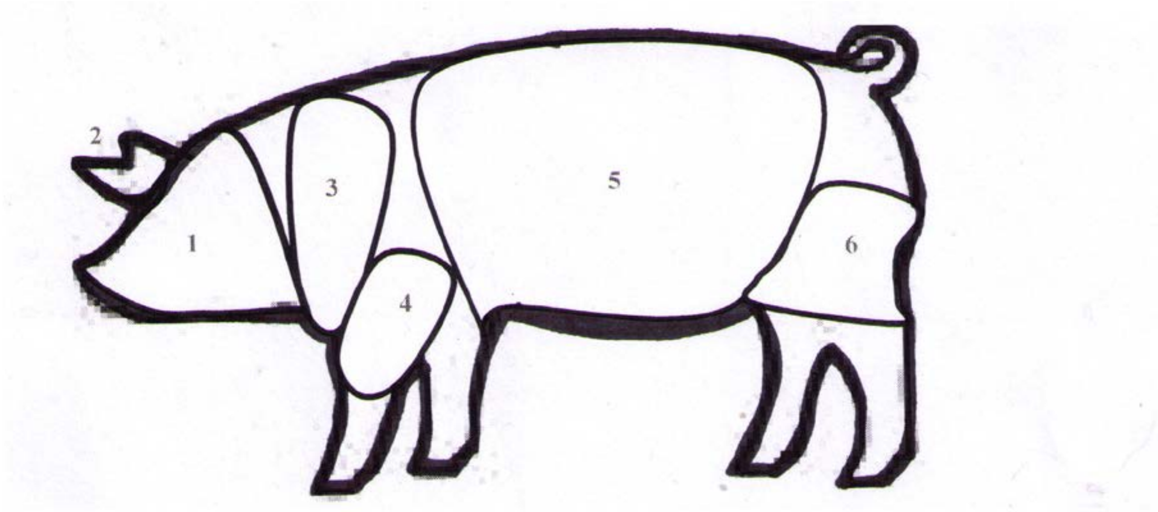

Figure 3.1. Areas of Analysis for Lesion Scoring

1. *Head*
2. *Ears*
3. *Shoulders*
4. *Left Front/Right Front*
5. *Torso*
6. *Left Back/Right Back*

3.3 Results

3.3.1 Comparing Genotypes for Total Lesions Sustained

Hampshires had a markedly lower number of lesions compared to both Large White and Pietrains (Figure 3.2, *F*= 19.15; d.f. = 2; *P*<0.001).

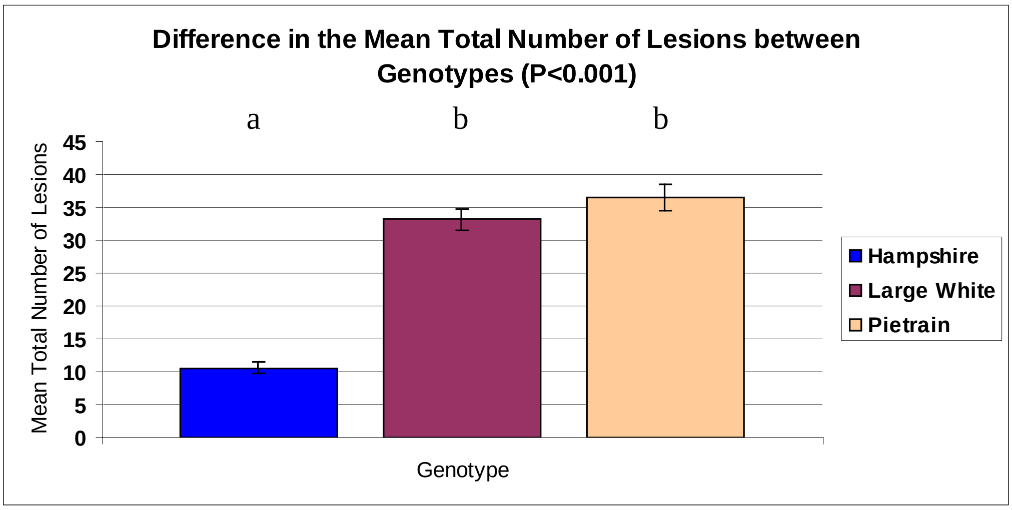

Figure 3.2. Comparison of the mean total number of lesions found on pigs of different genotypes (P<0.001). Hampshires had significantly fewer lesions than both other genotypes.

A sex effect was also found, with males having larger numbers of lesions than females (Table 3.1, *F*= 4.00; d.f. = 1; *P*<0.05).

Total Number of Lesions	Mean	SE mean
Hampshire	10.7 [a]	1.8
Large White	32.4 [b]	3.2
Pietrain	36.7 [b]	4.1
Male	30.2 [a]	2.5
Female	22.9 [b]	2.7

Table 3.1. Means and Standard Errors for Total Number of Lesions compared by Genotype (P<0.001) and Sex (P<0.05).Superscripted letters identify where differences were significant.

3.3.2 Comparing Genotypes for Lesions by Body Area

The number of lesions found on the head differed significantly between genotypes with greater numbers found on Pietrains than on Hampshires (Table 3.2). A sex difference in lesions to the head was also apparent (*F*= 4.67; d.f. = 1; *P*<0.05) with males having more than females. Pietrains had the greatest number of lesions to the ears compared to Hampshires and Large Whites, with Hampshires sustaining the least number. This was also true of the front and rear areas of the body. Hampshires had significantly fewer lesions to the shoulders than both Large

Whites and Pietrains, with Large Whites sustaining the most. Males had a greater number of lesions to the torso than females (F= 4.88; d.f. = 1; P<0.05). Females had less lesions to the front of the body than males (F= 4.25; d.f. = 1; P<0.05).

Genotype	***Hampshire***		***Large White***		***Pietrain***		**F Value**	***P* Value (<)**
Area	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**		
Head	0.89^{a}	0.23	1.88^{ab}	0.30	2.36^{b}	0.47	4.63	0.05*
Ears	2.91^{a}	0.38	6.16^{b}	0.59	8.60^{c}	0.82	20.4	0.001***
Shoulders	1.74^{a}	0.33	13.34^{b}	1.78	9.48^{b}	1.55	17.6	0.001***
Torso	2.04^{a}	0.50	4.43^{b}	0.59	5.64^{b}	0.86	4.88	0.05*
Front	2.41^{a}	0.74	5.54^{b}	0.71	7.52^{b}	0.98	9.59	0.001***
Back	0.61^{a}	0.25	1.89^{ab}	0.45	2.90^{b}	0.53	6.80	0.001***

*Table 3.2. Genotypic differences between the numbers of lesions found to various areas of the body. Superscripted letters identify areas of significance horizontally. Significant results are marked using *=P<0.05, **=P<0.01, ***=P<0.001.*

3.3.3 Distribution of Lesions within Genotype

Figure 3.3 illustrates the distribution of lesions within genotype as a percentage of the total number of lesions sustained. Hampshires had a greater percentage of their lesions on the ears, whilst Large Whites displayed a higher amount on the shoulders. Ear and shoulder lesions of Pietrains were intermediate between the other two breeds. The frontal areas of all genotypes attracted the majority of damage.

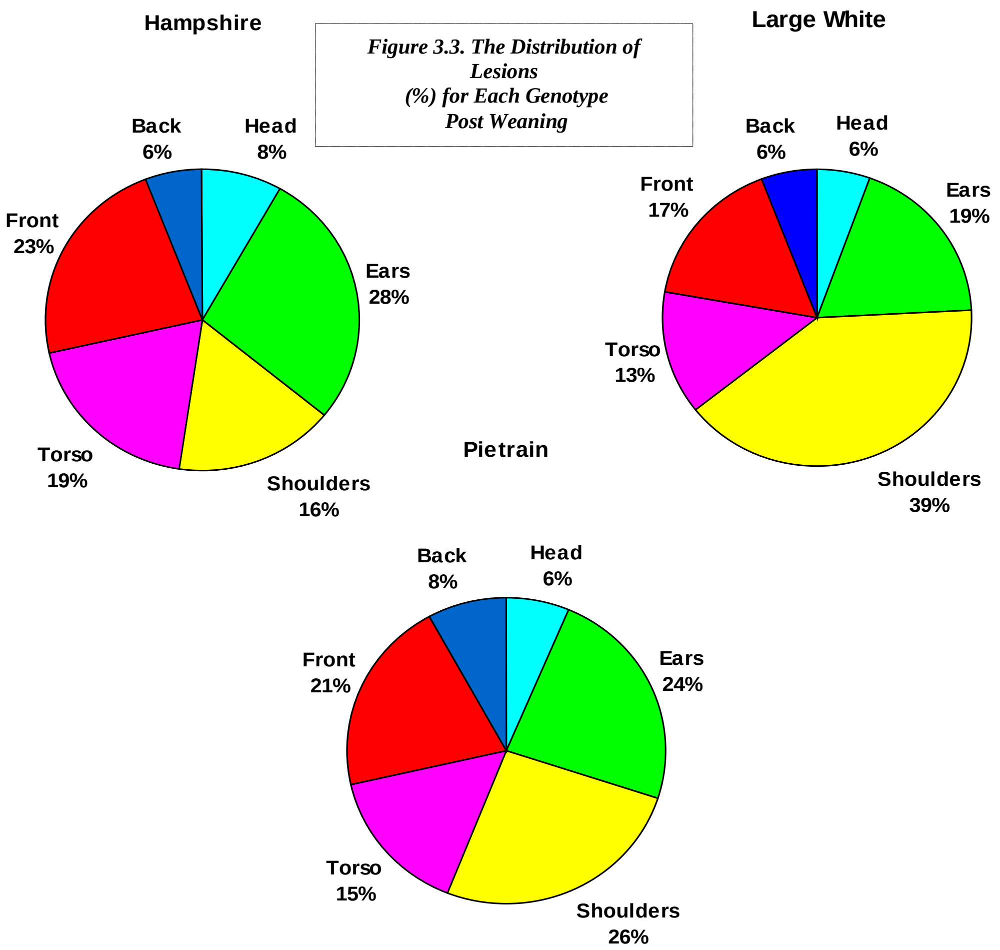

Figure 3.3. The Distribution of Lesions (%) for Each Genotype Post Weaning

3.4 Conclusions and Discussion

Low numbers of lesions have successfully been identified as a good indication of whether pigs have avoided reciprocal fighting and bullying (Turner *et al.*, 2006b; Jensen, 1980). In this experiment, it seems that Hampshire pigs are more likely to avoid agonistic confrontation than Large White and Pietrain pigs. The total number of lesions found on Hampshire pigs was far fewer than those found on both Large White and Pietrain pigs. Although Hampshires are darker and hairier than the other breeds, this was not thought to affect the accuracy of counting. The cross-bred nature of the pigs used in this trial meant that the Hampshire pigs did not have such dark markings as the purebred phenotype. This made it equally easy to see the lesions on all three genotypes.

The higher number of lesions found on male pigs in this study may reflect the dominance hierarchy seen in wild boar. Despite the matriarchal nature of pig societies, males are generally the more competitive of the sexes, with disputes over space and food being particularly prevalent (Kyriazakis and Whittemore, 2006). Therefore, the move to a new pen containing unfamiliar pigs results in battles to become the dominant male. As the pigs used were of weaning age, this is perhaps not the most suitable conclusion, however, high levels of testosterone are likely to have been present even at this pre-pubertal stage.

The allocation of a range of weights in this research may have helped lessen aggression, by reducing the number of same-weight clashes for dominance (Gonyou *et al.*, 1998). Large areas of trough space in the pens may also have aided hierarchal settling, by allowing all pigs' adequate access to food.

Turner *et al.* (2006b) suggested that lower numbers of lesions may result from pigs engaging in less severe forms of fighting, such as pushing. Relating this to the distribution of lesions on each genotype, it was found that the majority of lesions on Hampshire pigs were on the ears and front leg areas. This could fit with the hypothesis that dominance hierarchies are formed using less violent interactions (Meese and Ewbank, 1972), as ear biting could be considered more an anxious behaviour than an aggressive one. The prevalence of lesions to the front leg and torso areas concurs with the notion of pushing, as these are easily contacted areas of the body. Lesions sustained to the head, neck and shoulders are considered to illustrate reciprocal fighting (Turner *et al.*, 2006b; McGlone, 1986). The large percentage of lesions in these areas on Large White and Pietrain pigs suggested elevated levels of reciprocal fighting, however this can only be hypothesised.

In addition to low lesion counts, there was also greater uniformity in numbers of lesions in Hampshire pigs, as indicated by a smaller standard deviation. When considering the infliction of lesions to the shoulders (an identified target area for wound infliction during fighting), the standard deviation of the number of lesions was 2.42. However, in comparison to this, Large White and Pietrain pigs had deviations of 13.10 and 11.35 respectively. This could suggest that Hampshire pigs, regardless of size and sex, were a less injurious genotype. Rather than individuals being targeted, all categories received similar amounts of lesions, suggesting that conflict was less targeted to a few individuals, and aggression was in fact distributed throughout the group. These results may also suggest that Large White and Pietrain pigs had a tendency for certain members of the group to be involved in fighting, whilst others avoided confrontation.

However, Turner *et al.* (2006b) suggested that a high lesion count was unlikely to be attributed to a single bout of fighting with one pig. Their recorded observations indicated rather that pigs which won a high number of fights were more likely to have initiated them and engage in a higher duration of fighting overall. The willingness to continue fighting is strongly influenced by recent success, as shown in many animals including chickens and pigs (Cloutier *et al.*, 1995; Rushen 1988).

An alternative explanation for the differing numbers of lesions could be that they were resultant of physiological differences. It may be hypothesised that the different genotypes were more or less capable of inflicting serious injury due to their oral structure, for example, if Hampshires were unable to widen the mouth to the same degree as Large White and Pietrain pigs, they may have been less able to inflict injury. There are possibilities of identifying this using simple dissection, and so future work may be well targeted in this area.

The genotypic differences found in this research regarding lesion counts in these three breeds have not been reported before, although differences between other breeds have been investigated. Turner *et al.* (2006a) found no significant effect of gender or genotype on the number of lesions found on purebred and crossbred Large White and Landrace pigs, whilst Gadd (1967) and Lund and Simonsen (1995) both presented evidence that Landrace pigs are particularly prone to tail biting and aggressive traits. However, Breuer *et al.* (2003) found Landrace pigs to spend less time ear biting. Duroc pigs in the same study showed lower levels of belly nosing than Landrace pigs.

These results give cause to believe that aggressive temperaments differ between breeds of swine. There is also evidence of correlations between abnormal oral behaviours, with Hunter *et al.* (1999) reporting that ear damage was positively correlated with tail biting. If this is the case, it should not be unexpected for the genotypes in this study to differ in detrimental behaviour traits throughout their life. This may warrant further investigation, with the aim of selectively breeding out these traits.

Firstly however, the identification of the types of aggressive behaviours shown in each genotype should be quantified. Although the method used here provided insight into the nature of the interactions between pigs, it is not a definitive approach. Video recording or continuous observations still remain the best indicators of aggressive traits. Non-injurious behaviours could also be measured. This may go some way to explaining the differing numbers of lesions found between genotypes.

Further effects of genotypic differences in aggression should include investigation into outdoor production environments. Agonistic behaviours have been shown to be more prevalent post-weaning in indoor piglets (Hötzel *et al.*, 2004), as well as high levels of inactive behaviour and oral-nasal behaviours such as chewing and sucking. However, this may not be the case in outdoor pigs, as they generally have more space and opportunity to engage in other behaviours.

Additionally, large herd sizes, lack of bedding and poor ventilation have all been shown to contribute to aggression (Chambers *et al.*, 1994). Further research into the effects of these factors on each genotype would therefore be beneficial. For example, if large group sizes were found to be the main contributing factor to aggression in one genotype, advisory caution on the number of pigs per pen could be issued.

In conclusion, mixing at weaning is a practice which should be reduced for all pigs due to its detrimental effects on welfare and productivity. However, this research indicates that Large White and Pietrain pigs are more prone to injurious aggression at this time. Hampshires have been shown to be the least aggressive of the three genotypes used in this research, and so may have preferential coping strategies. Extra care should be taken when mixing Large White and Pietrain pigs, and future research should focus on developing genotype-specific methods for reducing aggression.

Chapter 4 The Response of Pigs at 4 and 15 Weeks of Age to Movement Courses Designed to Evaluate Management Ease, Fearfulness and Learning Capacities

4.1 Introduction

Routine farm practice involves some degree of handling, whether it is the movement of pigs, provision of medical treatment, artificial insemination or vaccination. The current literature suggests that the management of pigs at slaughter can be difficult, and can have negative impacts on meat quality, via elevated stress levels (see Chapter 5). However, many do not consider the effects of movement at a younger age on both the welfare of the animal and associated labour load. Stress is known to have negative impacts on growth, therefore highlighting the importance of management schemes which minimise fear. This chapter will focus on the behavioural responses of the three genotypes of pigs to being handled through a regular on-farm system at two ages; the post-weaning period and fifteen weeks of age. This is hoped to give insight into the ease of managing pigs at various ages, and may predict the response of pigs at slaughter. It also aims to highlight problematic areas of farm systems for each genotype so that recommendations can be formed regarding suitability of genotypes to various farm setups.

There are many different types of handling, dependent on the nature of the task. The daily feeding of pigs requires human presence to ensure smooth operation, but this may not necessarily result in engagement with the pigs. In contrast, weighing pigs to track their gain or moving pigs to different buildings involves a lot of physical contact with the animals. The handling of pigs can generally be divided therefore into 1) leading/moving, 2) capture, 3) restraint within handling facilities and 4) animal specific procedures such as ear tagging, vaccination and teeth clipping. Restraint whilst being handled is discussed in the following chapter, but here the focus is on movement of pigs.

Handling procedures are a cause of stress to both handler and animal. Heart rate of the stock can reach almost double its resting level and blood pressure can be increased two fold (Stephens and Rader, 1982). Pigs that have not become accustomed to any form of human handling, positive or neutral, are likely to be fearful of humans and as a result behave erratically (Duncan, 1990). Rough handling is generally harmful to livestock (Grandin, 1983) with around half of carcass bruising caused by rough handling. Further reports in 1993 estimated that bruising cost $26 million dollars in the USA in just one year. The direct effects of handling on meat quality are discussed further in Chapter 5.

The stress reaction caused by movement around the unit can be attributed to fearfulness. High levels of fearfulness lead to pigs which are reluctant to explore unfamiliar surroundings (Boissy, 1995). Sudden noise can be unnerving, and flapping objects, puddles and drains can slow movement (Grandin, 1987). From a management perspective, fearful animals are more difficult to handle and this may result in injury to both livestock and stockman (Le Neindre *et al.*, 1996). This invariably decreases job satisfaction and motivation, creating a negative feedback cycle, with stockpersons' positive attitudes towards their livestock generally degenerating. This can eventually lead to a decrease in the standards of care, and enhances fear in the animal (Jones, 1996).

The effect of moving pigs across standard farm units has previously been investigated by Lewis and McGlone (2007). Their handling course within a confined area resulted in increased individual heart rates. However, the focus of their work was to identify the effects of group size on movement. Time taken to complete the course was positively correlated with group size, with no benefits seen on labour input until groups consisting of 5 pigs were moved. However, groups over 7 also proved problematic. The 15 week movement protocol in this research used groups containing between 8-10 pigs, as it was considered more beneficial to move pigs in their home pen groups rather than confound the experiment with social separation effects. The course constructed by Lewis and McGlone did not incorporate any novel objects, ramps or transportation, whereas this research has aimed to challenge pigs whilst being moved to identify what may be perceived as threatening. Pigs from indoor production environments have been shown to react strongly to novel stimuli (Stolba and Wood Gush, 1980), so novelty was incorporated into both experimental designs here. A wealth of literature exists on the varying responses of pigs from enriched or barren housing to novelty (Mendl *et al.*, 1997; De Jong *et al.*, 1998; Stolba and Wood-Gush, 1980), but it was considered here that novelty may also affect genotypic responses of pigs from the same environment.

An area of research not often investigated regarding the movement of pigs is the consistency of behaviour over time. Moving pigs on a regular basis is considered to be a beneficial procedure prior to slaughter. Geverink *et al.* (1998c) allowed pigs out of their pen repeatedly in the days preceding slaughter, and found that the time to load into movement trucks at slaughter was significantly reduced. A laborious part of moving pigs can be getting them out of the home pen, as they are moved away from familiarity, and introduced to novel stimuli. In an attempt to quantify this, Abbott *et al.* (1994) moved pigs once a week for three weeks, and discovered that time taken to leave the home pen was decreased. Both of these studies indicate that the intensity of labour required on movement days can be improved. If pigs are able to be moved more efficiently and easily, this will also have a positive impaction on stockman attitudes (Waiblinger *et al.*, 2006).

The effect of moving pigs several times before a routine laborious task (such as loading into transport) has therefore been previously shown to improve the workload and potentially the welfare of the pigs. This may be due to a capacity for learning, however, this has rarely been studied in regards to genotypic effects. Genetic experiments concerning animal learning have shown that strains vary in sensory capacity, motivation, memory and activity levels (Olsson *et al.*, 2003). However, this has only been shown in a small number of cases.

The ability to store information is important to learning, but retaining it may indicate differentiation between genotypes regarding their coping abilities. When challenged, if particular breeds are able to retrieve the information required to solve the task, they will instantly be efficient when compared to others that struggle with memory retrieval (McGaugh, 1966). This may serve to separate pigs into learning capable and learning deficient pigs.

Current research into the learning capacities of pigs has shown a stability of temperament between different trials. Siegford *et al.* (2008) challenged piglets with a hippocampus-dependent maze task to identify whether there was any effect on subsequent long term and immediate stress responses. They theorised that the time spent completing a second spatial task should reveal whether cognitive ability had been enhanced by the first task. By constructing panels containing doors around the farrowing pen, they challenged piglets to return to the sow by choosing the correct doors. These piglets were then assessed via a human approach test, where it was discovered that pigs which had completed the maze quicker were more willing to approach unfamiliar humans at seven weeks of age. This would indicate that stimulation of cognitive development during a critical learning period (generally around the weaning period) can result in reduced stress at a later age (Hemsworth *et al.*, 1986). However, contrary to this, Olsson *et al.* (1999) found no reduction in physiological stress responses after five social challenges in growing pigs.

Exposure to humans can have a positive effect on management, as shown by Boissy and Bouissou (1995) who discovered that cattle handled regularly were easier to lead, approach and were more likely to feed in a novel environment. However, Grandin (1987) warns that pigs which were given human contact twice weekly became over-familiar and thus became more difficult to drive due to a decrease in fear. Grandin concluded in later work (1989) that handling should produce pigs that are calm and easy to drive, but not tame enough that they follow the person rather than being driven. This is perhaps not a risk on most commercial farms, however it may be found that pigs will become less fearful and therefore less willing to move.

The consistency of handling over time has shown to be important. Negative handling within a course of positive handling may be more detrimental than negative handling alone (Hemsworth *et al.*, 1987). Jones (1993) however, found that chickens exposed to negative handling, i.e. being held upside down by the legs, were still willing to approach humans in subsequent trials, begging the question, can animals apply previous experience to future interactions with humans? The present study aimed to investigate this via the use of repeated testing, in order to test the ability of pigs to learn about a handling situation.

It is hoped that the two methods used in this chapter will give good insight into whether genotypic differences exist when driving pigs, and where these differences lie. The use of pigs at both weaning age (4 weeks) and 15 weeks of age should also provide knowledge on alterations in stress response with age. The 15 week movement course (as discussed in Chapter 1) is designed to challenge the pigs in various ways, in the hope of illuminating problem areas of farm design for each genotype. The repeated movements of the weaner pigs however is hoped to identify whether learning occurs when pigs are repeatedly moved through a simple course.

4.2 Methods and Materials

4.2.1 Movement of Weaner Piglets

Twelve groups of ten weaner piglets were selected for this trial, with 4 groups of each genotype (H, LW, and P; N=120 pigs). Piglets were weaned at 28 days of age into standard weaner accommodation consisting of 8 pens a room (see 2.2 for layout). Groups consisted of a single genotype, balanced for litter origin, weight and sex. At 4 days post weaning, all piglets in a group were removed from their home pen, and moved along the route shown in Figure 4.1. by a single handler standing behind the pigs.

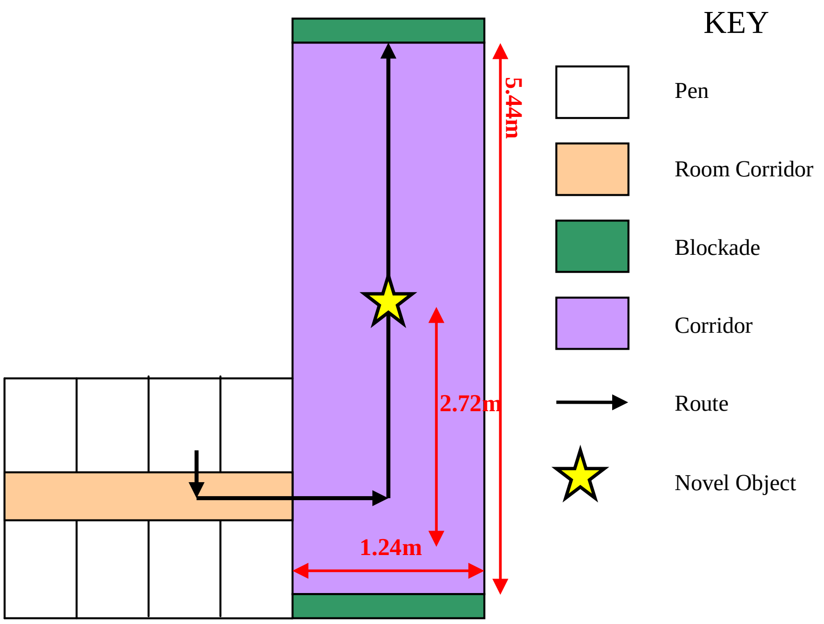

Figure 4.1. Movement Route including Novel Object Location. Blockades were 0.76m tall. Ceiling height was 2.44m.

The handler did not drive the pigs with anything other than a pig board to ensure no reverse movement, and gentle vocal persuasion. The experimenter walked forward at one pace per second and placed the board against any pigs which were not moving. A stopwatch was started as soon as the experimenter entered the pen, and times were recorded up to the pigs reaching within 0.3m of the blockade, and again back into the home pen. Timings were based on the whole group reaching the blockade/pen rather than timing individual pigs. Pigs were also given a score for their ease of management and a speed score for the pace at which they completed the course. Scores were given to the whole group (Tables 4.1, 4.2), with two scores per run, one away from the pen and one towards the pen. These scores were preliminarily tested on random groups of pigs to ensure that the ethogram was precise and relevant.

4.2.1.2 Management scores

	Management Scores
1	Pigs move forward with no encouragement in a calm manner
2	Pigs move forward with little encouragement in a calm manner
3	Pigs need encouragement to move and behave frantically
4	Pigs need moderate encouragement to move forward and behave erratically
5	Pigs need copious encouragement to move forward and behave agitatedly

Table 4.1. Management Score Ethogram

4.2.1.3 Speed Scores

	Speed Scores
1	Pigs move very slowly and steadily along the course
2	Pigs move slowly along the course
3	Pigs make moderate progress along the course
4	Pigs move quickly along the course
5	Pigs bolt along the course

Table 4.2. Speed Score Ethogram

This process was conducted four times, four days apart. Table 4.3 shows the number of groups used for each trial. Four groups were used repeatedly for each genotype. At Trial 3, 2 naïve control groups per genotype were also used (n=6).

	Trial 1		**Trial 2**		**Trial 3**		**Trial 4 (Novelty)**	
	Trial	*Control*	*Trial*	*Control*	*Trial*	*Control*	*Trial*	*Control*
Hampshire	4	-	4	-	4	2	4	2
Large White	4	-	4	-	4	2	4	2
Pietrain	4	-	4	-	4	2	4	2

Table 4.3 Groups of pigs used in each trial. Trial groups were used across all 4 trials, whilst each control group was used only once. In total, 24 pens of pigs were used.

At Trial 4, a novel object was added to the course. This was a large pile of feed sacks positioned halfway along the corridor (See Figure 4.1). Pigs from Trials 1, 2 and 3 were moved along this route, alongside 6 more control groups which had not previously experienced the route.

4.2.1.4 Statistical Analysis

Trial 1-4 data were analysed using Genstat repeated measures ANOVA. This included the Greenhouse Geisser correction factor detailed in Chapter 2. A GLM ANOVA model was used to analyse between trial groups and control groups. Sex and weight were not included in the analysis since all pens were balanced at weaning to ensure even distributions. Therefore, the only factor investigated was genotype. Tukey Post Hoc procedures were used to identify where significant differences lay, and this is indicated throughout via the use of superscripted letters.

4.2.2 Movement of 15 Week Old Pigs through a Maze

12 pens of each genotype were used for this trial, with 8, 9 or 10 pigs per pen. The pigs were housed in standard grower accommodation consisting of pens measuring 0.79m (h) by 2.36m (l) by 1.55m (w). Troughs were affixed to the front wall of the pen, containing one feeding space and drinking taps were available at the rear of the room. Pigs were housed in these rooms for 11 weeks post weaning, and were therefore 15 weeks old when used in this trial.

Pigs were moved through the maze by an experienced member of staff, who was able to use pig boards and vocal signals to move the pigs. However, this contact was kept to the minimum needed to move the pigs, and should have represented normal management routine. The pigs were moved as standard into finisher accommodation at the end of this trial.

4.2.2.1 Description of the Course (Figure 4.2)

1. PEN - Pigs were moved from their home pens as a group and herded into the passageway previously used. They then proceeded to a ramp leading to an outside yard.

2. RAMP - Pigs were required to descend the ramp onto a solid concrete yard

3. NOVEL - This ramp was bordered by two large solid metal hurdles measuring 3.05m long and mounted on wheels. These wheels met 1.52m away from the base of the ramp, and provided a novel object for the pigs to navigate.

4. OPEN - This corridor adjoined the wheeled hurdles and was constructed of railed hurdles, allowing the pigs to see into the yard, therefore coined open.

5. CORNER - This corridor led to a right-angled turn to the left, which was constructed of two large solid metal sheets, therefore requiring the pigs to walk towards a solid wall.

6. WHITE - The corner was constructed of white painted sheets which then led on to a corridor measuring 6ft.

7. U-TURN – The white sheets led into a U turn constructed of solid metal sheets. This then turned into an open area and signalled the end of the course.

4.2.2.2 Scoring System

A scoring system was developed to enable a picture of behaviour for each area of the course based on that seen in 4.2.1 (Tables 4.4 and 4.5). Pigs were scored depending on their performance as an entire group. However, the scoring system was modified here from that described in Tables 4.1 and 4.2, as it was considered that the original scoring system placed too much emphasis on the behaviour of the pigs and not the ease of management. Timings were taken from the entrance of the stockman into the home pen until all pigs had reached the end point past the U Turn. Timings were also recorded for each section of the course (See Figure 4.2).

Management Score	Description of Scoring
1	Pigs are easy to move, calm and cooperative
2	Pigs move steadily and together making herding easier
3	Pigs put up some resistance to handler
4	Pigs move as individuals and there is incidence of back running
5	Pigs refuse to move and there is high incidence of back running

Table 4.4. Scoring system for Management Ease

Speed Score	Description of Scoring
1	Pigs are very slow and stubborn
2	Pigs move steadily and calmly
3	Pigs move forwards at a good pace with few stops
4	Pigs move forwards quickly but calmly
5	Pigs bolt forwards erratically

Table 4.5. Scoring system for Speed

4.2.2.3 Statistical Analysis

Data were analysed using Minitab 15.0. A GLM ANOVA was used to compare genotypes over each area of the course, including times taken, management scores and speed scores. Sex, group size and group weights were not included in analysis since pens were balanced for these factors.

4.2.2.4 Course Dimensions

Arrow Colour	**Distance walked (m)**	**Width of Course (m)**
Red	8.56	1.04
Blue	4.51	0.98
Pink	1.34	0.76
Green	1.68	1.04
Yellow	0.49	1.04
Light Blue	2.53	1.04
Lavender	2.80	1.04

Table 4.6. Dimensions of the Course- Arrows relate to those used in Figure 4.2.

Barrier	**Height of Barrier (m)**
Wheeled Hurdles	0.88
Low Fence	0.82
Metal Fence	1.28
Railed Hurdles	0.98

Table 4.7. Heights of Different Fencing throughout the Course

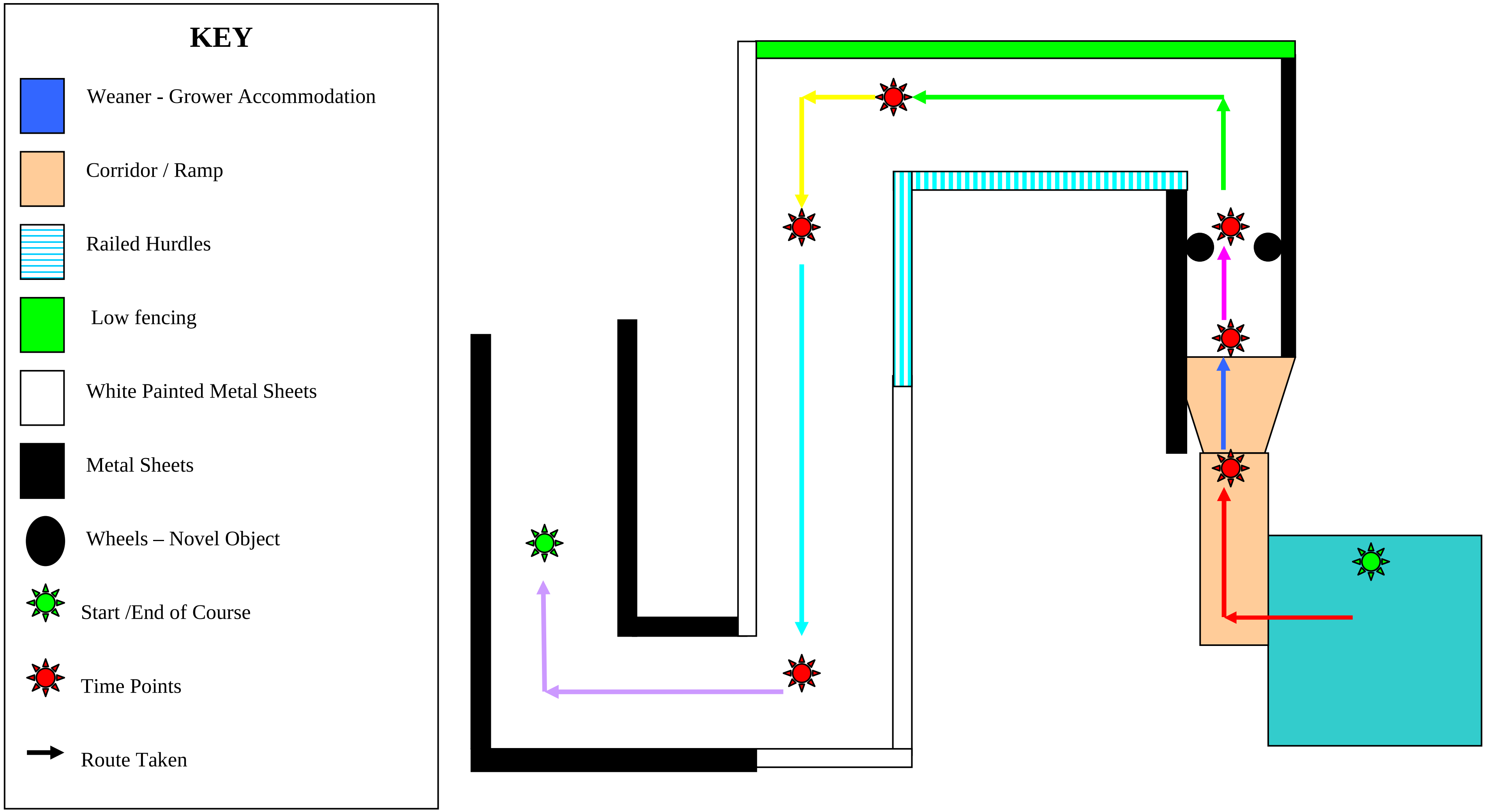

Figure 4.2. Layout of the Course used. Arrows show the route taken by pigs, stars show time points.

4.3 Results

4.3.1 Movement of Weaner Piglets

4.3.1.1 Trials 1-4 Comparison

Total Time Taken to Complete Course

Significant effects were seen between genotypes in the total time taken to complete the course (Figure 4.3; *F*= 10.60, d.f. = 2, *P*<0.01). There was also a time effect, whereby pigs completed the course quicker with consecutive trials ($F= 25.65_{3, 27}$, *P*<0.001). However, there was no significant genotype/trial interaction.

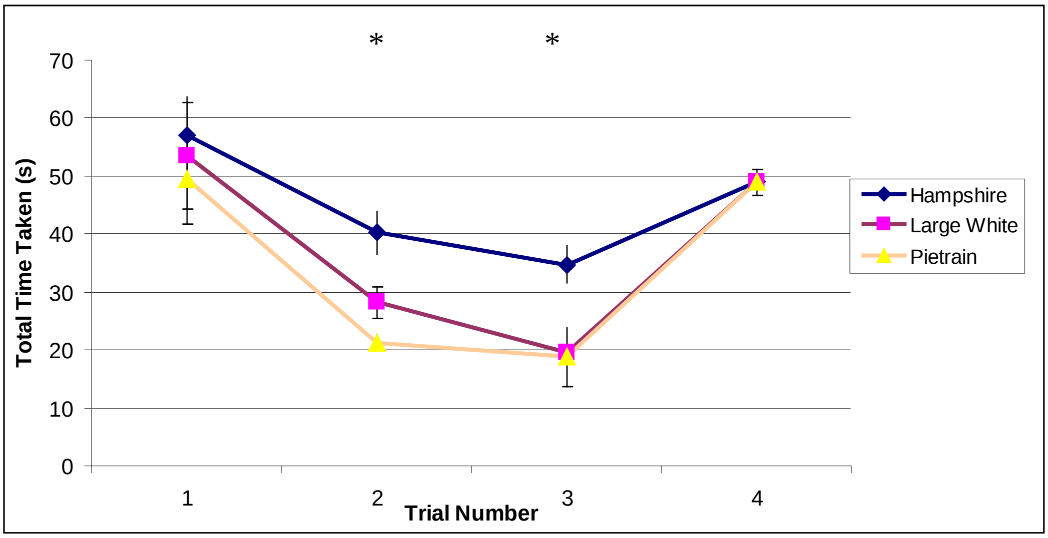

Figure 4.3. The total time taken to complete the movement course in Trials 1-3 and Trial 4 (novelty trial). Significant genotype effects (P<0.01) and time effects (P<0.001) were found. Genotype effects are indicated by asterisk. Pigs became quicker to complete the course over Trials 1, 2 and 3.

All genotypes became slower when faced with novelty, with the time taken reflecting the times seen in Trial 1. Hampshires were consistently slower to complete the course than Large White and Pietrain pigs.

Time taken away from the Home Pen

A significant genotype effect was found here, with Pietrains reaching the barricade fastest (table 4.8). Hampshire pigs were slowest throughout (*F*= 15.97, d.f. = 2, *P*<0.001). A time effect was also apparent, with trials 1-3 becoming progressively faster for all genotypes. Trial 4 however was much slower ($F= 25.80_{3, 27}$, *P*<0.001).

Time taken towards the Home Pen

A significant genotype effect was also found on the return to the home pen (Table 4.9, *F*= 4.43, d.f. = 2, *P*<0.05), with Pietrains and Large Whites being faster than Hampshires. The time taken also became faster with successive trials ($F= 12.18_{3, 27}$, *P*<0.001).

	Hampshire		Large White		Pietrain	
	Mean	**SE**	**Mean**	**SE**	**Mean**	**SE**
Trial 1	27.8	5.88	26.3	4.15	25.8	3.52
Trial 2	17.5 a	1.71	13.3 b	2.29	9.0 c	0.91
Trial 3	13.8 a	0.95	7.8 b	0.48	7.3 b	1.11
Novelty (4)	32.3	1.25	32.3	1.19	32.3	0.91

Table 4.8. Mean Time taken away from the Home Pen (s) across Trials 1-4 for Trial Groups. All genotypes were significantly different in Trial 2, whilst in Trial 3, Hampshire pigs took significantly longer (P<0.001).

	Hampshire		Large White		Pietrain	
	Mean	**SE**	**Mean**	**SE**	**Mean**	**SE**
Trial 1	29.3	2.95	27.3	5.31	23.8	5.14
Trial 2	22.8 a	3.12	15.0 b	1.78	12.3 b	1.11
Trial 3	21.0 a	3.85	11.8 b	1.49	11.5 b	4.56
Novelty (4)	16.8	0.25	16.8	1.31	16.8	1.50

Table 4.9. Mean Time taken Towards Home Pen (s) across Trials 1-4 for Trial Groups. The same pattern emerged here as seen in the time taken away from the pen (P<0.001).

Management Score Away from Pen

Differences were seen between genotypes (F= 6.50, d.f. = 2, P<0.01) and trials (F= 2.73 $_{3, 27}$, P=0.087) as well as a significant genotype/trial interaction (F= 6.41 $_{6, 27}$, P<0.01). Figure 4.4 shows that Pietrains were most difficult to manage, whilst Large Whites were consistently easy throughout Trials 2-4. Hampshire and Pietrain pigs both showed an increase in management difficulty in Trial 2.

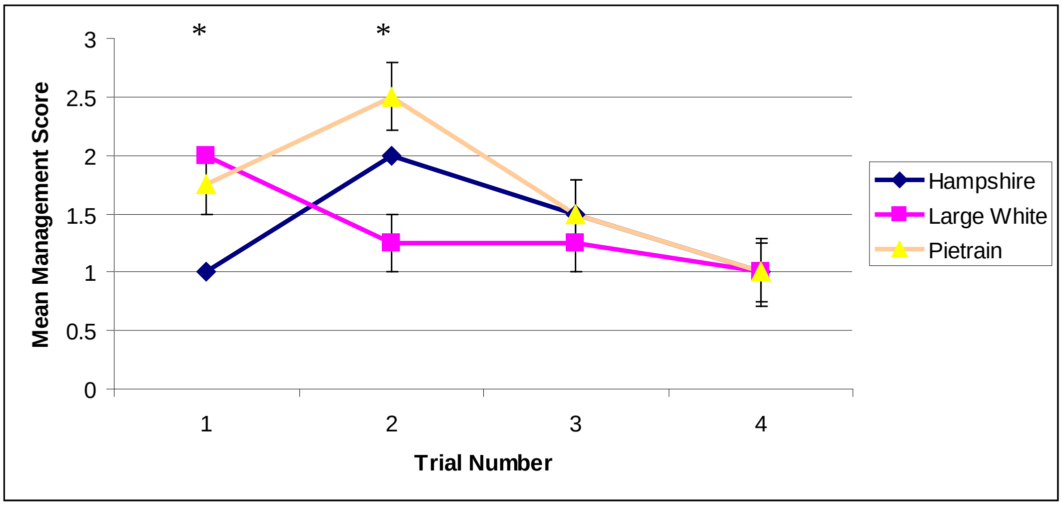

Figure 4.4. Management scores across trials 1-4 for each genotype. Asterisk indicate where significant differences are found between genotypes within a trial (P<0.01).

Management Score towards Home Pen

No significant differences were found in the return to the pen, however there was a genotype trend for Pietrains to be more difficult than both other genotypes (Table 4.10, F= 4.15, d.f. = 2, P=0.053).

	Mean	SE
Hampshire	1.81	0.16
Large White	1.56	0.18
Pietrain	2.31	0.15

Table 4.10. Mean management score towards the Home Pen for all Trials combined

Speed Score away from the Home Pen

Significant differences were seen between genotypes (F= 11.21, d.f. = 2, P<0.01) and trials (F= 30.67 $_{3, 27}$, P<0.001). A significant genotype/trial interaction was also found (F= 4.83 $_{6, 27}$, P<0.01). Figure 4.5 shows that Hampshires were generally less speedy throughout the trials than the other genotypes. Large White and Pietrain pigs followed a very similar pattern however. All genotypes became much slower paced in Trial 4.

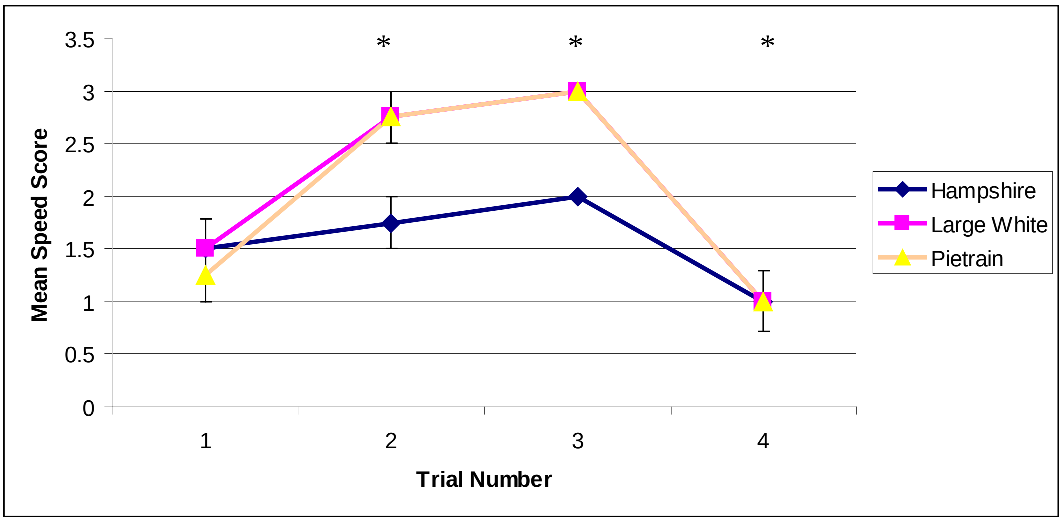

Figure 4.5. Speed score away from the Home Pen for each Genotype across Trials. Asterisk indicate where genotypic differences lie within trial (P<0.01). Hampshires were the slowest paced genotype throughout.

Speed Score towards the Home Pen

Significant effects of both trial (F= 5.82 $_{3, 27}$, P<0.01) and genotype (F= 23.90, d.f. = 2, P<0.001) were found here (Table 4.11). Hampshires again had lower speed scores than the other genotypes, who mirrored each other. Again, all genotypes had the same speed score when faced with novelty. All genotypes increased in pace over Trials 1-3, before dropping dramatically in Trial 4.

Genotype	*Mean*	*SE Mean*
Hampshire	**1.8** [a]	**0.2**
Large White	**2.6** [b]	**0.1**
Pietrain	**2.8** [b]	**0.2**

Table 4.11. Changes in Speed score over trials for each genotype (P<0.001). Hampshire pigs were significantly slower paced than the other genotypes.

4.3.1.2 Trial 3 vs. Control Group

Total Time Taken to Complete Course

There were significant differences in the time taken to complete the course (F= 108.07, d.f. = 1, P<0.001). This difference was also apparent between genotypes (F= 12.48, d.f. = 2, P<0.001), and a genotype/trial interaction was found (F= 4.00, d.f. = 2, P<0.05). Figure 4.6 illustrates that all control genotype groups took longer to complete the course than trial pigs. Pietrains were also the fastest genotype to finish.

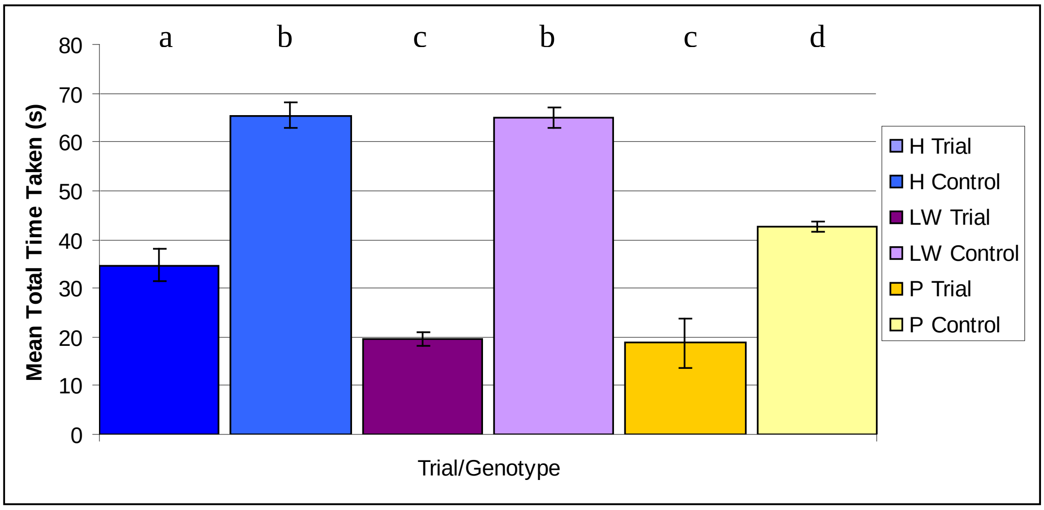

Figure 4.6. The total time taken to complete the course by genotype in Trial and Control groups. Hampshire and Large White Control Groups took significantly longer (P<0.05).

Time Taken Away from the Home Pen

Significant differences were found between control and trial pigs (F= 513.37, d.f. = 1, P<0.001). Genotype differences were also found (F= 57.46, d.f. = 2, P<0.001). There was a significant genotype/trial interaction (Table 4.12, F= 8.21, d.f. = 2, P<0.01).

	Time Away from Home Pen (s)				Time Towards Home Pen (s)			
	Trial Group		**Control Group**		**Trial Group**		**Control Group**	
	Mean	*SE*	*Mean*	*SE*	*Mean*	*SE*	*Mean*	*SE*
Hampshire	13.8 [a]	0.95	37.5 [b]	1.06	21.0 [a]	3.85	28.0 [b]	3.54
Large White	7.75 [a]	0.48	27.0 [b]	0.71	11.8 [a]	1.49	38.0 [b]	2.84
Pietrain	7.25 [a]	1.11	22.5 [b]	0.35	11.5 [a]	4.56	20.0 [b]	1.42

Table 4.12. Time taken towards and away from the home pen for Trial and Control groups of genotypes. Trial groups took significantly less time than Control groups for all genotypes (P<0.01)

Time Taken Towards the Home Pen

Control pigs took significantly longer to return to the pen than Trial pigs (F= 17.10, d.f. = 1, P<0.001). Trends were found towards genotype differences (Table 4.12, F= 3.14, d.f. = 2, P=0.08) and a genotype/trial interaction (F= 3.37, d.f. = 2, P=0.07).

Management Score Away from the Home Pen

Trends were found towards genotypic differences between Trial and Control pigs (F= 2.77, d.f. = 2, P=0.103), whereby Pietrain pigs were most difficult to manage. A trend was also seen for a genotype/trial interaction (Table 4.13, F= 3.18, d.f. = 2, P=0.08).

	Score Away from Home Pen				Score Towards Home Pen			
	Trial Group		**Control Group**		**Trial Group**		**Control Group**	
	Mean	*SE*	*Mean*	*SE*	*Mean*	*SE*	*Mean*	*SE*
Hampshire	1.50	0.29	1.00	0.00	2.00	0.41	1.50	0.35
Large White	1.25	0.25	2.00	0.00	1.00	0.00	1.50	0.35
Pietrain	1.50	0.29	2.50	0.35	2.25	0.25	2.00	0.00

Table 4.13. Trial and Control group differences in management scores.

Management Score towards the Home Pen

A trend for a genotype difference was found here (F= 3.29, d.f. = 2, P=0.07). Pietrain pigs were most difficult to manage.

Speed Score Towards the Home Pen

Significant differences were found between Control and Trial pigs (F= 32.19, d.f. = 1, P<0.001). A genotype/trial interaction was also found (Figure 4.7, F= 5.90, d.f. = 2, P<0.05). Large White control pigs were the slowest group, whilst Large White trial pigs had the fastest pace. All control groups were slower than their associated genotype trial groups.

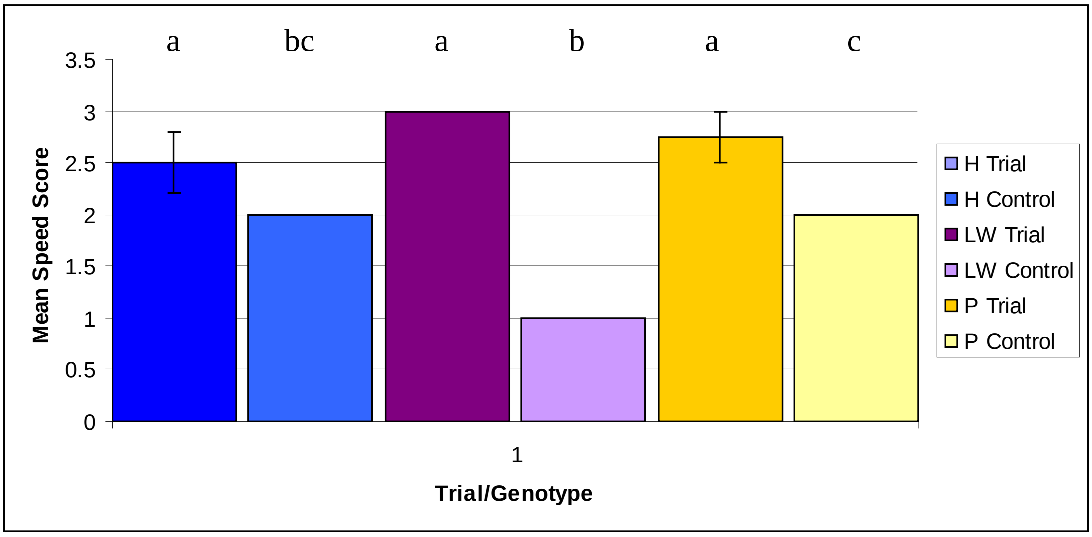

Figure 4.7 Speed Scores towards the Home Pen for Control and Trial Pigs. All Trial groups were faster paced than Control groups (P<0.05).

4.3.1.3 Novelty Trial – Control Pigs vs. Trial Pigs

Total Time Taken to Complete Course

Significant effects were found between genotypes (*F*= 172.01, d.f. = 2, *P*<0.000) and trials (*F*= 32.27, d.f. = 1, *P*<0.001). There was also a genotype/trial interaction (Figure 4.8, *F*= 13.4, d.f. = 2, *P*<0.001). Hampshire Control pigs took the longest of all groups, however, Pietrain Control pigs were the fastest group.

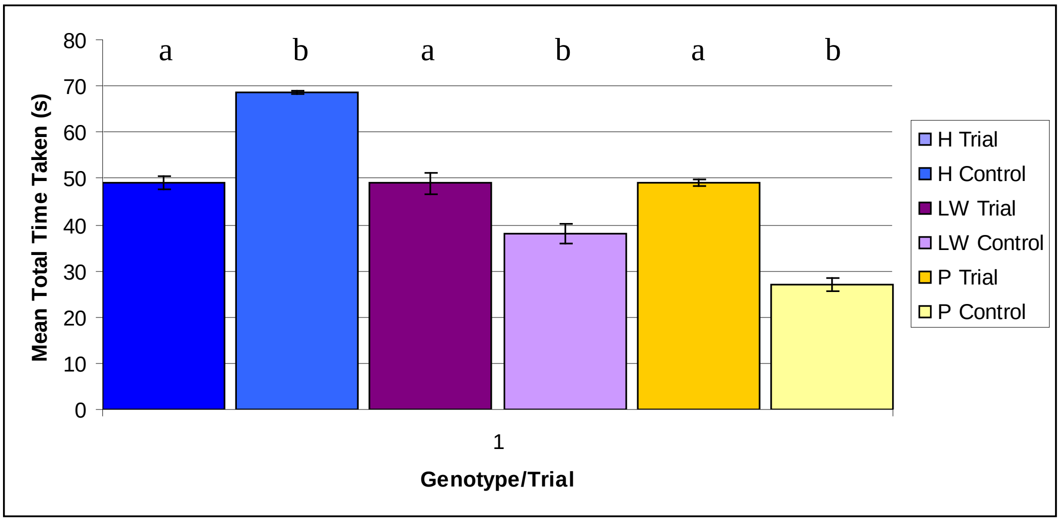

Figure 4.8. Total time taken for control and trial groups when faced with novelty. Hampshire Control pigs took longer than all other groups – notably longer than Hampshire Trial pigs. All other Control groups took less time than Trial groups of the same genotype (P<0.001).

Time Taken Away from the Home Pen

Significant differences were found between trial groups (*F*= 5.69, d.f. = 1, *P*<0.05), whereby Control groups were faster than Trial groups (Table 4.14)

	Mean (s)	SE
Trial Group	20.92	2.81
Control Group	23.50	4.07

Table 4.14. Group differences in the time taken away from the home pen (s). Control groups were significantly faster (P<0.05).

Time Taken Towards the Home Pen

Significant differences were found between genotypes (*F*= 39.95, d.f. = 2, *P*<0.001) and trial groups (*F*= 24.84, d.f. = 1, *P*<0.001). A genotype/trial interaction was also found (*F*= 25.09, d.f. = 2, *P*<0.001). Control Hampshire pigs took the longest to return to the home pen, whilst Control Large Whites were fastest. Control Large White and Pietrains were faster than all other groups (Table 4.15).

	Time Taken Towards the Home Pen(s)				
	Trial Group		**Control Group**		
	Mean	*SE*	*Mean*	*SE*	
Hampshire	16.8	0.25	34.5	1.06	*
Large White	16.8	1.31	13.5	2.48	*
Pietrain	16.8	1.50	15.0	0.00	

Table 4.15. Genotype and group differences in the time taken to return to the home pen (P<0.001). Asterisk show where significant differences lie on rows. Hampshire and Large White Control groups were slower than Trial Groups.

Management Score Away from the Home Pen

A significant genotype difference (*F*= 7.26, d.f. = 2, *P*<0.01) and a trend towards trial differences (*F*= 3.70, d.f. = 1, *P*=0.08) were apparent here. A genotype/trial interaction was also indicated as a trend (Table 4.16, *F*= 1.93, d.f. = 2, *P*=0.19).

	Management Score Away from the Home Pen			
	Trial Group		**Control Group**	
	Mean	*SE*	*Mean*	*SE*
Hampshire	1.0	0.00	2.0 b	0.00
Large White	1.0	0.29	2.5 a	0.35
Pietrain	1.0	0.25	2.0 b	0.00

Table 4.16. Management score differences between genotypes and trial group. The Large White Control Group was the hardest to manage (P<0.01).

Management Score Towards the Home Pen

A trend was seen here for trial differences (F= 4.0, d.f. = 1, P=0.07), as well as a genotype/trial interaction (Figure 4.9, F= 4.0, d.f. = 2, P<0.05). Control Hampshires and Large Whites were more difficult to manage than the associated genotype Trial group. Pietrains showed no differences.

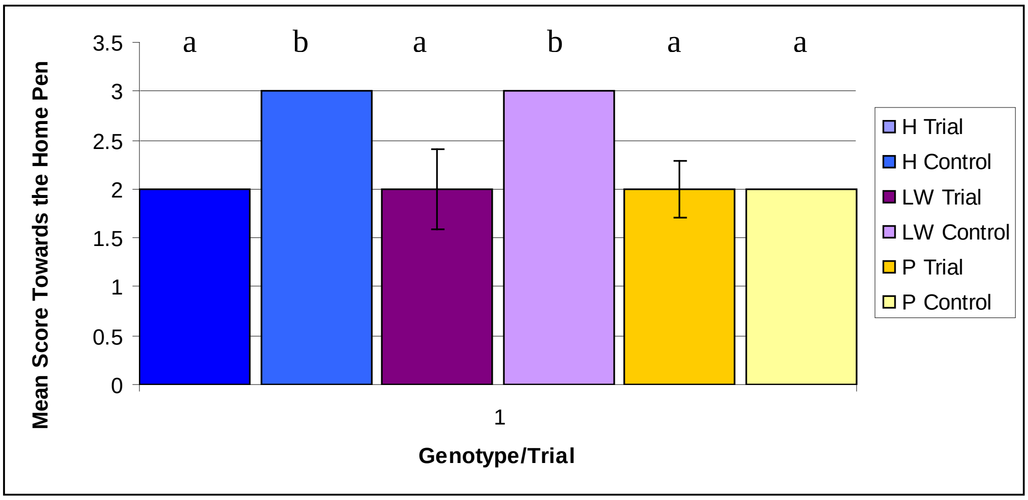

Figure 4.9. Genotype and Trial Group differences in management score towards the Home Pen (P<0.05). Hampshire and Large White Control Groups were hardest to manage.

Speed Score Away from the Home Pen

Genotype differences (F= 57.33, d.f. = 2, P<0.001), trial group differences (F= 12.0, d.f. = 1, P<0.01) and a significant genotype/trial interaction were found (F= 4.0, d.f. = 2, P<0.05). Figure 4.10 illustrates that Control Large Whites and Pietrains were the fastest paced groups, whilst all other groups were slow paced.

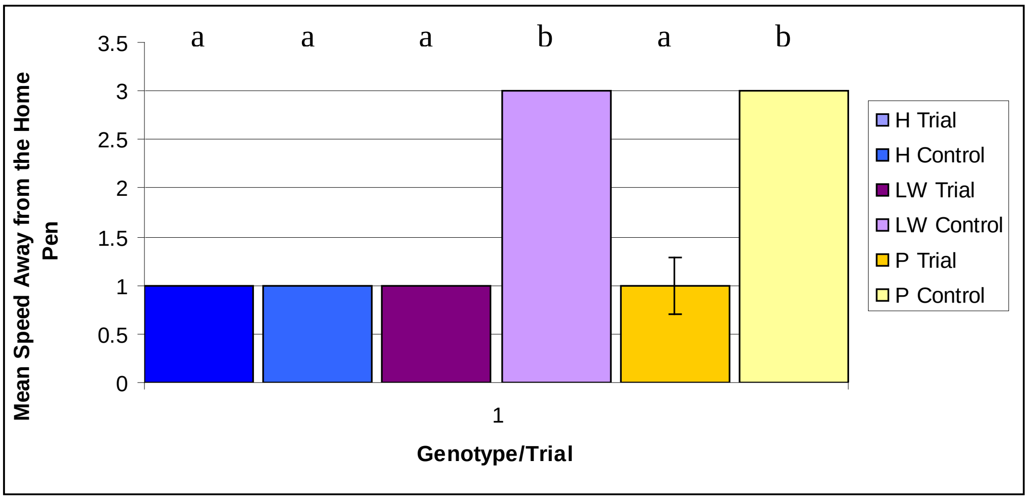

Figure 4.10. Speed scores away from the home pen for genotypes and trial groups (P<0.05). Large White and Pietrain Control Groups were the fastest paced groups.

Speed Score Towards the Home Pen

A significant genotype difference was apparent here (*F*= 14.18, d.f. = 2, *P*<0.001). However no trial group differences were apparent. Table 4.17 shows that Pietrain pigs were the fastest paced of the three genotypes.

	Mean	SE
Hampshire	1.00 [a]	0.00
Large White	2.17 [b]	0.31
Pietrain	2.67 [b]	0.21

Table 4.17. Genotypic differences in mean speed returning to the home pen (P<0.001).

4.3.2 Movement of 15 Week Old Pigs Through A Maze

4.3.2.1 Total Scores and Times Taken

Pietrains took numerically less time than both Hampshire and Large White pigs to complete the course, although this was not statistically significant (*F*= 1.77, d.f.= 2, *P*=0.186). Table 4.18 shows that Pietrains and Hampshires were the most difficult to manage. Large Whites had the highest Speed Score, but the longest time taken, suggesting that they had a good pace and did not bolt through the course.

	Total Time (s)		***Total Management Score***		***Total Speed Score***	
Genotype	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**
Hampshire	170.5	26.6	2.7	0.1	2.7	0.2
Large White	178.2	31.6	2.4	0.2	3.1	0.2
Pietrain	116.5	14.3	2.7	0.1	2.8	0.1

Table 4.18. Mean Total Values for Time Taken, Management Score and Speed Score. No significant effects were found, however, Pietrains were numerically quicker with a faster pace but hard to manage.

4.3.2.2 Time Taken for Each Area of the Course

No significant differences were found between the genotypes in times taken to complete different parts of the course (Table 4.19). However, trends were seen, as illustrated in Figure 4.11. In general, Pietrains were quickest to complete each part of the course, with Large Whites taking longest in some areas. Hampshires appeared to have a steady pace throughout.

Area of Course	***F Value***	***DF***	***P Value***
Pen	1.19	2	0.32
Ramp	2.61	2	**0.08**
Novel	0.57	2	0.57
Open	3.06	2	**0.06**
Corner	2.08	2	0.14
White	2.16	2	0.13
U Corner	0.64	2	0.53

Table 4.19. P values for the genotypic comparison of the time taken to complete each area of the course. The Ramp and Open areas found trends towards genotypic differences.

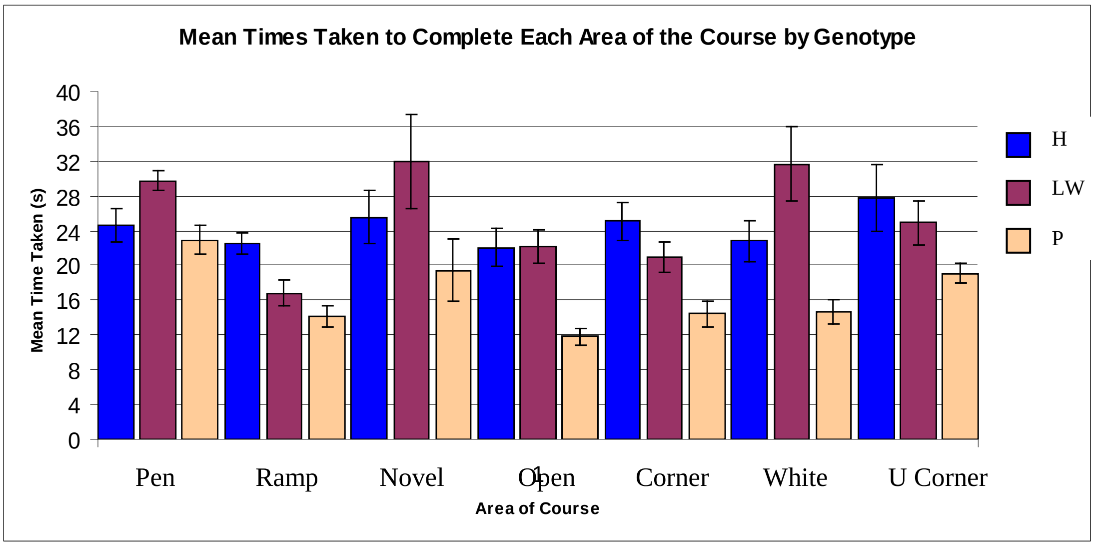

Figure 4.11. Time Taken to Complete Areas of the Course for Each Genotype. Pietrains were quicker to complete the Open area and Ramp.

4.3.2.3. Management Score for Areas of the Course

No significant differences were apparent between genotypes regarding management score over different areas of the course, with the exception of the score for moving down the ramp (Table 4.20; F= 4.95; d.f. = 2; P<0.05). Numerically, Large Whites were generally the easiest genotype to manage, when moving down the ramp. Pietrains were hard to manage, particularly in the first stages of the course. Hampshires however were difficult moving from the pen, and the latter stages of the course.

	Pen		Ramp		Novel		Open		Corner		White		U Corner	
	Mean	*SE*	*Mean*	*SE*	*Mean*	*SE*	*Mean*	*SE*	*Mean*	*SE*	*Mean*	*SE*	*Mean*	*SE*
Hampshire	**2.9**	0.23	**2.3ab**	0.23	**2.6**	0.19	**2.6**	0.19	**2.9**	0.23	**2.8**	0.22	**2.8**	0.22
Large White	**2.5**	0.20	**1.8a**	0.27	**2.7**	0.26	**2.8**	0.25	**2.8**	0.18	**2.1**	0.29	**2.5**	0.29
Pietrain	**2.8**	0.21	**2.8b**	0.17	**2.8**	0.24	**2.6**	0.23	**3.1**	0.19	**2.3**	0.23	**2.5**	0.14

Table 4.20. Management Scores per Genotype for Different Areas of the Course. Superscripted letters identify any significant differences between genotypes. This only occurred in scores for the Ramp area (P<0.05), whereby Pietrains were the hardest to manage.

4.3.2.4. Speed Scores for Each Area of the Course

Speed Score differences were found between the genotypes as shown in Figure 4.12. LW pigs showed a tendency to be faster paced than the other two breeds in all areas (leaving the home pen; F= 2.63; d.f. = 2; P=0.08; descending the ramp, F= 3.05; d.f. = 2; P=0.06; moving around the U corner F= 5.27; d.f. = 2; P<0.05).

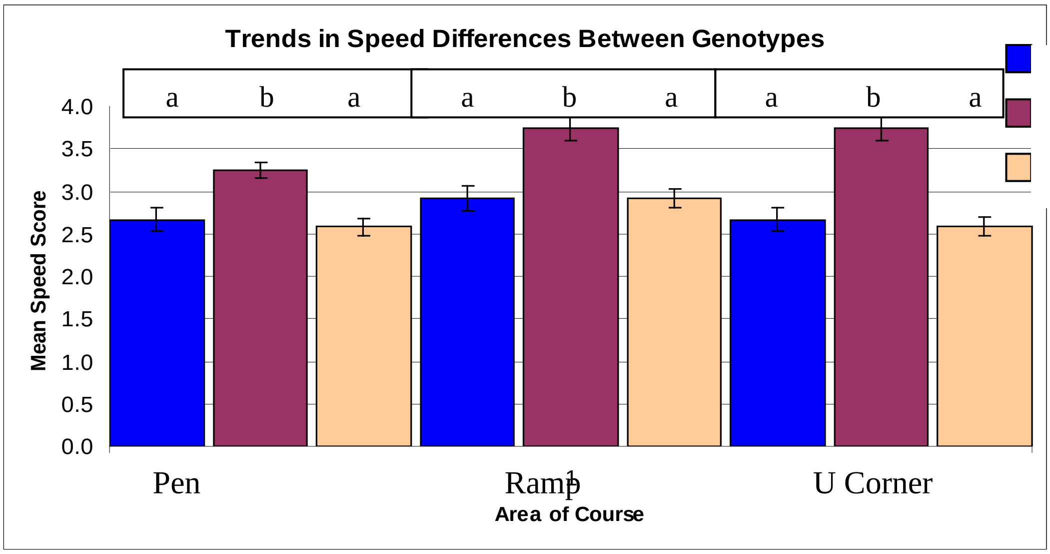

Figure 4.12.Speed Differences When Moving through Selected Areas of the Course. Superscripted letters signify genotypic differences for each area. The U Corner area found Large Whites to be significantly higher in speed score than the other genotypes (P<0.05).

4.4 Conclusions and Discussion

These experiments aimed to identify the ease of movement of three pig genotypes around a standard farm unit. The methods used here successfully highlighted that differences exist between genotypes regarding their behavioural reaction to being managed in routine circumstances. Analysis of the weaner piglets revealed that in Trial 1, Pietrain pigs were the quickest genotype to complete the course. However, over the following trials, it became apparent that Large White and Pietrain pigs were prone to completing courses quickly, whilst Hampshire pigs remained slower. When combining this with the management scores, Hampshire pigs were then seen to be relatively easy to manage, due to their slower pace. Pietrain pigs proved most difficult, having a tendency to bolt through the course, and therefore became harder to control. This data is comparable to the Bacon Weighing results (see Chapter 5), where Pietrains were seen to bolt into the weighing equipment. Pietrains were shown to be more difficult to manage than the other genotypes, which is perhaps attributed to a trait for bolting when faced with an unknown situation. The group tended to become disjointed, making it harder to drive the pigs forward. This may be explained by De Jong *et als*.' (2000) theory of a reduced need for social support, and may indicate a minimally fearful response.

Conversely, Large White pigs reached a low management score in Trial 2 and remained at this level. These results suggest that genotypic variation does exist, and can affect routine management procedures. Hampshire pigs appear to be preferential here, due to their calm movement; however, they did require high labour input to maintain pace. Pietrain pigs are fast to move, and may therefore be well suited to units where movement is required at various stages of production. However, their tendency to bolt requires well-built races, and perhaps they may be best driven by building a complete route between destinations and allowing them to effectively move themselves.

Large White pigs appeared to be well suited to the on-farm system used here, as they were capable of keeping good pace, whilst remaining grouped. This would enable lower labour input.

The capability of the genotypes to learn the course seemed to be similar. Large reductions were seen in the time taken to complete the course between trials 1 and 2. However, management score increased in trial 2 for Hampshire and Pietrain pigs, suggesting that repeated movement of these genotypes may not be beneficial. Despite this, in trial 3 they attained low management scores. This may suggest that management ease can be altered beneficially by moving pigs, but only after two runs.

Large White pigs became consistently easier to manage over trials, but the most improvement was seen between trials 1 and 2. Therefore, they may only require two movements from the home pen before becoming sufficiently habituated to confer an advantage to the handler.

Although no significant differences were found when comparing the response of genotypes to the movement challenge, the results clearly show that pigs are capable of learning a simple route and becoming familiar with it and therefore more confident. This was evident after just a few trials. Previous literature focussing on pre-slaughter movement from the home pen suggests that pigs need to be handled on several occasions in order to purvey an advantage on the time taken to load into lorries at slaughter (Geverink *et al.*, 1998; Abbott *et al.*, 1994). Geverink *et al.* (1998) presented results showing a marked decrease in latency to leave the home pen between Trials 1 and 2 in their research, with consequent trials showing a reduced effect. This is mirrored in the present study (Figure 4.3), whereby all genotypes had a reduced difference in reaction between Trials 2 and 3 than the initial decrease in time taken seen between Trials 1 and 2.

With this in mind, it may therefore be recommended that driving pigs from their pens at least once before a particular event (e.g. slaughter day loading, movement to new buildings) may significantly decrease the workload. Obviously this requires additional labour prior to the event, but with time scheduling often tight on slaughter day, it may be beneficial to invest time on a less hectic day. With advantages seen after just one trial, this would not be a massive task.

Research such as Abbott *et al.* (1994) and Geverink *et al.* (1998) implicates that meat quality can be improved by the use of such techniques. In this research, pigs were moved in the immediate post-weaning period to see whether behavioural traits were recognisable at a younger age, and if learning capacity is already apparent. This was felt to be important, as the logistics of moving pigs at a young age are preferential to moving pigs prior to slaughter. If pigs are capable of storing information long term, movement in the post-wean period may be enough to confer a benefit at slaughter. This may be particularly true if pigs are driven along the route that they will experience at slaughter, maybe even incorporating transport. Good farm management may therefore take this opportunity at a time of routine movement such as relocation from grower to finisher accommodation.

Care was taken in this research to ensure that effects seen over trials were not the result of age effects, but could be attributed to learning. The use of control groups identified that this was indeed the case, as naïve control pigs and pigs with experience of two previous trials behaved significantly differently. The behaviour of control pigs showed similarity to the responses seen in trial 1. This clearly illustrates that learning has positive effects on ease of movement, whilst age has little effect.

The novel object clearly had impact on the movement of all pigs, with the time taken to complete the course being slower than that seen in trial 3. Whilst Large White and Pietrain pigs became much slower when faced with novelty, Hampshires slowed to a lesser extent. Management of all genotypes became easier, possibly due to the slower movement. Pietrain pigs did have a tendency for being most difficult however. De Jong *et al.* (2000) defined fearfulness of a novel object as an increased latency to leave the home pen. They also concluded that the disbanding of a group suggested a decreased requirement for social support. It should follow therefore that the increased time to complete the course seen in the pigs indicated a fearful response, and that time was needed before the environment could be perceived as unthreatening. Hampshire pigs did not show such a strong response. This should lead to the conclusion that they were less fearful. Observation of the reactions suggested that the pigs were intrigued by the novel object and slowed to investigate it. Pietrain pigs however were more inclined to approach fearfully. Management scores were also affected here, with all pigs showing a similar difficulty.

To combat this discrepancy over the interpretation of behaviours, it may be beneficial to film behavioural work of this nature to enable detailed evaluations to be made. However, this could lead to over-analysis of the footage, making it more difficult to decipher from a farming perspective, whereby opinion is formed quickly over how to manage animals and the traits they purvey.

The movement of pigs through a more complex maze at 15 weeks of age found no strong genotypic differences. However, it did highlight problematic areas for the pigs to navigate. All genotypes were difficult to move from the pen, as has been previously shown by Abbott *et al.* (1994). Moving down the ramp caused Hampshire pigs to take longer than Pietrain pigs, however, management score was higher for Pietrain pigs here due to fast movement down the ramp away from the handler. Brown *et al.* (2005) found that pigs being loaded into transport using ramps tended to stop or turn round frequently. They suggested that the ramp caused no physical difficulty, so the response found was purely a behavioural one. The first steps seemed to be most difficult, both here and in Brown *et al.*'s work, but once progression was made, the pigs found it unproblematic.

The more open areas of the course seemed to instigate easier movement. This was originally thought to be due to the effects of illumination (see Chapter 5), but movement through the white painted areas caused some difficulty. Pietrains seemed to have no issues in this area, with a quick time and a low management score compared to the other genotypes. Interestingly, Large White pigs seemed to react aversively with a long period of time spent in this area. This is in contrast to the results found in older Large White pigs encountering white areas (again, see Chapter 5), but this could be merited to higher interest in the area rather than a fearful reaction. In the Slaughter Weighing Trials later in this thesis pigs did not have time to investigate the apparatus due to the need for efficient practice.

Corners were problematic for all genotypes, as expected, due to anticipation of the upcoming areas of the course which couldn't be seen. The U Corner presented more difficulty than the right angled corner, possibly because of a higher amount of back turning rather than following the curve of the bend.

Comparative to the movement of the weaner piglets, novelty in this trial had an impact on the movement of pigs. Large White pigs slowed down dramatically, and became difficult to manage, similarly to the behaviour seen in younger pigs. 15 week old Hampshire pigs also showed similar characteristics to the weaner pigs, and indeed Large Whites. Pietrain pigs were quick to pass the novel object at 15 weeks, a pattern not seen in younger pigs. They also became the hardest genotype to manage through this area.

These results indicate a certain level of consistency in behaviour over time and situations. This facilitates the opportunity to interact with pigs at a younger age in order to prepare them for later challenges. Although the two movement trials were similar, the challenging aspects of the 15 week trial served to encompass some of the characteristics of typical slaughter day movement from the home pen, through unfamiliar areas (including outdoors and into an aversive environment) including the use of ramps, changes in surface and the presence of barriers blocking sight. The subtle differences in response seen between genotypes suggests that there would be no real benefit to designing genotype specific walkways on farms, however, certain elements of the course were problematic to all, and so measures should be taken to adapt farm structure to eliminate these potential stressors. This should result in decreases in labour input, creating a happier workforce and contented pigs, ultimately leading to a better slaughter price.

Chapter 5. The Reaction of Slaughter-Age Pigs to being Handled, Restrained and Weighed

5.1 Introduction

This chapter focuses on the behavioural response of pigs at slaughter weight to a routine handling procedure. Genotypic differences have rarely been measured in relation to behaviour at slaughter, but this may be of equal importance to the more widely researched effects on meat quality. Literature exists on the detrimental effects of transport (Werner *et al.*, 2007) and the handling procedures used in slaughter lairage (Geverink *et al.*, 1998). However, there is a lack of knowledge concerning the effects of handling and breed differences prior to slaughter treatment, and this research aims to target this.

It is well known that stress levels are elevated by the procedures leading to slaughter (transport, movement, lairage) and this can have detrimental effects on meat quality due to varying glycogen levels (Nielsen, 1981). It can lead to Pale Soft Exudative (PSE) meat or Dark Firm Dry (DFD) meat. This highlights the importance of developing handling procedures which increase the ease of handling.

DFD meat is thought to arise from physical stressors preceding slaughter, as it results from muscle glycogen depletion caused by prolonged physical activity (Kyriazakis and Whittemore, 2006). The pH of the meat then fails to drop, and this is further exasperated by inadequate lactic acid production. PSE meat tends to be related to stress immediately pre-slaughter, for example that caused by poor handling. There is also a major gene affecting the occurrence of PSE. Porcine stress syndrome (PSS) elevates the prevalence of PSE meat, and is thought to be caused by the halothane gene which increases the susceptibility of the carrier to stress, particularly in homozygous carriers (nn) (Fabrega *et al.*, 2002). It has been reported that Pietrain type pigs often present as carriers, burdening them with a significant disadvantage when compared to heterozygous pigs of other breeds. Murray and Johnson (1998) also presented evidence that Pietrain type pigs have a higher mortality rate than their contemporaries.

Fabrega *et al.* (2002) discovered that halothane carriers were susceptible to higher cortisol levels after long durations in lairage. This resulted in additive stressors such as food deprivation, muscle glycogen depletion and skin blemishes. The research also discovered higher levels of LDH (lactate dehydrogenase) and CPK (creatine phospho-kinase) in the muscle. This gives further evidence to suggest that different genetic strains are affected differently by pre-slaughter handling, and possibly that halothane carriers require a recovery period prior to slaughter.

There are certain elements of halothane type pigs which render them significantly advantageous from a marketing perspective. A superior lean content and conformation due to lower fat and bone proportions and better carcass weight distributions make the halothane gene a desirable trait (Oliver *et al.*, 1993; Fisher *et al.*, 2000; Fabrega *et al.*, 2002; Leach *et al.*, 1996).

Carriers also have greater feed efficiency (DeSmet *et al.*, 1998) and greater carcass yield (Fisher *et al.*, 2000). However, the paler drip-prone meat produced by the halothane is not desirable. It is documented by many as an inverse relationship between carcass lean content and meat quality (DeSmet *et al.*, 1998; Fisher *et al.*, 2000). This should not have been a problem in the Pietrain type pigs used in the current project, since they were halothane negative.

These effects on meat quality have led to different breeds being selected depending on the farms objective. For example, the Hampshire pig line used in this research has been shown to reach slaughter weight at a faster rate than both Pietrain and Large White pigs, but suffer from a poorer feed conversion ratio (H.M. Miller, *personal communication*). Large White pigs have a higher feed conversion ratio, whilst Pietrains produce the greatest quantity of lean meat. Therefore, several factors have influence over meat breed selection.

However, many do not consider the behavioural implications of producing certain breeds. Pigs which are harder to manage in the period preceding slaughter may present a significant disadvantage due to a need for increased labour, effort and time (Weeding *et al.*, 1993). This may outweigh the benefits of the meat they produce.

The economic impact of this was shown by Weeding *et al.* (1993). They sourced ‘difficult to handle’ and ‘easy to handle’ pigs from different farms and exposed them to handling and transport procedures pre-slaughter. The ‘difficult to handle’ pigs were more susceptible to stress, leading to poorer meat quality. The ‘easy to handle’ pigs however appeared to cope better with the procedures. The identification of ‘easy to handle’ breeds could therefore result in reductions of the time invested to move pigs, a better experience for both stock and stockman, and ultimately good quality meat to the consumer.

Abbott *et al.* (1992) suggested that recent experience was of high importance to behaviour, and handled pigs in the weeks preceding slaughter. They found this instigated easier pig movement and reduced the stress response at slaughter. If recent experience does indeed impact upon the behaviour at slaughter, positive handling procedures in the immediate pre-slaughter period may be of paramount importance. Whilst there are studies which concentrate on the response of pigs to transport and being housed in lairage, few consider the on-farm effects prior to this. Abbott *et al.* (1997) did investigate this by selecting ‘difficult to handle’ pigs to complete an on-farm procedure prior to being loaded into lorries. 20 pens of pigs were moved ‘considerately’ from their home pen into an outside area, through weighing equipment, and returned to their pen for three consecutive weeks. Compared to control pigs, five times the number of pigs were willing to leave their home pen on slaughter day. The ability of pigs to learn and adapt to being handled suggests possibility for farms to adopt simple procedures which may ultimately improve carcass quality and reduce labour load.

The influence of handling prior to slaughter on meat quality has been presented by Geverink *et al.* (1998a). Differences were apparent in the temperature of the lean meat of pigs that were allowed to leave their pens in the weeks prior to slaughter to those that received no human contact. Those which were handled presented increased temperatures, and reduced glycogen levels and water holding capacity of the meat. Whilst glycogen breakdown was increased, this did not result in PSE meat. However, pigs exposed to moderate exercise in the work of Essén-Gustavsson *et al.* (1988) also presented elevated glycogen levels. This is thought to have some influence in Geverink *et al.*s' work, as by allowing pigs out of the home pen regularly, they also received exercise.

The current experiment focuses on the response of pigs to a standard pre-slaughter farm procedure. Many farms weigh pigs prior to slaughter to ensure that the target weight has been reached. This procedure requires pigs to be driven from their pens into a confined area and then for individuals to be isolated from their social group and restrained in weighing equipment, such as a metal crate. The pigs used in this research also needed to be identified using an ear tag given at weaning, and were therefore touched around the head area.

Many studies of this nature concentrate on numbers of leg, head or tail movements, escape behaviours, vocalisations and the latency to react. Violent struggling has been recorded by Veissier *et al.* (1989) in cattle, whilst reactions on exiting restraint apparatus have been measured in zebu by Burrow and Corbet (2000).

Observations on restrained animals have generally been conducted on cattle (Kilgour *et al*., 2006; Watts and Stookey, 1999; Boivin *et al.*., 1998). Geverink *et al.* (2002) presented work on the effects of restraining gilts by separating them into high and low resistance groups dependent on their performance in a back-test in the pre-weaning period. This was shown to predict the response seen when subjected to restraint using a nose sling in adulthood, with increased levels of vocalisation seen in high resistant gilts.

Coutellier *et al.* (2007) however recorded the reaction of pigs to being weighed as part of an experiment on social regrouping. Behavioural parameters incorporated measures of nervousness and calmness. Pig behaviours were recorded as they walked to the weighing equipment, entered into the equipment, and were contained in it. This restraint approach was also used in the current experiment; additionally, behaviour when leaving the crate and being given a new tag were recorded. Timings were taken for the time taken to process each pig. This approach was hoped to identify several parameters of behaviour associated with challenge, isolation and human interaction.

Perception of the pre-slaughter environment may be a key factor in behavioural response. Geverink *et al.* (1998b) found loading to be the most stressful phase of pre-slaughter handling and that ascending and descending the ramp to the transport vehicle may pose the largest perceived threat to pigs. Grandin (1987) however highlights that objects disassociated with the movement process may also affect stress levels. Clanking metal, flapping objects, puddles and drains all evoked a balking response.

It was therefore decided in this research to further investigate the effect of varying one element of the pre-slaughter environment. Research presented by Tanida *et al.* (1996) investigated the effect of shadows and patterns on piglet behaviour. They exposed pigs to various patterns of light and dark, such as stripes on the floor, use of a spotlight and the shadow of a person. Patterns on the floor were found to have less effect than shadow treatments, suggesting that the pigs feared being in darkness. They were latent to move unless provided with lighting. Grandin (1987) also supports this, with evidence that pigs have a tendency to gravitate towards illuminated areas.

With this in mind, it was decided that brightening the areas surrounding the weighing equipment may induce a more willing attitude to entering the weighing equipment. Only the vertical aspects of the weighing area were painted white, since Tanida *et al.* (1996) found that despite piglets being fearful of darkness, they were also fearful of walking on white lines.

The approaches described above therefore aim to firstly identify any behavioural differences between the genotypes, and secondly to establish which particular aspects of the weighing process have an impact on behaviour. This is to be achieved by independently scoring each challenge (e.g. loading, exiting).

Thirdly, this work aims to investigate whether altering aspects of the weighing apparatus have varying effects on different breeds, and if this is the case, whether this can be used as a basis for improving conditions by specifically tailoring systems to genotype.

5.2 Materials and Methods

One thousand and thirty five pigs were observed whilst being weighed prior to slaughter. Of these, 470 tagged pigs (H =164, LW =161, P =145) were used in Trial 1, and 193 non-tagged pigs (H =65, LW =63, P =65). Trial 2 used 210 tagged pigs (H =70, LW =70, P =70) and 162 non tagged pigs (H =54, LW =54, P =54).

These pigs were parented by Large White x Landrace sows served with single sire semen from one of the three genotypes; Large White, Hampshire or Pietrain.

To assess the response of individual pigs to weighing, pigs weighing on average 102.8±10.0 kg were observed one day pre-slaughter when being processed for final weights. These pigs had not previously been weighed in the equipment used, and any previous weighing had taken place at least two months prior to this study. These finishing pigs had received little contact with farm or research staff since moving into finisher accommodation, where they had resided for a minimum of ten weeks. Finisher accommodation was indoor and consisted of pens of 10 pigs on slatted floor accommodation.

Slaughter weighing equipment consisted of a standard Electronic Pig Weigh Crate enclosed in a metal penned area (Figure 5.1). The weigh crate (internal dimensions 1.280m × 0.410m; 0.765m high) was made of orange-painted metal bars with an entrance and exit on either end. The entry gate slid upwards and allowed the pig to enter the enclosed area by walking forwards and stepping onto a mesh floor. The gate then closed behind the pig and the whole weigh crate was lifted upwards by a lever, suspending the crate 0.05 m from the ground.

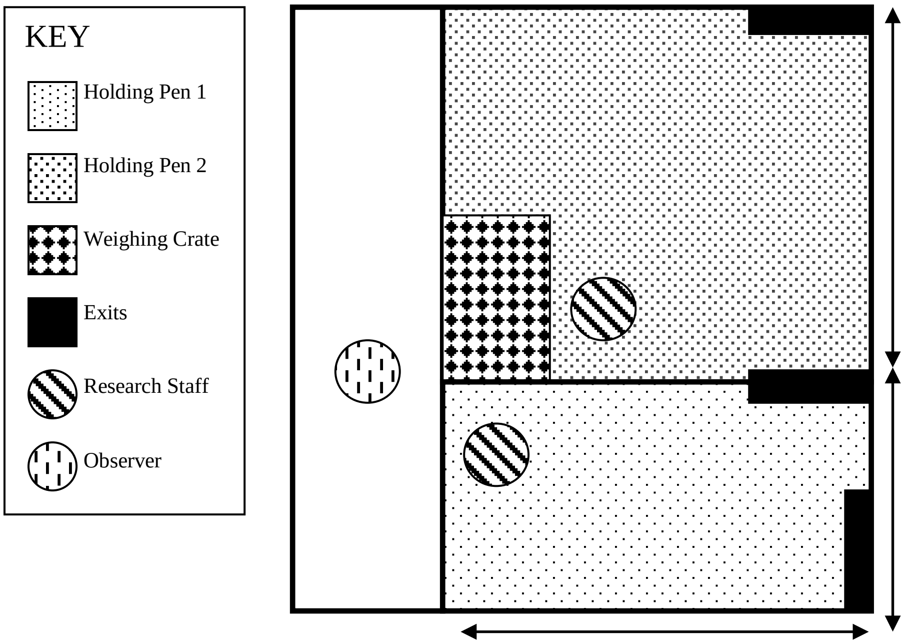

Figure 5.1. Slaughter Weight Pig Weighing Area. This figure indicates the position of the weigh crate and the location of research staff during the weighing procedure. Pigs were initially brought from their home pen into Holding Pen 1 pre-weighing. This was to enable faster processing of the pigs and keep them in their home pen groups. A pig was then selected at random to be moved into the weigh crate where a member of staff tagged it. The pig would then be released into Holding Pen 2 where it would remain whilst its comrade were weighed. All pigs were then moved back into their home pens.

The area surrounding the weigh crate was comprised of metal sheets measuring 1.30 metres high. These were pinned together to make the area shown in Figure 5.1. This created a holding pen prior to weighing to hold up to fifteen pigs, and a pen for the pigs to be held in post-weighing. Pigs were brought to the weighing area in home pen groups, typically comprising between 10 and 15 pigs. However, groups of 30 pigs were split in half and then brought into the weighing area. The order of bringing pigs out to the weighing area was completely random.

5.2.1 Trial 1 – Comparison of Genotype Differences in Behaviour during a Routine Weighing Process

At weighing, the individual ID (tag number), weight, approximate age, genotype and sex of each pig were recorded. The behavioural reactions of the pigs were scored on a 1-5 scale at each of 5 stages during the weighing procedure (Table 5.1). The time taken to complete each stage, and the overall time taken to weigh each pig was also noted as an additional measure of handling ease. Two categories of pigs were used; tagged and untagged and these were analysed separately. Tagged pigs had previously been part of a feeding trial on the unit, and therefore had received more human contact than untagged pigs. These pigs were therefore given a small button tag whilst being weighed, and so were scored for this in addition to other measures. The following subsections detail the procedure at each stage of weighing.

Loading

This involved a member of research staff guiding the pigs into the weigh crate using pig boards. The staff member was an experienced pig handler, and was therefore able to apply the same technique to all pigs to ensure standardisation. The test was started once the pig was lined up ready to enter the weigh crate. This was chosen as the start point as preliminary tests showed that if a pig was awkward to load, it was sometimes more efficient to select another pig rather than pursue the original. However, once pigs had reached the crate area, the handler was able to then continue the loading process. Pigs were given an individual score to reflect the ease with which they were loaded into the crate, which also gave an indication of how the pig was reacting. This part of the trial was considered complete once the pig was contained within the crate.

Behaviour in the Weigh Crate

Once contained in the crate, the pig remaining restrained whilst research staff held the ear of the pig to clean the tag. This stage lasted until the pig had been identified.

Tagging

This stage assessed the pigs' reaction to receiving a new tag into the right ear. Standard taggers were used to impart a small plastic button tag into the ear via piercing. Research staff had to hold the pigs' ear steady in order to achieve this, so restraint of the head was necessary.

Exit from the Weigh Crate

After the pig was successfully tagged, the lever on the weigh crate was adjusted to drop the crate back to ground level, and the exit door was swung open. This allowed the pig to see an opening in front of it. The pig was then allowed to leave the crate voluntarily, but if it did not move some encouragement was provided by gentle slapping on the rear, or talking to the pig. In some cases, the weigh crate entrance had to be opened and the pig pushed through the exit door.

Vocalising

Pig vocalisations were recorded as not occurring, occurring or occurring at a very loud volume. A pig was considered to have vocalised if it made agitated squeals at a time other than when it was tagged. All pigs vocalised whilst being tagged, but some were quiet for the rest of the weighing process.

Management Process	*Score*	*Description of Score*
Loading	**1**	Pig is willing to enter the crate with little or no encouragement
	2	Pig needs to be pushed gently some of the way into the crate
	3	Pig requires constant pressure to move into the crate
	4	Pig refrains from entering the crate and needs to be forcefully pushed in
	5	Pig refuses to move and attempts to escape the handler
Behaviour In Crate	**1**	Pig appears calm and stands still
	2	Pig appears frozen and fearful
	3	Pig rocks backwards and forwards
	4	Pig jumps around in the weigh crate and appears agitated
	5	Pig thrashes around and is very agitated
Tagging	**1**	Pig allows ear to be held and remains still
	2	Pig shuffles around whilst being tagged
	3	Pig rocks backwards and forwards
	4	Pig is agitated, jumps around in weigh crate and tosses head violently
	5	Pig thrashes and shakes and will not be restrained
Exit From the Weigh Crate	**1**	Pig leaves crate once door is opened with no encouragement
	2	Pig needs some gentle pushing to leave weigh crate
	3	Pig leaves crate after moderate pushing
	4	Pig has to be moved out of weigh crate using a series of forceful shoves
	5	Pig refuses to move voluntarily and is forcefully removed from weigh crate by being shoved or lifted fully out of the weigh crate.
Vocalisations	**1**	Pig vocalises loudly whilst contained in the crate
	2	Pig squeals agitatedly whilst contained in the crate
	3	Pig makes no vocalisations

Table 5.1. Ethogram for Behaviours whilst being Weighed

5.2.2 Trial 2 – Comparison of Genotypic Differences in Behaviour during a Routine Weighing Process with the Addition of White Painted Sheets to the Weighing Apparatus Area

This trial was identical to Trial 1, apart from the replacement of metal sheets in the weighing area (*Figure 5.2).* The original metal sheets used for Trial 1 were painted with white paint and reattached to the weighing area. The sheets chosen for painting were those adjoining the weigh crate, and additionally the one positioned directly opposite the front of the crate. Pigs were scored as in Trial 1, and tagged/untagged pigs were again analysed separately.

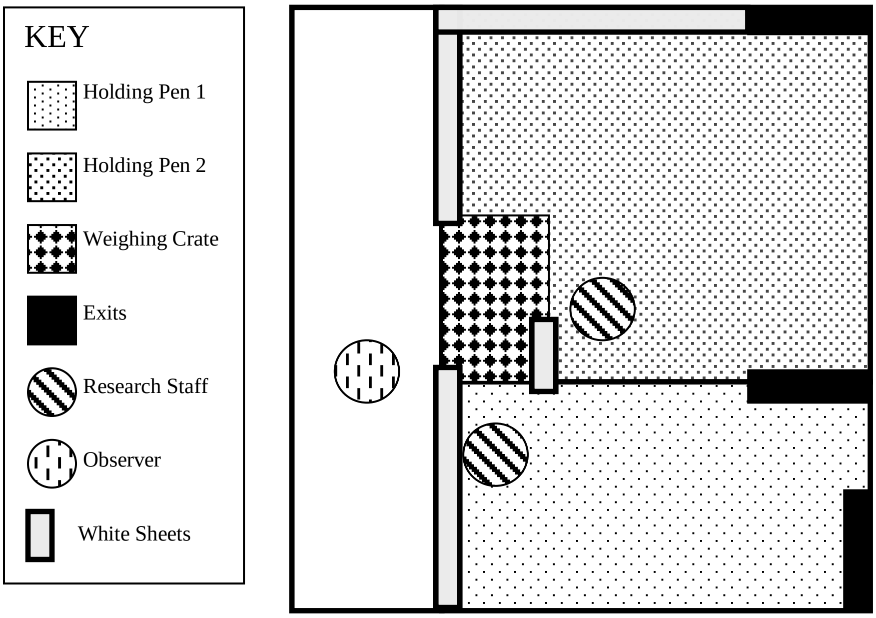

Figure 5.2. Adaptations to the Weighing Area shown in Figure 1. White sheets were added to the areas immediately surrounding the weigh crate.

5.2.3. Statistical Analysis

Data were analysed using Minitab 15.0 General Linear Model procedures. Genotype and sex interactions were included in the model. Weight was not included since all pigs were within a similar weight range (102.8 ± 10.0kg). Trials 1 and 2 were analysed separately, and then compared using this model. Tagged and untagged data were handled in the same way. Tukey Post Hoc procedures were applied to identify were significant differences lay due to three way interactions. These are shown in figures and tables via the use of superscripted letters.

5.3 Results

5.3.1 *Trial 1 – Genotypic Comparison of Behavioural Reactions to Weighing*

5.3.1a Tagged Pigs

Loading Behaviour

Pietrain pigs were significantly more difficult to load than the other two breeds (F= 4.95; d.f. = 2; P<0.01; Figure 5.3).

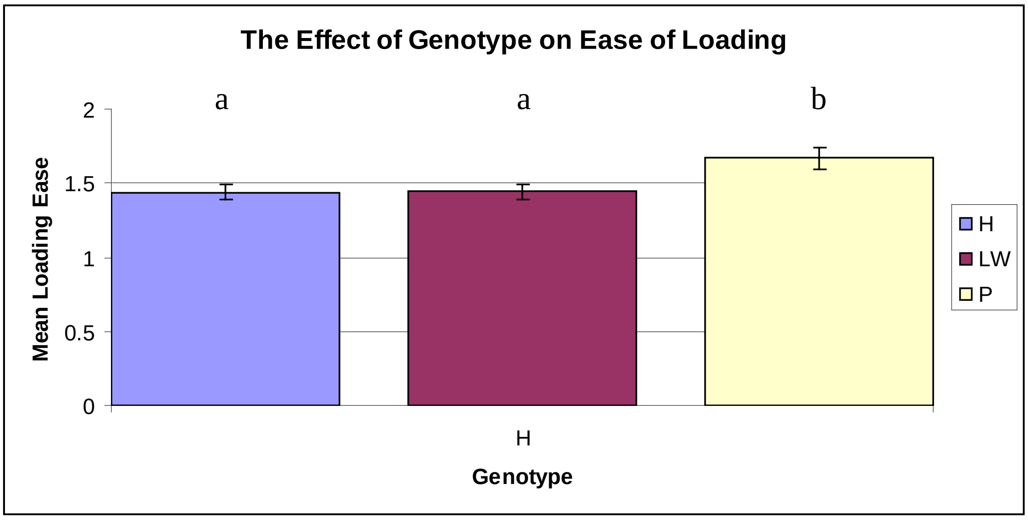

Figure 5.3.Mean loading score by genotype (P<0.01). Pietrains were significantly more difficult to load than both Hampshire and Large White pigs.

Behaviour in Weigh crate

A significant interaction was found between sex and genotype (F= 9.35; d.f. = 2; P<0.01; Figure 5.4). Hampshire Females had the highest scores, suggesting the most erratic behaviour.

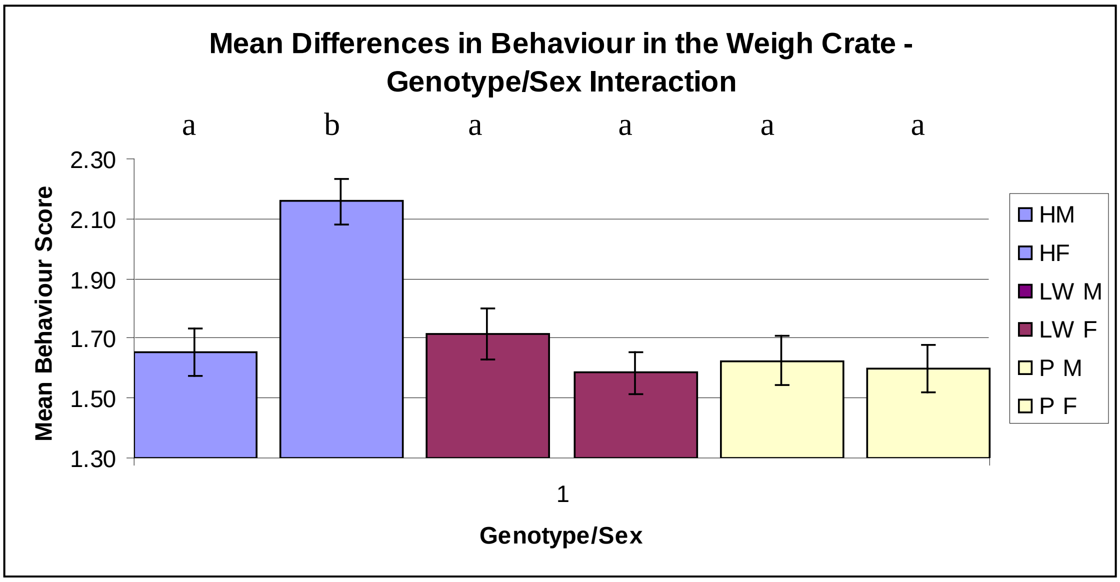

Figure 5.4. Mean Differences in Behaviour when contained in the crate between Genotypes and Sexes (P<0.01) Hampshire females were significantly more erratic in the weigh crate than all other groups.

Time Taken to Weigh

Large Whites took significantly less time to weigh than the other two breeds (F= 11.28; d.f. = 2; P<0.001; mean ± s.e = 41.28 ± 0.7s; Hampshires 48.89 ± 1.0s; Pietrains 47.01 ± 1.8s). Post Hoc tests revealed significant differences between Hampshires and Large Whites (T= -4.579; P<0.001) and between Hampshires and Pietrains (T= 3.339; P<0.01).

Exit from the Weigh crate

Males were significantly more difficult to remove from the weigh crate than females (F= 5.66; d.f. = 1; P<0.05).males (1.23±0.03) females (1.13±0.02). Post Hoc (T=-2.380, P=0.02)

5.3.1b Non Tagged Pigs

Loading Behaviour

Analysis of the loading behaviour of untagged pigs revealed a genotype difference (F= 3.98; d.f.= 2; P<0.05). Again, the Large White pigs tended to be easier than the other two breeds to load (1.4 ± 0.1s; Pietrain = 1.7 ± 0.1; Hampshire = 1.7 ± 0.1)

Behaviour in Weigh Crate

A non-significant breed difference was found (P= 0.067). Hampshire pigs were most agitated (1.6 ± 0.1) whilst Large Whites were calmer (1.5 ± 0.1). Pietrains scored the lowest (1.3 ± 0.1).

5.3.1c Tagged Pigs vs. Non Tagged Pigs

Loading Behaviour

Loading behaviour differed significantly between Tagged and Non-tagged pigs (F= 4.21, d.f.= 1; P<0.05). Tagged pigs were easier to load than Non-tagged pigs (1.51±0.06; 1.64±0.03).

Behaviour in Weigh Crate

Tag status had a significant effect on behaviour in the weigh crate (F= 15.96; d.f. = 1; p<0.001).. Tagged pigs were more unsettled in the weigh crate than Non-tagged pigs (1.72±0.03; 1.47±0.05). A significant genotype-tag-sex interaction was also found (F= 3.47; d.f.= 2, P<0.05). Tagged Hampshire Females were significantly more restless in the weigh crate than all other categories (Figure 5.5).

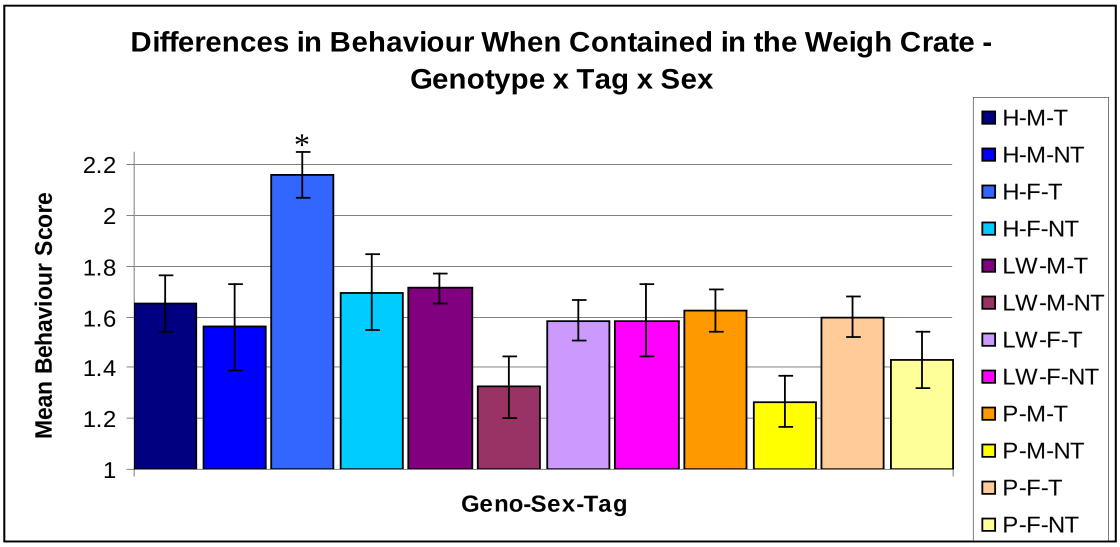

Figure 5.5. Behaviour when contained in the weigh crate compared by genotype with sex and tag interactions. Tagged female Hampshires were significantly more unsettled than other groups (P<0.05) as indicated by the asterisk.

5.3.2 Trial 2 –Genotypic Comparison of Behavioural Reactions to Weighing with the Addition of White Painted Sheets to the Weighing Apparatus

5.3.2a Tagged Pigs

Loading Behaviour

Hampshire pigs were more difficult to load than the other genotypes ($F= 13.30$; d.f. = 2; $P<0.001$).No differences were apparent between sexes (Figure 5.6).

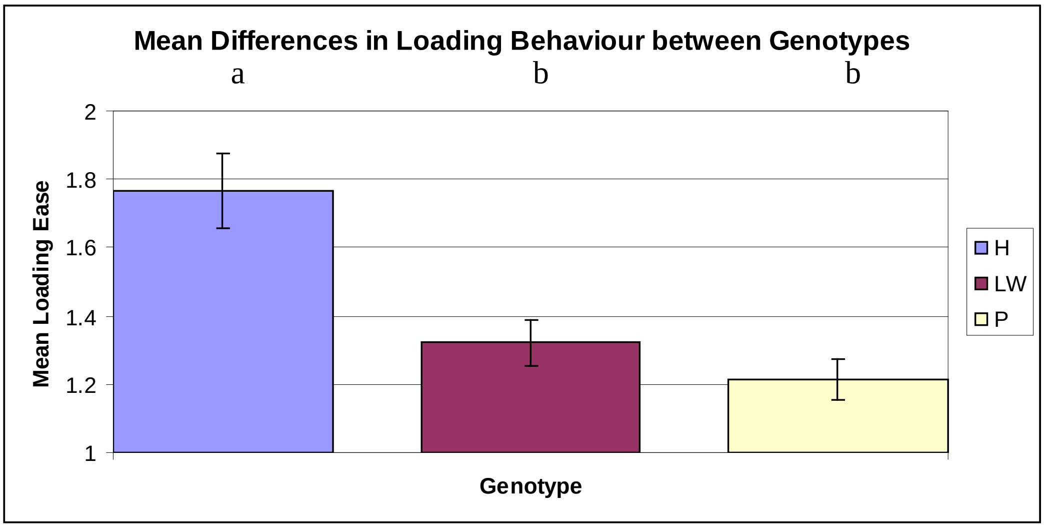

Figure 5.6. The effect of genotype on ease of loading (P<0.001).Hampshire pigs were significantly more difficult to load than both Large White and Pietrain pigs.

Tagging

Significant differences were found between genotypes being tagged (*F*= 5.65; d.f. = 2; *P*<0.01). Hampshire pigs were significantly more difficult to tag than Large Whites (1.233±0.06; 1.553±0.08; T= 3.234, *P*<0.05). Pietrain pigs were easier than Hampshire pigs (1.472±0.08).

5.3.2b Non Tagged Pigs

Loading Behaviour

Hampshire and Large Whites differed greatly in their ease of loading (*F*= 7.66; d.f. = 2; *P*<0.001). Hampshires were the most difficult whilst Large Whites were easiest (Table 5.2)

Behaviour in Weigh Crate

Genotypes differed in their behaviour in the weigh crate (*F*= 3.30, d.f.= 2; *P*<0.05). Hampsire pigs were the most difficult in the weigh crate, whilst Pietrains were easiest (Table 5.2).

Exit from Weigh crate

Significant differences were found between genotypes (*F*= 3.80; d.f.= 2; *P*<0.05). Hampshires presented as the most difficult genotype to remove from the crate, whilst Large White and Pietrain pigs were both easier (Table 5.2).

	Mean Loading Ease		
	Mean	SE Mean	Significant Differences
Hampshire	1.82	0.13	a
Large White	1.24	0.07	b
Pietrain	1.44	0.11	b
	Mean Behaviour in Weigh Crate		
	Mean	SE Mean	Significant Differences
Hampshire	1.70	0.11	a
Large White	1.49	0.08	ab
Pietrain	1.36	0.08	b
	Mean Exit Ease		
	Mean	SE Mean	Significant Differences
Hampshire	1.47	0.11	a
Large White	1.18	0.05	ab
Pietrain	1.17	0.08	b

Table 5.2. Mean differences in Loading Ease, Behaviour in the Weigh Crate and Exit ease compared by Genotype. Hampshires were significantly more difficult to load than both Large White and Pietrain pigs ($P<0.001$); Hampshire pigs were significantly more erratic in the weigh crate than Pietrain pigs ($P<0.05$); Hampshire pigs were significantly more difficult to remove from the weigh crate than Pietrain pigs ($P<0.05$).

5.3.2c Tagged vs. Untagged Pigs

Exit from Weigh Crate

A significant difference was found between Tagged and Untagged pigs regarding the ease of exit from the weigh crate (F= 5.24; d.f.= 1; P<0.05). Untagged pigs were more difficult than Tagged pigs (1.27±0.05; 1.14±0.03).

5.3.3 *White Sheets vs. Original Trial*

5.3.3a Tagged Pigs

Loading behaviour

A Genotype-Trial interaction was found regarding Loading behaviour (F= 14.35; d.f= 2; P<0.001). Figure 5.7 shows that Hampshires were more difficult to load with the implementation of white sheets, whilst Pietrains became easier. Large White pigs showed no significant difference between trials.

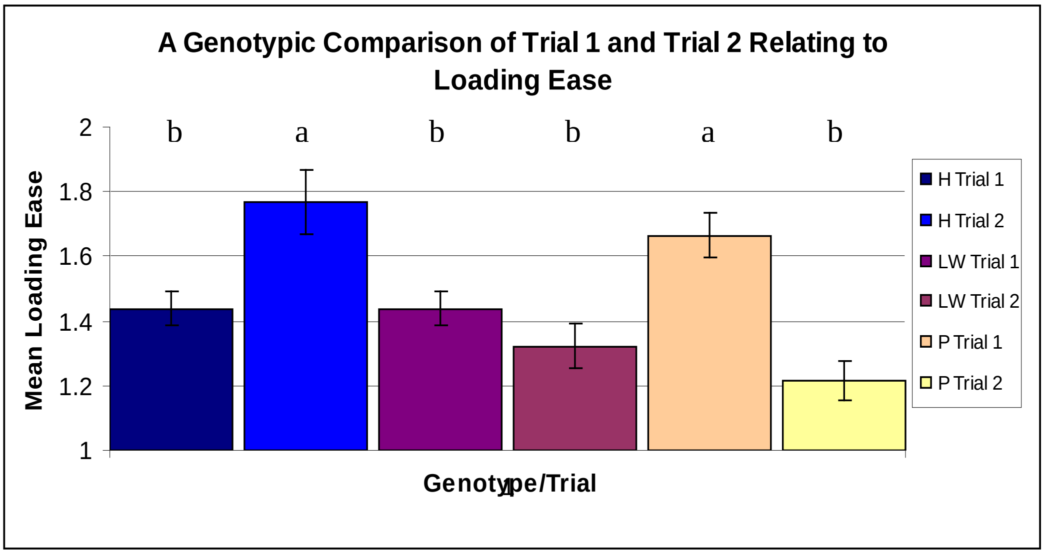

Figure 5.7. Genotype-Trial interactions when comparing loading ease (P<0.001). Hampshire pigs in Trial 2 were significantly the most difficult group to load, except when compared to Trial 1 Pietrains. Trial 2 Pietrains were significantly easier to load than Trial 1 Pietrains, suggesting that white painted sheets were advantageous to management. However, Trial 2 Hampshires were significantly more difficult than Trial 1 Hampshires, suggesting that genotype has a major effect on the implementation of new equipment success. Large White pigs showed no difference between trials.

Behaviour in Weigh Crate

A significant Genotype-Sex-Trial interaction was found here (F= 4.92; d.f.= 2;P<0.01). Trial 1 female Hampshires were significantly more unsettled in the crate than all other groups, except Large White and Pietrain females in Trial 2 (Table 5.3) whereby a trend was found.

Genotype	*Trial*	*Sex*	*Mean*	*SE Mean*	*Areas of Significance*
H	1	M	1.65	0.08	b
H	**1**	**F**	**2.16**	**0.08**	**a**
H	2	M	1.63	0.09	b
H	2	F	1.70	0.10	b
LW	1	M	1.71	0.09	b
LW	1	F	1.58	0.07	b
LW	2	M	1.67	0.12	b
LW	**2**	**F**	**1.71**	**0.12**	**b***(*P*=0.08)
P	1	M	1.63	0.08	b
P	1	F	1.60	0.08	b
P	2	M	1.32	0.08	b
P	**2**	**F**	**1.72**	**0.10**	**b***(*P*=0.06)

*Table 5.3. Differences in behaviour in the weigh crate between Genotypes, with interactions of Trial and Sex. Hampshire females in Trial 1 were significantly more unsettled than other groups (P<0.01). A trend was found for this same pattern when compared with Large White and Pietrain females in Trial 2 (P= 0.08; P= 0.06) as indicated by *.*

Time Taken to Weigh

A trend was found for a difference in the time taken to weigh between trials 1 and 2 (*F*= 2.93; d.f.= 1; *P*=0.087). Trial 1 pigs took longer to weigh than Trial 2 pigs (45.7±0.71; 43.5±0.99).

5.3.3 b Non Tagged Pigs

Loading Behaviour

A significant Genotype-Trial interaction was found in loading behaviour (*F*= 3.80; d.f.= 2; *P*<0.05). Pietrain pigs in Trial 1 were hardest to load, whilst Large Whites in Trial 2 were easiest. This same pattern was seen in Tagged pigs. Hampshire pigs were harder to load in the presence of white sheets (Trial 2). Table 5.4 indicates where the significant differences are.

				Areas of Significance			
				Pietrain Trial 1		***Large White Trial 2***	
Genotype	*Trial*	*Mean*	*SE Mean*	*T value*	*P Value*	*T value*	*P Value*
Hampshire	1	1.66	0.10	x		-2.98	0.035
Hampshire	2	1.82	0.13	x		-3.86	0.002
Large White	1	1.44	0.09	2.93	0.039	x	
Large White	2	1.24	0.07	4.19	0.000	n/a	
Pietrain	1	1.84	0.10	n/a		4.19	0.000
Pietrain	2	1.44	0.11	x		x	

Table 5.4. Loading difficulty compared by Trial and Genotype (P<0.05). Trial 1 Pietrains were significantly more difficult than Large White pigs of Trials 1 and 2. Large White pigs in Trial 2 were significantly easier to manage than Hampshires of Trials 1 and 2, and Trial 1 Pietrains.

Exit from the Weigh Crate

A significant difference was found between Trials 1 and 2 (*F*= 4.10; d.f.= 1; *P*<0.05). Pigs were more willing to leave the crate in Trial 1 than Trial 2 (1.16±0.05; 1.27±0.03).

5.4 Conclusions and Discussion

The results found in this experiment suggest that handling procedures prior to slaughter can be detrimental to pig welfare. The test used incorporated elements of restraint, handling and human interaction. The responses seen suggest that weighing prior to slaughter can result in various responses, such as calm or agitated behaviours.

The most interesting (and important to this research) finding here is that these responses are varied between genotypes. Pietrain pigs were found to be willing to leave the weighing equipment, and remain relatively immobile whilst in the weigh crate. This may confer a significant advantage in terms of labour, as if a pig is immobile during handling, procedures such as tagging are easier and quicker, and there is less likelihood of injury to both stock and stockman. However, it is important to consider that although labour input may be reduced, the Pietrain pig may be suffering detriment to its welfare. Tonic immobility has been shown in previous literature (Erhard and Mendl, 1999) to indicate a fearful response, and is characterised by an animal freezing rigid to the spot. Observations during this experiment did highlight this as a possible reaction, but the ethogram used failed to identify this behaviour as discriminate from a calm reaction. This difficulty in interpreting reactions has also been found in other research into behavioural reactions during weighing, which found a positive correlation between rapid movement and intense vocalisation (D'Eath *et al.*, in preparation). This suggests that although rapid movement may indicate eagerness and assuredness, when coupled with agitated vocals, it may be interpreted as a 'flight' style response. The difficulties in loading Pietrain pigs may again be explained by this 'flight' response, which appeared to make it more difficult to encourage the pigs into the weighing crate.

Returning to the genotypic differences found, Hampshire pigs were generally more agitated in their behaviour in the weigh crate. This may indicate that whilst Hampshire pigs are calm to drive (see chapter 4), they have a strong reaction to being restrained. This was particularly true of female Hampshires. One possible explanation may be that these pigs were less mature than the other breeds as previously discussed (5.1), as Hampshire pigs tend to reach slaughter weight at a younger age than the other breeds. An alternative explanation may therefore be found in terms of immaturity, but this should perhaps have been reflected in movement at 15 weeks of age (chapter 4).

Restraint has previously been shown to affect pigs by Geverink *et al.* (2002). Gilts classified as highly resistant vocalised more and had lower heart rates than low resistant pigs. It has also been shown that restraint results in increased opioid activity, which has the effect of calming and inhibiting behavioural responses (Rushen and Ladewig, 1991). This may go some way to explaining the immobility seen by some pigs when contained in the crate. However, Rushen and Ladewig also report that plasma cortisol levels begin to rise after 1 minute of restraint. Pigs in this study took on average 45.7±15.3 seconds to complete the whole weighing procedure, so it may prove beneficial in future research to investigate the effect of longer restraint on genotype, and measure the cortisol response.

Large White pigs were quicker to process through the weighing equipment than the other genotypes. They were generally calmer than Hampshire pigs, and more willing to enter the weighing crate than Pietrains. Their willingness tended to help in the loading process, as they often self-loaded, and were also willing to leave the weigh crate. Hampshire and Pietrain pigs were similarly difficult, as the Pietrains reluctance to loading, and the highly strung behaviour of the Hampshires when contained in the weigh crate both added to labour investment.

Non-tagged pigs were more difficult to load than tagged pigs, with both Hampshire and Pietrain pigs proving difficult. Hampshires were again the most unsettled breed in the weigh crate, but to a lesser degree than seen in tagged pigs. These results may suggest that human contact can have negative effects on behaviour when being handled (Grandin, 1987, 1989), as tagged pigs would have previously been fed by hand each day and therefore have been habituated to human presence. This is reflected in the results found in Chapter 1, where Hampshire pigs displayed high levels of ‘unconfident’ behaviour. This avoidance of human contact at an early age may indicate stability in temperament over time, however, a correlation investigation into pigs which appeared in both the Human Approach and Bacon Weighing experiments revealed no such consistency in behaviour.

Large White pigs in this research tended to be easy to handle across all stages of the weighing process. This was reflected in the time taken to weigh compared to the other breeds, whereby savings of 7.6 seconds per pig (compared to Hampshire pigs) offers a saving of 12.7 minutes when considered over 100 pigs.

The pattern which emerged from Trial 1 suggests that Large White pigs are easier to handle in all aspects than both Hampshire and Pietrain pigs. Coupled with the good feed conversion ratio seen in this genotype (Miller, pub), the Large White appears to be a good choice for many producers. However, when considering the faster growth benefit of the Hampshire and the leaner meat quality of the Pietrain, it may prove more advantageous to alter the handling process used for these genotypes.

Management systems have generally been based around the widespread use of Large White/Landrace pigs (see Chapter 1), so it is no surprise that Large White pigs tended to outperform the other genotypes regarding ease of management.

Trial 2 indicated that improvements in handling can be achieved through relatively simple measures. Pietrain pigs were easier to weigh in this trial, with a decrease in management score seen in both loading and exiting the weigh crate. Again, as mentioned earlier, this may not be of welfare benefit to the pig, but from a management perspective, it is a significant improvement.

Conversely, Hampshire pigs displayed an aversive reaction in Trial 2. They were more difficult to load and more unsettled in the weigh crate than the reactions seen in Trial 1. The white sheets may have therefore had a sensory effect on the pigs, either causing them to become immobile through stress, or much calmer, or conversely much more unsettled and unwilling to be restrained.

Large White pigs in Trial 2 showed no significant improvement or declination. These findings suggest a strong genotypic effect on environmental perception. The previous work by Tanida *et al.* (1996) into illumination effects on pigs suggested that pigs feared being in darkness and were latent to move unless provided with lighting. The illuminated areas in this research should therefore have encouraged movement towards the weigh crate. However, as previously discussed, piglets in the Tanida research were fearful of walking on white lines, which was explained as an aversion to glare. Therefore, the white sheets used here may have been too overwhelming for the pigs to process. Indeed, pigs have a similar eye composition to humans, with densities of rod cells (Chandler *et al.*, 1999), eyeball size and retinal area all being closely matched. However, a lower quantity of cone cells means that their vision may be poorer than humans at high luminance. If this were to differ between genotype of pig also, some explanation could be found for the differing reactions of Pietrain and Hampshire pigs. Generally speaking, if all pigs have detrimental eyesight at high luminance, the weigh crate may have been harder to visualise, resulting in either an oblivious response or one of fear from not being able to see forwards. Tanida *et al.* (1996) support this with the finding that three dimensional novel stimuli had an immobilising effect on pig movement, whilst floor patterns increased speed.

However, the white painted sheets could have evoked a response to novelty, as it is unlikely that the pigs would have been presented with such an item. This said, the food troughs used for these pigs when first weaned were bright white, so perhaps an association had been formed between white and positive emotions.

In conclusion, the response of pigs to being weighed prior to slaughter may have varying impacts on meat quality, as well as to the welfare of pigs and handlers. Genotypic differences should therefore be carefully accounted for when designing equipment and developing movement techniques. Large White pigs were the easiest genotype to manage throughout the weighing process, however, Pietrain pigs had a tendency to remain still in the weigh crate, making them less dangerous to handle. Hampshire pigs were generally agitated throughout the weighing process, suggesting that future apparatus design may be best focussed on improving their management. It was seen in Chapter 4 that Hampshire pigs are relatively easy to drive, so it may have been the effects of restraint in this trial which had the most damaging effects on behaviour, and consequently management ease.

Chapter 6. General Discussion

The aim of this research was to provide information on whether genotypic differences exist in relation to the management ease of three cross-bred genotypes of pig. It has previously been intimated in the literature that there is a lack of research which considers the effects of the entire production process on the behaviour of pigs, and the resultant effects on stockperson wellbeing and management efficiency. This research incorporated various methods which, when combined, intended to give a comprehensive insight into the behavioural reactivity of pig genotypes when situated on-farm.

The majority of the UK's management systems have been developed around the Large White/Landrace type of pig (as mentioned in Chapter 1). Modern genetic selection however has revolutionised the types of pig available to the producer, with many improvements being made to classic breeds, such as the Large White/Landrace, and the introduction of contemporary breeds such as Hampshire and Pietrain crossbreeds, which confer advantageous qualities. Whilst these changes are beneficiary to meat quality and productive output, there is always a risk that selecting for particular traits will inadvertently trigger the expression of other traits. These may include behavioural qualities which are detrimental to the management ease of the pig.

This research has provided clear evidence that genotypes do indeed differ in their behaviour in relation to a commercial farm management system. This has allowed me to form some recommendations regarding the appropriate handling for each genotype, as summarised below.

6.1 Hampshire

The Hampshire genotype used in this research showed independent traits to the other two genotypes across all trials. However there was a certain consistency in their behaviour across the trials, which indicates stability in temperament regardless of age and challenge. The Human Approach trial indicated that Hampshire pigs were unconfident around humans, and preferred to avoid contact. However, when this was analysed using the confidence score method, it was revealed that whilst at first contact Hampshire pigs had low confidence, by Trial Two they were more willing to approach the experimenter. Although this suggests that Hampshire pigs have the capacity to become more relaxed around humans after just one positive encounter, it may be argued that age was the factor and not experience. Unfortunately, it was not possible to test pure Control groups alongside Trial groups as the numbers of pigs available were low (due to other trial commitments). Had this been a possibility, naïve control groups of the same age as trial pigs could have been tested, as instrumented in the later movement trial (Chapter 4.2.1). If one positive contact with humans can confer an improvement to the avoidance behaviour of the Hampshire, this gives great scope for application of the method in production systems. The methods detailed in Chapter 2 are relatively simple and time effective, with the advantage of being applied to groups of pigs. However, further analysis needs to be conducted regarding group sizes and different age groups to ensure that the results found here are applicable. Another way of interpreting and utilising this result may be to recommend minimal contact production systems as a way of reducing stress levels. This may indeed be the better solution, since when repeatedly moved in the post-wean period, Hampshire pigs showed no significant improvement in management ease. Having said this, their behaviour did improve after the third trial, again suggesting that a small time investment may help with management of this genotype. The importance of maintaining a good management relationship with this genotype are clear when considering the good meat quality and yield gained from Hampshires, in addition to a fast growth rate and reasonable feed-conversion efficiency.

The movement behaviour of the Hampshire has led to them being labelled as a stubborn, slow moving pig, which was certainly reflected in the results detailed in Chapter 4. . They tended to be slow paced through all movement trials compared to the other genotypes, which may suggest that they have a low fearfulness of humans and unfamiliar surroundings. However, although this may be advantageous to the pig, slow movement may be detrimental to stockperson efficiency and frustration levels may be increased as a result. Management scores were generally poor in Hampshire pigs, due to the effort required to encourage them to move, this being the case both for movement at weaning, fifteen weeks of age, and movement associated with the weighing process prior to slaughter. Their pace when being moved remained slow and steady, which may have been a morphological trait since even with encouragement, the pigs appeared lithe to increase pace. This behaviour did not seem to differ across ages or situations. In the movement trial at fifteen weeks of age, the different areas of the course did not seem to affect movement, with the only highlighted problem area being leaving the home pen. Future research may therefore want to concentrate on this and the overall improvement of pace, perhaps including anatomical evaluation. Methods to improve movement must also be aware of welfare implications, such as those posed by the use of electric prods.

The behaviour of Hampshire pigs whilst being weighed is perhaps the most interesting result found. The general movement of the pigs was again slow and steady, but once contained within the weigh crate they exhibited very active, restless behaviour. This reaction was less pronounced in the other genotypes, suggesting a genotype specific trait. This aversive reaction not only seemed to impede Hampshire welfare, but also made it difficult and at times dangerous for management staff. The restraining atmosphere created by the crate evidently impacted negatively on Hampshire behaviour, sometimes even resulting in attempts to jump out of the crate. Further evaluation of apparatus is therefore necessary in relation to the behavioural reactions they may cause, as is investigation into why this reaction was mainly found in Hampshire pigs. One possible explanation may be that the visual capacity of the Hampshire differs from other genotypes, making it harder for them to assess the immediate area surrounding the crate. Handling by the staff may then have been unprecedented and perceived as threatening by the Hampshires resulting in agitation.

The integration of white painted sheets into the apparatus had profound effect on Hampshire behaviour, conferring a significant negative impact on management ease – they became harder to load, took longer to process and were difficult to move out of the equipment. This highlights the importance of genotypic behavioural differences regarding modifying production processes. Such a small change had a large effect on labour input, which should be taken into consideration by all in the food supply chain. Equipment providers may benefit from research such as this also in future product design, perhaps by introducing crates constructed from see-through materials, wider or narrower entrances, colour choices and safety considerations for labourers regarding the placement of restraining bars.

A positive aspect of Hampshire behaviour seen in this research was relatively lower numbers of lesions in the post mixing period following weaning. Far fewer lesions were found in total, but also the distribution of these lesions differed to those seen on Large White and Pietrain pigs. It was suggested that this may be due to a lower level of injurious fighting, and that individual differences may not exist. This intimates that Hampshire pigs engage in fighting bouts in a different way to the other genotypes, and this warrants further investigation to ensure that there are no alternative detrimental effects occurring at this time. This may be achieved through the use of video cameras and long term observation of interactions between the pigs.

In conclusion, Hampshire pigs are best suited to production units where human contact is minimal, or conversely, where there is sufficient labour to ensure regular contact with the pigs. A strong handling approach is required when relocating these pigs, which may infer that units where movement is rarely required would be better for both stock and stockmen.

6.2 Large White

Large White pigs consistently performed well across age groups and challenges. In no trial did they indicate fearful behaviour or become difficult to manage. The Human Approach test revealed a confident nature throughout repeated trials, with Large Whites also starting as the most confident genotype. In the second trial, they proved to increase further in confidence and then remained at a similar level. This suggests that Large White pigs are quick to habituate to human presence, and the low level of unconfident behaviour seen in the Approach tests suggests that they are not intensely fearful of unfamiliar situations. Indeed, the behaviour seen in the weaner movement trials indicated that Large Whites which had been given the opportunity to learn a course were less fearful of a novel object, since control pigs showed a stronger response by increasing their pace past the object. The presence of a familiar human may have strengthened their confidence, since fearfulness was seen to decrease with repeated Human Approach tests. Again, this capacity for adaptation to human presence was indicated through the movement trials at weaning age. There was a great reduction in the time taken to complete the course between trials 1 and 2 suggesting that Large Whites are capable of retaining information for several days. Further investigation into this would greatly enhance producers' ability for evaluating labour input, for example if just one positive experience is retained for several weeks, it would only be necessary to interact with the pigs every few weeks to maintain a good working relationship.

Large Whites showed a tendency throughout to keep a good pace and to move through different challenging situations with ease. Indeed in the second weaner movement trial, they had become much faster paced as a response to learning the course and perceiving it as a positive interaction. This related to becoming easier to manage in trial 2, but no further improvements were seen in the subsequent trials. When comparing the control and trial groups at trial 3, it was found that the control groups were much slower to complete the course. This lends support again to the hypothesis that learning in Large White pigs confers an advantage to management, and that these effects are not just a result of age. It would therefore be interesting to see if this occurs in all ages and group dynamics. A means of measuring the activation of memory retrieval through brain scans or hormone release would be extremely beneficial in determining the driving processes behind these actions, and could perhaps lead to genetic selection for animals capable of storing positive emotional experiences.

However, when introducing a novel object, Control pigs were faster to complete the course. This suggests that interruption to previously constructed memories and expectations can be more damaging to management than if the pig is naively approaching a challenge. This has the practical implication that all novel objects should be removed from walkways prior to moving pigs, particularly if effort has been invested to teach pigs a course or acclimatise to handling. However, the results seen in this research showed that trial pigs were still easier to manage in this circumstance.

Moving Large White pigs at the older age of fifteen weeks also proved to be easier than moving the other two genotypes. Although they took the longest to move, they still had significant labour input benefits, since they remained fast paced and grouped together. The novel object in this course caused difficulties however, again reiterating the need to prepare walkways prior to moving. The white painted fencing also caused problems, although this adaptation to equipment made no difference to the behaviour of Large Whites when being weighed.

The process of weighing Large White pigs required less labour input than that needed for both Hampshire and Pietrain pigs. Overall, they took less time to weigh, which would be considered preferable by all producers. They were easier to load and showed no tendencies for fearful or erratic behaviour when locked within the crate. This neutral behaviour was also seen in the Human Approach trials, suggesting a consistency in temperament or coping style across age and challenge.

The ability of the Large White to cope with various handling procedures makes it a strong choice for production units, with the development of systems based around Large White/Landrace pigs possibly providing the explanation for this.

From a management perspective, Large Whites appear to be beneficial in comparison to Pietrains and Hampshires. Their fast pace, whilst remaining as a group, allows efficient, low labour handling, and their calm nature whilst being restrained is advantageous. A negative aspect to Large White behaviour identified from this research is the incidence of high numbers of lesions post-mixing. This is known to be detrimental to meat quality, not only from a physical perspective, but also the heightened physiological stress response which accompanies aggression. The majority of the lesions sustained were to the shoulders, known to be a key area for aggressive infliction. Research may therefore be well invested in minimising these aggressive tendencies, perhaps by the use of hormone inhibitors, changes in stocking density, or rebalancing of pens to include different weight and sex ratios.

This research therefore suggests that current management units are well suited to the Large White. The procedures used in these trials presented no real difficulty to the pigs, and the ease of management was generally high. The effects of repeated handling of these pigs warrants deeper investigation, to accurately assess the level of interaction required to make significant improvements to management efficiency. Unfortunately, the high lesion scores seen in these pigs do pose a problem to producers, and measures should be taken to reduce aggression.

6.3 Pietrain

The Pietrain pigs in this research tended to avoid human interaction across various trials. Their confidence scores were much lower than those seen in the other genotypes. However, by Trial 6 they were as confident as the other genotypes. This suggests a capacity to habituate to human interaction, but at a slower rate than other genotypes. It is worth considering that the high levels of neutral behaviour displayed could suggest that Pietrains are not fearful of humans, but are instead disinterested, and the subsequent increases in confidence seen are a result of increased inquisition. However, it could be interpreted as an alternative display of fearful behaviour, whereby anxiety levels are increased, leading to a lack of motivation to approach humans. This interpretation concurs with the results from the movement trials, whereby distances between Pietrains and their handlers were maximised where possible. When moved post weaning and at fifteen weeks, they were found to complete courses faster than the other genotypes. When considering this alongside speed scores, it is evident that Pietrains have a tendency to bolt This renders them difficult to handle, as stockmen are often left trailing behind, leaving the pigs opportunities to turn back on themselves and subsequently cause jams. This increased the likelihood of injury also, since the pigs tended to charge into objects.

There is the possibility of using this information to provide positive output in the form of recommendations for handling Pietrains. By being aware that they may bolt, movement routes through farms could be strengthened and designed to flow in such a way that the pigs could effectively move themselves.

A further improvement to the management of Pietrains could be found in the implementation of white races. This research showed that Pietrains were more willing to move into weighing equipment when the area surrounding it was brightened using white paint. They also appeared calmer, and willing to exit the apparatus steadily. This response was also apparent in fifteen week old pigs, where speed score whilst passing the white painted races was increased.

Although Pietrains were easy to manage whilst being weighed, this was due to a tendency to 'freeze' to the spot. This, coupled with high levels of vocalisations, may suggest a highly fearful response whilst being restrained. Although this confers a management advantage, the effects on the stress levels and the welfare of the pig require investigation. It is well known that stress damages meat quality, particularly that caused immediately prior to slaughter. Further research may therefore want to focus on the physiological effects of handling on Pietrain pigs, such as the implementation of dissection to identify changes in brain components and the physiological response which ensues when the animal is challenged. This may identify morphological differences between genotypes as well as providing insight into the level of physiological stress response produced by each genotype.

The difficulties in loading Pietrains into the weigh equipment may perhaps be solved by narrower straight passageways running straight into a weigh crate, rather than retaining them in a pen prior to being selected to weighing. This would exploit the tendency for Pietrains to keep moving if pathways are defined.

Similarly to Large White pigs, Pietrains displayed large numbers of lesions post-mixing. Again, these lesions were focused on key areas for aggressive impact. This should therefore be investigated further as discussed for the other genotypes, with strategies developed for reducing aggression in this period.

In summary, Pietrain pigs tended to have flighty responses to human interaction, and are perhaps best suited to units where human presence is minimal. However there is the possibility of habituation to human presence, and units where sustained interactions can be maintained may see benefits in the Pietrain regarding handling. Movement of these pigs would benefit from fore planning regarding the construction of passageways, and the adoption of a movement regimen whereby the pigs have little human contact.

6.4 Conclusion

This research successfully identified behavioural differences between three pig genotypes across several routine management situations. The implication of these differences is that care needs to be taken over the application of farming methods to various genotypes. This warrants research into other pig genotypes and the difficulty of management related to their production, as well as further investigation into the breeds used here.

However, this research did not directly investigate production parameters such as growth rate and meat quality. Research conducted using these genotypes produced on the same unit suggested that there are advantages and disadvantages regarding meat quality. It would therefore be beneficial to investigate the effects of handling on meat quality and physiological stress levels. This would enable the development of a guide detailing the behaviour of different breeds and the management system they are best suited to.

A common problem highlighted with this research was the inability to distinguish whether genotype specific behaviours were the result of actual behavioural differences, or whether weight changes influenced behaviour. For example, fast growth of the Large White may have made it more confident than the other genotypes at a certain time point purely because of the size of the pig. Therefore, if replicated, this research should carefully track weight changes within genotype and factor this in to statistical analysis. Unfortunately this was not possible here, since the majority of pigs used were on confidential feeding trials, whereby allocation to pens by balance of weight was the only information available regarding growth.

Further, this research would benefit from being replicated on different types of production unit such as outdoor or straw based, to identify whether the results found here are only applicable to indoor slatted production. Different challenges are presented by different units, and this could only serve to improve the definition of genotype specific behaviour related to management. Future pig production would also benefit from research detailing economically viable solutions to management problems, such as the use of painted races, since the majority of farms would struggle to undergo mass adaptation for the benefit of the genotype being produced. This could vastly improve pig production regarding pig welfare, stockperson efficiency and ultimately consumer satisfaction.

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