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**Behavioural reactivity and ensuing
temperamental traits in young thoroughbred
racehorses (*Equus caballus*)**

by Sieglinde McGee

A dissertation submitted for the degree of
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Behavioural reactivity and ensuing temperamental traits in young thoroughbred racehorses (*Equus caballus*)

by Sieglinde McGee

Momozawa, Ono, Sato, Kikusui, Takeuchi, Mori and Kusunose (2003) note that while there are no methods considered to be standard in assessing temperament in horses, there are two that are commonly applied: (i) analysing behavioural reactions to stimuli and (ii) getting handlers to complete a temperament questionnaire. This thesis presents the findings of three behavioural reactivity studies and a single temperament-questionnaire study. The first study found that accompanying preweaned foals while they are separated from their dam during covering of the mare significantly reduces the frequency of vocalisations ($z=3.88$; $p<.001$) and pawing ($z=2.50$; $p<.05$) and eliminates the performance of self-harm behaviours ($\chi^2=19.18$; $df=1$; $p<.001$), namely hurling their body against a door or wall. Each of these behaviours is a recognised behavioural sign of distress in a foal. The second study measured behavioural reactivity of 1771 foals during their experience of being auctioned. Data were collected at three venues and were analysed in terms of a number of independent variables. Tentative evidence was found for a relationship between different aspects of behavioural reactivity and variables such as age, gender, sire, paternal grandsire, broodmare sire, family from which the dam came, family from which the sire came, inbreeding and whether or not the foal was bred for racing on the flat or over jumps. Tentative evidence was also found for a link between behavioural reactivity in the ring and whether or not the animal had also been assessed in the separation study ($N=7$). The third study measured behavioural reactivity of 2430 yearlings during their experience of being auctioned. Data were collected in the same three venues and subjected to the same types of analyses. Again, tentative evidence was found of a relationship between different aspects of behavioural reactivity and variables such as age, gender, sire, paternal grandsire, broodmare sire, family from which the dam came, family from which the sire came, inbreeding, whether or not the foal was bred for racing on the flat or over jumps and whether the animal had also been assessed in the separation study ($N=13$) or as an auction ring foal ($N=438$). The fourth study analysed temperament questionnaires returned by the handlers of 395 horses that had been assessed in at least one of the three earlier studies. Relationships were found between some aspects of behavioural reactivity to the auction ring experience and different temperamental traits when in training. Factor analyses of the questionnaire suggested that young racehorses are generally well adjusted and content with their lives. Tentative evidence was found that suggests the most inbred horses may be 'protected' from developing stereotypies. Overall the findings make a valuable contribution to what is known about equine behaviour and temperament.

Declaration

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Summary

This thesis is the culmination of a four-year research project carried out through the Department of Psychology in the University of Dublin, Trinity College and in which behavioural reactivity and ensuing temperamental traits were assessed in young thoroughbred racehorses (*Equus caballus*).

In Chapter 1 the reader is introduced first to the value and nature of the thoroughbred horse and then to key areas of the relevant literature. A general introduction to how the horse learns is provided, rather than a comprehensive analysis of what is an immense research area (i.e. animal learning) as learning is only one facet for consideration: the thesis is not a learning study. This is followed by sections on the effects of short-term separation of preweaned foals from their dam during covering, some of the other 'traumas' ahead for a young racehorse, the concept of well-being and how it's assessed, a general account of the effects of stress (there were no biological measures taken during the course of this study), the behavioural signs of distress in horses, equine stereotypies and how we deal with them, the evidence for inheritance of traits and temperament in horses, assessment of temperament, how early experience can relate to later behaviour, and the importance of considering the potential effects of human-animal interaction on the animals. Following a brief summary, the rationale for the thesis and the five research questions are then presented.

In Chapter 2 the reader is provided with an overview of some of the rules with regard to the naming and breeding of thoroughbred racehorses, a short but comprehensive course on how to read pedigrees of thoroughbreds and to calculate the amount of inbreeding within those pedigrees. The unsuitability of Wright's Coefficient of Inbreeding for use with thoroughbred pedigrees is highlighted and an alternative method for numerically expressing the amount of inbreeding, as a Pedigree Diversity Score, is proposed. The reader is then given an introduction to the figure system, which was once a fairly popular tool for choosing stallions for a mare. Inbreeding and the figure system have been utilised in the analyses that follow in Chapters 3, 4, 5 and 6.

Chapter 3 presents the findings of the initial study, in which the aim was to determine if accompanying a preweaned foal while separated from its dam

during covering would reduce the behavioural signs of distress exhibited by the foal. Foals in the control group were unaccompanied. This simple intervention, i.e. staying quietly in the stable with the foal, significantly reduced the behavioural signs of distress in the accompanied group, as compared to the isolated group. The findings were later published.

Chapters 4 and 5 present the two auction ring studies. Behavioural signs of reactivity were recorded for each of 1771 weaned foals and 2430 yearlings as they were auctioned by either Goffs (at Kill, Co Kildare), Tattersalls (at Newmarket, Suffolk) or Tattersalls Ireland (at Fairyhouse, Co Meath). There were a number of independent variables, such as age, gender, coat colour, sire, paternal grandsire, broodmare sire, family from which the dam came, family from which the sire came, inbreeding and whether or not the animal had also been assessed in the previous chapter(s). Reactivity scores were also analysed by type, i.e. whether they were flat-bred or national hunt-bred. Tentative evidence of effects for age, gender, bloodlines, inbreeding, type and prior auction ring experience was found. There were insufficient numbers of Chapter 3 subjects available for the foal auction ring study but tentative evidence of a link between reactivity during that separation period and reactivity in the auction ring was found in yearlings.

Chapter 6 presents the temperament study in which the handlers of 395 horses, who had been assessed in at least one of the studies above, completed a short temperament questionnaire. This represented a return rate of 25% of those it had been possible to track down. Aspects of temperament were found to be related to some signs of behavioural reactivity shown in the auction ring, as a foal or yearling, and tentative evidence was found to suggest that the most inbred horses may be 'protected' from developing stereotypies. Factor analyses of the questionnaire suggested that young racehorses are generally well-adjusted and content with their lives.

Chapter 7 summarises and discusses the findings in relation to how they answer the five research questions and provides a framework for a multifaceted approach to the study of equine behaviour, as well as a review of the limitations and strengths of the work presented and some recommendations for future research.

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This thesis, submitted the day before the Breeders' Cup, is dedicated to
the thoroughbred horse

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“The equine mind is one of the main reasons why most of keep and associate with horses: we don’t love them only because they are ‘black and beautiful’. If that were the case we would have a motor car or a beautiful painting instead. We love them because they have a mind, and to predict and understand their behaviour, to communicate even if only in flashes with the mind of another species is an ever-growing excitement and challenge”.

(Kiley-Worthington, 1997, p.80)

Chapter 1: Introduction

The quote above succinctly sums up the motivation of many researchers who seek to learn why horses do what they do, how they think and what they feel. The horse has a mind of its own and though we speak a different language we can sometimes feel a real sense of genuine two-way communication, a sense of knowing and understanding this unique individual that is so different and yet so similar to us. Those moments, those glimpses into the mind of our equine companion, make all the hard work, cold mornings and occasional frustration that being around horses brings, seem completely worthwhile.

This thesis focuses on thoroughbreds and examines both behavioural reactivity in foals and yearlings and temperamental traits in two-year-olds that are in training as racehorses. Though each of the studies conducted represents a discrete investigation in itself, there is also a longitudinal aspect as those assessed as two-year-olds were all horses who had also been assessed in at least one of the earlier studies, while a large proportion of those observed as a yearling had also been observed as a foal. There are necessarily a number of areas that need to be investigated when looking at behaviour and temperament in thoroughbred horses and this chapter aims to familiarise the reader with these. While it is acknowledged that there is a tremendous amount of research on behaviour of animals, the approach taken in the thesis is a psychological rather than biological one, and so areas such as the biology of stress, which has been the subject of considerable research but which has not been directly examined here, are only given somewhat superficial coverage. Bloodlines and breeding in thoroughbred horses, on the other hand, are directly examined and while the subject of a very brief introduction in this chapter, are discussed in detail in Chapter 2.

1.1 The Thoroughbred horse

There are hundreds of different breeds of horse around the world but the most valuable, most widely publicised and probably most populous breed of all is the thoroughbred. Foals have been sold for as much as 2,500,000 guineas (1 guinea = £1.05), the record-priced yearling made US\$13,100,000 at auction in Kentucky, horses in training or breeding stock have been sold for millions, stallions have been valued at tens of millions while the covering fees of the world's top sires are in excess of €100,000. In fact the highest stallion fee in the world in 2004 was US\$500,000 payable if a breeder's mare was certified in foal to Kentucky-based Storm Cat by 1st September, while the stud fee of Europe's top stallion, County Tipperary-based Sadler's Wells, is advertised as private but said to be in the region of €175,000 should a mare be in foal on 1st October. The 2005 stud fee for these two stallions, who will be 22 and 24 years old respectively, is to remain at these levels. The world's top-priced yearling in 2004 was an US\$8,000,000 son of Storm Cat who was sold at auction in Kentucky in September, while Europe's top-priced yearling was a 1,150,000 guineas Danehill colt sold in Newmarket in October.

Great Britain, Ireland and the United States of America are considered to be three of the most important producers of world class racehorses while countries such as Argentina, Australia, Canada, France, Germany, Japan, New Zealand and South Africa also have major racing and breeding industries. Many other countries have similar industries though of a somewhat lesser calibre. With so many countries involved, there are tens of thousands of registered thoroughbred foals now born worldwide every year. The sport and industry of thoroughbred horse racing has its own dedicated television channels (e.g. Attheraces, Racing UK), newspapers (e.g. *Racing Post*, *The Irish Field*, *Daily Racing Form*, *Thoroughbred Times*), information and news websites (e.g. www.bloodhorse.com, www.racingpost.co.uk, www.irish-racing.com, www.thoroughbredinternet.com, www.thoroughbredtimes.com), magazines (e.g. *The Blood-Horse*, *Thoroughbred Owner & Breeder*), statistical manuals (e.g. Weatherby's Statistical Record Annual, Weatherby's Return of Mares) and books, ensuring that the lives and exploits of thoroughbred horses receive wide coverage around the world.

A breed that was created in England, the lineage of all thoroughbreds can be traced back to one of three stallions, the Darley Arabian, the Godolphin Arabian and the Byerley Turk. Official records of births and registration of thoroughbreds have been kept by Weatherbys since 1793 though with many countries now having officially recognised Stud Books, only those animals born in Ireland and Great Britain, those sired by Irish and UK stallions but foaled abroad, and those imported to Ireland or the UK for racing or breeding purposes are registered with Weatherbys. A detailed explanation of rules and conditions that apply to the naming, breeding and bloodlines of thoroughbred horses is provided in Chapter 2.

As a breed they are often described as being highly reactive, sensitive, brave, gregarious, claustrophobic, being an 'open book', having a strong need for company and that "individuality is their trademark" (MacKay, 1997, p.147). McBane (1994) stated that if just one word was applied to describe the temperament of the horse it would be 'nervousness' while McGreevy (2000, p.16) suggested that "thoroughbreds are more likely to stand still in cold weather and look miserable, while native ponies plump for the far more sensible option of continuing their search for food or finding shelter". It's not that thoroughbreds are a stupid breed but probably more an artefact of the often over-controlled nature of their lives. As McDonnell (1999, p.39) states, the ability to retain what has been learned is a measure of intelligence and "horses do very well at remembering specific tasks, associations, discriminations or reversals that they have learned". As horses are capable learning associations between stimuli or events in a number of different ways, and the associations they make will influence their behaviour in relation to these, or similar, stimuli or events, it is important to have an understanding of how these methods of learning work.

1.2 How the horse learns

Horses are reasonably intelligent animals who tend to learn quickly. In fact sometimes they can learn an association between two items or contingencies from just a single trial (McDonnell, 1999; Kiley-Worthington, 1997). There is a considerable amount of literature on learning in animals, with countless papers and books published on the subject over the past century, and recent examples, covering a wide range of animals that includes horses, include

Staddon and Ettinger (1989) on adaptive behaviour, Heyes and Galef (1996) on social learning, Mackintosh (1994) and Schmajuk (1997) on learning and cognition, Kiley-Worthington and Randle (2000) on educational psychology, de Waal and Tyack (2003), Skipper (1999) and Page (1999) on intelligence, and Reader and Laland (2003) on animal innovation. Nicol (2002, p.194) states "there has been no published research on such basic learning abilities as habituation and sensitisation in the horse, and very little research on basic associative learning processes such as classical conditioning". These abilities and processes are just some of many topics within the wide-ranging area of learning in animals: others include topics such as operant conditioning, discrimination learning, memory, problem solving, concept formation, spatial learning and communication. As this thesis has not investigated learning, however, only a cursory glance at the topic will be presented.

Of the many types of learning in animals, the nine described by Houpt (1998) are outlined below as they represent some of the most basic forms of learning. They are, arguably, also the methods most applicable to the everyday life experiences of a young thoroughbred horse. These types of learning are (i) classical conditioning, (ii) operant conditioning, (iii) habituation, (iv) chaining, (v) discrimination learning, (vi) conceptual learning, (vii) imprinting, (viii) imitation, and (ix) conditioned taste aversion. While horses certainly learn by some of these methods, there is some debate with regard to their abilities at others.

Classical conditioning, operant conditioning and habituation are three common methods of learning in horses. Classical conditioning is the simplest form of associative learning and involves learning to make a connection between two stimuli that were not previously associated, for example the squeak of the wheels of the feed trolley with the imminent delivery of the evening meal. Like Pavlov's dogs learning to salivate to the sound of a bell, which had been paired with the arrival of food, horses who make this simple association will often turn away from whatever they were doing in the stable to face the door. Some will even start to paw, kick the door, drag their teeth along the metal grille (if there is one), nod their head vigorously, vocalise or perform a combination of some of these in anticipation of being fed.

Operant conditioning involves learning contingencies through positive reinforcement, negative reinforcement or punishment. Giving a reward for compliance offers positive reinforcement and makes it more likely that the desired behaviour will be repeated. Negative reinforcement also increases the likelihood of a desired behaviour being repeated but does so through making the association between failure to do something and an unpleasant stimulus or event. This occurs as a result of the desired response being followed by either cessation of or avoidance of an aversive stimulus (Colman, 2003, p.481). To avoid the unpleasant outcome, therefore, the animal is motivated to comply. Though often confused with punishment, negative reinforcement is not the same as the aim of punishment is to make repetition of a behaviour less likely to occur.

Habituation occurs when the repeated presentation of a stimulus no longer produces a response. For example, the first time one tries to lead a foal by the headcollar or to pick up one of its feet the animal tends to respond by trying to flee. This is the natural behavioural response of a prey animal to any attempt to 'capture' it. With patient persistence the animal learns that there is nothing to fear from this form of physical contact and learns not to react with panic. If horses were not able to learn by these three simple methods then they could never have been domesticated or trained.

Chaining is another method by which horses can easily learn. As its name suggests this process involves linking together a series of behavioural responses so that they will be performed in sequence and this is done through use of operant conditioning. In fact Cooper (1998, p.38) defines training as something that can best be explained as "a process that occurs through stimulus-response-reinforcement chains, whereby animals are conditioned to associate cues in their environment with specific behavioural responses and their rewarding consequences". A somewhat amusing example of a learned chain of behavioural responses was described by Sherry, Walters, Rodney and Henry (1994) where goats had been trained to jump three hurdles, walk on a raised walkway, pass through two barrels, and press a lever ten times. This is done through the process of progressive shaping, which involves "gradually building up the desired pattern of behaviour by selectively reinforcing closer and closer approximations to it, beginning with existing elements of the

subject's behavioural repertoire, until the required responses are learned" (Colman, 2003, p.674).

Horses also prove very able at discrimination learning tasks (McDonnell, 1999), a relatively simple form of learning that usually requires several trials before learning takes place, though Murphy, Waldmann and Arkins (2004) reported that, similar to findings in other species, male horses have better visuo-spatial ability than female horses. They were also able to successfully complete more tests, and made fewer errors, than the female horses. There have also been breed differences reported. For example, Mader and Price (1982) found that quarter horses were better than thoroughbreds on visual discrimination tests. They suggested that this may have occurred because quarter horses are less easily distracted than thoroughbreds. Like thoroughbreds, Arabs, trotters and pacers, the quarter horse is a breed with which there are associated racing and breeding industries. These animals typically race over a quarter of a mile, hence their name, and are quite popular in America. Nicol (2002) describes discrimination learning in horses as an important area of research because it "examines the extent to which horse behaviour is sensitive to control by environmental cues" (p.194). Such studies have been able to provide information about visual (e.g. Smith & Goldman, 1999; Timney & Keil, 1992), auditory (e.g. Bubnalittitz, Weinberger & Windischbauer, 1995) and spatial (e.g. Marinier & Alexander, 1994; Mal, McCall, Newland & Cummins, 1993) perception in equids and such knowledge can contribute to our understanding of equine welfare.

It has been said that horses are unable to engage in conceptual learning, which is a higher form of learning. Indeed May (1995) even went so far as to state that "they are incapable of making a logical decision as we know it: they simply react to their surroundings" and that "his brain has no capacity *whatsoever* for reasoning" (p.4 - italics in the original). Very little work has been done to investigate the ability of horses to engage in conceptual learning but it has been found that some horses can indeed learn in this manner. For example, Sappington and Goldman (1994) found that one horse in four was able to select a triangle rather than other shaped stimuli at a rate greater than would have been expected by chance. More recently, Hanggi (2003) reported that some horses had demonstrated their ability to solve problems based on

relative size concepts. The horses tested consistently chose the correct items, which were 3D rather than just two-dimensional as had been previously tested (Hanggi, 1999), even in novel situations. Moreover, she added, "they are able to generalise across situations that vary from flat, black shapes to objects of different materials and colours including balls, flower pots and PVC connectors" (p.201). These PVC connectors were t-shaped, 3D orange plastic objects in four sizes.

The term imprinting originates in ethology and describes the way in which newly born birds and animals learn to identify their primary caregiver, usually the mother. For example, precocial birds are 'programmed' to follow the first large moving object they encounter. Konrad Lorenz famously showed how greylag geese chicks would follow a human if that was what they first encountered. Ford (1999, p.131) suggested that the term imprinting represents an inaccurate translation of the word Lorenz had originally used, namely *Prägung*. This, he says, actually means stamping or embossing (as in the production of coins or medals), a process that suggests permanence, even though birds, for example, can sometimes learn to switch to other objects or individuals fairly quickly. Imprinting usually proves extremely resistant to extinction though with prolonged exposure to a stimulus that is "more effective in eliciting initial filial responses than was the stimulus used for imprinting" (Salzen, 1998, p.568) the response can be altered or even reversed, something Boakes and Panter (1985) have described as 'secondary imprinting'. Salzen (1998) also notes that even when secondary imprinting has taken place, the original imprinted preference can re-emerge.

There are considerable species differences and if imprinting did represent a permanent tether between mother and offspring in horses, then one would imagine that it would not be possible to get orphaned foals to accept a foster mare, particularly if they have spent several days, or longer, with their birth mother. Horses have been shown to be able to distinguish size and colour quite well and it is a fact that every year a number of thoroughbred foals are successfully fostered by mares who look absolutely nothing like their own mother. This does not suggest permanence in the imprinting process in equids. For example, when working on a thoroughbred stud farm over nine years ago, the author knew well a light bay thoroughbred foal, out of a dark

bay thoroughbred mare, who was orphaned at 11 days old. Within a matter of days she had been successfully fostered onto a grey pony mare. Now a broodmare and the dam of a three-time winner in Italy, the experience does not appear to have adversely affected her own maternal behaviour. Although covering a lamb with the scent of a ewe's living or dead lamb (e.g. Alexander, Stevens & Bradley, 1987), or establishing a common artificial order in both the ewe's own lamb and an orphaned one (e.g. Price *et al.* 1998; Porter *et al.* 1994) have proved useful in fostering orphaned lambs, such techniques are not normally used with foals. The two are usually placed in the same stable but with a barrier separating them. The mare is usually in very tight quarters and unable to move around much while the foal has freedom to move about. There is a gap in the barrier through which the foal can put its muzzle in order to feed from the mare. Not every foster mare will take to just any foal and sometimes several foster mares need to be tried before the foal will bond but the process of establishing a bond between the two can take as little as just a few days. Nicol (2002) notes that neither the physiological nor neural basis of imprinting has been examined in the horse.

There is debate as to whether or not horses can learn through imitation, which is also called social learning. Nicol (1995) reports that social influences have been demonstrated as influencing the development of behaviours in several species, including cats, dogs, hens and pigs. It was widely believed, and still is by some people, that horses can learn stereotypic behaviours through observing others perform them (Nicol, 2002). Therefore, stereotypies, particularly weaving, were said to be likely to spread through a stable (e.g. May, 1995; Mason, 1993; Kiley-Worthington, 1983). There is no evidence that horses actually learn to perform stereotypic behaviours in this way, though it is certainly possible that a foal, stabled with its boxwalking dam, may learn to boxwalk through habit having had to either follow its dam around the stable or stand in the middle of her circle getting continually bumped and pushed. Where there is an apparent 'outbreak' of stereotypic behaviour in a stable yard it is more likely a reflection of a similar behavioural response to a common husbandry practice rather than learned or imitative behaviour.

Stereotypies are some of the most instantly identifiable behavioural signs of distress in horses. They are often defined as repetitive behaviours that serve

no known function and occupy a large part of the animal's time (Houpt, 1998; Mason, 1991). Boxwalking, weaving, cribbing and windsucking are four of the major equine stereotypies though, as noted below, further evidence to support the findings of Mills and MacLeod (2002) with regard to the link between cribbing, windsucking and excess gastric acidity, may eventually lead to a reclassification of those two behaviours. Boxwalking involves the animal pacing in circles around its stall, often at a fast walk, for extended periods of time. A boxwalking mare with a foal at foot will even knock her foal out of the way in order to complete each circuit, leaving the foal with the choice of standing in the centre of the circle or following behind its mother. A weaver rocks its head and neck over and back repeatedly, often including repeated lateral movements of the whole front half of the body and sometimes with enough force that the animal may temporarily lose its balance. Some weavers only engage in this behaviour while indoors.

Charles Darwin (1871) and George Romanes (1884) both sought to determine whether or not animals could learn through imitation as they believed that if the human mind had evolved from the animal mind, then the highest levels of cognitive functioning in animals should be similar to the levels of "infants, savages and the feeble minded" (Galef, 1996, p.5). This was at a time when women were also considered to be incapable of the highest levels of reasoning and so Darwin and Romanes also included them along with these other three categories. Needless to say, such categorisations would not be so readily accepted today. Romanes (1882, 1884) presented numerous descriptions of imitative learning in animals though some of these, for example Icelandic mice who load up an improvised 'boat' with supplies and use their tails as a rudder to traverse a stream or a cat who opened gates (cited in Galef, 1996, p.614-615), were based on second-hand reports of observation of an animal's performance in an uncontrolled environment and without knowledge of the animal's prior experience. Thorndike (1898), for example, famously showed how cats could let themselves out of a cage but only after a process of trial and error, that is, trying different responses until the correct one emerges. Reber (1995, p.416) states that the course of this type of learning is "typified by the gradual elimination of ineffectual responses and the strengthening of those responses that are satisfactory".

A recent anecdotal example was reported, on television news broadcasts, in England where a dog, in an animal shelter, not only let himself out of his pen every night but also opened the doors to all the pens, releasing his neighbours. This was recorded on surveillance tapes but it is not known how the dog learned to open the latch - was it through imitation of the handlers or through trial and error?

Kiley-Worthington (1987) claims that foals seem to learn what to eat by imitating their dam, noting that when the animals are raised where poisonous plants are to be found, foals will often not be poisoned whereas new arrivals to the area may. Cooper (1998) agrees and notes that social learning is more commonly found in social species. Zentall and Galef (1988) state that social learning can be a faster way to learn about important things such as what foods are poisonous and which are palatable than can be achieved through trial and error.

McDonnell (1999) describes how she has seen foals play with objects in a manner that seems as though they were copying another foal who had engaged in similar behaviour but points out that experimental studies conducted to test the ability of horses to learn in this manner have been inconclusive. Typically these consist of teaching one horse how to perform a particular task while allowing other horses to watch and then later testing the equine observers to see how they perform. The observers tend to fare no better than the initial test subject but what these studies do not appear to account for is motivation, a key factor in understanding behaviour. If a human was seated in a waiting room while a technician operated a piece of equipment at the far side of the room, and this human had not been told that s/he was supposed to pay attention to what was being done, then it is likely that s/he will not automatically know how to operate the piece of equipment when asked to do so. Why, therefore, should we presume that by positioning a horse so that it can see what another is doing it somehow knows, or is motivated, to study its companion's actions?

Conditioned taste aversion is, as its name suggests, a learned response to the taste of something, often occurring when something tasted or eaten has been paired with a negative outcome such as feeling ill (Garcia & Riley, 1998). With

horses, and some other animals, the negative stimulus needs to follow closely after the initial stimulus or else the connection will not be made. For example, Houpt, Zahorik and Swartzman-Andert (1990) demonstrated that an injection of apomorphine immediately after being fed, led to taste aversion in ponies. There was no effect, however, if the apomorphine was administered 30 minutes after feeding. Apomorphine induces vomiting in laboratory rodents (Nicol, 2002). In some species, for example humans, this pairing can be separated by many hours. When the two stimuli are presented closely together, pair learning often occurs in a single trial. This form of learning can be potentially life-saving in the wild though it is not a topic that has generated much research in horses (Nicol, 2002).

In stabled horses, however, this is something that is usually not considered by handlers and with some equine medications being clearly unpalatable, if one judges from the reactions of the horse receiving them, care should be taken about mixing them into feed. Some years ago the author knew a mare who was being treated for a respiratory infection and whose prescribed medication was being mixed into her evening feed. She detected it the first day and would not eat the feed. When again presented with the medication and feed mix the following evening and a third evening she again refused to eat. On the fourth day there was no medication in the feed but she would not approach it. It took a few more days before the mare would trust her evening feed. Oddly when asked why the medication was continually being mixed into the feed despite the mare's refusal to eat it, the foreman insisted that she would 'learn' and 'would eat her feed when she was hungry enough'. This highly anthropomorphic response showed a clear lack of understanding of equine behaviour.

1.3 Effects of short-term separation of preweaned foals from their dam

In the Northern Hemisphere the Thoroughbred breeding season traditionally runs from the start of February until mid-July with the foaling season typically running from early January until late June. All Thoroughbreds (*Equus caballus*), in this hemisphere, are given an official 'birthday' of January 1 of the year in which they are born, in order that they can race against others

of the same official age later in life, particularly as two- or three-year-olds. Clearly, when racing at these ages, an animal born early in the season will be several months more physically mature than one born towards its end, and this may give it a significant advantage.

The gestation period of Thoroughbred horses is usually eleven months. Mares come into season again about six to nine days after giving birth and while they will be usually teased during this time, many will not be covered during this particular period of estrus. This is often to give the mare's body a chance to recover after foaling and also because conception rates are known to be lower during this estrus period when compared to subsequent ones (e.g. Bell & Bristol, 1987; Loy, 1980). The hope of most breeders is for each of their mares to produce a foal every year, preferably as early in the season as possible. The mare is generally first teased (courted by, usually, a pony or vasectomised stallion to check for sexual receptiveness) at six days post foaling. For this she is taken out of the stall while the foal is left behind. This is usually the first time the foal will have been separated from the mare. This experience may be repeated every morning for up to five consecutive days, until the mare goes out of season. The mare may or may not be sent to the stallion shed for covering during this estrus period. If the mare is covered but does not go 'in foal' the process is likely to be repeated three weeks later.

The period of mare-foal separation during teasing tends to be relatively brief, usually lasting no more than five minutes, and occurs at a time when there are other mares and (vocalising) foals in the vicinity of the stable. Also, the foal can usually still hear the mare and, in the taller or older foal, can often see the mare through the grille on the door.

Practice varies as to what happens when the mare is sent for covering. On some farms, the foal is separated from the mare for anything from 15 minutes to over an hour at a time, while on others the foal accompanies the mare to the covering shed. When the foal is left behind in its stall it is often roughly shoved away from the mare and has the stable door closed in its face. If there is no grille on the upper part of the door then the top half is usually closed over, occasionally leaving the foal in semi-darkness, as the stable windows may be very dirty. This procedure and the isolation that follows may be a very

distressing experience for the pre-weaned foal. Not only is it separated from its dam but also it is isolated from others of its kind. In the wild such isolation would leave a young prey animal, such as a foal, vulnerable to attack. As Houpt (1998) notes, it is the foal who usually works to maintain the contact between itself and its dam and though this need for close proximity decreases as the foal ages (Kusunose & Sawazaki, 1984a), in a time of fear, panic or danger the foal will return to its mother's side (Waring, 1983).

Though a recent study by Houpt (2002) looked at responses of 10 pony mares and their foals to brief weekly periods of separation at up to nine weeks of age, most research on separation distress in foals has previously been done with respect to the artificial weaning process (the permanent separation of the foal from the mare). This artificial weaning usually takes place when the foal is between four and nine months old. Kiley-Worthington (1997, p.176) described this period as "a crucial time when the youngster is learning very fast". Rapid learning is a feature of foals, even at a much younger age than that at which artificial weaning takes place. Indeed, both Mader and Price (1982) and Houpt, Parsons and Hintz (1982) reported that younger horses tend to learn more rapidly and more consistently than older horses. Thus the potential exists that a foal distressed at being separated from its mother for short but frequent periods in its first few weeks of life may develop problem behaviours or even stereotypies.

Often when a foal is isolated from the mare during covering there is considerable activity in the vicinity of the stable, with tractors, blowers or loud radios/stereos, for example, operating nearby. Such additional events, combined with the already stressful process of separation, may serve to intensify the experience. A foal that is repeatedly subjected to a distressing situation, such as being separated from its mother during covering, therefore may be at increased risk of developing stereotypies.

1.4 Other 'traumas' ahead for a young racehorse

Separation from their dam during covering is certainly not the only 'trauma' to which the young future racehorse is exposed. The nature of the flat racing industry is such that a horse will typically have experienced a greater variety

of events in the first two years of its life than an ordinary hack may experience in five or six years.

Kiley-Worthington (1987) has stated that, in her experience, many behavioural problems in horses can be traced back to the time of artificial weaning. Similarly, Nicol (1999) notes that some horses who develop stereotypic behaviours do so as a result of their early experiences before and around weaning time. The young thoroughbred, who will typically be weaned at anywhere from five to eight months of age, may not only have experienced the trauma of being separated from its dam during teasing and covering, on more than one occasion, but will have had its first experiences of intensive handling, veterinary procedures and treatment by a farrier as well as having had a change in location and peer groups, probably several times.

Many thoroughbred farms will headcollar a neonatal foal within its first 48 hours and start leading a foal within a couple of days of its birth. Though initially involving one handler leading the mare while another leads the foal by placing one arm around its chest and one around its quarters to guide it forward, the progression to being led by the headcollar and on a lead rein is rapid. In order to lead the foal in and out of the stable each day, therefore, the foal has had to be caught and while some foals take to this very quickly others appear to find the procedure highly stressful. Within a few months the foal will have been microchipped, a procedure that also involves clipping away a large square of hair from its neck before the microchip is inserted under the skin. A sample of blood will also have been drawn - all thoroughbreds are blood-typed and DNA tested to prove parentage.

A foal born on a public stallion farm will typically take its first ride in a horsebox within 48 hours of birth, either to be moved to another stableyard on the farm or to be sent to the farm on which the mare usually resides. The animal that is merely moving to another yard on the farm, usually because its dam is due to be covered either by one of the resident stallions or one who resides at a nearby stud that does not board mares, will usually remain in the same stable for the duration of its stay but will be a part of frequently-changing turn-out groups. Initially turned out in a nursery paddock with only its mother for company, the foal graduates quickly to a larger paddock and

several turn-out companions. As some horses go home and others arrive, and as foals strengthen up enough to go into even larger paddocks, its social companions may change every few days or weeks. From this very early age the thoroughbred foal is learning that its circumstances and even surroundings are continually changing.

A first visit from the farrier can be either a quiet event or a traumatic one, depending upon a combination of the patience of the farrier, the patience and ability of the handler, and the temperament of the foal. If a foal has become used to being handled quietly and if its regular handlers have taken the first steps towards getting it used to having its feet and legs handled and to having its feet picked up and cleaned out, then the initial farrier visit will often pass quickly and with a minimum of fuss. If this time has not been taken with the foal and the foal panics, an unskilled or impatient handler will occasionally become very rough with the foal. The author has seen foals physically manhandled during their initial farrier visit, with one or two handlers roughly pinning the vocalising and squirming foal to a wall while a farrier attempts to work on its feet. Horses are very good at learning associations, sometimes requiring just one trial (McDonnell, 1999; Kiley-Worthington, 1997). This, surely, is not the lesson one wants a foal to learn about a procedure it will face many times in its lifetime.

Artificial weaning, which is accepted as a very traumatic event for many foals, will be, for hundreds of thoroughbred foals, quickly followed by the intensive handling involved in preparing a foal for the auction ring. The weanling will often, particularly in Ireland, wear a bit for the first time and will have to learn to walk, trot, halt, step backwards and stand still in the manner desired by the handler. Even so many are clearly unprepared for what awaits them when they step into the auction ring for the first time. As a prey animal a horse's instinct is to flee when confronted by a threatening situation. But the auction ring animal is led into an enclosed arena, all exits are blocked off, there are up to tens or hundreds of people in the surrounding area which is often brightly lit and very noisy. It is noticeable that some foals, and yearlings, who are initially silent when they enter the ring will start vocalising only once the auctioneer's voice is broadcast over the public address system. The humans

present find it loud, and a horse has considerably more sensitive hearing than we do (Saslow, 2002). Is it any wonder that they object?

The young animal may not go through an auction ring at all before it goes into training but thousands, in Ireland and the UK alone, will do so every year. If not offered as a foal it will probably be auctioned as a yearling. Quite a few who went through the auction ring as a foal will return as a yearling, either because they were unsold the first time around or because they were bought by a pinhooker (i.e. a buyer who purchases a foal with a view to selling it on the following year, hopefully for a profit).

Many colts with poor, unfashionable or 'national hunt' pedigrees will be gelded by the time they are 21 months old - some will be gelded after as little as 10 to 12 months of age. Many such colts, or those who are proving difficult to handle, who go through the auction ring as a yearling will have been gelded by the time they go into training. Those with better pedigrees are rarely gelded this soon in Ireland, England or France as geldings are excluded from competing in the European Classics¹, from any Group 1 races² in France, or in

¹ The Classics were created in England and are a series of five races restricted to three-year-old colts and fillies only. Geldings are excluded. The St Leger, run over an extended 14 furlongs (there are eight furlongs to a mile: a furlong equals 220 yards or approximately 200 metres) at Doncaster in September, is the oldest of the Classics and is open to both sexes. The 1,000 Guineas and 2,000 Guineas are run over a mile at Newmarket in the Spring with the former restricted to fillies only and the latter open to both genders. The Derby and the Oaks are both contested over 12 furlongs (a mile and a half) at Epsom in early June. The Oaks is restricted to fillies only while the Derby is open to both sexes. Should a horse win the 2,000 Guineas, Derby and St Leger, he is said to have won the Triple Crown. To date only 11 horses have achieved this feat, the most recent being champion colt Nijinsky in 1970. A filly that wins the 1,000 Guineas, Oaks and St Leger is said to have won the Fillies' Triple Crown and Oh So Sharp, in 1985, is the most recent such winner.

Most countries that have horse racing have Classic modelled on the English system. In Ireland there are four Classics, the Irish 1,000 Guineas, Irish 2,000 Guineas, Irish Derby and Irish Oaks. Though many sources, usually for advertisement purposes, call the Irish St Leger a Classic this race, in fact, relinquished its Classic status in 1983 when the race was opened up to older horses. Since then few three-year-olds have run in the race with only a handful actually winning.

In France the Classics are the Poule d'Essai des Poulaches, Poule d'Essai des Poulains, Prix du Jockey-Club and Prix de Diane. These mirror, respectively, the 1,000 Guineas, 2,000 Guineas, Derby and Oaks with the only difference in terms of conditions and distances (up to Oct. 2004) being that the Prix de Diane is run over ten and a half furlongs: the Prix du Jockey-Club is to be run over ten and a half furlongs from 2005). The French also opened up their equivalent of the St Leger, the Prix Royal-Oak, to older horses some years back. The Germans, Italians and Japanese also have races equivalent to the five Classics though, unlike English, Ireland and France, not all carry Group 1 status.

In America there are three Classics, all run on dirt, rather than on the turf, and open to geldings as well as colts and fillies. The three, which together are called the Triple Crown, are the 10 furlong Kentucky Derby, nine and a half furlong Preakness Stakes and the 12 furlong Belmont Stakes, all carrying Grade 1 status. Though several horses have come very close to

Group 1 races open to two-year-olds in Ireland and England. There are no such restrictions in America, Canada, Australia or New Zealand. While the Americans and Canadians tend not to rush into the decision to geld, such a proportion of colts are gelded in Australia and New Zealand that many of the countries' top races are dominated by geldings. This was, and is, partly responsible for their need for overseas 'shuttle' stallions³ to boost the local breeding industries - most of the best racehorses, obviously, could not be used as breeding stock.

Fillies are not immune to traumatic veterinary procedures and, in particular, may have to undergo a Caslick's procedure, which is carried out under local anaesthetic to correct a structural defect of the vulva. This defect is an abnormality that leads to pooling of urine (urovagina) and aspiration of air (pneumovagina), bacteria and other contaminants into the vagina, leading to infection and, in a broodmare, failure to conceive or loss of the pregnancy. Fillies in training, as well as broodmares, may undergo this procedure. If a broodmare has been sutured, the stitched area must be cut before she foals.

Another traumatic experience for many young thoroughbreds is that of being broken to saddle. Usually driven in long reins for several weeks beforehand, having to carry a rider on its back can come as quite a shock. In the wild predators often bring down an equine by pouncing on its back. Indeed the panic reaction of the young horse to being backed by a rider for the first time

sweeping the series in recent years, including Smarty Jones in 2004, the most recent to succeed in the Triple Crown was Affirmed in 1978.

² Since the introduction of the Pattern System in 1970, races are categorised under a number of headings. Those of the highest calibre are called Pattern races and are designated as Group 1, Group 2 and Group 3. Group 1 is the highest level and victory in Pattern races boosts the value of the animal. Below these Pattern races are races classified as Listed. These races also confer an increase in value on the animal but to a lesser degree than Pattern races. Finishing in the first three in either a Pattern or Listed race entitles the animal's name to be recorded in bold type in all future catalogues. Those successful in these races will have their name in bold blocked capitals while those only placed at these levels will have their names in bold lower case type. This is known as black-type. Below these are the ordinary races, ranging from high grade handicaps and conditions races down to the lowest grades of sellers and claimers. Many countries around the world subscribe to the Pattern System with the result that some level of comparison between countries is made possible. In North America, South America and Australasia the Group races are designated as Graded races.

³ A 'shuttle' stallion is a thoroughbred stallion who stands the Northern Hemisphere stud season in Europe, America or Japan and then travels to the Southern Hemisphere to serve their breeding season. Shuttle stallions usually spend the second half of the year in either Australia, New Zealand or South America. A horse normally based in the Southern Hemisphere but who travels to Europe, America or Japan for our stud season is often referred to as a 'reverse shuttle' stallion.

can be quite dramatic. While visiting a leading stud farm in Canada a number of years ago, the author saw the damage caused to an arena, a station wagon and several stud-railed fences by a well-handled yearling colt whose reaction to being backed for the first time was to buck, kick and flee, blindly. He charged right through the padded wooden walls of the arena, ran straight into, and rolled right over, a parked station wagon (flattening the roof in the process), picked himself up and charged off across the farm, damaging several wooden fences en route. When eventually caught it was found that, despite causing thousands of dollars of damage, his only injuries were some minor lacerations to his muzzle, chest and legs.

For those whose place of training is a country other than the one in which they were born, the thoroughbred yearling may have to travel by ferry or plane. Hundreds of horses are bought in America every year, particularly at the Keeneland September Yearling Sale in Kentucky, Keeneland November Breeding Stock Sale (mares and foals) and the Fasig-Tipton Select Yearling Sale in Saratoga. Most thoroughbreds appear to handle flying well though there have, as one might expect, been cases of horses panicking in flight. When this happens there is little option but to put the horse down. Although there does not appear to have been any studies conducted on this, a horse who has flown several times may still panic on a later flight. A striking example was the stallion Tate Gallery, a Group 1 winning full-brother to many-times champion sire Sadler's Wells. He flew from America to Ireland as a yearling, travelled over and back between Ireland and England, but panicked on a plane when en route to Japan a few years later. He had to be destroyed.

Most horses will experience only a few of these events in their entire lives but many thoroughbreds will have experienced several or many of them by the time they have reached their second birthday. Each has the potential to lead to later behavioural problems.

1.5 What is well-being and how is it assessed?

The term 'well-being' is one frequently used by animal researchers but it is a highly problematic concept. Advances in psychological and behavioural research show that practices relating to animal husbandry are often contrary

to the physiological or psychological health of the animals. Kiley-Worthington (1997) comments that bringing about change in such husbandry practices is often very difficult due to a strong sense of traditionalism, a "that's the way it has always been done" mentality. This form of thinking is particularly evident in the equine industry. When people are slow to change their thinking - and this applies equally to researchers - it creates or exacerbates difficulties in defining concepts such as 'well-being'. The animal's physical and psychological needs are being determined based on the researcher's interpretation of the situation. This is akin to the acknowledged problem/difficulties in health of applying the assumptions/ ideas of one cultural belief system to another without trying to set these aside and truly see the other's point of view. Therefore, definitions of 'well-being' tend to be a reflection of the writer's viewpoint rather than an understanding of an animal's needs. Difficulty or inconsistency in defining terminology is a contributing factor in the variation in results of studies based on or testing for the concept. In essence, each researcher is testing something different and so variation in findings are only to be expected.

'Well-being', therefore, tends to be defined in a variety of ways. This may be in terms of meeting basic needs for food, water and shelter but even this definition is problematic. Take horses, for example. Depending on their intended use, many will be confined to a stable for up to 23 hours a day. The standard stable may appear quite roomy to us but it affords little manouvering space for a large animal or, as on a stud farm, a mare with foal at foot. A horse has evolved to roam and will usually cover many miles per day in the wild. If confined this degree of movement becomes next to impossible and there is some evidence to suggest (e.g. McGreevy, 2000; Houpt, 1998; Cronin, Wiepkema & van Ree, 1985; Meyer-Holzapfel, 1968) that locomotory stereotypies may be triggered by an inability of the confined animal to adapt to its circumstances.

This inability to adapt to ones circumstances, of course, meets part of most sets of criteria for stress. And yet the provision of adequate shelter is usually overlooked as a possible factor in 'problem behaviour'. Provision of food and water also causes difficulty within the concept of 'well-being'. Horses are biologically predisposed to spend up to 16 hours per day grazing - this is a

biological necessity given the functional anatomy of their digestive system. Yet most horses are fed two or three concentrated feeds per day. While these meals meet the biochemical nutritional requirements of the animal, they completely fail to meet the animal's psychophysiological needs (Kiley-Worthington, 1997). This means that the animal can be, in effect, underfed even though its biochemical nutritional requirements have been provided. The equine digestive system can only process nutritional elements at a specific rate and the practice of administering concentrates often leaves the animal lacking essentials - clearly not in the animal's best interests (Houpt, 1998). Also, this form of feeding regimen has been implicated in the development of the oral stereotypies (for example, Mills & MacLeod, 2002; Redbo, Redbo-Tortensson, Ödberg, Hedendahl & Holm, 1998, McGreevy, Cripps, French, Green & Nicol, 1995). All this means that though welfare requirements of providing food and shelter have been met, these provisions cannot truly be said to be in the best interests of the animal's welfare.

Other definitions of 'well-being' are based around an absence of the display of abnormal behaviours. However, this may merely be an indication that the animal has either adapted or has lapsed into a state of what Seligman (1968) termed learned helplessness. Learned helplessness has been defined as "an apathetic condition in an animal or a human being resulting from exposure to insoluble problems or inescapable physical or emotional stress" (Colman, 2003, p.404). The animal that stands quietly in its box all day may be content or alternatively it may be an animal that has learned that there is nothing it can do to improve its situation. Mal and McCall (1986), for example, suggested that the findings of their handling study with young foals, which found that those handled intensively in the first 42 days of life performed better on a halter test than those who did not receive intensive handling until after 42 days of life, may have reflected either a critical handling period or "a phenomenon similar to learned helplessness" (p.115). Their lack of protest, therefore, may have been due to training or because they learned that being haltered and led around was something over which they had no control.

Similarly, Houpt (1998) suggests that foals that appear to learn to tolerate a wide range of handling procedures under Miller's (1991) 'imprint training' may actually be showing signs of learned helplessness as much of this handling

takes place when the foal is too young either to stand or to resist. It has also been argued that learned helplessness plays a role in depression (e.g. Mirowsky & Ross, 1989; Seligman, 1975) and, hence, is a maladaptive mode of thinking. Clearly the concept of 'well-being' needs some thought before it can be usefully applied to/in definitions of stress. The same applies to the term 'welfare' as the same caveats apply. The resistance to change has also been described by Rollin (1989, p.1) as the "we have always done it this way so why change" mentality.

Animals, like us, use different methods of coping with their environmental conditions. When coping occurs the animal is said to have adapted (Broom & Johnson, 1993) though, again like us, this adaptation is not always possible. An animal may habituate to the stimuli or may learn that no threat is presented. The animal may also engage in particular behaviours in an attempt to eliminate or reduce the annoying stimulus, for example threatening to bite or kick a person who brushes a sensitive area with too much force. If the stimuli or environmental conditions are more severe, however, then the animal's ability to cope may be compromised, thereby leading to a failure to adapt. It has been suggested that stereotypic behaviours may represent a coping mechanism in animals, including horses (e.g. Pell & McGreevy, 1999; Broom & Johnson, 1993; Rushen, 1993; Broom, 1991; Mason, 1991; Dantzer, 1986). It has also been suggested that an animal that may appear to have adapted to its environment or circumstances may actually be experiencing subclinical levels of stress (Moberg, 1985, 2000) and may be approaching a 'breaking point'. Knowing whether an animal is trying to cope or has actually adapted is an important consideration when trying to assess its welfare.

Another difficulty in using the presence or absence of abnormal behaviours as an indicator of 'well-being' is in the determination of what these behaviours mean. Most equine studies are conducted on domesticated animals that have long been stabled, fed, worked, and so on. Therefore our understanding of what constitutes 'normal' equine behaviour is a representation of our interpretation of how they behave in our artificial environment. 'Normal' behaviour of the species is more likely to be seen in feral populations but, of course, there are few such populations remaining and they are not necessarily the same as the feral species from which they came. Even the przewalskii

breed, which is often studied as a feral horse (e.g. Hoffman, 1985), has 'domesticated' genes mixed into its population - the breed was revived from near extinction. Also, as many breeds were engineered by man, there are no feral populations to represent them. The thoroughbred, the most financially valuable breed of horse, is a notable example. The Arab is another and is probably second only to the thoroughbred in terms of value. It is also of note that the thoroughbred is a breed created by man and which has Arab roots.

However, as much of this 'normal' behaviour, for example quietly spending up to 23 hours a day in a small confined area and without interaction with conspecifics, differs from what is seen in feral equine populations, it represents an adaptation on the part of the animal. This ability to adapt is of great importance. Inability of an animal to adapt to its circumstances, for example a horse failing to adapt to length periods of confinement, can lead to considerable stress and the development of locomotory stereotypies (e.g. McGreevy, 2000; Houpt, 1998; Cronin, Wiepkema & van Ree, 1985; Meyer-Holzapfel, 1968). At its most extreme, failure of a species to adapt to a changing or changed environment can lead to extinction of the species. This is one of the two main competing theories as to why Pleistocene megafauna such as the woolly mammoth and Irish elk became extinct: the other is the impact of human predation (Barnosky, Koch, Feranec, Wing & Shabel, 2004).

There is also difficulty inherent in the use of the term 'abnormal behaviour'. Psychology has produced four full editions, and two interim editions, of the Diagnostic and Statistical Manual of Mental Disorders (DSM) (American Psychiatric Association, 1994) and is currently working on the fifth. Global, environmental, cultural, societal and economic factors continually change and with these changes can come manifested difficulties in coping and adjustment in human populations. It is therefore logical to presume that animals in domesticated and feral situations will also be faced with a changing need for adaptation. There is no equivalent of the DSM for animals. This is probably due, in part, to the fact that for much of the twentieth century animal behaviour was largely seen as being driven by biology and basic maintenance needs with citation of Morgan's canon - "in no case may we interpret an action as the outcome of the exercise of a higher psychical faculty, if it can be interpreted as the outcome of the exercise of one which stands lower in the

psychological scale” (Morgan, 1854/1977, p.53) - as justification for denying animals the capability to reason or strategise or be driven by strong, complex emotions.

As Epstein (1998) and others (e.g. Corstall, 1993; Rollin, 1989; Epstein, 1987) have pointed out, however, Morgan’s canon was simply a call for parsimony rather than a rejection of the animal mind. Indeed, Rollin (1989, p.75) also quotes Morgan (1893, p.231) as saying “there can be very little question that the higher animals have impressions and ideas analogous to ours”. A shift towards recognising the cognitive skills and emotional needs of varying species has been evident over the course of recent decades though the occasional recent writer, for example, May (1995), still denies that animals can reason or experience complex emotions.

1.6 The effects of stress

Another relevant term used in everyday language, applied in a wide variety of situations, and a key factor in determining well-being, is stress. Yet pinning down a definitive explanation of what constitutes stress has proven difficult. There is a considerable amount of literature on the biological bases of stress (see Toates, 1995 or Moberg & Mench, 2000 for a comprehensive review) but as no biological measures were taken during the course of this thesis, this important aspect of stress will only be given a brief overview.

Psychological definitions of stress tend to have a common theme, that of a difficulty or inability to cope with some situation or environment or challenging our perceived limits. For example, stress has been described as “stimulation beyond the capacity for complete adaptation” (Broom & Johnson, 1993, p.57), as something perceived by the individual to be taxing, exceeding his/her resources or as threatening his/her well-being (Lazarus & Folkman, 1984), as “psychological and physical strain or tension generated by physical, emotional, social, economic, or occupational circumstances, events or experiences that are difficult to manage or endure” (Colman, 2003, p.711), as the result of the individual having to make “abnormal or extreme adjustments in its (an animal) physiology or behaviour in order to cope with adverse aspects of its environment and management” (Fraser, 1980, p.237), and as a mismatch between a stimulus and the organism’s perceived ability to cope

(Bandura, Cioffi, Taylor & Brouillard, 1988). Moberg (1985, 2000) describes the stress response as being in three stages: (1) recognition of the presence of a stressor, (2) the biophysiological response and (3) the consequences.

It would therefore appear that definitions include both biological and behavioural elements and, as in the case of 'welfare', this may lead to some discrepancy in research. If a 'stressor', that is any stimulus that triggers a stress response, is defined in biological terms then it includes any stimulus that triggers the biological side of the stress response. This, for example, would include the startle response. If, however, 'stressor' is defined as that which triggers a "maladaptive behaviour", then this would exclude the startle response. Yet the startle response is often used as an indication of a stressor in animal studies, particularly those involving horses (e.g. Simpson, 2002).

The final stage of the stress response, that is, the consequences, is also of importance in research. If one researcher is using the startle response as a sign of stress and another is not, then different results can be expected. The consequences of the startle response will see the animal quickly return to its previous level of functioning with the only potential lasting effect being some degree of learning with regard to whatever the stimulus was (for example an umbrella being suddenly opened in front of them). A behaviourally-based stressor, on the other hand, is much more likely to have more lasting consequences as the duration of the physiological effects will be longer. Also, there is greater likelihood of the organism learning fear or avoidance responses to the stressor that may result in maladaptive behaviours.

Biologically-based explanations (e.g. Toates, 1995; Minor, Chang & Winslow, 1994a, b; Ursin, 1988; McCarty, 1983; Allen, Allen, Greer & Jacobs, 1973) of stress often begin with activation of the hypothalamic-pituitary-adrenal (HPA) axis. Neural input to the hypothalamus triggers the secretion of corticotrophin-releasing factor (CRF) and arginine vasopressin (AVP). These act upon the pituitary, thereby triggering the release of, respectively, adrenocorticotrophichormone (ACTH) and β -endorphin. Toates (1995, p.43) notes that there also appears to be a negative feedback effect of endogenous opioids on the HPA axis, citing a rat study (McCubbin, 1993) in which the opioid blocker naloxone triggered an increase in ACTH and corticosterone

levels.⁴ ACTH, produced by the pituitary, then acts on the cortex of the adrenal gland (i.e., the adrenal cortex). This has the effect of promoting the synthesis and secretion of corticosteroids.

Researchers often use measurements of corticosteroid levels as an indicator of stress. Corticosteroids, as noted, also have a negative feedback effect on the pituitary and the hypothalamus, thereby (at the pituitary) inhibiting both the synthesis and release of ACTH. If an adrenalectomy is performed, the negative feedback loop is removed and this is associated with activation of CRF and ACTH. While the adrenal cortex is activated by ACTH, the sympathetic nervous system (SNS) acts on the adrenal medulla. This, in turn, triggers secretion of adrenaline and noradrenaline. The former has a triggering effect on both the hypothalamus and pituitary whereas noradrenaline activates the pituitary. This serves to strengthen the response. The sympathetic branch of the autonomic nervous system (ANS) serves 'arousal' functions. The parasympathetic branch, on the other hand, is "involved in digestion and maintenance of functions that conserve and protect bodily function and is dominant during quiet, restful periods" (Reber, 1995, p.75).

Toates (1995, p.55) further notes that the process of synthesis of catecholamines at the adrenal medulla is sensitised by repeated exposure to a stressor, this being due to a build-up of the enzymes involved in the synthesis (Kvetnansky, 1980). This may be a biological indicator of what Moberg (1985, 2000) calls subclinical stress. That is when the organism experiences a series of mild stressors that while not individually strong enough to produce a visible stress reaction, may accumulate. By the time the clinically visible stress is presented it may be difficult to identify the trigger accurately.

This has implications for stress management in animals as the animal cannot discuss its experiences with a counsellor. This may also explain why some racehorses appear to undergo a rejuvenation when transferred from one trainer to another, and could also offer an explanation as to why such a large percentage of racehorses develop stereotypies and/or problem behaviours.

⁴ Naloxone, when used in horses, has been found to reduce the incidence of certain stereotypic behaviours by up to 100 per cent, while on the medication (Dodman *et al.* 1987), but with regulations banning the use of any substances that act on the central nervous system in racing Thoroughbreds, this benefit is limited.

The young animal undergoes a continual series of stressors from birth. The preweaned foal is often forcibly separated from its dam for teasing and covering of the mare. It is artificially weaned at around 4-6 months of age, may go through sales preparation and the auction ring as a foal and/or as a yearling, is then broken, put through training and a racing career. For those that fail to adapt, stereotypies may be a result.

Are these abnormal behaviours a coping mechanism or a sign of mental illness? Some of these behaviours mirror those of psychiatric disorders, for example obsessive compulsive disorder (OCD). In the case of OCD there is some biological evidence (e.g. Stein, 2000; Nurnberg, Keith & Paxton, 1997; Stein, Schoulberg, Heiton & Hollander, 1992; Rapaport, Ryland & Kriete, 1992) to suggest that some stereotypic animals, including horses, may be suffering from a disorder similar to that found in humans. Some researchers (e.g. Luescher, McKeown & Dean, 1998) argue, however, that the word 'obsessive' cannot be included in a non-human disorder as there is no evidence that other animals can engage in ruminative thought.

Stress is also defined in terms of the effects on the immune system. Blecha (2000, p.111) states that "one could argue that the immune system is the result of the evolving response of the host to the stress of pathogen challenge" while others (e.g. Hemsworth & Coleman, 1998; Johnson *et al.* 1994; Dunn, 1988; Seyle, 1976; Seyle, 1973) describe how stress affects and causes suppression of the immune system. A major problem every racing season is 'the virus'. Several yards each year have their activities restricted as many or all of their team develop a 'cold'. No yard appears to be immune and as this tends to affect Flat yards more than National Hunt yards, stress may be the answer: Flat yard populations are much younger than those of National Hunt yards, typically containing mostly two-year-olds and three-year-olds compared to the four- to 12-year-olds usually found in a National Hunt yard. The older animals have more training, racing and life experience than the younger animals and, therefore, may not find the routine and practices of the racing stable as stressful as a less experienced horse.

Stress also negatively affects the cognitive processes (e.g. Arnsten & Goldman-Rakic, 1998; McEwan & Sapolsky, 1995) and so the stressed young animal

may be slower to learn the tasks and behaviours required of it. This, in turn, may exacerbate the degree of stress experienced as slowness in learning may make handlers impatient or mistake the animal's lack of understanding as a refusal to cooperate. This can, in turn, lead to behavioural difficulties as the negative response from the handler may reinforce the animal's perspective that the situation it is in is uncomfortable, stressful, painful or to be feared. Reinforcement and punishment shape learning and behaviour, whether desirable behaviour or not. Horses learn quickly, often needing only one trial in order to make an association. If stress levels are affecting their cognitive processes then it may prove more difficult to teach them a desired behaviour or association, eliminate an undesired response or to teach the animal that a particular fear response is unwarranted.

Using immunological responses / factors as an indicator of stress has proven problematic and this, according to Moberg (2000), is due to the difficulty in defining what is meant by the term stress. In order for any measure, whether it be behavioural, biochemical or immunological, to be of value when assessing stress levels, it is clearly essential that we have a unified meaning for, and understanding of, 'stress'. If not, we are all testing something vague and, potentially, something different. Some writers (e.g. Zanchetti, 1972) even go so far as to suggest that the term essentially has no meaning or value and that it should be abandoned. This, however, is unlikely to happen as it would no doubt be seen by many as simpler to stick with a familiar and supposedly single concept rather than to test, name or identify the various suggested components separately. While the purpose of identifying and naming a concept is to introduce a measure of clarity and consistency, the concept of 'stress' would appear to have failed.

Another difficulty with the different measures of stress is that not all stressors will produce the same response in an organism. Also, the body sometimes produces similar physiological responses to supposedly positive events as it does to distressing ones. For example, Colborn *et al.* (1991) found that stallions secreted similar amounts of cortisol regardless of whether they were being restrained, exercised or allowed to mate.

An additional problem in using biochemical measures to determine stress, or indeed behavioural measures, is the fact that many of the studies may, in themselves, produce a stress reaction - a confounding variable. In the researchers' attempts to control the experimental environment, the settings and circumstances often do not reflect part of the animal's usual daily routine and experience. As horses are neophobic, the potential for confounding variables is clear. Also, many studies rely on taking samples from the animals after exposure to the 'stressor' yet the procedures involved - restraint, needles, and so on - are likely to affect the results.

There is also an ethical consideration with regard to deliberately stressing the animals so as to measure their biological and behavioural responses. An animal cannot give informed consent and cannot be debriefed after completion of the experiment. It is a strength of the studies presented in this thesis, that the stress responses of young animals were recorded in situations in which many of their kind find themselves due to routine husbandry or ownership transfer practices. The only form of intervention was in the accompaniment of some of the foals while alone during the covering of their dam (Chapter 3).

Yet another difficulty in animal stress studies is that individual differences tend to be overlooked. Unless they are specifically under investigation, there is often little or no consideration given to personality or temperament, life experiences, normal or usual coping styles or even, sometimes, to breed differences. It is often surprising to see so many equine studies that do not control for what are often well-established breed differences, using a mix of breeds in a single study rather than just representatives of a single breed. Also, many past equine studies used very small sample sizes. Other than making some forms of statistical analysis problematic and potentially failing to constitute a representative sample, results from a small sample will also be more likely to be skewed by one or two outliers.

1.7 Behavioural signs of distress and stereotypes

Rushen (2000) warns of the difficulties in interpreting behavioural signs of distress but there are certainly some behavioural responses that are easier to interpret than others. For example, the previously silent and calm foal who suddenly becomes loudly vocal and very active when its dam is taken away for

covering, thereby leaving the foal alone in the stable, can be reasonably described as showing signs of distress. An understanding of the motivation of the animal is important in interpreting their behaviour: the foal in this example is calling for the mare and makes attempts to follow her. As a prey animal most of the behavioural signs of distress shown by horses relate to the fight or flight response. If they feel threatened and their escape route is blocked they may resort to biting, kicking, rearing, striking or bucking, for example. Others will back away or freeze and they may show physiological signs of stress such as sweating or defecation. The frightened horse will often also have flared nostrils and wide-open eyes. If the animal is in pain its ears are usually held slightly back and in a fixed position for long periods, its eyelids pucker and the eye appears to be in a fixed stare (Fraser, 1980). Some behaviours suggest a specific problem. For example, backing into a corner or pushing the head against a wall, lying recumbent in a stall, continually looking around at the abdomen and flanks are often symptoms of colic.

As noted earlier, stereotypies are some of the most instantly identifiable behavioural signs of distress in horses. Both boxwalking and weaving are classed as locomotory stereotypies whereas cribbing and windsucking are regarded as oral stereotypies. A crib-biter grabs a solid object, for example the top of the stall door, a fence or even its own limbs, presses down with its incisors, arches its neck and emits a grunting sound. A windsucker, on the other hand, arches its neck and emits a grunting sound without grabbing onto an object and this behaviour gets its name from the fact it was believed that the animal was swallowing air. This has since been shown not to be the case (McGreevy, Richardson, Nicol & Lane, 1995) yet the term persists.

There are several theories as to the origins of stereotypies. It is possible that there are hereditary factors in the development of such behaviours, or that genetic factors may make some animals more prone to learn these behaviours than others. There is also considerable evidence of a role of various neurotransmitters (e.g. Pell & McGreevy, 1999; McGreevy & Nicol, 1998a, b; Würbel, Freire & Nicol, 1998; Cooper & Dourish, 1990; Dodman, Shuster, Court & Patel, 1988; Dodman, Shuster, Court & Dixon, 1987) but as no biological measures were recorded during the course of the studies conducted for this thesis, this evidence is acknowledged but not discussed.

One of the more popular psychological theories of the cause of stereotypies, for example, is operant conditioning theory, which would suggest that, for a foal that has been isolated, the return of the mare (a positive event for an isolated and distressed foal) will reinforce whatever behaviour the foal is performing immediately prior to her return. For example, should a foal pace its stall in response to separation from its dam, it will be rewarded by the subsequent return of the mare. This positive reinforcement will increase the likelihood that the animal will again pace the next time it is separated. If such behaviour does become a habit it may generalise to occur in other stressful situations and, potentially, develop into boxwalking. Boxwalking *per se* may not have been exhibited immediately prior to the rewarding return of the mare but the use of locomotory behaviours at this time of distress may have been reinforced. If the same or similar type of actions are used and rewarded during a subsequent period of distress, an abnormal behaviour pattern may be potentially learned through chaining. Confirmed boxwalkers, for example, have been known to incorporate obstacles, such as tyres placed in their stall, into their stereotypic 'routine', thereby developing an even more complicated series of moves.

The development of stereotypic behaviour in thoroughbreds, as opposed to non-racing breeds, has added implications to the obvious welfare concerns. Boxwalking, for example, also has financial implications in thoroughbreds. A horse sold at auction that is a boxwalker but was not declared as such is returnable under Condition 2, subsection 2(a) of the Conditions of Sale printed in the front of every auction catalogue of Robert J Goff & Co plc. An undeclared weaver or windsucker is also returnable under the same clause. The Conditions of Sale of both Tattersalls (Ireland) Ltd (conditions 8f and 8g) and Tattersalls Ltd (condition 9) make similar provisions.

McBane (1994) cited private research conducted on stereotypies in British-based Thoroughbreds, funded by the National Racehorse Trainers' Federation (Prince, 1987), which found that 1.7% wind-suck, 2.5% crib-bite, 2.8% weave, 1.1% boxwalk and 8.9% rug-chew. The findings were based on returned questionnaires from the trainers of 1,033 horses in training. The trainers were also asked to estimate the reduction in value of a horse with one of these stereotypies and the results showed a 50% reduction in the case of a wind-

sucker, 44% for a crib-biter, 22% for a weaver, 33% for a box-walker and 1.1% for a rug-chewer.

Prevalence rates for equine stereotypies differ from study to study. Breed differences are often apparent but it is also possible, in the case of thoroughbreds, that any rates based on the return of questionnaires may not be entirely accurate. As noted above, stereotypies reduce the value of a thoroughbred racehorse and, in certain circumstances, a stereotypic horse who was bought at auction is returnable. Therefore, owners, trainers, breeders or handlers may not be willing to identify their horse as having a problem. This may be particularly so if there are a number of stereotypic horses based at the one training establishment. Old notions that these stereotypic behaviours are somehow contagious are still believed by some, even though there is no evidence to suggest that they are either 'contagious' or are learned through observing conspecifics. Where there are several horses in the one yard or barn who exhibit stereotypies, the most likely cause is some common feature of the conditions in which they live. Feeding practice has been found to be a potential factor for stereotypy development in some animals (e.g. Waters, Nicol & French, 2002; Powell, Newman, McDonald, Bugenhagen & Lewis, 2000; Redbo *et al.* 1998), housing and management conditions have been implicated in others (e.g. Bachmann, Audige & Stauffacher, 2003; Redbo *et al.* 1998; Cooper & Nicol, 1996) while a genetic component has also been suggested (e.g. Vecchiotti & Galanti, 1986).

Mills, Alston, Rogers and Longford (2002) found an overall declared stereotypy prevalence of 5.1% in horses sold at five particular Tattersalls auctions held in the one year. The prevalence rate in two-year-olds, however, was found to be 16.4%, which the authors speculated may indicate that stereotypy development is "dependent upon management factors at certain ages" (p.6) and that "a proportion of young horses may cease to perform the behaviours as they grow older or are subjected to changes in management" (p.7). A possible management factor put forward with regard to the prevalence rate for stereotypic behaviours in two-year-olds was that many of them may have been only recently broken to saddle and bridle or may have been going through that process at the time they went through the auction ring.

Vecchiotti and Galanti (1986) reported a 2.5% prevalence rate in Italian thoroughbreds, Luescher, McKeown and Halip (1991) found evidence of stereotypies in 15% of Canadian horses investigated, Bachmann, Audige and Stauffacher (2003) reported a rate of 3.5% for Swiss horses while McGreevy, Cripps, French, Green and Nicol (1995), who looked at a mix of breeds, found a rate of 13.7%. Bachmann *et al.* (2003) also noted that thoroughbreds were 3.1 times more likely than horses of other breeds to become cribbers, weavers or boxwalkers.

Whatever the ultimate causes of stereotypy development, the proximal cause for their performance has been identified by Kiley-Worthington (1987, p.220) as “the results of frustration (an environmental imperfection where something is required and not received) or a mismatch between the environment that is expected and that observed”. She also noted that fearful situations and approach-avoidance conflicts (a type of frustration), as well as innate fears, such as of sudden loud noises or bright lights, are also potentially stressful situations for a horse and thereby potential triggers for abnormal behaviour.

1.8 Dealing with stereotypies

Mills (2001, p.1) states that behavioural problems “arise as a result of an interaction between factors relating to both the environment and the patient”. He adds that the owner is an important part of this environment and quotes Askew (1996) to illustrate: “...the problem is not the animal’s behaviour per se but rather the problems that this behaviour poses for its owner” (Mills, 2001, p1). A variety of factors have been implicated in the development of stereotypies and, depending on what people believe the causes to be, owners, trainers and handlers have employed a range of methods to control or attempt to eliminate the performance of these abnormal behaviours.

Behavioural methods such as anti-cribbing collars, anti-weaving bars, nails or foul-tasting substances attached to or painted on the tops of doors, or placing obstacles, for example tyres, in the stall of a weaver, have only limited success and can lead to the animal merely finding a different method of expressing the stereotypy, such as, for example, using its own legs for cribbing. Some horse owners have even resorted to surgery to eliminate windsucking, crib-biting or head-tossing, for example. But it is surely more important and more likely to

be effective if the underlying motivation or drive to perform the behaviours is investigated rather than just taking steps to prevent a horse from performing behaviours that we humans have looked upon as problematic, a vice, bad behaviour, distressing (for us) to watch, and even “a form of mental masturbation”, this latter, somewhat bizarre and almost Freudian interpretation attributed to Captain H.S Mosley in 1912 (McGreevy, 2000, p.112).

In commenting on the relative lack of success resulting from applications of these various methods of ‘prevention’ or ‘cure’, Ball, Simpson and Howard (2001, p.106) go so far as to say: “these so-called solutions are extremely cruel and can only make the horse’s suffering worse”. They suggest that expecting these practices to solve the problem or cure the behaviour is like expecting that to tie a suicidal human patient to a post will somehow cure her mental disturbance. This analogy is rather extreme but perhaps some of our approaches to dealing with stereotypies in horses are analogous to some methods once applied when dealing with human psychological disorder, for example spinning people around in circles or showering them in icy cold water or the forcing of female patients to wear “a neat or even pretty cap” in order to help them to recover from the obvious mental illness they showed by failing to attend to the dress of their head (Showalter, 1985, p.84). It may sound bizarre today but a superintendent of the Colney Hatch Mental Hospital in England in Victorian times believed that “it is not natural to the woman to neglect the dress of her head” and that making her wear a cap would gradually restore her natural tendency and, hence, cure her illness (Showalter, 1985, p.55).

Various drugs, such as naloxone, nalmefene, diprenorphine and haloperidol, for example, have been shown to reduce the incidence of crib-biting in horses (Dodman *et al.* 1987), though only while the animal is on the medication. McBride and Cuddeford (2001) found that naloxone, which has a sedative effect, significantly reduced crib-biting behaviour by an impressive 84% but that there was no reduction in weaving. As naloxone is an opiate antagonist, they suggested that crib-biting is, therefore, a rewarding behaviour for the horse. If cribbing is rewarding then it may be a coping mechanism for the animal which, McBride and Cuddeford (2001) point out, has obvious welfare

implications: should a horse be prevented from crib-biting? Is its welfare being compromised by preventing it from engaging in this compulsive behaviour?

Changes in diet, usually in the form of reducing the amount of concentrates being fed, have also been found to reduce stereotypic behaviours though this can be highly problematic for the management of a racehorse in training. A simple dietary modification, however, was reported by Mills and MacLeod (2002): supplementing a crib-biter's diet with antacids significantly reduced the amount of cribbing behaviour. This was a double-blind study to test what the authors described as a forgotten regime. They cited work by Mayhew (1888) and Fitzwygram (1911) that provided early evidence of a potential link between crib-biting and gastric acidity, noted that McGreevy, Cripps, French, Green and Nicol (1995) and Redbo *et al.* (1998) found a relationship between the behaviour and the feeding of concentrates, and that Nicol (1999) had suggested that cribbing may represent an attempt to increase the levels of alkaline in saliva so as to reduce the acidity caused by ingesting concentrates.

If crib-biting is indeed a function of the horse's attempt to deal with acid indigestion, then, clearly, methods employed to prevent it from engaging in this behaviour are contrary to its welfare. It may also, in part, explain why crib-biting and the related behaviour of windsucking, have been considered as 'contagious'. If all horses in a yard are being fed the same concentrates, then it is probable that more than just one or two will develop excess acidity as a result. Furthermore, as the definition of a stereotypy includes reference to the behaviour seeming to have little or no purpose, further evidence to support the findings of Mills and MacLeod (2002) would necessarily see both crib-biting and windsucking being reclassified.

Despite the effects of medications on stereotypic behaviours these remedies or temporary solutions cannot be applied to racehorses in training. It is not clear if any antacids would contain ingredients that fall under the banned substances list so caution would be advised. Any substance that acts on the central nervous system is a banned substance under the Rules of Racing (Walcroft, 2001 - personal communication), and any horse found to have any of these in its post-race urine sample is subject to disqualification with the

likelihood of fines, or even bans, imposed on the trainer. As medication is, therefore, not an option for racing thoroughbreds, other methods of prevention of abnormal behaviours need to be sought. As most abnormal behaviours are considered to be a result of stress, interventions that seek to reduce stress in young horses may prove to be an answer. These interventions can be simple yet effective and an important key is knowing the individual horse and what it is that motivates him/her and what it is that he/she does or does not like.

For example, in a recent newspaper interview (Racing Post, Monday 2nd August 2004), trainer Brian Ellison described how he eliminated boxwalking in his recently-retired stable star Fatehalkhair. Bought for just 1,900gns as he had a cannonbone fracture that wouldn't heal due to his boxwalking, Ellison took a chance on the horse because of his pedigree (Kris - Midway Lady): his sire was a champion racehorse, champion sire in 1985 and has sired many top horses, while his dam was a champion racemare and dual English Classic winner. Initially penned in between two gates for four months to give the fracture a chance to heal, the horse, described as being a very 'good-tempered' individual, was then put in a modified stable. One wall of the stable, which overlooked a paddock, had been knocked down thereby giving the horse free access to the paddock whenever he wants it: Fatehalkhair reportedly chooses to spend most of his time outdoors, even when it snows. Described as a horse who prefers to work alone and who dislikes 'fuss and being shut up' he won a total of 20 races (13 over jumps and 7 on the flat) from 99 starts, earning £129,867. Of course not every trainer has the space, time or manpower to turn horses out for a short time each day, even though it may greatly benefit some individuals. As it is the owner who decides upon the trainer, perhaps the owners of stereotypic horses should consider finding a trainer who will be able to accommodate the differing needs of the animal.

Another example comes from experiments conducted by McGreevy (2000) and McAfee, Mills and Cooper (2002), both of whom have found that placing large mirrors in the stable of a weaver significantly reduces the amount of that stereotypical behaviour performed. McGreevy described how subjects moved to stand beside their reflection at times of peak frustration rather than weaving at the stable door as they would usually do (2000, p.234). McAfee, *et al.* (2002, p.159) suggested that the positive effect of the mirror may be that it

mimics visual contact with conspecifics or that it provides some sort of environmental distraction. They reported that the horses spent a large proportion of the time standing facing the mirror and speculated that reasons for the reduction in weaving could include a reduction in the sense of social isolation, an environmental distraction or a reduced sense of confinement in the animals.

A possible explanation for the success of these mirrors in reducing weaving behaviour could indeed be related to the latter as perhaps it is claustrophobia that is the disorder and weaving merely the symptom. Many thoroughbreds, for example, exhibit an aversion to entering starting stalls on the racetrack but placing a thick rug over a horse's sides and quarters encourages the animal to walk in calmly. This rug, known as a Monty Roberts rug, is now a common sight on European racecourses. It is designed to come away easily and is clipped to the stall when the horse enters so that it will be pulled off as the horse gallops away. It is believed to work due to the fact the claustrophobic horse cannot feel the sides of the stall as it enters and stands waiting for release, thereby giving the impression that the stall is much wider than it is in reality. The horses in the mirror studies would stand facing the mirror and were reported to move towards it and to stand beside their reflection at times of peak frustration. Having a mirror in a room makes the room appear to be bigger than it really is, particularly if one stands in front of it looking in.

McGreevy (2000) states that horses do not appear to recognise themselves in a mirror and, so, probably have no concept of self. They are, obviously, able to recognise the sight of other horses so it would appear logical to presume that, therefore, they recognise that the reflection they are seeing is that of a horse. However, as horses do not usually attempt to interact with their image as they would another horse, it would be reasonable to conclude that these animals, who have been shown to be so good at discriminative learning, have some understanding that the image is that of themselves. Not even young foals appear to take fright or to try to interact with the reflection looking back at them from a puddle or water trough, for example. This would suggest that the effect of the mirrors in McGreevy (2000) and McAfee *et al.* (2002) may not be entirely the result of mimicing visual contact with conspecifics or providing

environmental distraction. Perhaps stabling these horses, or other weavers, in a considerably larger stall, and/or providing them with the opportunity for physical contact with another of their kind - for example by placing an open window between two stalls - may produce a similar effect and reduce the amount of weaving behaviour exhibited. Horses rarely weave when turned out into a paddock that contains at least one other horse.

1.9 Inheritance of traits and temperament in horses

Pottinger (2000, p.295) states that “the evidence for a significant genetic contribution to stress responsiveness in vertebrates is overwhelming” though while evidence of a potential genetic effect on stereotypies has been found in horses (e.g. Vecchiotti & Galanti, 1986), the evidence for inheritance of traits or temperament in horses is somewhat mixed.

Ball, Simpson and Howard (2001, p.110) state that “some particularly anxious horses seem to inherit fearfulness in the same way they inherit coat colour and conformation” but there is, as yet, no convincing evidence to support this claim. They also suggest that horses inherit a predisposition to aggression from their parents and while there is plenty of anecdotal evidence to support this position, more scientific evidence is lacking. McDonnell (1999, p.27) notes that “horse breeders have long recognised the heritability of certain basic temperaments in lines of horses” and while it is true that professionals in the thoroughbred industry will often identify specific traits or behaviours that appear to have been passed on from stallions or stallion lines, there is, as yet, no conclusive proof of this.

Wolff and Hausberger (1994) found tentative evidence for inheritance of some traits through the sire in French Standardbred foals though this preliminary study was based on only 13 subjects representing five stallions. Wolff, Hausberger and Le Scolan (1997) found that young horses, of the same breed, tended to behave more like others by their sire rather than like those by other sires on several behavioural tests. Arguably the most persuasive findings with regard to the inheritance of traits in thoroughbreds, however, came from a Japanese study in which 9644 young thoroughbreds in training at two training centres were assessed on how they responded to three handling procedures (Haupt & Kusunose, 2000) - checking of the mucous membrane of

the eye, auscultation (i.e. listening with a stethoscope) of the chest and taking of a blood sample. A horse was given an A if it remained calm, a B if it could be restrained without the need for a twitch, and a C if a twitch had to be applied. This meant that each horse received a three-letter overall grade, for example, AAA or ABA, and so on. A significant correlation was found between how the progeny of 62 stallions behaved in one training centre and how the progeny of those same stallions behaved in the other training centre. A concern though is that three-quarters of all the horses achieved the maximum score across the three tests, which may indicate that these tests did not sufficiently discriminate between horses.

The methods we use to assess temperament in horses can produce varying results for the same animals if they are assessed on different tests (Seaman, Davidson & Waran, 2002) suggesting that the usual types of tests used assess different aspects of a horse's temperament. This is one reason why it is difficult to find conclusive evidence that temperament can be inherited in horses. Another is that sample sizes in studies done tended to be rather small. There is, however, a potentially more important reason that tends to be overlooked. Typically these studies involve taking a group of horses, assessing their behavioural responses on a test and then looking to see whether or not there is some consistency in results when analysed by sire. What is not looked at is the temperament of the stallion himself. It would be a more difficult study to conduct unless one had access to a large stud farm but ideally one should assess the stallions, assess the progeny, without the observer knowing either the stallions' results or the sire of the test subjects, and then analyse results to determine whether or not traits may have been inherited.

1.10 Assessing temperament

Temperament has been defined as "an aspect of an individual's general make-up characterized by dispositions towards particular patterns of emotional reactions, mood shifts and levels of sensitivity resulting from stimulation" (Reber, 1995, p.788) or "an individual's basic stance towards continuing changes and challenges in its environment" (Creighton, 2004, p.239). How an animal handles or reacts to a novel object or scenario, that is, the amount of reactivity it shows, is often regarded as an important factor in the assessment

of its temperament, though the scenarios tested with horses tend to involve situations that the animal may never again encounter - a maze or a falling, open umbrella, or rotating balloons suspended from a ceiling (e.g. Visser *et al.* 2003; Momozawa *et al.* 2003).

The choice of testing method used may have an important effect on the results found. For example, Seaman, Davidson and Waran (2002) used three typical behavioural response tests - an arena test, respond to person test and respond to object test - with a group of 33 horses and found that there was no relationship between how the animals responded in one test compared to how they responded in another. They concluded that horses vary widely in how they respond to artificial behavioural tests.

The two most common methods of assessing temperament in horses are (i) analysing behavioural reactions to stimuli, and (ii) getting handlers to complete questionnaires (Momozawa *et al.* 2003). Within the first category there is a variety of tests that are typically applied - a respond to object test, a respond to person test, handling tests and a respond to novel object/situation test. Neither category, that is analysing behavioural reactions and use of questionnaires, is without its problems. Some writers caution against relying on behavioural indicators of stress (e.g. Rushen, 2000) and yet some degree of stress is typically involved in these reaction tests. Also, behavioural reaction tests usually focus on 'negative' traits such as reactivity or stress responses. Questionnaires can broaden the scope of the investigation as they can easily include items that would be difficult to test. Problems with questionnaires, however, include the fact that the ratings are often subjective rather than objective, responses may be coloured by prejudices the handler has with regard to the colour, gender, age, breed or sire of the animal, responses may reflect the current state of relations between the horse and handler, or the handler may not wish to paint his charge in a negative light and, hence, may choose not to mention the fact that the animal is, say, a boxwalker and weaver who chews his rugs and bites being saddled. This last point could be particularly true in the case of using questionnaires for thoroughbred racehorses. As noted above, some stereotypic behaviours are notifiable if the horse goes up for auction and failure to do so can result in the animal being returned to the vendor. Occasionally a stereotypy has not been declared,

either in error or because the vendor was not aware that the animal had a problem. Also, as Prince (1987) found, racehorses with stereotypies are considered to have reduced financial value.

A small number of studies have attempted to match aspects of equine temperament to aspects of human personality theory, most commonly to Costa and McCrae's (1992) Five Factor Model. The five dimensions proposed by this model are extraversion, agreeableness, neuroticism, conscientiousness and openness to experience. Creighton (2004), for example, reported that the validity of scores from a series of behavioural tests as measures of temperament in horses corresponding to these five factors was not established, leading her to suggest that behavioural responses shown by horses on typical reaction tests may be more a reflection of their past experiences rather than their underlying temperament. Morris, Gale and Duffy (2002) found that when handlers were asked to assess a number of horses on temperament questionnaires, the highest amounts of agreement between them came on dimensions most closely related to the extraversion and neuroticism of the Five Factor Model. This led them to conclude that some equine traits are seemingly easier to identify than others. French (1993), assessing the temperament of donkeys, found that the asses' trait of obstinacy was most closely related to agreeableness on the Five Factor Model while their trait of vivacity related to the Model's extraversion factor.

Costa and McCrae (1999) describe the 'basic tendencies' and 'characteristic adaptations' associated with each of the five factors in their model but some of the former and almost all of the latter need to be adapted or modified if the model is to be usefully applied to any non-human species. For example, under 'conscientiousness' they identify a basic tendency of 'achievement striving', to which they add 'strong sense of purpose and high aspiration levels' (p.143). Similarly, the basic tendency under 'neuroticism' is depression, identified by the authors as "a tendency to experience dysphoric effect - sadness, hopelessness, guilt" (p.143). Whether or not there is any merit to attempting to map equine temperament onto a model of human personality traits is open to question.

There is an important point to consider in designing a questionnaire study to examine temperament in horses - will most, if not all, of the assessors have the same understanding or interpretation of the various terms used? For example, can one be sure that two different raters will agree on what is 'flightiness', or 'boldness', or 'gregarious'? The lack of a standard taxonomy of terms and of large sample sizes were identified by Gosling and Bonnenburg (1998) as the two obstacles to "an integrative approach to personality in anthrozoology" (Morris *et al.* 2002, p.68).

1.11 Early experience and later behaviour

In addition to the 'traumas' discussed above, many authors (e.g. Beattie, Walker & Sneddon, 1995; Appleby, 1984; Kusunose & Sawazaki, 1984a,b; Heird, Lennon & Bell, 1981; Fraser, 1980) have observed that very early experience can have an affect on the subsequent emotional and behavioural responses of various animals, including horses. Indeed Kusunose and Sawazaki (1984b, p.277) suggested that a foal's interactions and experiences with its dam could lead to "marked differences in 'personality' observed" when they were older. The effects of intensive early handling on subsequent behaviour has been somewhat less clear.

A popular American early handling technique is called 'imprint training' (Miller, 1991), though its developer, Robert Miller, admits that it has little to do with the concept of imprinting and more to do with systematic desensitisation. The technique involves intensive handling of a neonatal foal, following a specific pattern and at four periods over the first 48 hours of the animal's life. By touching, rubbing, pulling or handling every part of the animal, the belief is that these foals will grow up to be easier to handle, school and train. The approach is often the subject of glowing testimonials by those who apply it but when the effects of the procedure have been tested the findings have suggested that it has little long-term effect. For example, Williams *et al.* (2002) found no significant difference in reactivity levels in foals' behaviour at one, two or three months of age. Their subsequent study (Williams *et al.* 2003) failed to find any benefit of the procedure in six-month old foals.

Simpson (2002), however, found that foals who had gone through this intensive neonatal handling procedure were rated as significantly calmer, friendlier, easier to put into stocks, calmer during a veterinary procedure and more likely to allow a human to approach within four metres than foals who had not undergone the procedure. Some of the specific items in Miller's 'imprint training' procedure, namely inserting a finger up a foal's nose and repeatedly patting the foal's feet, had no beneficial effect on the behavioural responses, at four months old, to the two procedures they are supposed to mimic, namely insertion of a nasogastric tube and tapping with a farrier's hammer. Waring (1983) reported that handling neonatal foals led to better performance when they were halter-tested a day or two later. However if no further handling was applied, these same foals objected to being haltered and showed both uneasiness and avoidance behaviours at 90 days old.

Mal and McCall (1996) found that foals handled throughout the first 42 days of their life did better on a subsequent halter training task than foals who were handled only between days 43 to 84 (the next 42 day period) of age. There were only ten subjects split between the two groups and the authors suggested two possible interpretations of their results: (i) there may be a critical handling period during the first 42 days of a foal's life, or (ii) the results may be a reflection of a phenomenon such as learned helplessness.

These tests were only carried on foals, but the handling pre- and post-weaning study conducted by Lansade, Bertrand, Boivin and Bouissou (2004) found that foals that were handled in either period were easier to handle and less reactive than the non-handled controls on tests conducted both ten and 18 months after the handling. The effects, however, diminished over time, again suggesting that these isolated bouts of intensive handling do not seem to have much long term benefit. As ease of handling is an important part of working with horses, it is probably the case that regular handling on a daily basis is ultimately better at producing a manageable horse than procedures that effectively amount to just sending the horse on a short course, after which the skills learned are then not being practiced. Given the amount of experiences a horse will have over the course of its life it is questionable that a short period of training undertaken as a neonate or within the first few months of its life will have a major or easily detectable effect on its temperament or behaviour

when adult. Given the ways in which a horse learns, experiences that are more vivid, have a high emotional context and generate strong motivation, such as some sort of trauma, may have the potential for more long-lasting effects than short-term, relatively stress-free events. Testing this, however, would be rather difficult.

Many equine behavioural studies focus on stereotypy reduction and on assessing reactivity based on responses shown on any of a number of reaction tests. These provide useful and interesting information but, particularly in the case of the reactivity studies, they could be more valuable if they were able to show that measures taken at one stage of a horse's life could predict future temperamental traits or behaviour or performance. The studies described above looked at early experience and/or behaviour in foals but most only related these to other occasions within a few weeks, months or within the same year. Lansade *et al.* (2004) also followed up 18 months after the initial handling experience.

"Animals with differing exposure to environmental stimuli, as will occur in extensive and intensive husbandary conditions, may form different emotional connections between the same stimuli, resulting in different behavioural responses on later exposure" (Dwyer, 2004, p.277). This may make it difficult to establish links between early behavioural reactions and responses or temperament assessments made several years later. However, if the early responses reflect some stable temperamental characteristics of the individual rather than just temporary states of mind, the links should be there.

Visser *et al.* (2003) tested 41 Dutch Warmblood horses on a series of behavioural tests during the first two years of their lives and scored them on personality traits such as emotionality, reactivity to humans and learning abilities. At the age of three the horses were broken and began their training as showjumpers. When their performance in training was analysed in relation to their earlier personality assessments it was found that a significant amount of the variance in their performance could be accounted for by their earlier personality measures. As the authors pointed out, even though physical jumping ability is of major importance in a potential showjumper, having a temperament that enables the horse to maximize that potential by being able

to handle the various challenges and stresses that come with the job is also of considerable importance. It is a common mistake, they said, to place insufficient emphasis on temperament when buying or selecting a horse.

Being able to predict which performance/working animals will make the grade and which ones would be better suited to a different career has obvious financial benefits. There are also potential welfare benefits for the animal if it can be redirected towards a more suitable role at an earlier stage - less stress trying to cope with a difficult regime. The costs involved in training a large number of potential police dogs from which a proportion would fail to 'graduate' encouraged the South African Police Service Dog Breeding Centre to develop a testing procedure that could identify which puppies would be the ones who would later become successful police dogs (Slabbert & Odendaal, 1999). There were already a number of canine temperament tests in wide use but a series of behavioural response tests compiled by Slabbert and Odendaal and that included items or scenarios that an adult police dog could be expected to face in the course of its work, such as the sound of gunshot or having to navigate through a crowded environment without being distracted, was found to reliably predict future performance.

Whether or not the tests and assessments reported in the chapters that follow will help to identify which foals, yearlings and two-year-olds will become successful racehorses remains to be seen. While quite a few have already raced, and several have become Stakes winners, the majority have not yet commenced their racing careers.

1.12 Human-animal interaction

A key factor in a horse's ability to learn how to behave and survive in our world is the interaction it has with its human handlers. Patient, sympathetic but firm handling can both teach and reassure a horse. As a prey animal whose instinct is to fight or flee, it requires a considerable amount of trust to allow a human to pick up its feet, to handle it all over, to lead it into confined or strange surroundings. As Budd (1996, p.51) stated: "No foot, no escape - so any horse that willingly lifts its feet to be cleaned, or even steps out without hesitation on to a strange, untested surface is showing a degree of trust and confidence that goes against a deeply ingrained rule of thumb". A breakdown

in communication, or a failure to communicate, can lead to misunderstandings on both sides of the relationship and this can result in a horse failing to learn, of living in a continually stressful environment, of developing problem behaviours and stereotypies, of becoming violent and/or uncooperative.

Positive human-animal interaction has been shown to be of benefit in several species. For example, Baker (2004) reported that chimpanzees who received positive human interaction in the form of relaxed treat feeding, playing and what they described as “other forms of social interaction compatible with personnel safety” (p.239) engaged in increased level of mutual grooming (with other chimps) and a reduced level of several behaviours including abnormal oral behaviours. Bayne, Dexter and Strange (1993) found that positive human interaction in the form of providing singly-housed rhesus macaques with treats, reduced performance of abnormal behaviours while Baker, Bloomsmith, Griffis and Gierhart (2003) reported a reduction in both anxiety-related behaviours and abnormal behaviours, in the same species, when what they described as positive reinforcement training provided as environmental enrichment was applied. Lensink, Raussi, Boivin, Pykkönen and Veissier (2001) reported that calves that received additional rather than just minimal handling were easier to load and had lower heart rates during that procedure than calves who had not received any additional handling, while Rushen, Munksgaard, Marnet and De Passillé (2001) found that human contact reduced some of the stress responses in cattle who were milked in an unfamiliar room compared to those who were milked in an unfamiliar room without any human contact. Hennessy, Williams, Miller, Douglas and Voith (1998) found that not only did petting a dog reduce its stress response during blood sampling but that those animals petted by a female handler, rather than a male handler, yawned more often during the procedure and spent more time in a relaxed, head-up posture (p.63).

Of course the opposite is also true: negative human-animal interactions can have a negative effect. For example, several studies (Breuer *et al.*, 1998; De Passillé *et al.*, 1996; Munksgaard *et al.*, 1995) have shown that cattle will rapidly learn to show avoidance behaviour towards humans if they receive slaps or brief shocks with a battery-operated prod. Bayley (2002) states

that horses who are being handled by a person that they do not like often become anxious or nervous.

Hemsworth and Coleman (1998, p.1) describe human-animal interactions as “a key feature of modern livestock production” and state that “the quality of the relationship that is developed between stockpeople and their animals can have surprising effects on both the animals and the stockpeople”. Several researchers (e.g. Hemsworth & Barnett, 1987; Hemsworth & Gonyou, 1997), have emphasised that the personality of the human handler is very important and that a person’s personality can determine how good an animal handler or trainer he or she will become. Young and Cipreste (2004) state that while animal training is not a complex process and that most people can be taught how to correctly teach and interact with animals, not everyone has the necessary personality traits to be able to do it well. They describe the required traits for a good handler or trainer as (i) having a great deal of patience, (ii) a calm demeanour, (iii) consistency in the individual’s own behaviour, and (iv) the ability of the individual to analyse their own behaviour. Unfortunately, they added, few people have this combination of characteristics. The same writers also warn of two potential pitfalls for animal trainers: (i) the animals they are training are not their ‘friends’, and (ii) the animals will try to train them (Young & Cipreste, 2004, p.230).

1.13 Summary

The thoroughbred is the most valuable, most widely publicised and probably most populous breed of horse and as its production is closely regulated and monitored by industry bodies this reactive breed is eminently suitable for behavioural research. It also appears to be a reasonably intelligent breed of horse, something that is important given the number of ‘traumas’ a young potential racehorse can be expected to undergo by the age of two: early experience has been shown to relate to later behaviour and temperament and horses can learn to associate contingencies very quickly, sometimes in just one trial. Stereotypies, which are abnormal behaviours considered to be a sign of distress, frustration or possibly a coping mechanism to deal with stress, are fairly common in thoroughbreds with prevalence rates as high as 16% depending upon factors such as age or stereotypy. There is a variety of ways in which one can deal with the stereotypic horse but as substances that

act on the central nervous system are ruled as banned substances in a racing horse, alternatives to the medications that have been shown to be effective in reducing or eliminating these behaviours need to be applied. Reactivity is often taken as an indication of temperament in horses and so equine temperament, which may be partially inherited, is typically assessed in two ways: (i) measuring behavioural and/or physiological responses to stressors, usually in the form of arena tests, response to person tests, response to object tests or handling tests, and (ii) getting those who are responsible for the animals' care to complete a temperament questionnaire. Both methods have their difficulties but appear to be useful. A key factor in the horse's ability to learn, behave and survive in our world is the quality of the human-animal interaction it receives - it has been shown that positive human-animal interaction can, for example, reduce distress in a variety of species.

1.14 Rationale for this thesis

Harlow's classic work (e.g. Harlow & Zimmerman, 1959; Harlow & Harlow, 1962) with infant chimpanzees showed that young distressed animals would take comfort in an artificial mother object if their own mother was absent. Similarly other authors (e.g. Baker, 2004; Baker, Bloomsith, Griffis & Gierhart, 2003; Bayne, Dexter & Strange, 1993) have found that positive human-animal interaction can reduce anxiety-behaviours and abnormal behaviours in the animals. Even so, the foal separation study presented in Chapter 3 was inspired by not an academic source but by a single foal encountered by the author when working on a thoroughbred stud farm in 1995.

'Wee Charlie', as she was known in the yard, was alone in her stable while her dam was at the covering shed. She had been whinnying loudly and was found to be cowering, wide-eyed, behind a mound of fresh straw when the author entered the stable to shake down the box (i.e. distribute the fresh straw evenly around the stable). After talking to her quietly for a minute or so, the foal started to calm down and to initiate physical interaction. Within another minute or so she was happily playing with the author and showing no signs of distress at all. Having observed, first hand, how this foal's behaviour changed by having human company at this obviously distressing time and how distressed other foals seemed to be during their period of isolation, the

separation study was an obvious first place for this thesis to start. 'Wee Charlie', incidentally, later became a two-time winning racehorse (under a different name) and is now a young broodmare in Britain.

Some authors (e.g. Kiley-Worthington, 1987) have observed that the start of behavioural problems in horses can often be traced back to the time of artificial weaning. The thoroughbred industry presented the ideal opportunity to examine whether or not this could be taken a step further, to investigate if behavioural responses exhibited during the temporary separation from the dam during covering could also be linked to behavioural problems, that is, by looking at a stressful period in the life of a typical preweaned thoroughbred foal and later examining it in relation to their temperament when a racehorse (Chapter 6).

Much of the literature on reactivity, emotionality or temperament in horses (e.g. Visser *et al.*, 2003; Seaman, Davidson & Waran, 2002; Visser *et al.*, 2001; Wolff, Hausberger & Le Sclan, 1997) is based on the results of behavioural tests, typically novel object tests, response to person tests, handling tests or response to object tests. Some combine these with temperament questionnaires (e.g. Momozawa *et al.*, 2003). The novelty tests often involve stimuli a horse will not usually encounter in its lifetime, for example a falling open umbrella or rotating balloons suspended from the ceiling. The ability of such tests to predict future temperament as assessed by the animals' primary caregivers must therefore be in question. By using a setting that a large proportion of young thoroughbreds will face at least once before they go into training as racehorses, namely the auction ring, it was possible for a single observer to assess reactivity not only in a large number of subjects (more than 3700 individual animals) but to a stimulus situation that is similar to one they will encounter every time they go to the racetrack (Chapters 4 & 5). The parade rings at racecourses are also enclosed, railed-off areas surrounded by large numbers of people and a lot of noise, including public address systems, in which a young horse will be led around by a single handler. A notable difference between the two situations is that in the auction ring the horse is the only animal in the ring while at the racecourse there are usually several others, depending on the number of runners in that particular race.

As Momozawa *et al.* (2003) stated, getting handlers to complete temperament questionnaires is a common way of assessing the temperament of the horses in their care. Therefore, in order to test whether or not the behavioural responses of foals and yearlings in separation and auction ring studies would enable prediction of temperamental traits when they were older, it would be necessary to track down as many of the subjects as possible and to request that their current handler complete a short temperament questionnaire (Chapter 6).

1.15 Research Questions

There were five research questions under investigation in this thesis, which were as follows:

1. Will accompanying a pre-weaned foal while it is separated from its dam during covering of the mare reduce the behavioural signs of distress exhibited by the foal?
2. Will behavioural signs of reactivity shown by young flat-bred horses in the auction ring differ from those shown by young national hunt-bred horses in the ring, thereby suggesting a potential role for husbandry practices in the development of equine psychological maturity?
3. Can the number of behavioural reactions shown by a yearling in the auction ring be predicted from the number of behavioural reactions it showed, as a foal, during its first experience of the auction ring?
4. Can temperamental traits in two-year-old racehorses, as assessed by their primary caregivers, be predicted from how they responded to what are typically stress-provoking stimuli as a foal and/or as a yearling?
5. Is there any evidence of potential inheritance of temperamental traits in thoroughbred horses?

Chapter 2: Thoroughbreds Horses - Naming and Pedigrees

2.1 Introduction

Much of the analyses that are presented in the following chapters are based on looking at various aspects of the bloodlines of the horses observed. It is important, therefore, to first explain certain points with regard to (i) the naming of thoroughbreds and some of the regulations relating to their breeding, (ii) how to read a pedigree, (iii) how to calculate the amount of inbreeding within four and five generations, (iv) the inbreeding coefficient, (v) how inbreeding can be more usefully expressed as a Pedigree Diversity Score (PDS), and (vi) what is meant by the figure system in the breeding of thoroughbreds. It should, therefore, be clear that this breed is one that is strictly regulated, something that makes it a very valuable breed to use for behavioural research.

2.2 The Basics - Naming and Breeding

A number of stallions have been identified in the chapters that follow so it is important to point out that each thoroughbred to be used for racing or breeding has a unique registered name and that this name cannot be changed once the animal has (i) raced, (ii) sired a registered foal, or (iii) produced (i.e. given birth to) a registered foal. Therefore, as the name of a thoroughbred is a permanent one so long as it remains within the thoroughbred industry, it is a unique identifier.

All rules and regulations pertaining to the naming and breeding of thoroughbreds have been laid down, and are enforced, by Weatherbys Group Limited, which is based at Sanders Road, Wellingborough, Northamptonshire NN8 4BX, England. The Irish division is based at Tara Court, Naas, Co Kildare. This organisation has been responsible for the creation and maintenance of the General Stud Book since official records were first published in 1793 and it is with them that all thoroughbreds to be raced or used for breeding in Britain or Ireland must be registered. A fully updated version of the General Stud Book is published only occasionally, but a number of supplementary issues are issued each year. For example, *The Statistical*

Record Return of Mares 2003, published in November 2003, was the third supplement to Volume 44 of the General Stud Book. This invaluable volume, published every November, documents every registered foaling and covering in Ireland and Britain during the year. It also records, where notified, any foals born abroad as the result of a covering in Ireland or Britain, and provides details of the regulations pertaining to the registration of thoroughbreds.

In order to be registered as a thoroughbred, there are several criteria that must be fulfilled. First, a foal must be the result of a natural covering of a registered mare by a registered stallion. Artificial insemination (A.I.), a common practice in many equine sectors, is absolutely outlawed in the thoroughbred industry: there are no exceptions. Secondly, every animal within the first eight generations of the foal's pedigree must be a registered thoroughbred. If even one of these 506 individuals is not classed as thoroughbred the foal will be registered as non-thoroughbred. There is, however, an exception to this particular rule: if the foal has a non-thoroughbred within those 506 individuals but the questionable one is in the eighth generation of the family, then, as the foal would represent another generation for any of its future progeny, the foal can be classed, on application, as a 'vehicle' horse. The animal will be allowed to race and its progeny will be classed as thoroughbred, presuming the other criteria are met. A notable recent example of a vehicle horse was the highly talented sprinter Clantime who was allowed, on application, to stand as a sire of thoroughbreds. He sired several talented racehorses and has a son at stud in England.

Upon registration, each thoroughbred is issued a passport: this will usually be done as a foal. This document will, throughout its lifespan, be updated to include registration of its official name, vaccinations, racing and travel records and other information that will enable the animal to be identified. Although thoroughbreds are famed as being the most valuable breed of horse in the world, they are, in fact, relatively worthless without their passport. All are also blood-typed and, since 2001, all Irish and British thoroughbred foals are DNA tested to prove parentage. Since 1999 each foal must also be implanted with subcutaneous microchip, in a specific section of the left side of the animal's neck, as an additional means of identification. In America all

Thoroughbreds are given a permanent numerical tattoo under their upper lip while in Australia and New Zealand each animal is given an identifying brand mark on their near side shoulder.

Thoroughbreds being aimed at flat racing are usually not given an official name until they are yearlings or two-year-olds. In France, though, horses are often named as a foal. A horse being aimed at the national hunt industry will usually not be named until the age of three or four. There are a number of rules pertaining to the naming of Thoroughbreds and most racing countries adhere to these. No two horses, alive at the same time, may have the same name. Most names may be reused after a specified time following the death of a horse but the time frame involved depends on whether the animal was a mare, stallion or gelding. Also, some names have been placed on a protected list, and none of these can be reused. Names on this list include Classic and Grand National winners as well as horses successful in any of a specified number of other races. Therefore, nobody could name another horse Shergar, Red Rum or Desert Orchid, for example, in any of the world's major racing countries.

Another important point is that once a name has been registered and the animal has raced, the name may not be changed. Hong Kong, Singapore and Malaysia are three countries in which this rule does not apply and, hence, horses that have raced in Europe, America or Australasia often have their names changed when entering these countries. Despite this, the original name will still be used in official statistical records in their country of origin, usually with the second name attached. For example, major 2003 Hong Kong winner Olympic Express (GB) raced in Europe under the name Ecclesiastical (GB) and, hence, is identified as Olympic Express (GB)/Ecclesiastical (GB) in the official statistics produced by Weatherbys (see Scoble, 2004, p.125). Should the now, say, Hong Kong-based horse travel to Europe to race its name recorded in entries and on racecards will be the original one, except in very rare circumstances. The best known exception is multiple Hong Kong champion Indigenous (IRE), who originally raced in Ireland as Qualtron (IRE): his better-known name published when he travelled to England to compete in a top level contest.

The suffix after a Thoroughbred's name is part of its legally registered identification and, hence, should be included. For the purposes of clarity, however, suffixes will not be used with the names of horses mentioned in the chapters that follow. The suffix indicates the country in which the animal was born: the abbreviations are not the same as those used in vehicle registration. Although horses born in North America (USA), Australia (AUS), Austria (AUT), Canada (CAN), France (FR), Germany (GER), Italy (ITY), Japan (JPN) and New Zealand (NZ), for example, have always had these suffixes recorded as part of their legal name, it is only since 1988 that the suffix IRE has been officially recorded for Irish-born Thoroughbreds and GB recorded as part of the legal name of horses born in Great Britain. Hence Fillies' Triple Crown heroine Oh So Sharp (born in 1982) has no suffix whereas 2004 leading middle-distance horse Doyen (IRE) is a son of Sadler's Wells (USA) and Moon Cactus.

Although there cannot be two horses with the same name registered at the same time, the first part of the name, for example Eva Luna, can be used with any other suffix unless the name is on the list of internationally protected names. Using the above example to further clarify, there are currently two broodmares with the name Eva Luna and both were in training in the same years. One is Eva Luna (IRE), a former racing star in Ireland and now a moderately successful broodmare. The other is Eva Luna (USA), a Group 3 winner on the track and now the dam of Group 1 winning colt Brian Boru (GB). Although it may appear that both carry the same name, the suffixes make them different. Another reasonably prominent and current European example is the mare Averti (USA) and the stallion Averti (IRE). The latter, a highly talented sprinter in England, is now emerging as a good source of sprinting progeny, while the former was a black-type placed racemare (see footnote 2 on p.17) that has since produced a black-type winning daughter. Again, technically they do not have the same name. Non-protected names can be reused years after the death of an animal, the number of years being dependant upon whether the previous name-holder was an active stallion (25 years), a broodmare (15 years) or a gelding (10 years).

With the fairly recent advent of 'shuttle stallions', that is, stallions who stand the Northern Hemisphere stud season in Europe, America or Japan before travelling to the Southern Hemisphere for their stud season, lines that may

have become weaker over time, in terms of their ability to produce top class racehorses, are again being strengthened by recombination with some of the world’s strongest lines. Hence countries such as Japan, Germany, South Africa and Argentina, for example, are emerging as important producers of notable racehorses.

2.3 Reading a Pedigree

Figure 2.1 gives an example of how a pedigree chart appears in an auction catalogue and this chart will be used as illustration for the basics of reading a pedigree. There are no technical manuals or academically published ‘rules’ for reading a horse’s pedigree, just the ordinary basics of reading any genetic relationships, modified by an internationally-accepted understanding that is passed on from generation to generation.

grey colt (IRE) February 19th, 2001	Daylami (IRE)	Doyoun	Mill Reef (USA)
			Dumka (FR)
	Style Of Life (USA)	Daltawa (IRE)	Miswaki (USA)
			Damana (FR)
		The Minstrel (CAN)	Northern Dancer (CAN)
			Fleur (CAN)
		Bubinka (USA)	Nashua
			Stolen Date (USA)

Figure 2.1: A three-generation pedigree as it would appear in any Irish or English auction catalogue. This is the pedigree of 2004 Irish Derby winner Grey Swallow (IRE).

The colt in this example (Figure 2.1) is 2004 Irish Derby winner Grey Swallow, an Irish-born son of Daylami (the sire) and out of Style Of Life (the dam). He was born on February 19th 2001 and is registered as grey. The sire’s pedigree always goes on the top half of the chart with the distaff side of the family on the bottom half. The colt’s paternal grandsire is Doyoun and paternal grand-dam is Daltawa, while The Minstrel and Bubinka are called, respectively, the broodmare sire (or maternal grandsire) and second dam (or grand-dam). Stolen Date is described as the third dam. This is obvious, but it is when talking about relationships such as half-brother or three-parts sister, for example, that reading thoroughbred pedigrees can differ markedly from reading relationships in, say, human family trees.

If Style Of Life produces another Daylami foal, say a colt, this would be described as a full-brother, or an own-brother, to Grey Swallow. A filly, of

course, would be a full-sister or own-sister. In 2002 the mare produced a filly by Sinndar (Figure 2.2) and she is, clearly, a half-sister to Grey Swallow. She is also inbred 5x3 Northern Dancer but this sort of relationship will be explained later.

bay filly (IRE) 2002	Sinndar (IRE)	Grand Lodge (USA)	Chief's Crown (USA)
			La Papagena
	Style Of Life (USA)	Sinntara (IRE)	Lashkari
			Sidama
	Bubinka (USA)	The Minstrel (CAN)	Northern Dancer (CAN)
			Fleur (CAN)
			Nashua
			Stolen Date (USA)

Figure 2.2: Three-generation pedigree of Moonlight Dance (IRE), a half-sister to Grey Swallow (IRE).

If the mare were to produce a colt foal by Dalakhani (Figure 2.3) then this would be described as three-parts brother to Grey Swallow. This is because Daylami (sire of Grey Swallow) and Dalakhani are half-brothers. If the two stallions were in fact full-brothers, then the foal would be described as a brother-in-blood to Grey Swallow.

colt (IRE)	Dalakhani (IRE)	Darshaan	Shirley Heights
			Delsy
	Style Of Life (USA)	Daltawa (IRE)	Miswaki (USA)
			Damana (FR)
	Bubinka (USA)	The Minstrel (CAN)	Northern Dancer (CAN)
			Fleur (CAN)
			Nashua
			Stolen Date (USA)

Figure 2.3: Three-generation pedigree of a hypothetical cross between Dalakhani and Style Of Life. This is a three-parts brother to Grey Swallow.

The major difference in determining relationship in thoroughbreds as opposed to humans comes when the common ancestor is the sire, not the dam. Two children by the same father but from different mothers would be called half-brothers or half-sisters but in thoroughbred horses two foals by the same stallion but from different mares are not considered to be related at all. Therefore, though Stakes winners Whazzat and Bay Tree are by the same sire as Grey Swallow, the trio are not considered to be related to each other.

Another relationship that can be described in thoroughbreds is that of being bred on similar lines to some other horse, for example a horse by Danehill and

out of a mare by Be My Guest could be described as being bred on similar lines to champion colt Rock Of Gibraltar, a son of Danehill and the Be My Guest mare Offshore Boom. This is a very weak relationship that indicates nothing more than the fact that this type of cross has worked previously. Of course the same or similar cross may have been tried many times previously without success. One of the most popularly perceived successful crosses at the moment is to breed Darshaan mares to Sadler's Wells. This has produced seven Group 1 winners, notably dual Derby winner High Chaparral, but has also produced a lot of lower calibre racehorses too.

2.4 Calculating the amount of Inbreeding

Inbreeding is said to occur when one or more horses are repeated within the first five generations of a pedigree. Some web-based databases (e.g. www.pedigreequery.com) will produce nine-generation crosses showing all duplications, if the user wishes. However, these databases still acknowledge five generations as the industry standard and identify this as the default setting. Although there is no explicitly stated rule on the use of five generations, it is taken to make practical sense as an individual animal in the fifth generation contributes just 3.125% of the genetic material of the current animal. Indeed, some geneticists claim that very little influence can be exerted by a progenitor beyond the third or fourth generation, a situation commonly referred to as the Galton Law (Varola, 1974, p.5).

If there are no duplications with the first five generations then the pedigree is said to be an outcross.

Duplicated animals are usually highlighted in auction catalogues by putting the name of the specific animal in bold, though these catalogues, for reasons of lack of space, will typically only display the first three generations of the pedigree and, consequently, only any inbreeding that occurs within those three generations. On printed or web-based pedigree charts, coloured bars, alongside the names of the duplicated animals, are often used to highlight the crosses.

Inbreeding in a pedigree is expressed numerically, based on the generations within which the duplication has occurred. So a horse that has Northern

Dancer once in the third generation and once in the fourth generation would be described as being inbred 3x4 Northern Dancer (spoken aloud as 3 by 4 to Northern Dancer). If the fourth generation instance of Northern Dancer was higher up on the pedigree chart than the third generation instance, as shown in Figure 2.4 below, then this would be expressed as 4x3 Northern Dancer.

			Northern Dancer	
			Northern Dancer	

					Northern Dancer			
			Northern Dancer					
				Northern Dancer				

solely because of the presence of their son Northern Dancer and, therefore, they are not mentioned. If, however, one or more of these other duplicated animals is also contained with the immediate ancestors of a different animal, and this duplication falls within the first five generations of the pedigree of the current horse under investigation, then their presence would be indicated: their presence in the pedigree is *not* solely dependent upon a single animal. In the example below (Figure 2.7) Natalma is additionally represented through Spring Adieu, while Native Dancer (the sire of Natalma) is additionally represented through Raise A Native. Therefore they are included in a report of the amount of inbreeding in the pedigree and this one would be described as being inbred 5x5 Native Dancer, 4x3x4 Northern Dancer, 5x5x4x5 Natalma.

			Raise A Native	Native Dancer
				Raise You
			Northern Dancer	Nearctic
				Natalma
			Spring Adieu	Buckpasser
				Natalma
		Northern Dancer	Nearctic	Nearco
				Lady Angela
			Natalma	Native Dancer
				Almahmoud
			Northern Dancer	Nearctic
				Natalma

Figure 2.7: Five-generation pedigree chart showing inbreeding of 5x5 Native Dancer, 4x3x4 Northern Dancer, 5x5x4x5 Natalma.

As pedigrees in auction catalogues typically only show three generations, and the pedigrees of stallions displayed in stud brochures often only show four generations, many instances of 5x5, or even 4x5, inbreeding may be accidental. However, when closer inbreeding occurs it is usually by design, as an attempt to double-up on any potential effect there may be of having a particular animal in the pedigree. Breeders will typically choose to inbreed to

a successful stallion or an influential mare, even though it is impossible to know specifically what influence each one has on any given pedigree.

Two of the most popular stallions for duplication, in Europe and America, are Northern Dancer and Mr Prospector. Each was an exceptionally successful sire of racehorses and each has become a major progenitor of successful stallions and broodmares. Breeders will also often inbreed to their sons (Danzig, by Northern Dancer is a very popular one). The result is that many Northern Hemisphere racehorses show some inbreeding to one or both of these major stallions. In Australia and New Zealand the most popular stallion is currently Danehill (by Danzig, by Northern Dancer), many times champion sire and with many sons at stud. The frequency with which he is appearing in duplicate in pedigrees is causing concern to some breeding pundits in the region.

In order to determine whether or not the amount of inbreeding in a pedigree might be linked to reactivity, two Pedigree Diversity Scores (PDS) were calculated for each horse, one representing the amount of diversity within the first four generations of their pedigree and the other representing the amount of diversity with the first five generation. The reason these were used instead of an inbreeding coefficients is explained below.

The reason that the amount of inbreeding within the first four generations was examined, in addition to the amount within the first five generations, which is, as stated, usually taken as the industry standard, was to separate those animals who are more closely inbred from those for whom the bulk of the inbreeding occurs through relationships in the fifth generation. Each ancestor in the fourth generation contributes 6.25% of the genetic material.

2.5 The Inbreeding Coefficient

Wright's Coefficient of Inbreeding, devised by Sewell Wright in 1922, has been used extensively in quantitative genetics and evolutionary biology and has been applied by some to looking at pedigrees of thoroughbred horses (see Hardiman, 2000). The coefficient is derived by applying the formula

$$F_x = \sum \left[\left(\frac{1}{2} \right)^{n_1+n_2+1} (1+F_A) \right]$$

where F_x is the inbreeding coefficient of the horse in question, F_A is the inbreeding coefficient of the common ancestor, n_1 is the number of generations from the sire to the common ancestor and n_2 is the number of generations from the dam to the common ancestor (Hardiman, 2000, p.1). Hardiman notes that the formula can be used to compute either the standard inbreeding coefficient, that is, the inbreeding within the first five generations of the pedigree, or the cumulative inbreeding coefficient, which represents all inbreeding in the pedigree as far back as records will permit.

As this equation is only applied to inbreeding where the common ancestor appears in both the male and distaff sides of the pedigree, this led John Hardiman to produce his own approach in 2000, called Hardiman's Method. This considers all incidences of duplication within the first five generations of a pedigree, whether they occur both the male and distaff sides of the chart or just on one side. His method is based on assigning a total value of 25% to each generation and dividing this figure in various ways based on the number of duplications there are in each generation. Neither of these methods, however, is appropriate for looking at the inbreeding within the first four or five generations of a thoroughbred horse's pedigree for the purposes of this thesis, or indeed for any general pedigree research. Both are unwieldy tools and produce a number, as the end result, that does not in itself tell us anything of real use. Even Hardiman cautions that any inbreeding coefficient is of little value unless one has something against which to compare it (Hardiman, 2000).

Additionally, in the case of Wright's Equation it is not possible to produce a solution unless one has access to previously calculated inbreeding coefficients: one needs the inbreeding coefficient of the common ancestor in order to compute an inbreeding coefficient for the target individual. It also ignores all inbreeding that occurs in just one half of the pedigree, for example two crosses of Northern Dancer appearing in the distaff side of the family. This alone makes it a method of little value for looking at thoroughbred horses as it will frequently produce inaccurate results. Many thoroughbreds that are inbred within five generations will have these duplicated ancestors appearing in just one half of their pedigree.

Application of these methodologies has been widely used in other fields but they do not serve any meaningful purpose in general or applied pedigree research in thoroughbred racehorses. The system outlined in section 2.4 above is the way in which the description of inbreeding in thoroughbreds has always been done and given that it is a simpler, more clear and more widely recognisable method, it will remain the one that pedigree analysts and breeders will employ.

Even so the calculation of inbreeding coefficients has been applied to thoroughbred horses though with differing results. Zechner, Sölkner, Bodo, Druml, Baumung, Achmann, Marti, Habe & Brem (2002) in their investigation of pedigree and morphological traits in Lipizzaner horses, note that Vaez Torshizi, Nicholas and Tier (1998) computed an inbreeding coefficient for Australian thoroughbred (N=7085) of 9.26% whereas Mahon and Cunningham (1982) had reported a figure of 12.5% when they investigated 21.5 recorded generations of pedigrees of Thoroughbred mares from Ireland and Britain.

Though Zechner *et al.* (2002) offer no explanation for this discrepancy it is most likely a reflection of the effects of the 'shuttle' stallion policy that has been operating between the two regions for the past two decades. A number of stallions that cover mares during the Northern Hemisphere season then travel to Australia and New Zealand, and other countries such as Argentina and Chile, for the Southern Hemisphere. While the distant ancestors of the all these thoroughbred populations were more closely related, they became more distantly related over time. With the influx of 'shuttle' stallions, which has had a profound effect on the Australian and New Zealand racing and breeding industry, lines that were comparatively common in the Southern Hemisphere could now be crossed with major European and American bloodlines that had become divergent from their own. Subsequent analyses of inbreeding coefficients in the region may find different results, however, as the amount of inbreeding to horses from these stronger Northern Hemisphere lines has increased to such an extent that, as noted above, concern has been expressed by some breeding and pedigree pundits.

2.6 Calculating the Pedigree Diversity Score (PDS)

The traditional method of describing inbreeding in the pedigrees of thoroughbred horses, described in section 2.4 above, does not produce a quantifiable result that can be easily used in statistical analyses so some form of numeric transformation needed to be applied so that the amount of inbreeding could be expressed as a single score. As neither Wright's nor Hardiman's approaches are suitable for the purposes of this thesis, for the reasons outlined above, an alternative method was developed in order to investigate whether or not there may be a relationship between the amount of inbreeding in a pedigree and reactivity shown by foals and yearlings in the auction ring, or their temperament as assessed by the primary caregivers of two-year-olds in training. This is the Pedigree Diversity Score (PDS), which indicates the number of individual animals within the first five, or four, generations of a horse's pedigree. It is easy to calculate, can be produced in a matter of seconds and requires access to no other information other than the appropriate chart of the individual's pedigree.

A five-generation pedigree chart can contain a maximum of 62 individual animals. All horses have a potential maximum PDS of 62 and a horse with this score will be described as representing an outcross. If examining only the first four generations, the potential maximum PDS will be 30. Many will have some degree of inbreeding within five generations but considerably fewer will show inbreeding when only the first four generations are taken. In all cases, these have been identified by using the hypothetical mating function on the Pedigree Online Thoroughbred Database website (www.pedigreequery.com).

To calculate a horse's PDS using a five-generation pedigree, simply apply the formula

$$(62 - \Sigma C) + (\Sigma D + \Sigma N)$$

where 62 is the maximum number of individuals possible in five generations, C is the number of cells covered by the inbreeding in the pedigree, D is the number of individual animals that are duplicated in the pedigree, and N is the number of individuals who are covered by an incidence of inbreeding but are not themselves duplicated within the five generations. For a four-generation

pedigree, replace the 62 with 30 and continue as before. This formula is easily adaptable. Should one wish to calculate a PDS based on six generations, for example, 62 is replaced with 126, the maximum number of individual animals possible in a six-generation pedigree.

In the first example below (Figure 2.8), the inbreeding, within five generations, covers 10 cells, Northern Dancer, Nearctic and Natalma are duplicated while Nearco, Lady Angela, Native Dancer and Almahmoud are covered by the inbreeding but are not themselves duplicated. Mathematically this would be represented as $(62 - 10) + (3 + 4)$, giving a PDS of 59, meaning that there are 59 different animals represented in this pedigree. If this same pedigree was only being examined to four generations, then the formula would read $(30 - 4) + (1 + 2)$, thereby producing a PDS of 29.

		Northern Dancer	Nearctic	Nearco
			Natalma	Lady Angela
			Nearctic	Native Dancer
			Natalma	Almahmoud
			Nearctic	Natalma
			Natalma	

Figure 2.8: Five-generation pedigree chart showing the animals covered by inbreeding 3x4 Northern Dancer, and highlighting the duplications.

In another example there are multiple duplications (Figure 2.9). This time there are 15 cells covered by the inbreeding, the duplicated animals are Northern Dancer, Nearctic, Natalma, Native Dancer and Briartic, and those

covered by the inbreeding but not themselves duplicated are Nearco, Lady Angela, Almahmoud and Sweet Lady Briar. The PDS would therefore be calculated as $(62 - 15) + (5 + 4) = 56$: there are 56 different animals represented within the first five generations of this pedigree. As much of the duplication occurs within the fifth generation, this pedigree would still produce a PDS of 29 if examined to just four generations.

		Northern Dancer	Nearctic	Nearco
				Lady Angela
		Natalma	Native Dancer	
			Almahmoud	
			Nearctic	
		Natalma		
		Briartic	Nearctic	
			Sweet Lady Briar	
			Briartic	
			Native Dancer	

Figure 2.9: Five-generation pedigree chart showing the animals covered by inbreeding 3x4 Northern Dancer, 4x5x5 Nearctic, 4x5 Briartic, 5x5 Native Dancer, and highlighting the duplications.

It can be clearly seen, therefore, that the choice of how many generations to examine can result in horses being grouped together differently in the subsequent analysis. A horse that would be scored as an outcross (PDS=30) in a four-generation pedigree, for example, could be classified as a horse that has sufficient inbreeding in his pedigree to produce a PDS of, say, 56 in a five-generation pedigree. Also, as a greater degree of inbreeding in a pedigree produces a lower PDS than would result from a less inbred pedigree, this implies a linear relationship and, therefore, suitability of the PDS for correlating with ratio or interval scales.

2.7 The figure system

The figure system for breeding racehorses was introduced by Bruce Lowe in 1895 and is regarded by some as a horse's "surname" (Ulbrich, 2003). Though described in a recent paper as "often considered an important indicator of genetic value within the multibillion dollar thoroughbred industry" (Hill, Bradley, Al-Barody, Ertugrul, Splan, Zakharov & Cunningham, 2002, p.288), the system is seldom actively used today by Irish or British breeders in arranging mating plans for their broodmares. The system was based on an examination of the female line of all the pre-1890 English Classic winners with a family number being assigned on the basis of the number of Classic winners produced from any given line. The family responsible for the most such winners was identified as family 1, the next most successful as family 2, and so on. In all Lowe identified 43 families, or 43 foundation mares.

Of these 43 families Lowe identified what he called the major nine families with these nine being subdivided into 'running' families and 'sire' families. These nine families were those numbered 1, 2, 3, 4, 5, 8, 11, 12 and 14 and in explanation of his decision to classify these families as 'major' he says:

"...only about nine appear to be indispensable in the pedigree of any first class horse of the present day. Every racehorse of today, as a fact, contains in his table the whole of the nine, either direct or through collateral branches some distance back. But my contention is that some of the branches of these choice families must be represented within the *top three removes*, and in proportion to the amount of inbreeding to these few choice families will be the measure of vitality contained in the individual - other conditions of course being equal. ...I have divided these nine families into two classes, *running* and *sire*, or, in other words, *feminine* and *masculine*" (Lowe, 1895, p.5).

Those families he identified as 'running' or 'feminine' families were numbers 1, 2, 4 and 5 with families numbered 3, 8, 11, 12 and 14 being designated 'sire' or 'masculine' families. The value of these family numbers does not appear to be great today. If one takes the system's ability to identify potentially top stallions as an example, it emerges that five of the world's most outstanding

stallions of the past century, Mr Prospector, Northern Dancer and his sons Danzig, Sadler's Wells and Nureyev, do not come from 'sire' families. Mr Prospector represents family 13, Northern Dancer comes from the line designated 2, Danzig represents 7 while Sadler's Wells and Nureyev come from 5. Families 2 and 5 were identified by Lowe as being 'running' or 'feminine' families while families 7 and 13 were not included in the major nine.

Sunday Silence and Storm Cat, however, are two example of recent major sires to have emerged from Lowe's 'sire' families as former American Horse of the Year Sunday Silence, who died in 2002, was the most outstanding stallion in the history of Japan's racing and bloodstock industry (family 3), while Storm Cat, currently something of a sensation in America where he has twice been champion sire, represents family 8.

Lowe died before his book was published but even less than 50 years later some writers were questioning his classification of 'running' and 'sire' families. Miller (1939), for example, notes that Family 2 was showing evidence that it should be classified as a 'sire' family as amongst the notable stallions to have emerged from this line were The Tetrarch and Gainsborough, two of the great stallions of the time. Today this Family continues to be a source of major sires with such as Northern Dancer and Machiavellian representing Family 2.

Since Lowe, further families have been identified. Bobinski and Zamoyski (1953) together produced the first edition of *Family Tables of Racehorses*, now popularly known as the Bobinski Tables, in which Lowe's numbering system was expanded to accommodate more horses. This tome is now in its fourth edition, edited by Shirai (2004), and the family numbers have been identified in Table 2.1 below (www.bloodlines.net/TB/families/familynumbers.htm). The subdivision of Family numbers came about with this 1953 publication. This was applied to the larger English families and, hence, most, though not all, horses today will have a letter attached to the Family number. For example, Northern Dancer represents branch d of family 2, Sadler's Wells and Nureyev are from branch h of Family 5 while former European sprint champion and leading young English stallion Pivotal is from Family 7. Despite all these classifications, Shirai (1990) notes that there are 25 major winners worldwide that cannot be traced to any family. These, he says,

include 1960 and 1969 Grand National winners Merryman II and Highland Wedding.

Table 2.1: The numbering system used in Family Table of Racehorses

Families 1 - 74	trace directly to a mare in the General Stud Book (GSB)
Families 1 - 49	are numbered according to Lowe and Goos
Family 50	has been restored to Family 13
Family 51	is comprised of the descendents of the King William IV Arabian Mare (as in Keylock)
Families 52 - 74	remain unclassified or without a number designation
Families Ar1 - Ar2	are Argentine families
Families P1 - P2	are Polish families
Families A1 - A37	descend from American Stud Book (ASB) mares who cannot be traced to the GSB but which are accepted as foundation mares
Families C1 - C16	are described in the Australian Stud Book as approved Colonial Families
Families C17 - C33	descend from Australian and New Zealand mares who cannot be traced to the GSB
Families B1 - B26	trace directly to Prior's Half-Bred Studbook

Although today most breeders talk of stallion lines rather than matriarchal lines, Lowe's concept of importance being attached to the bottom line on a horse's pedigree chart rather than the top line can be linked to what we know today of mitochondrial DNA (mtDNA). This genetic material is usually passed on only through the female line and so if there were contained within it some key material in the makeup of a good racehorse or producer, then an understanding of and ability to identify successful female lines could be useful.

Recent research on equine mtDNA (Hill *et al.* 2002), however, uncovered some anomalies in the family number system. They examined representatives of 19 families (numbers 1-14, 16, 17, 19, 22 and 25) and found anomalies in eight (1, 5, 6, 9, 11, 12, 16 and 19) of these. While the anomalies found in Families 1, 11, 16 and 19 were described as relatively recent, those found in Families 5, 6 and 9 were described as being deep rooted, possibly from confusion at the foundation stage. The study also found genetic evidence that Families 4, 11 and 13 may, in fact, descend from a single common founder. This is interesting when compared with Lowe's classification of 'feminine' and 'male' families, particularly as Family 4 falls under the former heading while Family 11 is one of the latter.

Hill *et al.* (2002) also found evidence to suggest that there may be a “matrilineal relationship between Family 7 and one of more of the founders of Families 2, 8, 16, 17 and 22” (p.293). They note that there has been some historical literature suggesting that these five families do descend from a single founder but Hill *et al.* (2002) are the first to provide tentative evidence of this supposition.

Hill’s research, like almost all in the field of genetics, has worked on the theory that mtDNA is only passed on through the female line. However, recent findings by Schwartz and Vissing (2002) have challenged this, reporting that in a case involving a Danish family, it was found that the majority of mtDNA in one of their patients came from the father and not the mother. Morris and Lightowlers (2000, p.1290), while noting that available clinical data mean that this would be very rare, offer as explanation for the possibility of inheritance of paternal mtDNA, the following:

“The hypothesis is based on evidence that mtDNA may undergo recombination. If this does occur, maternal mtDNA in the egg must cross over with homologous sequences in a different DNA molecule; paternal mtDNA seems the most likely candidate”.

The evidence for potential transmission of mtDNA through the male suggests that if this does occur it is extremely rare. As such it is likely that the anomalies found by Hill *et al.* (2002) are indeed indicative of possible errors in the female lines.

2.8 Summary

Thoroughbred horses are a well regulated breed whose registration and naming are subject to strict rules. The criteria applied to determine whether or not a horse qualifies as thoroughbred mean that all members of the breed, regardless of where in the world they are based, come from the same basic gene pool and this makes them an ideal breed for behavioural research.

Once it has raced, sired or produced a foal, a thoroughbred’s registered name does not change, so long as it remains within the thoroughbred business and within the major racing countries. Hong Kong, Singapore and Malaysia are

three countries in which a thoroughbred's name can be changed before it commences racing there. The suffix attached to each name indicates the country of birth. These suffixes were not used for Irish- or British-born foals before 1988.

The sire, dam, paternal grandsire and maternal grandsire/broodmare sire are analogous to the terms father, mother, paternal grandfather and maternal grandfather in humans. The terms second dam and third dam are the equivalent of grandmother and great-grandmother in humans. Horses with the same dam but different unrelated sires are called half-brothers or half-sisters. However, should they have the same sire but different unrelated dams, they are considered to be unrelated. If the sires of two foals from the same mare are half-brothers, then the two foals are said to be three-parts brothers or sisters. If both foals have the same sire and dam they are said to be full-brothers/sisters or own-brothers/sisters.

Inbreeding means the duplication of two or more animals within a pedigree. This is usually applied within the first five generations of a family. Auction catalogues usually display only the first three generations due to pressure on space, hence inbreeding is rarely immediately apparent to the reader who is not familiar with thoroughbred pedigrees. For the purposes of analysis in relation to behavioural data, inbreeding can be expressed as a Pedigree Diversity Score (PDS), that is, a count of the number of different animals that appear with any given number of generations of the individual's pedigree.

A system that has been used by some breeders in deciding matings has been the figure system, pioneered by Lowe in the late nineteenth century but since developed through compilation of what are known as the Bobinski tables. Each female family is assigned a number based on the number of Classic winners the family produced before 1890. This system is, however, rarely used today and needs modification as, even 50 years after its creation, flaws with the system were evident. Recent genetic evidence (Hill *et al.*, 2002) found further flaws.

Chapter 3: Foals separated from their dam during covering

3.1 Introduction

Some Thoroughbred stallion farms separate the mare from the foal during breeding, leaving the foal alone in its stall. Such separation often leads to distress in the foal, as evidenced by behavioural indicators such as vocalisations, pacing or moving about, pawing and striking the body against solid objects. Kiley-Worthington (1987, p.121) notes that in her experience it is frequently possible to trace the start of behavioural problems back to the time of weaning. The study presented here, however, is the first to look at a time of stress experienced several months before weaning, an event that many preweaned foals face on at least one occasion.

A variety of behavioural signs of distress, both locomotory behaviours and vocalisations, were recorded for the pre-weaned thoroughbred foals while the dam was absent for covering. The aim was to determine whether the amount of distress exhibited would be reduced if a human handler quietly accompanied the foal during this period of separation. The findings were subsequently published (McGee & Smith, 2004a).

Accompanying or handling an animal during a time of distress has often been shown to reduce the behavioural signs of the discomfort. Some racehorse trainers, for example, have found that having another animal, for example, a pony, goat or sheep, live with a horse that is prone to exhibition of high levels of stress or stereotypic behaviour, reduces these behaviours. Human intervention has been found to reduce behavioural signs of distress in animals undergoing stressful procedures, for example, petting during invasive procedures in dogs (e.g. Hennessy *et al.*, 1998).

3.2 Methods and Procedures

3.2.1 Design

An observational study utilising opportunistic sampling. The independent variables were (i) the length of the separation of the foal from the mare (this was not under experimenter control) and (ii) the condition into which each foal

was placed, ie. the 'accompanied group' or the 'unaccompanied group'. A number of dependent variables were employed in the form of behavioural responses of the foals.

3.2.2 Subjects

A total of 57 thoroughbred foals were observed. All were boarding at a leading Irish stud farm during part of either the 2001 or the 2002 Northern hemisphere breeding seasons, and their dams were to be covered by one of the resident stallions on the farm. Data were obtained on 27 foals in the 'accompanied' condition (m=10; f=17; age range=10-64 days; $M=33$ days) and 30 in the 'isolated' condition (m=15; f=15; age range=9-97 days; $M=35$ days).

3.2.3 Materials

Behavioural responses (see section 3.2.4.3) of the foals and the length of the duration of their separation were recorded using pen, paper and a stopwatch. The observer, for safety reasons, wore a jockey's skullcap during recording of the 'accompanied' group.

3.2.4 Procedure

On each day when the observer was present on the farm, any foal was observed whose mother was removed from the box for covering. It was planned to allocate each foal alternately to either the 'accompanied' or 'isolated' group. However, in practice this sequence had to be altered when practical or safety issues became paramount. For example, if it was not possible to see the foal from outside of the stall, due, for example, to inaccessibility of the window when the top half of the stall door was closed over, then such foals were assigned to the 'accompanied' group, even if the sequence dictated that they should be in the 'isolated' group. Similarly, foals that became available after the yard staff had left for the evening were assigned to the 'isolated' group rather than the 'accompanied' one, because insurance restrictions prevented the observer from entering a stall with a foal if there was nobody else in the vicinity. The sequence was never altered for reasons based on behaviour, temperament or gender of the foal, and the original sequence was always reinstated at the earliest opportunity.

3.2.4.1 'Accompanied' condition

In the 'accompanied' condition the observer entered the stall only after the trailer removing the mare had pulled away. Mares being separated from their foals are often difficult to load, and, in the interests of safety, it was judged that the mare should not see the observer enter or leave the stall where her foal had been left behind. While accompanying a foal, the observer did not approach the foal but stood inside the (closed) door of the stall recording observations. If the foal initiated physical contact then the observer responded by reciprocating the contact and desisting as soon as the foal pulled away. If the foal showed obvious interest in the observer but hesitated to approach, the observer asked the foal to approach by making a clicking noise and using the extended-fingers gesture that is thought to attract a horse's attention due to the similarity of this movement to the nose-to-nose greeting typical of the species (Budiansky, 1997). As soon as the trailer returned to the yard the observer terminated the session and exited the stall.

3.2.4.2 'Isolated' condition

In the 'isolated' condition the observer was able to view the foal either through the bars, while standing a couple of steps to the left of the door, or, alternatively, by standing on top of a box placed on the ground to the right of the window. There was no contact made with any of these foals, though given their acute sense of hearing and smell, it cannot be ruled out that they were occasionally aware that somebody was nearby. That said, there was usually several people working in the vicinity of the stable during the time of the foals' separation and, hence, a lot of noise from stereos, vehicles and mechanical equipment. The observer only moved into position as the trailer was leaving. This was so that the mare would not see someone approach the location of her foal, and additionally so that the vehicle would mask any sounds made by the arrival of the observer. As soon as the trailer returned to the yard, the observer stopped recording and moved away.

3.2.4.3 Behavioural measures

The potential behavioural indicators of distress shown by the foals that were recorded were vocalisations, pacing or moving about, and pawing, together with the number of times the animal struck a solid object with its body.

A record was made of the number of vocalisations (defined as any whinny, squeal, snort or nicker) uttered during the period of observation. The time spent moving around the stall and the time spent pawing were recorded using a stopwatch. Movement around the stall did not include any movement of less than three continuous steps at a time (hence the movement of a foal stepping forward a single step at a time, for example, to sniff something, was not included). Pawing was defined as the striking of the ground with a front foot in the manner characteristic of that behaviour. Striking of the body against a solid object was recorded as the number of times the foal charged into the door or bucked into the wall - these were the only forms of such behaviour exhibited.

It was decided to use the recorded observations from the entire duration of the separation period rather than use only the first 10 minutes of that period. The reasons for this were as follows. It was noticeable that some isolated foals seemed to be particularly upset for up to the first 10 to 12 minutes of their separation period before becoming comparatively calmer, though still clearly distressed. Of these, the behavioural signs of distress would again increase in some if a person entered their stable or if a motor vehicle passed close by. It was felt, therefore, that a more accurate account of how an isolated foal handled the experience would be possible by using its responses from the entire separation period. It was also found that while most of the accompanied foals would become more calm as soon as the observer entered the stable, others did not begin to approach the observer with any confidence until after 15 minutes had passed, while some interacted immediately and others chose not to interact at all. Using just the initial ten minute period for all would have allowed for a more direct comparison between behavioural responses of the two groups (minute by minute). However, had it been decided to use just data from the first 10 minutes of the separation period, whether accompanied or isolated, then this aspect of the differing temperaments of the animals would have been lost and results could have been made unreliable.

3.3 Results

3.3.1 General

The duration of the session for which each foal was observed was outside the

control of the observer and varied unpredictably. There was no significant difference between the two groups in the mean session duration (the mean duration was 1397 sec in the 'accompanied' group and 1490 sec in the 'isolated' group). However, the variation in the session durations made it necessary to convert some of the data in appropriate ways in order to make them comparable from one session to another.

The more distressed a foal is the closer together are the whinnies it emits and the greater the proportion of time it will spend pacing or moving about in an enclosed area. These behaviours can be expected to occur in all cases. Therefore, in the case of vocalisation, the data analysed were the mean intervals between vocalisations (i.e. the duration of the session divided by the number of vocalisations), while in the case of the time spent pacing/moving about, the data analysed were the percentages of the session times spent performing these behaviours.

Pawing or striking the body against solid objects are behaviours less commonly seen during a period of distress - some foals will not exhibit either - and, as such, it was the actual amount of these behaviours shown that was of interest. Therefore no conversion was performed in either the case of pawing, where the total amount in time, in seconds, that each animal spent engaging in the behaviour was analysed, or in the case of striking solid objects, where the data analysed were the number of times each foal struck the door or a wall. Nonparametric statistical tests were employed throughout, because the data on most variables did not meet the requirements for parametric testing.

3.3.2 Vocalisation

As Figure 3.1 illustrates, the isolated foals vocalised on average at shorter intervals than the accompanied ones, and the range of mean intervals between vocalisations was lower in the 'isolated' group than in the 'accompanied' one. Foals in the 'isolated' group vocalised on average at intervals of 14.8 sec (range = 5.2 to 30.3 sec) while those in the 'accompanied' group vocalised on average at intervals of 26.8 sec (range = 8.5 to 81.2 sec). The Mann-Whitney test revealed that the 'isolated' foals vocalised at significantly shorter intervals than the 'accompanied' ones ($z=3.88$; $p<.001$).

Figure 3.1: Frequency distributions (grouped into 5-sec intervals) of mean intervals between vocalisations in the 'accompanied' ($n = 27$) and 'isolated' ($n = 30$) foals

3.3.3 Pacing/moving about

The foals in the 'accompanied' group spent a smaller proportion of the session time pacing/moving about the stall than those in the 'isolated' group, but the difference was not statistically significant. On average, the 'accompanied' group spent 13.7% of the time pacing/moving about the stall (range = 1.5% - 52.2%), while the 'isolated' group spent 20.7% of the time performing this behaviour (range = 2.1% - 62.2%).

3.3.4 Pawing

Only 12 of 27 foals in the 'accompanied' group pawed during the observed session, while 21 of 30 'isolated' foals performed this behaviour. The proportion of foals that pawed at least once was approaching significance on a chi-square test ($\chi^2=3.81$; $df=1$; $p=.051$). A Mann-Whitney performed on the actual amount of time spent pawing revealed that the foals in the 'isolated' group spent significantly more time engaged in this behaviour than those in

the 'accompanied' group ($z=2.50$; $p<.05$). Mean pawing time in the 'accompanied' group was 6.8 sec; in the 'isolated' group it was 29.6 sec.

3.3.5 Striking solid objects

A total of 17 of the 30 'isolated' foals hit themselves against a solid object at least once during the period of separation while none of the 'accompanied' foals engaged in such behaviour. This difference was highly statistically significant ($\chi^2=19.18$; $df=1$; $p<.001$). Of the 17 foals that hit themselves against a solid object, 9 hit the door or a wall between 2 and 9 times. Of the other 8, one foal hurled itself against the door 11 times (filly), one 24 times (filly), two 28 times (both colts), one 30 times (filly), one 35 times (filly), one 41 times (filly) and one 67 times (colt). One colt, which charged the door 9 times, also displayed signs of weaving.

3.3.6 Relationships between variables

Table 3.1 shows the Spearman rank correlation coefficients for the different pairs of dependent variables. There were significant negative correlations between the mean interval between vocalisations and the percentage of the session time an animal spent moving around ($r_s = -.38$; $n = 57$; $p<.01$) and between the mean interval between vocalisations and the number of times an animal struck a solid object ($r_s = -.42$; $n=57$; $p<.01$). In addition, there were significant positive correlations between the percentage of the session time an animal spent moving around and the number of times it struck a solid object ($r_s = .43$; $n=57$; $p<.01$), and between the time an animal spent pawing and the number of times it struck a solid object ($r_s = .37$; $n=57$; $p<.01$). Age, gender and the number of times that the animal had been previously separated from its dam for teasing or covering were found to be not significantly related to any of the behaviours recorded.

Table 3.1: Coefficients of correlation (Spearman) between the dependent variables ($n=57$)

	% time spent moving	Time spent pawing	No. of times objects struck
Mean vocalisation interval	-.38 **	-.21	-.42 **
% time spent moving		-.11	.43 **
Time spent pawing			-.37 **

** $p < .01$ (2-tailed)

3.4 Discussion

Rushen (2000) warned that the interpretation of behavioural responses is fraught with difficulty and that this limits our ability to use behavioural indicators of stress. However, while some behaviours may be difficult to interpret in this regard, a dramatic or prolonged alteration in behaviour occurring at the time of an unusual event can reasonably be interpreted as a sign that the animal is experiencing some kind of distress. So, for example, a foal that was resting or foraging quietly in its stall that suddenly becomes loudly vocal and very active when and while its mother has been removed from the area, can be assumed to be exhibiting distress. The intercorrelations between the various measures employed in this study are strong evidence that they are each an indicator of an underlying construct that may reasonably be labelled as 'distress.'

In most circumstances it is the foal that ensures that the distance between itself and its mother is close, with the mare and foal remaining within five yards of each other 94% of the time during the first week and 52% of the time by the fifth month of the foal's life (Houpt, 1998, p.196). When the mare has been removed from the stall and the foal left behind, the foal is highly motivated to follow. The closed door prevents this and hence the foal is distressed because not only has its mother been taken away but also it is unable to do anything to change its situation. The isolation is confirmed when the foal receives no reply to its calls for the mare. As almost every other mare and foal in the yard will usually be turned out in fields at this time (unless it is the evening or early morning) the foal often does not even receive a reply from another nearby animal and hence its sense of isolation and abandonment is potentially increased. Horses are herd animals and being isolated or abandoned instils fear. In the wild they were prey animals and for a prey animal to become isolated from its herd, the consequences can be very serious: it makes a relatively easy target.

In other farm animals acute stress can even cause sudden death. Fraser (1980), for example, noted that 'acute stress syndrome' accounts for a substantial number of cases of sudden death among pigs. He stated that it is a problem most commonly associated with transporting of animals but that

“deaths can also apparently result from milder forms of handling and after such routine treatments as weighing and tattooing” (p.235). Post-mortem examinations, he claimed, reveal no infectious disease or physical injury. Experienced van drivers have been known to advise handlers to keep a close eye on the foal with which they are travelling as, on rare occasions, it has been found that an otherwise healthy foal may be dead in the trailer upon arrival at its destination. Indeed it is has been possible, in some countries, to take out a foal mortality insurance policy to insure against this possibility. In short, even a relatively acute period of stress can have serious consequences for a foal.

The results of the present study, as a whole, suggest that accompanying a foal while it is separated from its dam during covering reduces the distress experienced by the animal during this event. This is evidenced by considerable differences between the ‘accompanied’ and ‘isolated’ groups in terms of the time between vocalisations, the percentage of time spent pacing and moving about and the time spent pawing. The fact that there was no effect on any of the measures of the age, gender or the number of times the foal had previously been separated from its dam for teasing or covering, further suggests that it was the intervention with the ‘accompanied’ group that produced the differences that were found between the two groups.

Of considerable concern with regard to the immediate welfare of the foals was the number of foals that hit themselves against solid objects during the period of separation. None of the ‘accompanied’ foals engaged in this behaviour but 17 of the 30 ‘isolated’ foals did. Two of these foals sustained multiple minor lacerations, to the chest, nose and legs. Of these foals it is interesting that the one to hurl himself against the door 67 times, sustaining multiple lacerations as a result, was in a fairly dark stall in which the top door was closed. This is an obvious welfare issue that needs urgent attention.

That there was a significant relationship between the time spent moving about the stall and the amount of pawing was not surprising given that both can be considered displacement behaviours. Displacement behaviours tend to be species-typical, with a high probability of occurrence in the normal life of the

particular animal (Cabib, 1993), and have been defined by Kiley-Worthington (1997) as “apparently irrelevant behaviours that occur when the behaviour the individual would like to perform is not possible, either because it is blocked or the individual has an approach/avoidance conflict” (p. 49). Kiley-Worthington further noted that a displacement behaviour is indicative of frustration or a conflict of some sort. A foal that is frustrated in its futile attempts to escape confinement and follow the mare is likely to engage in such behaviours. It has also been suggested that stereotypies can emerge from unsuccessful attempts to escape confinement (Toates, 2000; Würbel & Stauffacher, 1997; Dantzer, 1986).

The nature of the intervention in this study was of such a kind that it is not possible to conclude whether or not certain elements of the intervention were crucial to the effect of reducing distress. While accompanying a foal the experimenter behaved in a way best calculated to keep the foal calm, and interacted with the foal at such times as the foal appeared to want such interaction to occur. It is unlikely that the mere presence of the experimenter in the stall would have had the effect it did if such interaction had not taken place. Indeed, if the experimenter had refused all interaction, it is possible the outcome would have been very different - the foal could have reacted to their presence as a threat.

The findings reported here have obvious implications for the welfare of the foals but there are also implications for potential locomotory stereotypy development. In the riding-horse stereotypies may seem to be no more than merely a nuisance to the handler, but in the Thoroughbred industry the implications extend beyond the welfare of the animal. Many breeders, for example, breed to sell at public auction and the Thoroughbred with stereotypies not only has its sale value potentially reduced but it may prove very difficult to sell at all. As previously noted, a Thoroughbred that is a windsucker, weaver or boxwalker and has not been declared as such at auction, may be returned under the Conditions of Sale of the main auction houses.

Whether stereotypies in a horse develop through learning, or are related to either a genetic susceptibility to stress (Luescher, McKeown & Halip, 1991; Sambraus & Radtke, 1989; Vecchiotti & Galanti, 1986) or to perform certain behaviours (Vecchiotti & Galanti, 1986; Hosoda, 1950), the fact remains that they usually appear to develop in response to stress. As horses often learn associations between events and contingencies fairly quickly, it is important that the animal learns associations that will benefit it rather than bring about further distress.

The intervention provided by this study reduces the behavioural signs of distress exhibited in what is a particularly upsetting event in a young foal's life, and, in helping the animal remain relatively calm during an otherwise distressing situation, there is the potential for the foal to learn that human company in times of distress or frustration is beneficial. With the relative trauma of auctions, breaking, training, a racing career, castration (for most colts) and, particularly in the case of those fillies later used as breeding stock, frequent invasive veterinary procedures, to come, the lesson that humans can be trusted, learned early, could also be of considerable value to future owners, trainers and handlers.

3.5 Conclusions

Having a handler simply remain in the stall with a pre-weaned Thoroughbred foal while its dam is at the covering shed reduces the behavioural signs of distress displayed. It also eliminates the potentially self-injurious, or even possibly life-threatening behaviour of charging into solid objects such as the stall door. It may also help the foal to learn that handlers can be trusted, so that it becomes less distressed when encountering potentially upsetting experiences in the future. Perhaps most importantly, the reduction in the level of distress exhibited may reduce the likelihood of the development of locomotory stereotypies that may be a handicap to the animal's own adjustment and that may have serious consequences in terms of its financial value.

Chapter 4: Weaned foals' first experience of the auction ring

4.1 Introduction

Temperament can be defined as “an aspect of an individual's general make-up characterized by dispositions towards particular patterns of emotional reactions, mood shifts and levels of sensitivity resulting from stimulation” (Reber, 1995, p.788). How an animal handles or reacts to a novel object or scenario, that is, the amount of reactivity it shows, is often regarded as an important factor in the assessment of its temperament, though the scenarios tested with horses tend to involve situations that the animal may never again encounter - a maze or a falling, open umbrella (e.g. Visser *et al.*, 2003).

An analogous test for dogs was developed by Slabbert and Odendaal (1999). Based on measuring behavioural responses of untrained pups to stimuli of the kind they would encounter as part of their work as adult police dogs, it was found that puppies which would later go on to be successfully trained for the job as adults could be identified. Many Thoroughbreds will go through the auction ring as foals and/or as yearlings. As the auction ring bears a striking resemblance to the parade ring at most racetracks, this particular scenario may be a potentially valuable one for the purpose of predicting future behaviour.

This study, therefore, measured the behavioural responses of weaned thoroughbred foals to their first experience of the auction ring with a view to determining whether variables such as age, gender, coat colour, sire, paternal grandsire, broodmare sire, female family, male family or inbreeding were related to the behavioural responses shown by the foals to being in the ring. The data would later be used to determine whether the responses shown at this time would provide a guide to how they would also react to a similar experience when a year older (Chapter 5) and/or to how their primary caregivers would assess their temperament when they became two-year-olds in training (Chapter 6).

A thoroughbred being aimed at the flat market will be fed, handled and trained with the view of reaching a sufficient state of maturity to be able to

compete at the age of two and three. A racehorse who does not make his competition debut until the second half of his three-year-old year is referred to, within the industry, as a late-maturing type and this is something that breeders may shy away from if he later becomes good enough to merit the chance at stud. Indeed stallion owners can have difficulty attracting the same number and calibre of mares to their horse, as they would for a horse who was champion two-year-old or champion three-year-old, if his best racing form came only as an 'older horse', that is, the age of four or five. Such is the rate of turnover, however, that a stallion's merit as a sire of successful racehorses can be determined within five or six years of his retirement from the track.

The national hunt market is noticeably different in that most horses will not even be broken to saddle until they are three, four or even five years of age. Many fillies will never be raced while all but a handful of the colts will be gelded before they begin competition. This means that an overwhelming majority of national hunt stallions are horses who failed to succeed as a sire of flat horses, are high class flat horses with pedigrees that are considered unfashionable by the flat breeders, or are high class flat horses with good pedigrees but whose owners feel they are more likely to attract 200 mares a year if they market him as 'national hunt' rather than by aiming him at the flat sector. It may seem like something of a contradiction that horses bred to go jumping are almost entirely by horses who have never jumped a hurdle or fence in their lives or never raced beyond the age of three or four, but that is the way husbandry practices within the sector have shaped the industry. Champion Hurdle winner Alderbrook is a rare exception but he was a near top class flat horse with an unfashionable pedigree that was tried over jumps rather than just sent to stud to sire them. By the time a national hunt stallion has proven that his progeny do or do not jump well enough or have enough stamina for the distances they are being asked to travel, he has usually sired hundreds of offspring, if not more.

So, although flat and national hunt bred horses come from the same basic bloodlines, it is the way that they are handled, fed and trained that largely determines their precocity. One would expect, therefore, that differences in this relative maturity would be reflected in how foals from the two sectors handled a stress-provoking situation such as the auction ring. In this study

both flat and national hunt foals were observed, permitting a comparison, the purpose of which was to determine whether differences in husbandry practices might be a factor in the scores.

4.2 Methods and Procedure

4.2.1 Design

This study recorded and analysed the behavioural responses of weaned thoroughbred foals during their first experience of a novel situation, that of being in an auction ring. There were a number of independent variables, such as age, gender, coat colour, sire, paternal grandsire, broodmare sire, family from which the dam came, family from which the sire came, the amount of inbreeding in the pedigree and whether or not the foal had been assessed in the separation study discussed in Chapter 3. The dependent variables were the behavioural responses of the foals during their time in the ring.

4.2.2 Subjects

The total number of subjects observed was 1771, broken down as 1426 'flat-bred' foals and 345 'national hunt-bred' foals. All were weaned thoroughbreds.

All the 'flat-bred' foals ($m=892$; $f=534$) were born between January and June 2002 and all but 11 (4 in USA, 4 in France and 3 in Germany) were foaled in either Ireland or Britain. Of these, 697 ($m=436$; $f=261$) were auctioned by Goffs Bloodstock Sales Ltd in Kill, County Kildare in Ireland, while 729 ($m=456$; $f=273$) were auctioned by Tattersalls Ltd in Newmarket, England. The age range of the Goffs foals was from 175 to 319 days old (mean = 239.48; SE = 1.18) with a mean age for colts of 237 days (236.81; SE = 1.46) and 244 days (243.95; SE = 1.95) for fillies. The age range of the Tattersalls foals was 185 to 327 days of age (mean = 256.76; SE = 1.15) with a mean age for colts of 254 days (254.05; SE = 1.42) and of 261 days (261.28; SE = 1.90) for fillies.

The 'national hunt-bred' foals ($m=247$; $f=98$) were born between January and August 2003 and all were foaled in either Ireland or Britain. They were all auctioned at Tattersalls (Ireland) Ltd in Ratoath, County Meath in Ireland. The age range of the Tattersalls (Ireland) foals was from 134 to 308 days old (mean = 211.05; SE = 1.84) with a mean age for colts of 210 days (209.99; SE = 2.19) and of 214 days for fillies (213.71; SE = 3.40).

4.2.3 Materials

A scoring sheet was designed (see Appendix 1) and with each sheet containing the space to score, separately, two individual foals. These sheets were bound together in books of 200 for ease of use and transportation. The sheet listed 24 behaviours that were selected based on what is known about how horses respond to stressful situations and from years of experience observing thoroughbred auctions. These behaviours included vocalisation, freezing, bucking, kicking, sweating, defecating, attempting to exit the ring against the wishes of the handler, and others. It would be expected that a horse that was completely at ease with being in the auction ring would not exhibit any of these behaviours. Details of the specific behaviours, why they were chosen and how they were measured are provided in 4.2.4.2 below.

The length of time each foal was in the ring was recorded using a stopwatch. Details of the date of birth, sire, paternal grandsire, dam and broodmare sire of each foal, obtained from the auction catalogue provided for each sale, were later added to each scoring sheet. A full five-generation pedigree was then obtained for each 'flat-bred' foal by using their sire and dam as the criteria for a hypothetical mating search on Pedigree Online Thoroughbred Database (www.pedigreequery.com).

4.2.4 Procedure - Behavioural Data Collection

4.2.4.1 Observations

The observations were carried out by a single viewer and at three auction houses, two of which were in Ireland and one in England. The 'flat-bred' observations were conducted in November 2002 while the 'national hunt-bred' observations took place in November 2003.

It is acknowledged that there are limitations to using observations recorded by only a single viewer in that there is, by definition, no available measure of inter-rater reliability. While the ratings of a single viewer may be consistent within themselves, the lack of an indicator of inter-rater reliability means that there is no guarantee that other viewers would have assessed the animals' behavioural responses in exactly the same way. Morris, Gale and Duffy (2002) found that stable personnel achieved a high level of inter-rater reliability when asked to assess the personality of the same ten horses. The most agreement

came on the dimensions most closely related to the 'Big Five' dimensions Neuroticism and Extraversion (Costa & McCrae, 1992), suggesting that some traits are easier for handlers to identify than others. In the present study it was felt that most of the behavioural responses noted were ones that are instantly recognisable and require little, if any, subjective interpretation (see 4.2.4.2 below). Therefore one could reasonably expect that the behavioural responses recorded for each horse would have been so recorded regardless of who was conducting the observations, even though this cannot be established quantitatively.

In Kill (Goffs) the observer sat at the edge of the second row, directly in front of the rostrum. There is a single exit in the ring and this is directly under the rostrum. As the midpoint of the circular path in the ring is opposite the rostrum, this was the point used to determine if the foal was accelerating towards or from the exit. As in most cases an animal engaging in this behaviour did so close to the exit, use of this midpoint was rarely needed. In Newmarket (Tattersalls) the observer sat at the outer seat in the second row of the press area. This restricted area is to the immediate left of the rostrum. The ring at Tattersalls is larger than the one at Goffs. Horses enter at one end and leave through an exit at the opposite end. The foal may not be aware that this exit (rather than entrance) is there, as the heavy doors at the end of the exit chute remain closed until needed. The doors at the entrance remain open. Access to both chutes is blocked by a heavy rope while the foal is being auctioned. The rostrum here is situated halfway between the entrance and the exit so, at Tattersalls, this was used as the midpoint of the ring. The exit was treated as such for scoring purposes as some foals may have seen the doors opened as the previous foal was leaving.

In Ratoath (Tattersalls Ireland) the observer sat in the front row, directly opposite the entrance/exit, the observer's position marking the midpoint. Use of the midpoint, however, was not necessary at this venue. The ring at this venue is smaller than that at Newmarket and there is a single entry/exit point. While a horse is in the ring it can see others milling around in the parade ring just outside. While waiting its turn to enter the ring the animal is placed, with its handler, in a small open stall with only a rope strung across the entrance preventing it from entering the auction ring.

Observation in each of the auction houses began as soon as the foal began to enter the ring. The lot number and a sequential ID number were noted and each instance of any of the target behaviours was recorded on the scoring sheet. Frequencies, rather than times or durations, were recorded for all target behaviours, except sweating which was observed simply as present or absent, and recording was continuous throughout the duration of the foal's time in the ring. Observation terminated as the foal left the ring and the duration was then recorded before resetting the stopwatch for the next foal.

4.2.4.2 Categorisation of behaviours

Behavioural responses were grouped into six categories: (i) vocalisation, (ii) emotionality, (iii) defensive, (iv) locomotory, (v) freezing, and (vi) escape. A horse is a flight animal and, as such, will tend to flee a stress-provoking situation unless it has been trained to do otherwise or it chooses to fight instead (Fraser, 1992). How these behavioural categories were scored and the rationale for using each of them is explained below.

(i) Vocalisation

Vocalisation was simply the number of whinnies emitted during the time of observation. This behaviour occurs when horses are separated from herd mates (McDonnell, 2003) and is a sign of reactivity that tends to increase in both volume and quantity when the equid is highly motivated (Fraser, 1992). Other species, for example cattle, also vocalise when separated from other animals (Boissy & Le Neindre, 1997).

Although former practice had the mare accompany her foal into the auction ring, with forced weaning occurring as soon as they left the arena, these days, in Ireland and Britain, the foal has been weaned before getting to the sales and, hence, is normally the only animal in the ring at any one time. Occasionally, if the animal becomes very distressed to the point of freezing up or becoming difficult to manage, a second one is brought in and led around in front of it. This usually has the desired effect of calming down the distressed animal.

(ii) Emotionality

Signs of emotionality were defecating and sweating between the hind legs.

The number of defecations was recorded while sweating was recorded as present or absent. Between the hind legs was the only sign of sweating recorded as inclement weather at times meant that some foals were wet from rain when entering the ring. No animal, however, was observed to have any obvious sign of sweating on any part of their body other than between their hind legs.

Defecation and measures of physiological arousal are frequently used as measures of reactivity in animals (Mason, 2000). While the former was easy to observe, sweating behind the legs was taken to be an indication of physiological arousal. The thoroughbred is a highly reactive breed and, in the absence of heat or humidity, tends to sweat when anxious, nervous or excited, as can be seen at racetracks even in the middle of winter.

(iii) Defensive

Behaviours in the defensive category were the number of instances the animal bucked, reared, stamped or kicked. These behaviours typically form a part of the 'fight' part of the 'fight or flight' response shown by equids. Another common one is biting, but none of the foals were observed doing this.

(iv) Locomotory

Locomotory behaviours consisted of accelerating towards or from the exit, showing hesitation approaching or leaving the exit, breaking into a trot and pulling the handler forwards. Accelerating simply meant a perceptible increase in pace without breaking into a trot, while hesitation was recorded as a perceptible decrease in pace without coming to a complete stop. These were independent of any increase or decrease of pace requested by the handler leading the animal around the ring but did include any response to outside interference, for example having a catalogue or sweeping brush waved at the animal. As Fraser (1992, p.76) notes, "a suddenly visible stimulus will more readily cause an alarm reaction in the horse than a strange sound".

The direction of the movement, that is whether it was towards or from the exit, was taken to be the half of the ring that the animal was in at the time of its increase or decrease in pace. Taking the exit as the starting point, a midpoint in the circuit of the ring was used (see 4.2.4.1 above) for this purpose.

The number of times the animal broke into a trot was recorded rather than the number of steps it took at that pace. This did not include any incidences of the animal breaking into a trot following a request from the handler to increase its pace. As each of the behaviours were recorded as reactions to being in the ring, it was felt that recording the number of times a trot was initiated was more useful than recording the number of steps taken as the occasional foal trotted for most of its duration in the ring, without returning to a walk - a continuous reaction rather than a number of reactions. Also, it was a concern that it would have been difficult for a single observer to record the number of steps taken during a period of continuous trotting while simultaneously recording the number of instances of the other target behaviours.

Pulling the handler forwards was recorded as the animal walking at such a pace that the handler was having difficulty keeping up, almost as though it was the handler who was being led around the ring.

(v) Freezing

Freezing consisted of the number of instances the animal froze entering the ring, exiting the ring, at the exit (rather than walking past it during a circuit of the ring) and anywhere else in the ring. Freezing was taken to mean coming to a complete stop, regardless of the duration of this stop.

(vi) Escape

Escape behaviours were recorded as the number of times that a foal tried to leave the ring by pushing through the barrier placed across the exit, the number of steps taken while moving backwards at either a walk or trot, and the number of times it pulled backwards against the handler. This latter behaviour only occurred at times when the foal had come to a complete stop. The number of steps taken while moving backwards was chosen, rather than the number of times the animal initiated this behaviour, as, when a horse exhibits this behaviour in the ring, there is often a short duration between steps taken, thereby making it difficult to be sure of whether the steps taken are either a continuous reaction or a rapid series of separate reactions.

Escaping is part of the 'flight' response. In this case the foal was trying to flee from either the auction ring or away from the handler who was trying to encourage it to move forward through what the foal interpreted as a threatening situation.

As the animal has been separated from others of its kind and has been brought into an enclosed area that is surrounded by people, noise and, often, bright lights, it is understandable that a prey animal would react in this way. It is vulnerable to any attack and its means of escape has been cut off.

4.2.5 Procedure - Pedigree Data Collection

The sire, dam and broodmare sire of each animal was recorded from the information provided in the auction catalogues. The sire and dam were used as the search criteria, for each 'flat-bred' subject (i.e. those sold in Kill and Newmarket), in order to obtain the pedigree, inbreeding and family numbers using the hypothetical mating function in the internet-based pedigree database at www.pedigreequery.com. While the basic four- or five-generation pedigree of any horse, using their name as the search criterion, is available without charge, payment of a subscription fee is necessary to allow use of the hypothetical mating function.

The inbreeding within the first four and five generations each of these pedigrees was recorded and a Pedigree Diversity Score (PDS), which indicates the number of different animals that appear within the first four or five generations of the pedigree, was calculated for each horse.

4.3 Results

4.3.1 General

Average time spent in the auction ring was 127.91 seconds in Kill (s.e.m. = 1.59; range = 47 - 324 sec), 143.21 seconds in Newmarket (s.e.m. = 1.62; range = 59 - 408) and 155.64 seconds in Ratoath (s.e.m. = 2.32; range = 75 - 307).

For each animal a reactivity score was calculated within each category, by summing the number of instances of each of the target behaviours in that category, and also the total number of instances across all categories was

calculated. Therefore, for example, a foal that broke into a trot six times, whinnied once, was sweating between its legs, defecated and bucked once would score 6 in locomotory, 1 in vocalisation, 2 in emotionality and 1 in defensive. This would produce a total of 10 reactions.

It is acknowledged that there is a difficulty in summing the number of reactions across categories to produce a total reactivity score. This is due to the non-comparability of its constituent components. For example, while most of the items were scored in terms of the number of instances that a behaviour was exhibited, sweating was recorded as an either/or situation. Also, whether a horse sweated or defecated in the ring (emotionality), for example, cannot really be equated with the number of times it took a step backwards or whinnied in the ring. The purpose of the total reactivity score, therefore, was an attempt to give an impression of the total range and number of behavioural responses shown by each horse.

The maximum, minimum and median scores across the six behavioural categories, and the total, are shown in Table 4.1 below for both ‘flat-bred’ foals and ‘national hunt-bred’ foals. Only 168 ‘flat-bred’ foals (11.8%) and 46 ‘national hunt-bred’ foals (13.3%), obtained a reactivity score of zero, suggesting that this did not appear to be a stressful procedure for them.

A Mann-Whitney test showed that there was no significant difference between the total reactivity scores of the ‘flat-bred’ and ‘national hunt-bred’ foals. However, when a Mann-Whitney was performed between ‘flat-bred’ and ‘national hunt-bred’ on the six behavioural categories, several significant differences emerged between the two markets (see section 4.3.3 below).

Table 4.1: Minimum, maximum and median scores for ‘flat-bred’ (N=1426) and ‘national hunt-bred’ (N=345) foals across six behavioural categories, and the total, showing the standard error and standard deviation for each.

flat-bred						national hunt-bred				
min.	max.	med.	S.E.	S.D.		min.	max.	med.	S.E.	S.D.
0	16	1.00	.06	2.28	vocalisation	0	11	1.00	.12	2.14
0	4	1.00	.02	.68	emotionality	0	3	.00	.03	.61
0	4	.00	.00	.18	defensive	0	8	.00	.03	.59
0	19	1.00	.07	2.46	locomotory	0	13	1.00	.11	2.11
0	8	.00	.02	.85	freezing	0	8	.00	.07	1.29
0	20	.00	.03	1.13	escape	0	39	.00	.15	2.78
0	40	3.00	.12	4.46	total	0	49	3.00	.30	5.59

4.3.2 Age / gender / coat colour

As the scores were not normally distributed the Kruskal-Wallis test was used to determine if there were any significant differences in the total reactivity scores (all foals), or the reactivity scores on each of the six categories above, when the data were analysed by age and coat colour (Table 4.2). A Mann-Whitney was used to test the same for gender.

Table 4.2: Mean rank scores, by age (in months), gender and coat colour, across the six categories, and total, of reactivity score and showing the number of foals in each category (N=1771). Also shown are results from the Mann-Whitney test on gender and the Kruskal-Wallis tests on age and colour.

	N	vocalisation	emotionality	defensive	locomotory	freezing	escape	total
AGE								
4	8	719.13	648.88	870.00	536.31	893.25	899.06	468.06
5	59	762.06	792.23	884.94	790.75	1009.74	935.18	771.77
6	285	850.67	832.75	891.78	870.49	953.71	922.49	875.59
7	529	899.62	855.19	888.42	905.34	895.03	899.10	903.16
8	462	879.00	891.20	877.63	909.69	869.93	861.53	878.06
9	344	904.92	962.06	890.63	867.48	836.34	871.58	904.91
10	84	984.02	1009.07	880.49	862.55	803.55	837.50	899.52
$\chi^2 =$		11.08	26.56***	4.09	9.33	27.75***	15.98*	9.76
GENDER ^a								
colt	1139	866.63	889.03	884.75	883.51	895.67	895.84	876.29
filly	632	920.90	880.54	888.25	890.49	868.56	868.27	903.50
$z =$		-2.29*	.708	.550	.772	.139	-2.06*	-1.08
COLOUR								
bay/brown	1403	883.21	880.99	885.14	882.36	886.87	885.29	880.35
chestnut	323	892.35	894.95	891.97	915.59	889.16	896.11	916.83
grey	43	926.99	983.86	870.00	781.37	819.08	837.64	840.50
black	2	938.25	852.75	870.00	911.50	1204.50	795.00	848.50
$\chi^2 =$		.44	2.27	1.73	3.28	2.93	2.08	1.72

* p<.05; ** p<.01; *** p<.001
^aMann-Whitney test

A preliminary analysis on flat-bred foals (McGee & Smith, 2004b), in which the behaviours were grouped into just three different categories, labelled (i) ‘movement’, (ii) ‘fear’ and (iii) ‘defensive’, found no significant effect for age, gender or coat colour. In these groupings, ‘movement’ behaviours included hesitation and/or acceleration towards or from the exit, attempts made to push through the exit and breaking into a trot, ‘fear’ behaviours consisted of freezing, defecating, pulling or stepping backwards, sweating between the legs, and the number or whinnies or squeals emitted, while ‘defensive’ behaviour was made up of rearing, bucking and kicking.

By breaking down the reactions into the six different behavioural categories above, however, several significant relationships were found. Fillies tended to

be more vocal than colts ($z=-2.29$; $p<.05$) though colts were more likely than fillies to exhibit escape behaviours ($z=-2.06$; $p<.05$). There were significant differences between age groups on emotionality ($\chi^2=26.56$; $df=6$; $p<.001$), freezing ($\chi^2=27.75$; $df=6$; $p<.001$) and escape behaviours ($\chi^2=15.98$; $df=6$; $p<.01$).

To determine whether or not there were any trends between age and any of these variables, age (in months) was correlated with mean rank on each of the six behavioural categories and the total reactivity score. This showed that foals become more vocal as they get older ($r_s=.964$; $N=7$; $p<.001$), are more likely to show signs of emotionality ($r_s=1.000$; $N=7$; $p<.001$) and, hence, obtain a higher overall score on reactivity ($r_s=.821$; $N=7$; $p<.05$). Conversely, freezing behaviour decreases with age ($r_s=-.786$; $N=7$; $p<.05$).

When the summed scores within each category were recoded to indicate whether or not each foal exhibited any behaviours within that category (0=no; 1=yes), a chi-square analysis again showed age was related to emotionality ($\chi^2=19.92$; $df=6$; $p<.01$), locomotory ($\chi^2=14.08$; $df=6$; $p<.05$), freezing ($\chi^2=26.67$; $df=6$; $p<.001$) and escape ($\chi^2=15.37$; $df=6$; $p<.05$). Gender was also related to escape ($\chi^2=4.47$; $df=1$; $p<.05$). These results indicated that (i) foals were more likely to whinny or defecate as they got older, (ii) the likelihood of a foal exhibiting a locomotory behaviour increased with age, (iii) the younger the foal, the more likely it was to freeze in the ring, (iv) escape behaviours decreased with age, while (v) colts were more likely than fillies to display escape behaviours.

4.3.3 Flat - v - National Hunt

Flat-bred horses are bred and reared to mature more quickly than national hunt-bred horses as they will usually start racing by the age of two or three, compared to four, five or even six for the national hunt horse. Though a Mann-Whitney test found there was no significant difference in the total reactivity score obtained by foals in the two categories, the results of Kruskal-Wallis tests on age and coat colour in flat-bred foals, a Mann-Whitney test on gender in flat-bred foals, Kruskal-Wallis tests on age and coat colour in national hunt-bred foals and a Mann-Whitney test on gender in national hunt-bred foals, identified important differences between the way in which the

foals in both categories obtained those scores. These are shown in Table 4.3 below.

There was a total of 1426 (m=892; f=534) 'flat-bred' foals and 345 (m=247; f=98) 'national hunt-bred' foals. All the males were colts (i.e. there were no geldings). The age range was 175 to 327 days old (mean=248.32; s.e.m.=.852; SD=32.17) for 'flat-bred' foals and 134 to 308 days (mean=211.05; s.e.m.=1.84; SD=34.14) for 'national hunt-bred' foals.

As shown in Table 4.3, flat-bred foals were more likely to score highly on emotionality ($\chi^2=10.94$; df=1; $p<.01$). National hunt-bred foals, on the other hand, were more likely to exhibit defensive behaviours ($\chi^2=9.24$; df=1; $p<.01$), escape behaviours ($\chi^2=4.55$; df=1; $p<.05$) and to freeze in the ring ($\chi^2=29.50$; df=1; $p<.001$). They were less likely, however, to exhibit as many locomotory behaviours as their flat-bred counterparts ($\chi^2=4.20$; df=1; $p<.05$). In flat-bred foals age was related to emotionality ($\chi^2=17.43$; df=4; $p<.01$); colts showed more freezing behaviours than fillies ($z=-2.41$; $p<.05$). In national hunt-bred foals age was related to vocalisation ($\chi^2=10.97$; df=4; $p<.05$) and escape behaviours ($\chi^2=11.64$; df=4; $p<.05$); fillies vocalised more often than colts ($z=-2.23$; $p<.05$).

To determine whether or not there were any trends within these results, age (in months) was correlated with mean rank on each of the six behavioural categories and the total reactivity score, for both flat and national hunt foals. This showed that in flat foals age was related to an increase in the amount of vocalisation ($r_s=.900$; N=5; $p<.05$), emotionality ($r_s=1.000$; N=5; $p<.001$) and total reactivity score ($r_s=.900$; N=5; $p<.05$), and a decrease in the amount of freezing ($r_s=-1.000$; N=5; $p<.001$) and escape ($r_s=-.900$; N=5; $p<.05$) behaviours. In national hunt foals age was related only to an increase in the amount of vocalisation ($r_s=.900$; N=5; $p<.05$).

When the recoded scores for each category, that is whether or not each foal exhibited any behaviours within that category (0=no; 1=yes), were analysed, using a chi-square test, age was found to be related to whether or not flat-bred foals sweated or defecated in the ring ($\chi^2=11.58$; df=4; $p<.05$) while flat-

bred colts were more likely to exhibit escape behaviours ($\chi^2=6.10$; $df=1$; $p<.05$). Within national hunt breeds, age was found to be related to whether or not foals vocalised ($\chi^2=10.56$; $df=4$; $p<.05$) or showed any escape behaviours ($\chi^2=11.50$; $df=4$; $p<.05$).

Table 4.3: Mean rank scores, by age (in months), gender and coat colour, and split by type, across the six categories, and total, of reactivity score and showing the number of foals in each category (N=1771). Also shown are results from the Mann-Whitney tests on type and gender and Kruskal-Wallis tests on age and colour.

	N	vocalisation	emotionality	defensive	locomotory	freezing	escape	total
TYPE ^a								
flat	1426	882.05	903.68	881.79	897.64	862.53	879.28	886.19
NH	345	902.31	812.93	903.42	837.90	982.99	913.78	885.22
z =		-.706	-3.31**	-3.06**	-2.05*	-5.43***	-2.13*	-.032
flat								
AGE								
5-6	175	660.52	669.55	708.06	696.96	741.63	750.07	693.18
7	438	712.46	682.98	715.38	730.90	727.90	716.76	715.50
8	410	708.53	704.64	709.20	720.49	715.95	704.09	703.74
9	320	722.78	766.98	719.65	696.00	687.35	709.79	729.39
10	83	800.52	804.80	712.57	689.46	666.92	679.98	732.73
$\chi^2=$		6.81	17.43**	3.96	2.25	7.81	8.41	1.34
GENDER ^a								
colt	892	701.11	713.37	711.18	718.90	724.87	723.90	711.03
filly	534	734.20	713.72	717.37	704.48	694.51	696.13	717.63
z =		-1.58	-.017	-1.38	-.671	-1.95	-2.41*	-.295
COLOUR								
bay/brown	1106	711.45	709.67	713.02	711.20	712.60	712.08	710.56
chestnut	281	717.47	719.22	716.72	730.44	717.64	723.30	727.25
grey	37	742.36	786.92	704.00	652.92	694.34	685.30	698.51
black	2	756.25	671.50	704.00	726.50	986.25	645.00	686.50
$\chi^2=$		.30	1.67	1.00	1.44	2.08	1.54	.43
NH								
AGE								
4-5	64	145.00	164.59	169.16	160.92	177.59	177.55	148.17
6	113	168.85	171.84	175.68	174.84	182.69	173.41	172.41
7	91	190.58	171.38	174.13	172.88	170.10	184.73	189.71
8	52	173.12	186.46	169.78	192.51	158.34	153.80	177.44
9-10	25	199.20	177.68	173.32	155.45	158.46	156.74	169.18
$\chi^2=$		10.97*	1.98	2.23	4.27	4.30	11.64*	6.75
GENDER ^a								
colt	247	165.89	177.65	173.46	167.42	169.20	172.14	166.92
filly	98	190.92	161.29	171.83	187.06	182.58	175.17	188.32
z =		-2.23*	-1.58	-.415	-1.76	-1.36	-.435	-1.81
COLOUR								
bay/brown	297	171.90	173.35	172.31	172.65	172.76	173.02	170.58
chestnut	42	178.48	167.54	178.80	184.05	182.63	176.06	195.70
grey	6	189.00	193.83	166.50	113.00	117.50	150.50	133.75
$\chi^2=$		.36	.52	1.67	3.07	3.30	1.01	3.32

* $p<.05$; ** $p<.01$; *** $p<.001$
^aMann-Whitney test

4.3.4 Sire / paternal grandsire

As differences between the flat-bred and national hunt-bred foals had been found the two types were examined separately when looking at whether or not any individual stallions or paternal grandsires had greater than expected proportions of their foals scoring 0 or 1 in any of the six behavioural categories. Chi-square and binomial tests were performed and it was found that the sire of the animal may be a factor in some cases.

A total of 204 individual stallions were represented by the 1426 flat-bred foals, of which 10 or more foals represented each of 50 stallions. There were 102 paternal grandsires, of which 21 were represented by 10 or more foals and had at least 2 stallion sons represented, each of which was responsible for at least two foals. For the 345 national hunt-bred foals there was a total of 75 individual stallions of whom 11 were represented by 10 or more foals, and 47 paternal grandsires of whom 3 were represented by 10 or more descendants and had at least two stallion sons with two or more foals in the sample.

4.3.4.1 Flat-bred foals

To examine whether or not there may be a relationship between sire and presence or absence of behaviours exhibited in the six behavioural categories, a chi-square test was performed on the recoded scores. As including all 204 sires in this test would make it impossible for the expected frequencies in each cell to be greater than 5 ($1426 / (204 \times 2) = 3.5$), only those stallions described in 4.3.4 above, that is those with ten or more representatives, were included ($890 / (50 \times 2) = 8.9$).

This showed that there was a significant relationship between sire and whether or not foals vocalised ($\chi^2=83.61$; $df=49$; $p<.01$), or exhibited any locomotory behaviours ($\chi^2=70.58$; $df=49$; $p<.05$). The category paternal grandsire was related to vocalisation ($\chi^2=40.04$; $df=20$; $p<.01$), emotionality ($\chi^2=125.58$; $df=20$; $p<.001$) and locomotory behaviours ($\chi^2=120.20$; $df=20$; $p<.001$).

The overall proportion of foals scoring 0 or 1 on each of the six behavioural categories was calculated and these proportions were then used in a series of binomial tests to determine which sires had a statistically significantly greater

than would be expected percentage of their foals scoring 0 or 1 in each category. A summary of the results is shown in Table 4.4 below.

With a total of 300 binomial tests being performed on individual stallions (50 x 6), one would expect 15 of these to be significant at the 5% level purely by chance. There were 24 significant results. For the paternal grandsires there were 126 binomial tests performed (21 x 6) of which 6 would have been expected to be significant at the 5% level by chance. There were 14 significant results.

(i) Vocalisation

A total of 49.7% of the flat-bred foals did not vocalise while in the auction ring; 50.3% did. Nine of the stallions had a greater than expected proportion of their foals scoring 0 or 1 on vocalisation than the sample as a whole. Of these, five had the greater proportion for foals scoring zero, indicating that their foals were less likely than those of other stallions to vocalise while in the auction ring. These were Desert Style (N=11; $p<.05$), Grand Lodge (N=16; $p<.05$), Night Shift (N=20; $p<.01$), Raise A Grand (N=14; $p<.05$) and Rossini (N=28; $p<.05$). Foals by Desert Prince (N=18; $p<.01$), Mujahid (N=18; $p<.01$) and Royal Applause (N=23; $p<.05$) were more likely than those by other sires to vocalise in the ring.

Of the paternal grandsires who had two or more stallion sons represented, Grand Lodge (N=40; $p<.05$), Northern Dancer (N=24; $p<.05$) and Woodman (N=18; $p<.05$) had a greater than expected proportion of their representatives scoring 0, while Danzig (N=86; $p<.01$) and Formidable (N=14; $p<.05$) had more representatives who vocalised at least once in the ring than those by other stallions.

(ii) Emotionality

A total of 48.5% of the flat-bred foals neither sweated nor defecated while in the auction ring; 51.5% did. Six stallions had a greater than expected proportion of their foals scoring 0 or 1 on this measure of emotionality than the sample as a whole. Josr Algarhoud (N=13; $p<.05$), Lend A Hand (N=14; $p=.001$) and Orpen (N=34; $p<.05$) had a greater proportion of scoring 0 while Diktat (N=20; $p<.05$) and Vettori (N=16; $p=.05$) had a greater than expected proportion scoring 1.

The only paternal grandsire who had a greater than expected proportion of his representatives scoring 0, that is neither sweating nor defecating, was Darshaan (N=33; $p<.05$). No paternal grandsire had a significantly higher proportion of his representatives scoring 1.

Table 4.4: The individual stallions and the paternal grandsires (both listed alphabetically) who had a significant proportion of their flat-bred foals scoring 0 or 1 in each behavioural category.

		vocalisation	emotionality	defensive	locomotory	freezing	escape
sire	N						
Desert Prince	18	** a					
Desert Style	11	*			* a	* a	
Diktat	20		* a				
Grand Lodge	16	*					
Josr Algarhoud	13		*		***		
King's Theatre	10					** a	* a
Lend A Hand	14		**				
Lujain	23					*	
Mujadil	19					*	
Mujahid	18	** a					
Night Shift	20	**					
Orpen	34		*				
Pivotal	16				*		
Raise A Grand	14	*					
Rossini	28	*					
Royal Applause	23	* a					
Singspiel	14				*		
Spectrum	28						* a
Vettori	16		* a				
Victory Note	10				* a		
paternal grandsire	N	vocalisation	emotionality	defensive	locomotory	freezing	escape
Ahonoora	21						* a
Blushing Groom	12				* a		
Danzig	86	** a			* a		
Darshaan	33		*		*		
Formidable	14	* a					
Grand Lodge	40	*					
Green Desert	90					*	
Northern Dancer	24	*					
Storm Bird	39					**	
Warning	55					*	*
Woodman	18	*					

* $p<.05$; ** $p<.01$; *** $p<.001$; a greater proportion scoring 1

(iii) Defensive

A total of 98.7% of the flat-bred foals did not exhibit any defensive behaviours while in the auction ring; 1.3% did. No stallion or paternal grandsire produced a significant result but this kind of extreme split probably made it almost impossible to find one.

(iv) Locomotory

A total of 43.1% of the flat-bred foals did not exhibit any of the behaviours classed as locomotory while in the auction ring; 56.9% did. Josr Algarhoud (N=13; $p<.001$), Pivotal (N=16; $p<.05$) and Singspiel (N=14; $p<.05$) had a greater than expected proportion of their foals scoring 0, while Desert Style (N=11; $p<.05$) and Victory Note (N=10; $p<.05$) had a greater than expected proportion scoring 1.

Of the paternal grandsires, both Danzig (N=86; $p=.05$) and Blushing Groom (N=12; $p<.05$) had a greater than expected proportion of their representatives scoring 1 while Darshaan (N=33; $p<.05$) was the only paternal grandsire whose representatives were less likely to exhibit locomotory behaviours than those by other grandsires.

(v) Freezing

A total of 80.5% of the flat-bred foals did not exhibit any of the freezing behaviours while in the auction ring; 19.5% did. Lujain (N=23; $p<.05$) and Mujadil (N=19; $p<.05$) had a greater than expected proportion of their foals scoring 0. In fact, only one of the 23 Lujain foals exhibited any freezing behaviours while none of the 19 by Mujadil did. Desert Style (N=11; $p<.05$) and King's Theatre (N=10; $p<.01$) had a greater than expected proportion of their foals scoring 1, that is, showing freezing behaviours.

Paternal grandsires Green Desert (N=90; $p<.05$), Storm Bird (N=39; $p<.01$) and Warning (N=55; $p<.05$) had a greater than expected proportion of their descendents scoring 0. None had a greater than expected proportion scoring 1.

(vi) Escape

A total of 90.4% of the flat-bred foals did not exhibit any escape behaviours while in the auction ring; 9.6% did. King's Theatre (N=10; $p<.05$) and Spectrum (N=28; $p<.05$) had a greater than expected proportion of their foals scoring 1, that is, exhibiting at least one escape behaviour while in the auction ring.

Paternal grandsire Ahonoora (N=21; p<.05) had a greater than expected proportion of his descendents who exhibited at least one escape behaviour. Warning (N=55; p<.05) had a greater than expected proportion of his descendents scoring 0 with 54 of his 55 representatives showing no escape behaviours.

4.3.4.2 National hunt-bred foals

Only 11 of the 75 stallions and just 3 of the 47 paternal grandsires were represented by 10 or more foals. A series of binomial tests was performed, on the data from these 14 stallions, to determine whether any of them had a statistically significant percentage of their representatives scoring 0 or 1 on any of the six behavioural categories. A summary of the results is presented in Table 4.5 below.

Table 4.5: The individual stallions and the paternal grandsires (both listed alphabetically) who had a significant proportion of their national hunt-bred foals scoring 0 or 1 in each behavioural category.

		vocalisation	emotionality	defensive	locomotory	freezing	escape
sire	N						
Exit To Nowhere	14	*					
Old Vic	10				*		
Oscar	14		** a			* a	
	N	vocalisation	emotionality	defensive	locomotory	freezing	escape
paternal grandsire							
Alleged	23				* a		

* p<.05; ** p<.01; *** p<.001; a greater proportion scoring 1

With a total of 66 binomial tests being performed on individual stallions (11 x 6), one would expect 3 of these to be significant at the 5% level by chance. There were 4 significant results. For the paternal grandsires it could be expected that a single significant result be found by chance. Only 1 was found to be significant.

(i) Vocalisation

A total of 45.8% of the national hunt-bred foals did not vocalise while in the auction ring; 54.2% did. Of the individual stallions, only Exit To Nowhere (N=14; p<.05) had a significant proportion of his foals scoring 0. None had a significant proportion scoring 1. None of the paternal grandsires produced a significant result.

(ii) Emotionality

A total of 57.4% of the national hunt-bred foals neither sweated nor defecated while in the auction ring; 42.6% did. A greater than expected proportion of foals by Oscar (N=14; $p<.01$) either sweated or defecated while in the ring. No paternal grandsires produced a significant result.

(iii) Defensive

A total of 96.2% of national hunt-bred foals did not exhibit any defensive behaviours in the auction ring; 3.8% did. No stallions or paternal grandsires produced a significant result.

(iv) Locomotory

A total of 48.7% of national hunt-bred foals did not exhibit any locomotory behaviours while in the auction ring; 51.3% did. A greater than expected proportion of foals by Old Vic (N=10; $p<.05$) did not exhibit any locomotory behaviours. A greater than expected proportion of the descendents of paternal grandsire Alleged (N=23; $p<.05$) exhibited at least one locomotory behaviour while in the ring.

(v) Freezing

A total of 67.8% of national hunt-bred foals did not exhibit any of the freezing behaviours while in the ring; 32.2% did. A greater than expected proportion of the foals by Oscar (N=14; $p<.05$) exhibited at least one of the freezing behaviours. No paternal grandsire produced a significant result.

(vi) Escape

A total of 87.0% of the national hunt-bred foals did not exhibit any of the escape behaviours while in the ring; 13.0% did. No stallion or paternal grandsire had a greater than expected proportion of foals scoring either 0 or 1.

4.3.5 Broodmare sire

There was a total of 484 different broodmare sires amongst the 1426 flat-bred foals of which 26 had 10 or more representatives. Amongst the 345 national hunt-bred foals there was a total of 160 different broodmare sires of which just 6 were represented by 10 or more foals. Given the small numbers involved, the results for both flat and national hunt foals are presented

together. A chi-square test, using only those broodmare sires with 10 or more representatives, found no significant relationship between the category broodmare sires and each of the six behavioural categories for either flat or national hunt foals. To see if any individual broodmare sires might have influence a series of binomial tests was run. A summary of the results is presented in Table 4.6 below.

Table 4.6: The broodmare sires (listed alphabetically) that had a significant proportion of their flat-bred foals scoring 0 or 1 in each behavioural category.

		vocalisation	emotionality	defensive	locomotory	freezing	escape
flat	N						
Darshaan	15	*			*		
Shareef Dancer	11	* a					
national hunt							
Supreme Leader	26	* a					

* p<.05; ** p<.01; *** p<.001; a greater proportion scoring 1

With a total of 156 binomial tests being performed on flat broodmare sires (26 x 6), one would expect about 8 to be significant by chance. There were only 3 significant results. With national hunt broodmare sires (6 x 6) one would expect to find 2 significant results. Only 1 was found.

(i) Vocalisation

A total of 49.7% of the flat-bred foals did not vocalise in the auction ring; 50.3% did. Darshaan (N=15; p<.05) had a greater than expected proportion of his representatives who did not vocalise in the ring while Shareef Dancer (N=11; p<.05) had a greater than expected proportion who did. A total of 45.8% of the national hunt-bred foals did not vocalise while in the auction ring; 54.2% did. A greater than expected proportion of those from Supreme Leader (N=26; p<.05) mares vocalised.

(ii) Emotionality

A total of 48.5% of the flat-bred foals neither sweated nor defecated in the ring; 51.5% did. No broodmare sire produced a significant result. A total of 57.4% of the national hunt-bred foals neither sweated nor defecated while in the auction ring; 42.6% did. No broodmare sire produced a significant result.

(iii) Defensive

A total of 98.7% of the flat-bred foals did not exhibit any defensive behaviours; 1.3% did. No broodmare sire had a significant result but this kind of extreme split probably made it almost impossible to find a significant result. A total of 96.2% of the national hunt-bred foals did not exhibit any defensive behaviours while in the auction ring; 3.8% did. No broodmare sire was significant.

(iv) Locomotory

A total of 43.1% of the flat-bred foals did not exhibit any of the behaviours classed as locomotory while in the auction ring; 56.9% did. A higher proportion than expected of those descended from Darshaan (N=15; $p < .05$) did not show any behaviours from this category. A total of 48.7% of the national hunt-bred foals did not exhibit any locomotory behaviours while in the auction ring; 51.3% did. No broodmare sire produced a significant result.

(v) Freezing

A total of 80.5% of the flat-bred foals did not exhibit any of the freezing behaviours while 19.5% did. No broodmare sire produced a significant result. A total of 67.8% of the national hunt-bred foals did not exhibit any freezing behaviours while in the auction ring; 32.2% did. No broodmare sire produced a significant result.

(vi) Escape

A total of 90.4% of the flat-bred foals did not exhibit any of the escape behaviours while 9.6% did. No broodmare sire produced a significant result. A total of 87.0% of the national hunt-bred foals did not exhibit any escape behaviours while in the auction ring; 13.0% did. No broodmare sire produced a significant result.

4.3.6 Female family number / Male family number

As most of the 'national hunt-bred' foals have pedigrees that are not yet included in the online database, only the 'flat-bred' foals were used in the analyses of female family numbers and sire family numbers.

A chi-square analysis of the recoded behavioural category scores (0 and 1) with the categories female family number and male family number found no

significant relationship with any of the six categories. A series of binomial tests was then performed to see if any specific families, either female or male, could be identified. A summary of the results is presented in Table 4.7 below.

With a total of 126 binomial tests performed on female families (21 x 6) one would expect 6 to be significant at the 5% level by chance. There were 6 significant results. The number of binomial tests performed on male families was 120 (20 x 6), of which 6 would be expected to be significant at the 5% level by chance. There were 6 significant results.

Table 4.7: Female and male families (identified by the Bobinski numbers) who had a significant proportion of their flat-bred foals scoring 0 or 1 in each behavioural category.

	N	vocalisation	emotionality	defensive	locomotory	freezing	escape
female family							
1	254	* a					
2	74				* a		
11	31	* a	** a				
20	30	* a					
22	45	**					
male family							
1	233					* a	
4	68	*					
6	49				*		
13	84	**				*	
16	101				* a		

* p<.05; ** p<.01; *** p<.001; a greater proportion scoring 1

(i) Vocalisation

The percentage of flat-bred foals that did not vocalise in the ring was 49.7%; 50.3% did. Foals from female families 1 (N=254; p<.05), 11 (N=31; p<.05) and 20 (N=30; p<.05) had a greater than expected proportion of individuals who vocalised in the ring. Those from family 22 (N=45; p<.01) had fewer than expected who vocalised. Of the male families, foals representing families 4 (N=68; p<.05) and 13 (N=84; p<.01) had a greater than expected proportion of those who did not vocalise.

(ii) Emotionality

The percentage of flat-bred foals that neither sweated nor defecated in the ring was 48.5%; 51.5% did. Nearly three-quarters of the foals from family 11 (N=31; p<.01) exhibited at least one sign of emotionality while in the ring. No male family produced a significant result.

(iii) Defensive

The percentage of flat-bred foals that did not exhibit any defensive behaviours was 98.7%; 1.3% did. No female or male family produced a significant result but this kind of extreme split probably made it almost impossible to find one.

(iv) Locomotory

The percentage of flat-bred foals that did not exhibit any of the behaviours classed as locomotory was 43.1%; 56.9% did. A greater than expected proportion of foals from female family 2 ($N=74$; $p<.05$) exhibited at least one locomotory behaviour.

(v) Freezing

The percentage of flat-bred foals that did not exhibit any freezing behaviours was 80.5%; 19.5% did. No female family produced a significant result but a greater than expected proportion of foals from male family 1 ($N=233$; $p<.05$) exhibited at least one freezing behaviour while a greater proportion of those from male family 13 ($N=84$; $p<.05$) showed none.

(vi) Escape

The percentage of flat-bred foals that did not exhibit any escape behaviours was 90.4%; 9.6% did. No female or male family produced a significant result.

4.3.7 Pedigree Diversity Scores (PDS)

As most of the 'national hunt-bred' foals have pedigrees that are not yet included in the www.pedigreequery.com database, only the 'flat-bred' foals were used in the analyses of PDS scores.

4.3.7.1 Five-generation pedigrees

With five-generations the range of different animals within any one pedigree was from 48 to 62 individuals. The mode value was 61, the median 59 and the mean number of individuals in a pedigree was 59.10 (s.e.m.=.06). A total of 205 foals (14.4%) showed no inbreeding within five generations while a further 285 (20.0%) had only one duplication within those five generations.

As there were less than 10 foals with a PDS of 48, 49, 50, 51 or 52, these were grouped together ($N=23$) before a correlation between PDS and the proportion

of foals that exhibited at least one behaviour in any of the six categories (Table 4.8) could be calculated. The correlational analysis showed that vocalisation ($r_s=.691$; $N=11$; $p<.05$) decreased as a pedigree became more inbred (PDS decreased) and that escape behaviours ($r_s=-.627$; $N=11$; $p<.05$) increased as the PDS decreased.

Table 4.8: The proportion of foals representing each 5-generation PDS that scored 1 in each of the six behavioural categories.

PDS	N	vocalisation	emotionality	defensive	locomotory	freezing	escape
62	205	50.7	51.7	.5	56.6	21.0	8.8
61	285	48.4	49.1	2.8	60.7	20.7	9.1
60	207	59.9	46.4	.5	52.7	15.5	8.7
59	246	50.8	50.8	.4	51.2	15.9	11.8
58	190	48.9	57.9	1.1	55.8	20.0	9.5
57	115	46.1	59.1	.9	64.3	20.9	6.1
56	48	50.0	54.2	.0	64.6	27.1	4.2
55	59	40.7	39.0	5.1	67.8	27.1	13.6
54	30	46.7	50.0	.0	53.3	13.3	13.3
53	18	38.9	66.7	5.6	38.9	22.2	16.7
48-52	23	47.8	60.9	4.3	56.5	26.1	17.4

4.3.7.2 Four-generation pedigrees

Within four-generations the range of different animals within any one pedigree was from 24 to 30 individuals. The mode value was 30, as was the median, while the mean number of individuals in a pedigree was 29.43 (s.e.m.=.022). A total of 826 foals (58.0%) showed no inbreeding within four generations while a further 466 (32.7%) had only one duplication within those four generations.

As there were very few foals with a PDS of either 24, 25, 26 or 27, these were grouped together ($N=64$) before a correlation between PDS and the proportion of foals that exhibited at least one behaviour in any of the six categories (Table 4.9) could be calculated. The correlational analysis showed that both defensive behaviours ($r_s=-1.000$; $N=4$; $p<.001$) and escape behaviours ($r_s=-1.000$; $N=4$; $p<.001$) increased as PDS decreased, that is, these behaviours were more likely to be exhibited as the amount of inbreeding increased (lower PDS).

Table 4.9: The proportion of foals representing each 4-generation PDS that scored 1 in each of the six behavioural categories.

PDS	N	vocalisation	emotionality	defensive	locomotory	freezing	escape
30	826	52.2	49.3	1.2	56.4	19.0	9.2
29	466	48.3	55.4	1.3	57.1	18.9	9.7
28	70	41.4	50.0	1.4	70.0	25.7	10.0
24-27	64	50.0	54.7	3.1	46.9	23.4	14.1

4.3.8 Separation study foals

A total of 7 foals (m=3; f=4) that were observed in the separation study (Chapter 3) were assessed in the auction ring. All were flat-bred, six were from the ‘isolated’ group and one from the ‘accompanied’ group. Six were now 9 months old while one of the colts was 8 months old.

When these foals’ results from the separation study were correlated with their total scores on each of the six behavioural categories (from the auction ring) and the recoded scores, that is whether or not they showed at least one behaviour in any of those categories, four significant results were found. With a total of 60 (5 x 12) correlations performed on the scores from the ‘accompanied’ group one would expect 3 to be significant at the 5% level by chance.

The percentage of time spent moving about in the stable while their dam was at the covering shed was significantly related to both the number of locomotory reactions they showed in the auction ring ($r_s=-.927$; $N=7$; $p<.01$) and to whether or not they showed any locomotory behaviours ($r_s=-.866$; $N=7$; $p<.05$) while in the auction ring. The amount of time spent pawing in the stable was significantly related to both the total score obtained in the emotionality category ($r_s=-.854$; $N=7$; $p<.05$) and to whether or not they showed either of the behaviours in that category ($r_s=-.798$; $N=7$; $p<.05$), namely defecation or sweating.

These results suggested that the greater the percentage of time a foal spent moving around the stable while its dam was at the covering shed, the fewer locomotory behaviours it showed in the auction ring. Similarly, the more time that a foal spent pawing in the stable, the less likely it was to sweat or defecate while it was in the auction ring.

4.4 Summary and Discussion

One of the difficulties in assessing just how stressful any situation is to a group of individuals as a whole is the amount of interindividual variation there is within that group. A variety of factors can influence what causes one individual to perceive a situation, that will provoke little or no response from another, as stressful or threatening. Horses, however, tend to be neophobic, leading them to often trying to avoid unfamiliar or threatening situations (Cooper, 1998; Mal, McCall, Cummins & Newland, 1994; McCall, Salters & Simpson, 1993). This study investigated whether or not a number of independent variables could be related to reactivity shown by weaned thoroughbred foals during their first experience of the auction ring. Tentative links were found with several of these variables though, in some cases, these links may be unreliable. The findings are discussed in the order in which they are presented above.

4.4.1 Age

The older a foal is the more experience it has and, one could expect, the more novel situations it has encountered. He/she is probably more used to being handled than the younger foal and may be more likely to trust a familiar handler when presented with a stress-provoking situation. This is all part of its developing maturity and evidence suggests that it is the physical and mental development that would appear to be more important, particularly in very young foals, rather than intensive training or handling provided in its earliest days of life.

Results presented above showed that there was a significant relationship between age and the amount of emotionality ($\chi^2=26.56$; $df=6$; $p<.001$), freezing ($\chi^2=27.75$; $df=6$; $p<.001$) and escape ($\chi^2=15.98$; $df=6$; $p<.05$) behaviours shown by the foals and also that there was a correlation between age and the mean ranks produced by that initial test and both the amount of vocalisation ($r_s=.964$; $N=7$; $p<.001$) and the total reactivity score ($r_s=.821$; $N=7$; $p<.05$) obtained. Freezing and escape behaviours were found to decrease with age, while vocalisation, signs of emotionality, that is sweating and defecating, and the total amount of reactivity shown, increased with age.

Freezing and escape behaviours represent the 'flight' part of the 'flight or fight' response and it would appear, as one might expect, that as the animal acquires more life experience and learns to trust a handler's decision to enter a novel environment, the urge to flee is reduced. As Budd (1996, p.51) states: "No foot, no escape - so any horse that willingly lifts its feet to be cleaned, or even steps out without hesitation on to a strange, untested surface is showing a degree of trust and confidence that goes against a deeply ingrained rule of thumb". As the amount of vocalisation, sweating or defecating, and the total reactivity score increase with age, it may be that the urge to flee is just better controlled. Why should these other signs of reactivity increase with age? It is possible that the younger foals have undergone their stressful experiences, for example, farrier visits, veterinary checks, weaning, sales preparation, in a more condensed time frame than the older foals and so don't react as strongly when presented with yet another one, the auction ring. The older foal, in contrast, may have had a greater time span between these experiences and, hence, reacts more strongly when presented with another. In short, one could speculate that the younger foal has come to expect frequent change and so handles it better whereas the older foal is not so prepared, but there is no firm evidence to support this here.

4.4.2 Gender

There is a perception amongst some who work with thoroughbreds that fillies are 'flightier' than colts and that colts are more aggressive than fillies. However, other than anecdotes, there is no evidence for these positions. Furthermore, it is not absolutely clear what criteria make up 'flighty', for example, though this term typically seems to indicate excitability and being highly reactive. Mills (1998) has identified 'flightiness' as a combination of a tendency to run away and speed of movement. There is also a question over how such behaviours are interpreted by different handlers, particularly as perception can be affected by what we expect to see; eagerness at being brought out to the paddock could be interpreted as 'being difficult' if the handler's perception of the animal is as one who can be difficult to handle.

No significant differences were found here between the two genders in terms of the total amount of reactivity shown or in the amount of defensive, locomotory, and freezing behaviours. There was a difference, however, in

terms of the amount of vocalisation and number of times a foal showed escape behaviours. Colts who whinny a lot are often described by handlers as being 'colty' but colts were found to whinny less often in the ring than fillies ($z=-2.29$; $p<.05$). They did, however, exhibit more escape behaviours ($z=-2.06$; $p<.05$) than fillies.

Escape behaviours were measured in terms of trying to leave the ring by pushing through the barrier placed across the exit, the number of steps taken while moving backwards and the number of times the foal pulled backwards against the handler. They represent an attempt to flee from a stress-provoking situation, part of the 'flight' response shown by a prey animal. Such behaviours, shown in the auction ring, often trigger punishment from the handler or a bystander, usually in the form of a blow from the end of the lead rope, a slap, a push or having something waved at them.

Handlers asked why they punish such responses rather than recognise them as a sign of nervousness and make attempts to calm the animal often say they are trying "to stop him/her from getting away with it". It is unclear just what 'it' is but it seems that the escape behaviours, and indeed freezing behaviours, are often interpreted as misbehaviour rather than as a sign of nervousness. Kiley-Worthington (1997) warns against interpreting equine behaviour in "a totally human way" (p.109) and points out that this idea of a horse "trying to get away it" or "trying to outdo" the handler is a popular concept that is actually taught in equine training manuals. If a horse is punished when it shows a fear response then all the handler has done is to confirm that this was indeed a situation deserving of caution, yet the handler is taught, and presumably believes, that he/she has done a good job of handling this troublesome animal. Whether or not this perception of the animal trying to 'get away' with something is more common with, say, colts than fillies, has not yet been investigated.

Overall the results here would suggest that while there is no difference between colts and fillies in how much reactivity they show during their first experience of the auction ring, there is a difference in what types of behaviours they show to produce that overall score. Gender tends to be overlooked in equine temperament studies, possibly due to the often-small

numbers of animals involved. Wolff *et al.* (1997) found that there were only slight gender differences amongst a varying number of young horses (maximum N=42) on a number of behavioural tests whereas Momozawa *et al.* (2003), who indicated the number of entire males, geldings and females in their temperament study of 86 horses of various breeds, including thoroughbred, did not report any gender effects in their results. Similarly, Visser *et al.* (2001) gave a gender breakdown of their 41 Dutch Warmblood subjects but only reported analysis in terms of age. Visser *et al.* (2003), however, did report some gender differences in reactivity on a performance test: geldings refused to jump significantly more than fillies, but these were three-year-old showjumpers in training rather than foals.

4.4.3 Coat Colour

The idea that coat colour in animals may be related to temperament has been investigated from time to time with one author stating “light-skinned horses, such as the Palomino or Pinto, are gentle; dark-skinned chestnuts are unruly” (Keeler, 1947, p.271). There are no palomino or pinto thoroughbreds and almost all thoroughbreds have dark skin. The exceptions are the tiny handful of white thoroughbreds who have been born in America, most recently 2004 filly foal Snow Robin (USA), a daughter of Rob ‘N Gin (USA) and the unraced white mare Snow Baby Go (USA). White horses have pink skin.

In the thoroughbred business there is often a perception that chestnuts are more ‘excitable’ than the more ‘solid’ bays, or that blacks are aggressive. Again, there is only anecdotal evidence to support this, much of which may reflect an interpretation of behaviour influenced by preconceived ideas. This study found no evidence that chestnuts, bays/browns, greys or blacks react any differently to a novel situation.

Such is the negative perception of black horses that few owners actually register their thoroughbred foals as having that coat colour - dark brown is what will often be registered if even a handful of brown hairs are found in the animal’s coat. It is true, however, that black is a somewhat rare coat colour in thoroughbred horses. Multiple Group 1 winning filly Six Perfections (FR), born in France in 2000, is a current example: her sire is dark brown. Another is 2004 Stakes winning filly Petit Calva (FR), the product of two bays. As only

two black foals were among the 1771 observed here, there is insufficient evidence to be able to comment on whether or not they reacted any more strongly to their auction ring than foals of any other colour.

4.4.4 Flat -v- National Hunt

The purpose of the 'national hunt-bred' observations was for comparison of their reactivity scores with those of the 'flat-bred' foals to determine whether differences in handling practices might be a factor in the scores. Gibbs and Cohen (2001, p.280) found that in America "weanlings and yearlings were reportedly managed for moderate growth on 74% of farms and for rapid growth on 26% of farms". There do not appear to be any comparable figures for any of the major European countries but there is little doubt, particularly when one looks at the animals that turn up in auction rings in Ireland and England, that a considerable number of the foals and yearlings have been clearly managed for moderate to rapid growth. Some foals appear in the ring looking like a yearling, other than the fact their knees are still open - the epiphyseal plate has not yet fused.

While managing for rapid growth may have short-term commercial benefits to the breeder or pinhooker (one who buys a foal with the hope of selling it for a profit as a yearling), the animals are likely to be more prone to injury as racehorses. Osteochondrosis (OCD), a developmental disorder that particularly affects young thoroughbreds, it is characterised by abnormal growth of bone and cartilage. It can affect any of the major joints of the horse but is typically seen around the knees. Dyson (1987, p.173) reports that clinical signs of the disease are usually evident within the first two years of life and that, in Britain, it is most commonly seen in thoroughbreds. The condition requires surgery.

'Flat-bred' horses are bred and reared for precocity, to be ready to race at the age of two or three, and are often intensively handled from birth. 'National hunt-bred' horses are bred and reared to mature more slowly and will not start racing until the age of four or five. Consequently, they are often handled less intensively as foals. The effect on maturity that these differences in handling, feeding and training produce could be expected, therefore, to be reflected in how foals from the two sectors handled a stress-provoking

situation such as the auction ring, particularly when it is considered that, as noted earlier, flat and national hunt stock come from the same basic bloodlines.

There was no difference in the total amount of reactivity shown but there were notable differences in how those scores were obtained. For example, flat foals showed more signs of emotionality ($z=-3.31$; $p<.01$) and more locomotory behaviours ($z=-2.05$; $p<.05$) than national hunt foals. However the national hunt foals exhibited more defensive ($z=-3.06$; $p<.01$), freezing ($z=-5.43$; $p<.001$) and escape ($z=-2.13$; $p<.05$) behaviours than their flat-bred cohorts.

Increasing age was associated with a decrease in freezing ($r_s = -1.000$; $N=5$; $p<.001$) and escape behaviours ($r_s = -.900$; $N=5$; $p<.05$) in flat-bred foals but age was not correlated to these behaviours in the national hunt group. This is possibly an indication of differences in maturity and/or husbandry practices between the two sectors and that the national hunt foals, who may have been less intensely handled than their flat-bred counterparts or fed and reared to be less physically mature at this age, had not learned the same degree of trust in their handler's decision to enter an intimidating environment and, hence, were more likely to attempt to flee or to fight their way out.

There is an early training procedure known as "foal imprint training" (Miller, 1991) - Miller acknowledges that 'imprint' is the incorrect term to apply - but despite claims of its ability to produce horses that are easier to handle, manage and train, it has been found to produce no significant difference in reactivity levels in foals' behaviour at one, two or three months of age (Williams *et al.* 2002) or even at six months of age (Williams *et al.* 2003). Miller's technique, popular in America, involves intensive handling of the foal's entire body at 2, 12, 24 and 48 hours after birth. It would not be a practice carried out on many thoroughbred stud farms and it was not looked at in this study.

4.4.5 Sires and Paternal Grandsires of Flat-bred foals

Haupt and Kusunose (2000) and Wolff *et al.* (1997) report evidence of inheritance of temperamental traits through the sire though these studies were performed with more mature animals. Wolff and Hausberger (1994), on

the other hand, investigated the role of the sire in the temperament of foals and reported that findings supported such a link. As there were only 13 subjects in the whole study and these represented five stallions, their results need to be treated with caution. The authors noted, however, that these foals were very young (10-12 weeks of age) and that it remained to be seen whether or not the differences they found would also occur in older animals.

In the study presented in this chapter, a total of 20 of the 50 individual stallions, who had ten or more foals in the sample, had a greater than expected proportion of their foals scoring either 0 or 1 on at least one of the six categories. Seven of these had 20 or more representatives. Eleven of the 21 paternal grandsires, with ten or more foals assessed and who had at least two stallion sons each of which had at least two foals scored, had a greater than expected proportion of their descendents scoring either 0 or 1 on at least of the six categories. While these results suggest that progeny of some stallions are more likely than those by others to exhibit certain types of behaviours in the auction ring, or not to exhibit them, there are some cautionary points that should be made.

The numbers of their representatives assessed are, in many cases, fairly small, even in the cases of sires whose assessed representatives numbered between 20 and 40, as most of these stallions sire between 50 and 200 foals a year. While those assessed may indeed form a representative sample for each sire it should be noted that, particularly in the case of the more highly proven or promising younger stallions, a considerable number of their foals from each year are often the property of major private breeders and, hence, will not appear in the auction ring. As these major private breeders are often more likely than the breeders who sell at foal sales to own the more choice or highly prized broodmares, it is possible that a stallion's sales stock may include a number of individuals who are atypical.

In terms of racing performance, for example, there have been the occasional stallions whose best results come from these private breeders. Two notable examples of this are Doyoun and Kahyasi, the majority of whose major

winners have been bred by H.H the Aga Khan, at whose studs they have been based.⁵

Given the number of tests performed a more stringent significance level should probably be applied. This can be done by dividing .05 by the number of tests performed. For sires of flat-bred foals, on which there were 300 binomial tests performed, this would mean that in order for a result to be significant at the 5% level, the p-value would actually have to be $p < .0002$. Therefore, the only significant finding would be that foals by Josr Algarhoud ($n=13$) are more likely than foals by other sires to exhibit locomotory behaviours in the ring. Given the rather small number of representatives of this stallion that were assessed and the fact that *SPSS 11.0* only gives p-values to three decimal places, one could still not be confident in that result.

Similar cautions apply to interpretation of the results from the paternal grandsires. An additional one, however, is that the results of a single stallion son may be the reason why a paternal grandsire's overall results may be noted. For example, Darshaan ($n=33$), who had a greater than expected proportion of his descendents failing to exhibit any locomotory behaviours or signs of emotionality, owes his place on Table 4.4 solely to the scores of the foals by his son Josr Algarhoud ($n=13$). Similarly, removing the data from the Diktat ($n=20$) foals from Warning's ($n=55$) data sees this paternal grandsire removed from the table also, while Ahonoora ($n=21$) owes his presence to the foals of his son Dr Devious ($n=6$), Formidable ($n=14$) to those by his son Forzando ($n=5$), Northern Dancer ($n=24$) is noted solely because of his son Night Shift ($n=20$) and Storm Bird ($n=39$) is no longer significant when his son Mujadil ($n=19$) is removed from consideration. If a more stringent significance level is adopted, as with the individual sires of foals, then a p-value of $p < .0004$ would be required to be significant at the 5% level - a total of 126 binomial tests were performed on the paternal grandsires. This would eliminate all the paternal grandsires from consideration.

⁵ Doyoun and Kahyasi spent the majority of their stallion careers at the Aga Khan's Irish studs, Ballymany Stud and then Giltown Stud. Doyoun, sire of champion colts Daylami and Kalanisi, moved to Turkey in 1998 and died in 2002. Only one of his five Group 1 winners was not bred by the Aga Khan. Kahyasi, also the sire of Classic winners, is currently based at his owner's French stud. Four of his five Group 1 winners were bred by the Aga Khan - the fifth was sold *in utero* from his Irish broodmare band.

In summary, while a number of stallions had greater than expected proportions of their representatives scoring 0 or 1 on the various behavioural categories, adopting the more stringent significance level, as outlined above, suggests that there is no link between sire, or paternal grandsire, and how foals respond to this stress-provoking situation. Some academic evidence and a considerable amount of anecdotal evidence suggests that behavioural tendencies are indeed passed on but taking the more stringent view of the results, the evidence found suggests caution. It is also worth considering that much of the anecdotal evidence is based on handlers recognising traits from the sire appearing in their offspring - neither the current study nor those published ones mentioned above, have assessed the actual stallions themselves. Future research should ideally include data from that source.

4.4.6 Sires and Paternal Grandsires of National hunt-bred foals

Only three of the 11 individual stallions, who had ten or more of their foals assessed, had a greater than expected proportion of these foals scoring either 0 or 1 in any of the behavioural categories. Of the paternal grandsires only one of the three who had at least ten representatives and at least two stallion sons who had, in turn, at least two of their foals assessed, had a greater than expected proportion scoring either 0 or 1 in any of the categories.

Numbers in all cases were very small, particularly when it is considered that the more popular national hunt stallions often sire between 100 and 300 foals in a single year, and so there is the possibility, in both the analysis of the individual sires and the paternal grandsires, of both Type I and Type II errors occurring. For example, in 2003 Oscar ($n=14$) sired at least 190 live foals (Weatherbys Group Ltd, 2003) - returns for more than 30 of the mares he covered were not filed in time for publication of the total number. Therefore the Oscar foals assessed here represented just over 7% of all his known foals born in that year.

If the more stringent significance level, described above, is applied then a p -value of $p<.0008$, for the individual sires, is required to be significant at the 5% level and a p -value of $p<.003$ is required for the paternal grandsires. At these values no stallion produced a significant result.

4.4.7 Broodmare Sires of Flat and National Hunt-bred foals

Of the 26 broodmare sires who had ten or more representatives amongst the flat-bred foals, only two had a greater than expected proportion of their descendents scoring either 0 or 1 in any of the six behavioural categories. The numbers involved in all cases were very small. Only one of the six national hunt broodmare sires had a greater than expected proportion of his representatives scoring 0 or 1 in any of the six behavioural categories. Again the numbers of representatives were very small. This increases the likelihood of Type I or Type II errors occurring.

If the more stringent significance level is adopted then flat broodmare sires would require a p-value of $p < .0003$ to produce a significant result at the 5% level and national hunt broodmare sires would require a p-value of $p < .002$ to be significant at the same level. Using this criterion no broodmare sire, in either category, was significant.

4.4.8 Female and 'male' families

Lowe (1895) classified female lines into families based on the number of Classic winners they had produced. He also identified four of these as 'running' or 'feminine' families and five as 'sire' or 'masculine' families. Within 50 years of his work having been published, pedigree analysts were already questioning the merit of the system (Miller, 1939). Even so the figure system was widely used by many breeders, some with considerable success, though it is a system that is seldom used today. Also, as indicated in Chapter 2, Hill *et al.* (2002) found genetic evidence to suggest that some of the families may have become mixed up or confused over time with the result that the numbering system may be completely inaccurate. Despite these concerns the family numbers were taken as reported for the purposes of this thesis. There were some significant results found but, as outlined below, these should be treated with caution.

Four female families and five 'male' families produced a significant result on a single behavioural category while one female family and one 'male' family were significant in two categories. These results suggest temperamental tendencies may be passed on through mares from some lines. The 'male' families, of course, are the stallions that come from a particular female family. However

the possibility of other variables being involved in these results cannot be ignored.

For example, a greater than expected proportion of foals from female Family 1 vocalised while in the ring ($N=254$; $p<.05$). Of these 254 individuals, 16 were by three stallions who also had a greater than expected proportion of their progeny who vocalised at least once in the ring. If the progeny of each of these individual stallions is removed, that is remove the data from one stallion while leaving in the other two, then it emerges that results from the five Desert Prince foals appear to be a factor. When their data were removed and the binomial test rerun, Family 1 was no longer significant in this category. Removing only the two Mujahid foals or the nine Royal Applause foals had no apparent effect, that is, there remained a greater than expected proportion of foals from Family 1 who vocalised. In summary, as shown earlier (Table 4.4) Desert Prince ($N=18$; $p<.01$) had a greater proportion of his foals that vocalised at least once in the auction ring. Of these 18 five were out of mares from Family 1, a family that also had a greater than expected proportion of its foals who scored 1 in this category. When these five Desert Prince foals are removed from the Family 1 data then Family 1 no longer has a significant proportion of its representatives vocalising in the auction ring.

It is interesting that Desert Prince is himself from Family 1 but when the binomial test is rerun on the data from his foals but leaving out those from the five from family 1, there is still a significantly greater than expected proportion of his foals vocalising in the ring ($N=13$; $p<.05$).

A similar look at female Family 11, however, shows that none of the sires of these 31 foals had a greater than expected proportion of their foals scoring 1 on emotionality, yet Family 11 ($N=31$; $p<.01$) does. Also, sires from family 13 had a greater than expected proportion of their representatives remaining silent in the ring ($N=84$; $p<.01$) yet nine were out of mares from female family 1, which, as noted above, were more likely to vocalise. These sire family 13 foals also included five individuals from female family 22 who were also more likely to remain silent in the ring ($N=45$; $p<.01$) but removing this quintet and rerunning the binomial test saw sire family 13 remain significant at the 1% level in this category.

However, as there were 126 binomial tests performed on female families and 120 on male families, application of the more stringent significance level outlined above would eliminate all families from consideration as the p-values required to be significant at the 5% level would be, respectively, $p < .0004$ and $p < .0005$.

4.4.9 Pedigree Diversity Scores (PDS)

The majority of racehorses are inbred to some degree within the first five generations of their pedigrees. This is generally looked upon as being favourable, with the idea that inbreeding to a particular influential sire or mare will increase the chances of the animal becoming a successful racehorse. Although top bloodstock analyst Tony Morris compiles and publishes a list in the *Racing Post* newspaper, at the end of every year, of all the season's Pattern winners, showing which were inbred and which were outcrosses, a statistical analysis of whether or not inbreeding to any particular animal is actually useful has seemingly never been conducted.

Though inbreeding has been examined in several species, the traits under examination are often more related to morphological traits, fertility, longevity or meat quality (e.g. Zechner *et al.*, 2002; Burrow, 1998; Ecranbrack & Knight, 1993; MacNeil, Dearborn, Cundiff, Dinkel & Gregory, 1989; Dinkel, Anderson, Parker & Trevillyan, 1972). Inbreeding is usually determined using Wright's coefficient of inbreeding but, as explained in Chapter 2, this method is inappropriate for application to thoroughbred horses.

The method of looking at inbreeding that was designed and applied here found that how foals score in three of the six behavioural categories is related to the amount of diversity in their pedigrees. These were a reduction in vocalisation but an increase in defensive and escape behaviours as pedigrees became more inbred. Those more inbred within five generations showed a reduction in vocalisation ($r_s = .691$; $N = 11$; $p < .05$), increased inbreeding within four generations was associated with an increase in defensive behaviours ($r_s = -1.000$; $N = 4$; $p < .001$), while an increase in escape behaviours was associated with more inbred pedigrees of both five ($r_s = -.627$; $N = 11$; $p < .05$) and four ($r_s = -1.000$; $N = 4$; $p < .001$) generations.

A decrease in the amount of vocalisation is generally a sign of increasing maturity, a lesser need to contact other conspecifics when presented with an unusual situation. The increase in fight and flight responses would be in agreement with commonly held opinion that the more inbred an individual is the more 'highly strung' he is. If the animal is motivated to exhibit defensive or escape behaviours at a time of stress, this may be stronger than the motivation to seek out others of its kind, hence the corresponding decrease in vocalisation. From an evolutionary point of view this would make sense: ensure your own survival before worrying about anyone else's.

Burrow (1998) investigated the effects of inbreeding on a number of attributes in tropical beef cattle and took flight speed to be a measure of temperament. Though the changes in flight speed scores were small they were "in a favourable direction, indicating that more highly inbred animals were more docile" (p.240). This would contradict what was found here with regard to the increase in escape behaviours in foals. The more inbred foals were more likely to flee or exhibit defensive behaviours.

This could reflect a difference between the species or the way in which temperament was examined. The way in which temperament is defined or assessed will, of course, have an impact on the findings. Ruefenacht, Gebhardt-Henrich, Miyake and Gaillard (2002) highlighted this when showing that various studies on heritability of traits in canine breeds found differing results. Mackenzie, Oltenacu and Leighton (1985), for example, found evidence for heritability of temperament in German Shepherds while Wilsson and Sundgren (1997) found little evidence of this in the same breed.

Another method of looking at the potential effects of inbreeding on the behaviour of thoroughbred foals would be to look at the specific animals to which they are inbred, for example, does being inbred 4x4 Northern Dancer increase or decrease the likelihood of a foal exhibiting a particular type of behaviour while in the auction ring. This, however, would represent a considerable research project in itself.

4.4.10 Separation Study foals

Only seven of the 57 foals observed in the separation study (Chapter 3) were available for assessment in the auction ring. Even so, two measures from the initial study were found to be significantly related to two categories scored in the auction ring.

The percentage of time foals spent moving about the stable while their dam was at the covering shed was significantly related to both the number of locomotory behaviours they showed in the ring and to whether or not they showed any locomotory behaviours. However the relationship was not in the direction one might immediately expect as the more time they spent engaged in the behaviour in the stable, the less they exhibited it in the ring. A factor may lie in the motivation behind the behaviour in the two situations. In the stable the foals were distressed at being left alone and their motivation for engaging in locomotory behaviour will have stemmed from a desire to follow their mother. As they just end up going around in circles, or from one side of the stable to the other and back, such behaviour during the separation period can be considered as a displacement behaviour (McGee & Smith, 2004a; Kiley-Worthington, 1997). Another possibility is the motivation of a prey animal to escape a danger by keeping on the move. In the auction ring, however, the locomotory responses recorded represented a lesser degree of stress, more akin to startle or mild uncertainty. These motivational differences do not explain why a negative correlation should have been found between the percentage of time a preweaned foal spent moving about its stable and both the number of locomotory behaviour shown in the auction ring or whether or not they showed any locomotory behaviours in that venue but they suggest that the motivation of these seven foals to perform locomotory behaviours may be strongest when they are exhibiting high levels of stress or frustration.

The other notable result was that the more time a foal spent pawing in the stable during its separation, the less likely it was to sweat or defecate while it was in the auction ring. Again, the motivation behind these behaviours differ. Pawing has also been described as a displacement behaviour (McGreevy, 2000; Kiley-Worthington, 1997) whereas sweating and defecation, in times of stress, are measures of physiological arousal (Mason, 2000). It is possible

that those foals that engage in displacement behaviours to deal with a stressful situation may not become as easily physiologically aroused.

These findings do differ slightly from what Seaman *et al.* (2002) reported when they compared the results of 33 horses across three behavioural response tests. These tests, an arena test, a respond to person test and a respond to object test, did not produce consistent results within the horses studied, leading the authors to conclude that horses vary widely in how they respond to artificial behavioural tests. Both situations presented here represent real life situations rather than artificial behavioural tests but, with only seven animals involved, firm conclusions cannot be reached.

The auction ring scenario is clearly not an artificial test - it is a real life situation that thousands of young horses experience each year. While one could argue that the accompanied condition in the separation study could constitute an artificial test, in that a variable is manipulated to see if the animal's responses will change, the isolated condition is entirely a real life situation. Six of the seven foals assessed in the ring were from the isolated group.

It could be that the result found by Seaman *et al.* (2002) is as much a reflection of intraindividual differences as it is the artificial nature of the scenarios being tested. As with humans, one situation may produce a stress response whereas other typically stress-provoking scenarios may fail to elicit a reaction. Past experience, of course, can play a significant role and while both being confined, alone, in a stable without its mother and being brought into a closed arena in a noisy and crowded environment could be seen as potential triggers of fight or flight behaviours, the animal's life experience could make a difference in how it responds. For example, a foal may have learned to trust a handler when in a stress-provoking environment, hence being in the auction ring may not produce a strong reaction. However that same foal may become very distressed when left totally alone in a stressful situation.

4.5 Conclusions

Age and gender can be a significant factor in the amount of reactivity shown during a foal's first experience of the auction ring, but the differences found between those aimed at the flat market and those aimed at the national hunt market also suggest that husbandry practices may also be involved. Despite being classified as flat-bred or national hunt-bred, they all come from the same basic gene pool with the same sire lines, and even the same sires, being responsible for both groups.

While there is some tentative evidence to suggest that certain stallions and family lines may be having an influence on the temperament of some of their foals, the application of more stringent significance levels throws doubt on the reliability of that evidence and so it cannot be said definitively that sire or paternal grandsire or broodmare sire or female family or male family are a factor. There is also evidence to suggest that the amount of inbreeding within a foal's pedigree may influence how it responds to a novel situation. With only seven of the separation study animals available for observation in this auction ring study, firm conclusions cannot be reached with regard to whether or not behavioural responses in the first situation are related to behavioural responses shown in the second.

Chapter 5: Thoroughbred yearlings' experience of the auction ring

5.1 Introduction

This study involved the observation of weaned thoroughbred yearlings, some of which had been observed previously as foals. Applying the same principles as in Chapter 4, the study measured the behavioural responses of the yearlings to their experience of the auction ring with a view to (i) determining whether variables such as age, gender, coat colour, sire, paternal grandsire, broodmare sire, female family, male family or inbreeding were related to the behavioural responses shown by the yearlings to being in the ring, (ii) how similar or different would the responses shown by the 438 who were also assessed in the auction ring as foals be to both their own scores as foals and the scores obtained by the other yearlings, and (iii) would responses in the ring as yearlings relate to how the same animals responded in the separation study (Chapter 3). The data would also be used later to examine whether or not they would relate to temperamental traits, as assessed by the handlers responsible for the animals' care, when they were in training (Chapter 6).

5.2 Methods and Procedures

5.2.1 Design

This was an observational study of a novel scenario in which the behavioural responses of thoroughbred yearlings were recorded during their experience of being in an auction ring. There were a number of independent variables, such as age, gender, coat colour, sire, paternal grandsire, broodmare sire, family from which the dam came, family from which the sire came, the amount of inbreeding in the pedigree, whether or not the yearling had previously been assessed in the auction ring as a foal (Chapter 4), and whether or not the animal had been assessed in the separation study discussed in Chapter 3. The dependent variables were the behaviours of the yearlings during their time in the ring.

5.2.2 Subjects

A total of 2430 thoroughbred yearlings were observed, by a single viewer, in the sales ring in one of three different auction houses, two in Ireland and one

in England, during September, October and November 2003. All the animals (m=1519; f=911) were born between January and June 2002 and all but 141 (101 in USA, 21 in Germany, 15 in France, 2 in Denmark, 1 in Canada and 1 in Switzerland) were foaled in either Ireland or Britain. The males were further broken down as follows: 1216 colts (entire male), 300 geldings (castrated male) and 3 rigs (one or both testicles remain undescended).

The yearlings were being aimed at two different markets, namely the flat market and the national hunt (hurdles and steeplechases) market. The totals were 2050 (m=1207; f=843) for the flat market and 380 (m=312; f=68) for the national hunt market. Of the 'flat' males 6 were geldings and 3 were rigs. Of the 'national hunt' males, 294 were geldings.

The age range of 'flat' yearlings was from 483 to 650 days old (N=2050; mean = 565.16; SE = .74) with a mean age of 562 for colts (N=1198; mean = 562.43; SE = .95), 569 for fillies (N=843; mean = 569.18; SE = 1.15), 559 for geldings (N=6; mean = 559.50; SE = 11.44) and 532 for rigs (N=3; mean = 532.33; SE = 20.35). The age range for 'national hunt' yearlings was from 459 to 655 days old (N=380; mean = 552.81; SE = 1.86) with a mean age of 532 for colts (N=18; mean = 531.89; SE = 9.93), 562 for fillies (N=68; mean = 562.18; SE = 4.37) and 552 for geldings (N=294; mean = 551.92; SE = 2.06).

5.2.3 Materials

The materials used were the same as per the auction ring observations of the foals and have been detailed in Chapter 4.

5.2.4 Procedure

The observations, recorded using the same methods and from the same viewing points as outlined in Chapter 4 above, were carried out by a single viewer and at three auction houses, two of which were in Ireland and one in England. The 'flat-bred' observations were conducted in Kill in September 2003 and in Newmarket during October 2003 while the 'national hunt-bred' observations took place in Ratoath during November 2003. All pedigree data were also compiled and assessed as described in Chapter 4.

5.3 Results

5.3.1 General

Average time spent in the auction ring was 152.24 seconds in Kill (s.e.m. = 1.77; range = 75 - 339 sec), 146.85 seconds in Newmarket (s.e.m. = 1.21; range = 53 - 458) and 143.73 seconds in Ratoath (s.e.m. = 2.02; range = 75 - 364).

The minimum, maximum and median scores across the six behavioural categories, and the total, are shown in Table 5.1 below for both ‘flat-bred’ and ‘national hunt-bred’ yearlings. Only 266 of the ‘flat-bred’ yearlings, or 13.0% of the sample, obtained a reactivity score of zero, suggesting that this did not appear to be a stressful procedure for them. Of the ‘national hunt-bred’ yearlings, 72, or 18.9% of the sample, obtained a reactivity score of zero.

Table 5.1: Minimum, maximum and median scores for ‘flat-bred’ (N=2050) and ‘national hunt-bred’ (N=380) yearlings across six behavioural categories, and the total, showing the standard error and standard deviation for each.

flat-bred						national hunt-bred				
min.	max.	med.	S.E.	S.D.		min.	max.	med.	S.E.	S.D.
0	19	.00	.05	2.04	vocalisation	0	12	.00	.07	1.34
0	4	1.00	.02	.78	emotionality	0	3	.50	.03	.63
0	9	.00	.01	.32	defensive	0	4	.00	.02	.33
0	12	.00	.04	1.90	locomotory	0	9	1.00	.08	1.62
0	10	.00	.01	.51	freezing	0	8	.00	.05	.96
0	22	.00	.02	.93	escape	0	18	.00	.08	1.59
0	30	2.00	.08	3.67	total	0	26	2.00	.19	3.69

A Mann-Whitney test showed that there was no significant difference between the total reactivity scores of the ‘flat-bred’ and ‘national hunt-bred’ yearlings. However, when the same test was performed on the behavioural categories, using type as the grouping term, several significant differences emerged between the two markets (Table 5.2). Flat yearlings were more likely to sweat or defecate while in the auction ring but it was national hunt yearlings who were more likely to show a greater degree of freezing or escape behaviours.

When scores on the behavioural categories were recoded to indicate presence or absence of any of the behaviours, a chi-square test showed that it was not just the amount of these behaviours being shown that was significant but also whether or not they were being shown at all. Once again it was flat yearlings that were more likely to sweat or defecate ($\chi^2=43.09$; $df=1$; $p<.001$) while

national hunt yearlings were more likely to freeze ($\chi^2=78.10$; $df=1$; $p<.001$) or exhibit any escape behaviours ($\chi^2=23.52$; $df=1$; $p<.001$).

Table 5.2: Mean rank scores on each of the behavioural categories, and the total score across categories, for flat-bred yearlings (N=2050) and national hunt-bred yearlings (N=380). Also shown are the results from the Mann-Whitney test on type.

	N	vocalisation	emotionality	defensive	locomotory	freezing	escape	total
TYPE								
flat	2050	1223.58	1259.37	1215.84	1208.56	1185.54	1206.08	1223.08
NH	380	1171.89	978.81	1213.67	1252.93	1377.11	1266.32	1174.59
z =		-1.55	-7.82***	-.194	-1.23	-9.03***	-4.86***	-1.25

* $p<.05$; ** $p<.01$; *** $p<.001$

As a result of these findings, flat and national hunt yearlings were initially analysed together when looking at age, gender and coat colour but then analysed separately in these categories and when looking at, sire, paternal grandsire and broodmare sire. Only flat yearlings were examined with regard to female family, male family, PDS and prior experience. This was because (i) the pedigrees of most national hunt yearlings are not available in the online databases and (ii) only flat foals had been observed in 2002.

It was not possible to determine specifically which yearlings had gone through any auction ring prior to the day on which they were assessed. A Mann-Whitney test comparing the 438 scored as foals with those of the 1992 scored only as yearlings, found no significant difference between the groups in terms of total reactivity scores but that those assessed as foals were less likely to vocalise ($z=-2.09$; $p<.05$) and more likely to exhibit locomotory behaviours ($z=-2.03$; $p<.05$) than those assessed only as yearlings.

5.3.2 Age / gender / coat colour

As the scores were not normally distributed the Kruskal-Wallis test was used to determine if there were any significant differences in the total reactivity scores, or the scores on each of the six categories above, when the data were analysed by age, gender and coat colour (Table 5.3).

By breaking down the reactions into the six behavioural categories used in Chapter 4 (that is, vocalisation, emotionality, defensive, locomotory, freezing and escape) several significant relationships were found. Locomotory

behaviours ($\chi^2=20.84$; $df=5$; $p=.001$), freezing ($\chi^2=22.21$; $df=5$; $p<.001$) and the total reactivity score ($\chi^2=25.15$; $df=5$; $p<.001$) differed between age groups. To determine whether or not there were any trends within these results, age (in months) was correlated with mean rank on each of the six behavioural categories and the total reactivity score. This showed that vocalisation ($r_s = -.829$; $N=6$; $p<.05$), locomotory behaviours ($r_s = -.943$; $N=6$; $p<.01$), freezing behaviours ($r_s = 1.000$; $N=6$; $p<.001$) and total reactivity ($r_s = -.943$; $N=6$; $p<.01$) each decreased with age. The amount of vocalisation also decreased with age but this was not significant.

Table 5.3: Mean rank scores, by age (in months), gender and coat colour, across the six categories, and total, of reactivity score and showing the number of yearlings in each category ($N=2430$). Also shown are results from the Kruskal-Wallis tests on age, gender and coat colour.

	N	vocalisation	emotionality	defensive	locomotory	freezing	escape	total
AGE								
15-16	129	1227.90	1239.98	1228.70	1425.04	1310.12	1229.75	1375.70
17	525	1245.12	1172.11	1204.71	1203.16	1249.07	1219.93	1225.58
18	713	1243.22	1223.21	1224.09	1243.06	1217.50	1231.24	1270.77
19	652	1201.01	1219.36	1213.11	1196.25	1202.70	1207.12	1186.47
20	374	1160.73	1246.87	1214.03	1156.61	1163.97	1189.85	1115.89
21	37	1026.81	1212.15	1214.08	1063.43	1117.16	1206.61	967.34
$\chi^2=$		10.13	3.60	3.51	20.84**	22.21***	10.30	25.15***
GENDER								
colt	1216	1217.33	1257.74	1220.89	1223.86	1186.64	1203.86	1224.90
filly	911	1228.73	1223.33	1203.96	1196.66	1209.45	1213.44	1224.08
gelding	300	1155.76	1008.38	1216.56	1226.69	1338.69	1256.81	1139.19
$\chi^2=$		3.46	36.67***	3.78	1.06	38.78***	13.72**	4.00
COLOUR								
bay/brown	1837	1205.46	1215.15	1217.38	1221.59	1210.82	1220.58	1211.98
chestnut	514	1241.12	1204.68	1206.92	1204.75	1213.56	1199.04	1220.22
grey	78	1267.59	1279.38	1212.29	1127.22	1322.96	1188.70	1251.83
$\chi^2=$		2.06	.92	1.11	1.77	6.53*	4.91	.29

* $p<.05$; ** $p<.01$; *** $p<.001$

Gender was found to be significantly related to scores on emotionality ($\chi^2=36.67$; $df=2$; $p<.001$), freezing ($\chi^2=38.78$; $df=2$; $p<.001$) and escape ($\chi^2=13.72$; $df=2$; $p=.001$) behaviours. As there were only three rigs they were omitted from this analysis; their exclusion did not affect the pattern of results. The mean rank scores shown in Table 5.3 above indicate that geldings were the gender least likely to defecate or sweat in the ring but most likely to show freezing and escape behaviours.

In the analysis of coat colour the single black yearling was omitted. This resulted in a significant relationship between colour and freezing behaviour ($\chi^2=6.53$; $df=2$; $p<.05$). The mean rank scores (Table 5.3) of grey yearlings were much higher than those of bay/brown yearlings or chestnuts.

When the summed scores within each category were recoded to indicate whether or not each yearling exhibited any behaviours within that category (0=no; 1=yes), a chi-square analysis showed that age was related to locomotory ($\chi^2=18.15$; $df=5$; $p<.01$) and freezing behaviours ($\chi^2=14.49$; $df=5$; $p<.05$) while coat colour was related to freezing ($\chi^2=9.80$; $df=2$; $p<.01$) and escape behaviours ($\chi^2=9.23$; $df=2$; $p=.01$). These indicated that locomotory and freezing behaviours decrease with age, while a chi-square test showed that a greater proportion of greys exhibited at least one freezing behaviour ($\chi^2=9.79$; $df=2$; $p<.01$) and escape behaviours were shown more frequently by yearlings who were bay or brown ($\chi^2=9.22$; $df=2$; $p=.01$) rather than chestnut or grey.

A total of 266 of the 2430 yearlings (flat=175; national hunt=91) showed at least one freezing behaviour while only 84 of the 2430 yearlings (flat=55; national hunt=29) showed at least one escape behaviour. This means just 10.9% of the total number froze (flat=8.5%; national hunt= 23.9%) at least once while only 3.5% of the total (flat=2.7%; national hunt=7.6%) exhibited at least one escape behaviour.

Horses described as bay or brown ($n=1837$) made up 75.6% of the total, broken down further as 75.6% of the flat yearlings and 76.3% of the national hunt yearlings. Greys ($n=78$), on the other hand, made up just 3.2% of the total number, 3.4% of flat yearlings and 2.4% of national hunt yearlings (Table 5.4). When the proportion of flat horses described as bay or brown and who exhibited at least one escape behaviour was compared, using a binomial test, to the overall proportion of flat yearlings who scored 1 in this category, it was found to be not significant. This was also the case when looking at the national hunt yearlings.

Table 5.4: Overall percentages of greys, bay/browns and all yearlings (showing the total number in each category) and the proportions that exhibited either freezing or escape behaviours. Also shown are results from the binomial tests.

colour	overall %	% flat	% NH	flat freezing 18.8 N=69**	NH freezing 33.3 N=9	flat escape 3.3 N=1547	NH escape 7.2 N=290
grey	3.2	3.4	2.4				
bay/brown	75.6	75.6	76.3				
all yearlings				8.5 N=2050	23.9 N=380	2.7 N=2050	7.6 N=380

* p<.05; ** p<.01; *** p<.001

A binomial test showed that the proportion of grey flat yearlings that exhibited at least one freezing behaviour was significantly different (N=69; p<.01) from the overall proportion of flat yearlings that froze at least once. In the case of national hunt yearlings the proportion of greys that froze was not significantly different from the overall proportion. A closer look at the 13 grey flat yearlings that did exhibit at least one freezing behaviour failed to reveal any commonality between them and neither age nor gender appeared to be a factor.

5.3.3 Flat - v - National Hunt

Though the Mann-Whitney test on the total reactivity score found no difference between flat and national hunt yearlings, a series of Kruskal-Wallis tests found that there were significant differences in the way these yearlings obtained that total score. Table 5.2 above shows that flat yearlings were more likely to sweat or defecate in the ring (p<.001) while national hunt yearlings showed more freezing (p<.001) and escape (p<.001) behaviours.

When the summed scores in each category were analysed in terms of age, gender and coat colour, and split by type (Table 5.5), Kruskal-Wallis tests showed that in flat-bred yearlings locomotory ($\chi^2=21.94$; df=5; p=.001), freezing ($\chi^2=14.47$; df=5; p<.05) and total reactivity score ($\chi^2=23.74$; df=5; p<.001) were related to age. To determine whether or not there were any trends within these results, age (in months) was correlated with mean rank on each of the six behavioural categories and the total reactivity, for both flat and national hunt yearlings. This showed that locomotory ($r_s = -.943$; N=6; p<.01), freezing behaviours ($r_s = -1.000$; N=6; p<.001) and total reactivity ($r_s = -.943$;

N=6; p<01) decreased with age in flat-bred yearlings. There was no significant linear relationship between age and any of the behavioural categories in national hunt yearlings.

Table 5.5: Mean rank scores, by age (in months), gender and coat colour, and split by type, across the six categories, and total, of reactivity score and showing the number of yearlings in each category (N=2430). Also shown are the results of the Kruskal-Wallis tests on age, gender and coat colour.

	N	vocalisation	emotionality	defensive	locomotory	freezing	escape	total
Flat								
AGE								
16 (mths)	87	992.44	1088.46	1043.61	1267.26	1114.46	1056.90	1205.39
17	425	1060.50	1005.02	1018.24	1020.55	1044.74	1031.83	1049.52
18	589	1053.76	1041.76	1029.53	1045.45	1021.14	1030.92	1072.36
19	580	1009.96	1006.63	1024.75	1001.08	1020.87	1019.23	988.94
20	348	979.62	1039.34	1023.64	984.22	998.26	1010.13	944.11
21	28	883.18	1021.00	1032.86	938.45	976.50	1034.89	864.79
$\chi^2=$		9.85	3.23	2.20	21.94**	14.47*	8.23	23.74***
GENDER								
colt	1198	1019.37	1024.07	1029.17	1037.04	1023.97	1023.80	1025.50
filly	843	1033.16	1025.05	1016.86	1005.82	1024.67	1024.48	1024.40
gelding	6	661.00	862.00	995.00	975.92	936.50	996.50	668.08
$\chi^2=$		3.49	.54	2.79	1.69	.56	.17	2.24
COLOUR								
bay/brown	1547	1017.48	1029.35	1027.64	1033.80	1020.99	1031.79	1025.78
chestnut	434	1043.96	1011.13	1017.75	1010.83	1025.38	1005.06	1022.46
grey	69	1089.21	1029.69	1026.39	931.67	1127.28	1012.97	1038.25
$\chi^2=$		2.07	.39	1.15	2.74	9.08*	9.23*	.05
National Hunt								
AGE								
15-16	42	214.69	201.18	190.06	194.87	187.15	180.27	202.02
17	100	188.40	179.46	187.43	182.43	196.49	187.56	182.08
18	124	191.13	185.38	194.69	196.77	194.02	198.91	199.52
19	72	190.01	209.60	188.10	203.81	190.91	191.92	200.15
20-21	42	170.29	188.51	189.96	164.02	168.51	180.45	155.85
$\chi^2=$		5.05	4.94	3.83	5.19	3.85	7.23	6.78
GENDER								
colt	18	206.72	231.78	196.25	197.22	187.53	176.00	212.22
filly	68	190.91	156.62	185.50	203.79	212.63	198.65	202.05
gelding	294	189.41	195.81	191.30	187.02	185.56	189.50	186.50
$\chi^2=$		.61	12.37**	2.68	1.56	6.04*	3.36	1.89
COLOUR								
bay/brown	290	188.59	186.96	190.24	188.28	190.25	189.18	186.98
chestnut	80	197.69	193.50	189.68	194.44	187.86	194.62	198.04
grey	9	166.94	257.00	185.00	205.89	200.83	175.50	216.00
$\chi^2=$		1.21	4.69	.27	.45	.22	1.49	1.19

* p<.05; ** p<.01; *** p<.001

The Kruskal-Wallis tests also showed that there was a relationship between coat colour and both freezing ($\chi^2=9.08$; df=2; p<.05) and escape behaviours ($\chi^2=9.23$; df=2; p=.01). In national hunt-bred yearlings there was a

relationship between gender and both emotionality ($\chi^2=12.37$; $df=2$; $p<.01$) and freezing behaviours ($\chi^2=6.04$; $df=2$; $p<.05$).

When the recoded scores for each category, that is whether or not each yearlings exhibited any behaviours with that category (0=no; 1=yes), were analysed, it was found that (i) gender was related to emotionality ($\chi^2=11.54$; $df=2$; $p<.01$) in national hunt yearlings, (ii) age was related to locomotory ($\chi^2=18.14$; $df=5$; $p<.01$) and freezing behaviours ($\chi^2=14.49$; $df=2$; $p<.05$) in flat-bred yearlings, and (iii) coat colour was related to freezing ($\chi^2=9.79$; $df=2$; $p<.01$) and escape behaviours ($\chi^2=9.22$; $df=2$; $p=.01$) in flat-bred yearlings.

5.3.4 Sire / paternal grandsire

As differences between flat-bred and national hunt-bred yearlings had been found above, the two types were examined separately when looking at whether or not any individual stallions or paternal grandsires had greater than expected proportions of their foals scoring 0 or 1 in any of the six behavioural categories.

Chi-square and binomial tests were performed and it was found that the sire of the animal may be a factor in some cases.

A total of 241 individual stallions were represented by the 2050 flat-bred yearlings, of which 77 stallions were represented by 10 or more yearlings. There were 113 paternal grandsires, of whom 32 were represented by 10 or more yearlings and had at least 2 stallion sons represented, each of which was responsible for at least two yearlings. For the national hunt-bred yearlings there was a total of 92 individual stallions of whom 12 were represented by 10 or more yearlings, and 57 paternal grandsires of whom only 6 were represented by 10 or more descendents and had at least two stallion sons with two or more yearlings in the sample.

5.3.4.1 Flat-bred yearlings

To examine whether or not there may be a relationship between sire and presence of absence of behaviours exhibited in the six behavioural categories, chi-square tests were performed on the recoded scores. As including all 241 individual sires in this test would make it impossible for the expected

frequencies in each cell to be greater than 5 ($2050 / (241 \times 2) = 4.3$), only those stallions with 10 or more representatives were included (sires: $1540 / (77 \times 2) = 10.0$). With only 113 paternal grandsires in total, this was not a problem ($2050 / (113 \times 2) = 9.1$) but, to be consistent, only the 32 that had 10 or more representatives were used.

The chi-square test showed that there was no significant relationship between sire, or paternal grandsire, and whether or not yearlings exhibited behaviours in any of the six categories. Nevertheless, the proportion of yearlings scoring 0 or 1 on each of the six behavioural categories was calculated and these proportions were then used in a series of binomial tests to determine if any individual sires or paternal grandsires had a statistically significant proportion of their yearlings scoring 0 or 1 in each category. A summary of the results is shown in Table 5.6 below.

With a total of 462 binomial tests being performed on individual stallions (77×6), one would expect 23 of these to be significant at the 5% level purely by chance. There were 20 significant results. For the paternal grandsires there were 192 binomial tests performed (32×6) of which about 10 would be expected to be significant at the 5% level by chance. There were 16 significant results.

(i) Vocalisation

A total of 64.6% of the flat-bred yearlings did not vocalise while in the auction ring; 35.4% did. Intikhab ($N=14$; $p<.05$) and Zafonic ($N=29$; $p<.05$) had a significantly greater than expected proportion of their yearlings who did not vocalise in the ring while seven stallions had a greater than expected proportion of their yearlings who did vocalise in the ring. These were Almutawakel ($N=13$; $p<.05$), Anabaa ($N=16$; $p<.01$), Machiavellian ($N=31$; $p<.05$), Polish Precedent ($N=18$; $p<.05$), Sadler's Wells ($N=30$; $p<.01$), Topsy Creek ($N=11$; $p<.05$) and Vettori ($N=21$; $p<.05$).

Of the paternal grandsires, those descended from Gone West ($N=33$; $p<.05$) and Red Ransom ($N=20$; $p<.05$) were more likely to remain silent in the ring, than the overall proportions, while those from Ahonoora ($N=52$; $p<.05$), Danzig

(N=121; p<.05), Machiavellian (N=38; p<.001) and Mr Prospector (N=60; p<.05) were more likely than expected to vocalise.

Table 5.6: The individual stallions and the paternal grandsires (both listed alphabetically) who had a significant proportion of their flat-bred yearlings scoring 0 or 1 in each behavioural category.

		vocalisation	emotionality	defensive	locomotory	freezing	escape
sire	N						
Alhaarth	19						
Almutawakel	13	* a					
Anabaa	16	** a					
Bachir	11				* a		
Benny The Dip	20				*		
Cape Cross	18		*				
Danehill Dancer	13						
Danzero	11						
In The Wings	32				* a		
Intikhab	14	*					
Josr Algarhoud	14				*		
Machiavellian	31	* a					
Mind Games	17		*				
Montjeu	50		* a				
Nashwan	15		* a		*		
Polish Precedent	18	* a					
Sadler's Wells	30	** a	* a				
Soviet Star	17		*				
Tipsy Creek	11	* a					
Vettori	21	* a					
Zafonic	29	*					
paternal grandsire	N	vocalisation	emotionality	defensive	locomotory	freezing	escape
Ahonoora	52	* a			*		
Danehill	89		* a				
Danzig	121	* a					
Darshaan	39				*		
Fairy King	20		*				
Gone West	33	*					
Grand Lodge	47				*		
Kingmambo	44				* a		
Machiavellian	38	*** a					
Mr Prospector	60	* a					
Red Ransom	20	*					
Sadler's Wells	169			*** a	* a		
Storm Cat	58					* a	
Warning	48		* a				

* p<.05; ** p<.01; *** p<.001; ^a greater proportion scoring 1

(ii) Emotionality

A total of 32.5% of the flat-bred yearlings neither sweated nor defecated while in the ring; 67.5% did. A greater than expected proportion of the progeny of three stallions neither sweated nor defecated while in the ring. These were Cape Cross (N=18; p<.05), Mind Games (N=17; p<.05) and Soviet Star (N=17; p<.05). Three stallions, namely Montjeu (N=50; p<.05), Nashwan (N=15; p<.05) and Sadler's Wells (N=30; p<.05), had a greater than expected proportion of their progeny who did exhibit at least one of these behaviours.

Of the paternal grandsires, descendants of Fairy King (N=20; $p<.05$) were less likely to sweat or defecate in the ring while those from Danehill (N=89; $p<.05$) and Warning (N=48; $p<.05$) had a greater than expected proportion of their representatives exhibiting at least one behaviour in this category.

(iii) Defensive

A total of 97.2% of the flat-bred yearlings did not exhibit any defensive behaviours in the ring; 2.8% did. No stallion had a greater than expected proportion of his yearlings exhibiting behaviours in this category. Of the paternal grandsires, a total of 13 descendants of Sadler's Wells (N=169; $p<.001$) exhibited at least one defensive behaviour.

(iv) Locomotory

A total of 52.7% of the flat-bred yearlings did not exhibit any locomotory behaviours while in the auction ring; 47.3% did. A greater than expected proportion of the progeny of three stallions did not exhibit any locomotory behaviours in the ring. These were Benny The Dip (N=20; $p<.05$), Josr Algarhoud (N=14; $p<.05$) and Nashwan (N=15; $p<.05$). Progeny of Bachir (N=11; $p<.05$) and In The Wings (N=32; $p<.05$) were more likely to score 1 in this category than those by other stallions.

Of the paternal grandsires, those descended from Ahonoora (N=52; $p<.05$), Darshaan (N=39; $p<.05$) and Grand Lodge (N=47; $p<.05$) were less likely to show any locomotory behaviours in the ring while those from Kingmambo (N=44; $p<.05$) and Sadler's Wells (N=169; $p<.05$) had a greater than expected proportion who scored 1 in this category.

(v) Freezing

A total of 91.5% of the flat-bred yearlings did not exhibit any freezing behaviours while in the ring; 8.5% did. No stallion had a greater than expected proportion of his yearlings exhibiting behaviours in this category. Paternal grandsire Storm Cat (N=58; $p<.05$) had a greater than expected proportion of his descendants who froze at least once in the ring.

(vi) **Escape**

A total of 97.3% of the flat-bred yearlings did not exhibit any escape behaviours in the ring; 2.7% did. No sire or paternal grandsire had a greater than expected proportion of his representatives that exhibited behaviours in this category.

5.3.4.2 **National hunt-bred yearlings**

Only 12 of the 92 individual stallions and just 6 of the 57 paternal grandsires were represented by 10 or more yearlings. The criteria for inclusion of paternal grandsires were as described earlier. To determine whether or not any of these stallions had a statistically significant percentage of their yearlings scoring 0 or 1 on any of the six behavioural categories, compared to the overall proportions, a series of binomial tests was performed. A summary of the results is presented in Table 5.7 below.

Table 5.7: The individual stallions and the paternal grandsires (both listed alphabetically) who had a significant proportion of their national hunt-bred yearlings scoring 0 or 1 in each behavioural category.

		vocalisation	emotionality	defensive	locomotory	freezing	escape
sire	N						
Good Thyne	11					* a	
Luso	13				*		
Pistolet Bleu	19				**		
Presenting	31		* a				
Saddlers' Hall	19				* a		
Supreme Leader	23				*		
paternal grandsire	N	vocalisation	emotionality	defensive	locomotory	freezing	escape
Salse	15				*		
Top Ville	31				*		

* p<.05; ** p<.01; *** p<.001; ^a greater proportion scoring 1

With a total of 72 binomial tests being performed on individual stallions (12 x 6), one would expect about 4 to be significant at the 5% level by chance. There were 6 significant results. For the paternal grandsires it could be expected that 2 significant results be found by chance. There were 2 significant results.

(i) **Vocalisation**

A total of 67.1% of the national hunt-bred yearlings did not vocalise while in the auction ring; 32.9% did. No sire or paternal grandsire had a greater than

expected proportion of his representatives that exhibited behaviours in this category.

(ii) Emotionality

A total of 50.0% of the national hunt-bred yearlings neither sweated nor defecated while in the ring; 50.0% did. A greater than expected proportion of yearlings by Presenting (N=31; $p<.05$) either sweated or defecated in the ring but no paternal grandsire produced a significant result.

(iii) Defensive

A total of 97.4% of the national hunt-bred yearlings did not exhibit any defensive behaviours in the ring; 2.6% did. No sire or paternal grandsire had a greater than expected proportion of his representatives that exhibited behaviours in this category.

(iv) Locomotory

A total of 49.2% of the national hunt-bred yearlings did not exhibit any locomotory behaviours while in the auction ring; 50.8% did. Yearlings by Luso (N=13; $p<.05$), Pistolet Bleu (N=19; $p<.01$) and Supreme Leader (N=23; $p<.05$) had a greater than expected proportion of their yearlings scoring 0 in this category while those by Saddlers' Hall (N=19; $p<.05$) were more likely to show at least one of these behaviours. Of the paternal grandsires, Salse (N=15; $p<.05$) and Top Ville (N=31; $p<.05$) had a greater than expected proportion of their representatives scoring 0.

(v) Freezing

A total of 76.1% of the national hunt-bred yearlings did not exhibit any freezing behaviours while in the ring; 23.9% did. Good Thyne (N=11; $p<.05$) had a greater than expected proportion of his yearlings who froze at least once. No paternal grandsire had a greater than expected proportion of his descendents exhibiting behaviours in this category.

(vi) Escape

A total of 92.4% of the national hunt-bred yearlings did not exhibit any escape behaviours in the ring; 7.6% did. No stallion or paternal grandsire produced a significant result.

5.3.5 Broodmare Sires

There was a total of 523 broodmare sires responsible for the flat-bred yearlings of which 53 were represented by 10 or more. Of the national hunt yearlings there was a total of 164 broodmare sires with just 7 of them having 10 or more representatives. Given the very small number of national hunt broodmare sires involved, results for both flat and national hunt bred yearlings are presented together.

Chi-square tests, using only those broodmare sires with 10 or more representatives, found no significant relationship between the category broodmare sires and each of the six behavioural categories for either flat or national hunt yearlings. To see if any individual broodmare sires might have a greater than expected proportion of his descendents exhibiting behaviours in any of the categories a series of binomial tests was run. A summary of the results is presented in Table 5.8 below.

With a total of 148 binomial tests being performed on flat broodmare sires (53 x 6), one would expect about 7 to be significant at the 5% level by chance. There were 11 significant results. With national hunt broodmare sires (7 x 6) one would expect to find 2 significant results by chance. There were 3 significant results.

Table 5.8: The broodmare sires (listed alphabetically) that had a significant proportion of their yearlings scoring 0 or 1 in each behavioural category.

		vocalisation	emotionality	defensive	locomotory	freezing	escape
flat	N						
Diesis	15	* a					
Ela-Mana-Mou	16	* a					
Habitat	15	** a					
Mr Prospector	13				* a		
Nureyev	10				* a		
Pharly	12	* a					
Riverman	13	* a					
Royal Academy	22					* a	
Salse	10		* a				
Thatching	13				*		
Woodman	18					* a	
national hunt	N						
Buckskin	17	** a				* a	*

* p<.05; ** p<.01; *** p<.001; ^a greater proportion scoring 1

(i) Vocalisation

A total of 64.6% of the flat-bred yearlings did not vocalise while in the auction ring; 35.4% did. A greater than expected proportion of yearlings from mares by Diesis (N=15; $p<.05$), Ela-Mana-Mou (N=16; $p<.05$), Habitat (N=15; $p<.01$), Pharly (N=12; $p<.05$) and Riverman (N=13; $p<.05$) vocalised while in the ring.

A total of 67.1% of the national hunt-bred yearlings did not vocalise while in the auction ring; 32.9% did. A greater than expected proportion of those out of Buckskin mares (N=17; $p<.01$) vocalised at least once in the ring.

(ii) Emotionality

A total of 32.5% of the flat-bred yearlings neither sweated nor defecated while in the ring; 67.5% did. All of those out of Salse mares (N=10; $p<.05$) either sweated or defecated at least once while in the ring. A total of 50.0% of the national hunt-bred yearlings neither sweated nor defecated while in the ring; 50.0% did. No broodmare sire produced a significant result.

(iii) Defensive

A total of 97.2% of the flat-bred yearlings did not exhibit any defensive behaviours in the ring; 2.8% did. No broodmare sire produced a significant result. A total of 97.4% of the national hunt-bred yearlings did not exhibit any defensive behaviours in the ring; 2.6% did. No broodmare sire produced a significant result.

(iv) Locomotory

A total of 52.7% of the flat-bred yearlings did not exhibit any locomotory behaviours while in the auction ring; 47.3% did. Those out of Thatching mares (N=13; $p<.05$) were less likely to show any locomotory behaviours in the ring while a greater than expected proportion of those out of mares by Mr Prospector (N=13; $p<.05$) and Nureyev (N=10; $p<.05$) scored 1 in this category.

A total of 49.2% of the national hunt-bred yearlings did not exhibit any locomotory behaviours while in the auction ring; 50.8% did. No broodmare sire produced a significant result.

(v) Freezing

A total of 91.5% of the flat-bred yearlings did not exhibit any freezing behaviours while in the ring; 8.5% did. A greater than expected proportion of those out of mares by Royal Academy (N=22; $p<.05$) and Woodman (N=18; $p<.05$) performed at least one freezing behaviour while in the ring.

A total of 76.1% of the national hunt-bred yearlings did not exhibit any freezing behaviours while in the ring; 23.9% did. A greater than expected proportion of those out of Buckskin mares (N=17; $p<.05$) froze at least once.

(vi) Escape

A total of 97.3% of the flat-bred yearlings did not exhibit any escape behaviours in the ring; 2.7% did. No broodmare sire produced a significant result.

A total of 92.4% of the national hunt-bred yearlings did not exhibit any escape behaviours in the ring; 7.6% did. A greater than expected proportion of those out of Buckskin mares (N=17; $p<.05$) scored 0 in this category.

5.3.6 Female family number / male family number

As most national hunt-bred yearlings have pedigrees that are not yet included in the afore mentioned Pedigree Query Online database, only flat-bred yearlings were used in the analyses of female families numbers and male family numbers.

A chi-square test on the recoded behavioural category scores with the categories female family number and male family number found no significant relationships. A series of binomial tests was then performed to see if any individual family had a significant proportion of its representatives scoring either 0 or 1 in any of the categories. A summary of the results is presented in Table 5.9 below.

With a total of 162 binomial tests performed on female families (27 x 6) one would expect 8 results to be significant at the 5% level by chance. There were 2 significant results. The number of binomial tests performed on male

families was 138 (23 x 6), of which 7 could be expected to be significant at the 5% level by chance. There were 4 significant results.

Table 5.9: Female and male families (identified by the Bobinski numbers) who had a significant proportion of their flat-bred yearlings scoring 0 or 1 in each behavioural category.

		vocalisation	emotionality	defensive	locomotory	freezing	escape
female family	N						
5	108					* a	
11	51					*	
male family	N						
4	79		**				
5	79		*** a				
20	15			*			
17	29				*		

* p<.05; ** p<.01; *** p<.001; ^a greater proportion scoring 1

(i) Vocalisation

A total of 64.6% of the flat-bred yearlings did not vocalise while in the auction ring; 35.4% did. No female family produced a significant result. A greater than expected proportion of yearlings by stallions from family 4 (N=79; p<.01) did not vocalise in the ring while a significant proportion of those from family 5 (N=79; p<.001) did.

(ii) Emotionality

A total of 32.5% of the flat-bred yearlings neither sweated nor defecated while in the ring; 67.5% did. No female family produced a significant result though a greater than expected proportion of yearlings by stallions from family 20 (N=15; p<.05) scored 0 in this category.

(iii) Defensive

A total of 97.2% of the flat-bred yearlings did not exhibit any defensive behaviours in the ring; 2.8% did. No female or male family produced a significant result.

(iv) Locomotory

A total of 52.7% of the flat-bred yearlings did not exhibit any locomotory behaviours while in the auction ring; 47.3% did. No female family produced a significant result. A greater than expected proportion of the yearlings by

stallions from family 17 (N=29; $p<.05$) showed no behaviours from this category.

(v) Freezing

A total of 91.5% of the flat-bred yearlings did not exhibit any freezing behaviours while in the ring; 8.5% did. A greater than expected proportion of yearlings from female family 5 (N=108; $p<.05$) froze at least once in the ring while every animal representing female family 11 (N=51; $p<.05$) scored 0 in this category. No male family produced a significant result.

(vi) Escape

A total of 97.3% of the flat-bred yearlings did not exhibit any escape behaviours in the ring; 2.7% did. No female or male family produced a significant result.

5.3.7 Pedigree Diversity Scores (PDS)

As most of the national hunt-bred yearlings have pedigrees that are not yet included in the afore mentioned online database, only the flat-bred yearlings were used in the analyses involving PDS scores.

5.3.7.1 Five-generation pedigrees

With five-generation pedigrees the range of different animals within any one pedigree was from 47 to 62 individuals. The mode value was 61, the median was 59 and the mean number of individuals in a pedigree was 59.12 (s.e.m.=.05). A total of 318 yearlings (15.5%) showed no inbreeding within five generations while a further 390 (19.0%) had only one duplication within those five generations.

As there were less than 10 yearlings with a PDS of either 47, 49, 50 or 51, these were grouped together (N=18) before a correlation between PDS and the proportion of yearlings that exhibited at least one behaviour in any of the six categories (Table 5.10) could be calculated. Freezing behaviours ($r_s=-.609$; N=12; $p<.05$) were found to increase as a pedigree became more inbred.

Table 5.10: The proportion of yearlings representing each 5-generation PDS that scored 1 in each of the six behavioural categories.

PDS	N	vocalisation	emotionality	defensive	locomotory	freezing	escape
62	318	32.7	66.0	1.3	44.0	6.6	2.2
61	390	38.7	66.7	2.3	50.0	8.5	2.8
60	296	31.8	65.5	3.0	44.6	8.8	3.0
59	339	38.3	64.6	3.5	44.8	8.6	3.2
58	312	36.5	71.2	1.6	46.5	9.0	2.9
57	134	29.9	70.1	6.7	50.7	6.7	1.5
56	82	34.1	65.9	3.7	57.3	11.0	2.4
55	64	37.5	78.1	6.3	54.7	12.5	1.6
54	49	34.7	73.5	4.1	51.0	8.2	2.0
53	35	34.3	65.7	.0	40.0	8.6	.0
52	13	38.5	69.2	.0	46.2	15.4	7.7
47-51	18	38.9	72.2	5.6	55.6	16.7	5.6

5.3.7.2 Four-generation pedigrees

With four-generation pedigrees the range of different animals within any one pedigree was from 24 to 30 individuals. The mode value was 30, the median was 30 and the mean number of individuals in a pedigree was 29.45 (s.e.m.=.02). A total of 1211 yearlings (59.1%) showed no inbreeding within four generations while a further 645 (31.5%) had only one duplication within those four generations.

As there was only one yearling with a PDS of 24 and three with a PDS of 25, these were combined with the yearlings whose PDS was 26 (N=16) before a correlation between PDS and the proportion of yearlings that exhibited at least one behaviour in any of the six categories (Table 5.11) could be calculated. Correlations showed that both freezing behaviours ($r_s=-.900$; $N=5$; $p<.05$) and signs of emotionality ($r_s=-.900$; $N=5$; $p<.05$) increased as a pedigree became more inbred.

Table 5.11: The proportion of yearlings representing each 4-generation PDS that scored 1 in each of the six behavioural categories.

PDS	N	vocalisation	emotionality	defensive	locomotory	freezing	escape
30	1211	34.8	66.7	2.4	46.7	8.0	2.7
29	645	35.8	67.8	3.3	47.1	8.7	2.6
28	112	40.2	73.2	4.5	54.5	11.6	.9
27	66	36.4	68.2	3.0	47.0	10.6	6.1
24-26	16	31.3	75.0	6.3	43.8	12.5	.0

5.3.8 Horses scored as a foal and as a yearling

A total of 438 (m=310; f=128) horses that were scored in the auction ring as foals, were again assessed as yearlings. All were flat-bred. Three of the males

were now geldings. As one of the points of interest was whether or not yearlings showed a greater or lesser degree of reactivity than they had as foals, the mean summed score across the six behavioural categories was initially used before looking at the recoded scores as used above.

5.3.8.1 Total reactivity score

Amongst this group of 438 horses the mean reactivity as foals was 4.85 (SD=4.44; s.e.m.=.212) compared to their mean yearling reactivity score of 3.25 (SD=3.27; s.e.m.=.156). A total of 243 yearlings produced a lower reactivity score than they had done when assessed as foals. The total of horses that produced a higher reactivity score when assessed as yearlings than they had done as foals was 147, while 48 horses showed the same level on both occasions (Figure 5.1). As the differences between the scores in the two observation sessions were normally distributed, a paired-sample t-test was performed and the mean difference was found to be significant ($t=6.32$; $df=437$; $p<.001$).

Figure 5.1: Frequency distribution of the change in total reactivity score in the 438 subjects who were scored as a foal and as a yearling.

A Kruskal-Wallis test showed that age (in months) was related to the change in reactivity score ($\chi^2=10.79$; $df=3$; $p<.05$), that is between the score obtained as a foal and the score obtained as a yearling (Table 5.12). A non-parametric (Spearman) correlation between these two variables suggested that the change in reactivity score increased as age increased. This correlation, though low, was significant ($r_s=.15$; $N=438$; $p<.01$). As there were only eight yearlings aged 15 and 16 months these were combined with those aged 17 months. Similarly, the six who were aged 21 months were combined with those aged 20 months.

Table 5.12: Mean rank scores, by age (in months), gender and coat colour, for the change in reactivity score between that obtained as a foal and that obtained as a yearling (N=438). Also shown are the results of the Kruskal-Wallis tests on age and coat colour and the Mann Whitney test on gender.

	N	mean rank
AGE		
15-17 (months)	85	192.61
18	140	199.55
19	125	236.88
20-21	80	234.31
$\chi^2=10.79^*$		
GENDER		
colt	307	215.80
filly	128	223.28
$z=-.57$		
COLOUR		
bay/brown	331	216.57
chestnut	92	230.11
grey	15	219.10
$\chi^2=0.83$		

Neither gender (Mann Whitney) nor coat colour (Kruskal-Wallis) was found to be significantly related to this change in score. It was interesting to note that all three who had been gelded somewhere between having gone through the ring as a foal and again as a yearling, showed an increase in their reactivity scores during their second assessment. Subject T070/T2362 scored zero as a foal but 2 as a yearling, G060/F227 scored 1 as a foal and 10 as a yearling, while G439/F369 scored 9 as a foal and 19 as a yearling.

Of the 438 yearlings that were assessed twice, 436 were offered at flat yearlings sales and 2 at a national hunt sale. When the reactivity scores of the 436 flat yearlings were compared to those of the 1614 yearlings who had

only been assessed once a Mann Whitney test found no significant difference the two groups in terms of the total reactivity scores.

If the behavioural responses of foals and yearlings to being in the auction ring are an indication of more stable temperamental traits rather than just temporary states, then one would expect that the total reactivity scores obtained by the 436 flat animals scored in both years would be very similar on each assessment. While only 48 (11.0%) produced the same score on both occasions, a further 80 (18.4%) had a yearling score that was only ± 1 different from their foal score, another 81 (18.6%) producing a total that was only ± 2 different from their initial assessment, with a further 51 (11.7%) scoring ± 3 from their total as a foal. A more complete breakdown of the differences between foal and yearling scores in these doubly assessed animals is provided in Table 5.13.

Table 5.13: The difference between foal and yearling scores on total reactivity with the number of the 436 doubly assessed flat yearlings showing this change, the associated proportion of the whole and the cumulative percentage.

change	N	percentage	total
0	48	11.0	11.0
± 1	80	18.4	29.4
± 2	81	18.6	48.0
± 3	51	11.7	59.7
± 4	39	8.9	68.6
± 5	31	7.1	75.7
± 6	25	5.7	81.4
± 7	19	4.4	85.8
± 8	11	2.5	88.3
± 9	14	3.2	91.5
± 10	12	2.8	94.3
> 10	25	5.7	100.0

When the scores obtained as foals by these 436 subjects were correlated with those they got as yearlings there was no statistically significant relationship found. However, as can be seen in Figure 5.1, the distribution of change scores had long tails, that is a few animals had very extreme change scores. This may indicate that there was some unusual reason for the change, for example they were particularly disturbed on one or other occasion. In order to get an idea of the underlying correlation the following steps were taken: (i) a boxplot was used to identify the outliers in the change scores, (ii) the subjects with these change scores were removed, and (iii) a correlation was performed

between the foal reactivity score and yearling reactivity score of the remaining subjects.

This identified 407 subjects with change scores ranging from an increase of 8 to a decrease of 11 and resulted in a significant correlation between foal and yearling reactivity scores ($r=.238$; $N=407$; $p<.001$). In terms of the ability of foal scores to be able to predict yearling scores, however, the R^2 value was only .0566, indicating that the foal reactivity score only accounts for just over 5% of the variance in yearling reactivity score.

5.3.8.2 Six behavioural categories

While the vast majority of the 1614 once-assessed yearlings were having their first experience of the auction ring, it is likely that several had been through the ring previously, either as foals or yearlings, but this number, which would have been very difficult to determine, would have been very small as there were very few other opportunities for them to have appeared in a European auction ring.

When the scores, in the six behavioural categories, of the 436 twice-assessed yearlings were compared to those of the 1614 once-assessed yearlings, a Mann Whitney test showed that those who had also been through the auction ring as a foal were less likely to whinny in the ring as a yearling ($z=-2.08$; $p<.05$).

5.3.9 Separation study foals

A total of 13 animals who had been observed during the separation study (Chapter 3) were also assessed in the auction ring as yearlings. Six ($m=4$; $f=2$) of these had been in the 'accompanied' group and seven ($m=6$; $f=1$) in the 'isolated' group. Two of the 'isolated' group colts had also been assessed in the auction ring as a foal (Chapter 4). In addition to the four behaviours reported in Chapter 3, that is the interval between vocalisations, the percentage of time spent pacing/moving about the stable, the length of time spent pawing and the number of times the animal struck a solid object with its body, a fifth behaviour, the total number or times the foal urinated or defecated during the separation period, was included.

When these 13 yearlings' results from the separation study were correlated with their total scores on each of the six behavioural categories (from the auction ring) and also with the recoded scores, that is whether or not they showed at least one behaviour in any of those categories, two significant results were found. With a total of 60 (5 x 12) correlations performed on the scores from these 13 yearlings one would expect 3 to be significant at the 5% level by chance.

The interval between vocalisations in the stable while their dam was at the covering shed was significantly related to both the number of escape behaviours shown in the ring ($r_s=.559$; $N=13$; $p<.05$) and to whether or not they showed any escape behaviours ($r_s=.570$; $N=13$; $p<.05$) while in the auction ring. These results suggested that the wider the interval between vocalisations in the stable, the more likely the animal was to exhibit escape behaviours in the auction ring as a yearling.

As significant differences had been found (Chapter 3; McGee & Smith, 2004a) between animals in the 'accompanied' group and the 'isolated' group during the separation study, the 13 yearlings were then split into their original groups and the correlational analysis repeated.

(i) 'Accompanied' group

When just the six yearlings who had been assessed in the 'accompanied' group in the separation study were investigated, a correlational analysis performed on the same variables as above, found ten significant results. With a total of 60 (5 x 12) correlations performed on the scores from the 'accompanied' group one would expect 3 to be significant at the 5% level by chance.

The interval between vocalisations in the stable was related to total scores on vocalisation ($r_s=.880$; $N=6$; $p<.05$) and emotionality ($r_s=-.845$; $N=6$; $p<.05$) and also to whether or not the yearlings vocalised while in the auction ring ($r_s=.878$; $N=6$; $p<.05$). The percentage of time spent moving around the stable as a foal was related to total score both on vocalisation ($r_s=-.941$; $N=6$; $p<.01$) and emotionality ($r_s=.845$; $N=6$; $p<.05$) and also to whether or not the yearlings vocalised in the auction ring ($r_s=-.878$; $N=6$; $p<.05$). The amount of time spent

pawing while in the stable as a foal was related to the total score on both freezing ($r_s=.880$; $N=6$; $p<.05$) and escape behaviours ($r_s=.898$; $N=6$; $p<.05$) and also to whether or not the yearlings exhibited any behaviours in either the freezing ($r_s=.880$; $N=6$; $p<.05$) or escape ($r_s=.880$; $N=6$; $p<.05$) categories.

These suggested that (i) the greater the interval between vocalisations in the stable as a foal, the greater the likelihood that the animal would vocalise while in the ring as a yearling but the less likely it was to either sweat or defecate while in the ring, (ii) the more time a foal spent moving about the stable during the separation period the less likely it was to vocalise in the ring as a yearling but the more likely it was to defecate or sweat while in the ring, and (iii) the more time a foal spent pawing during the period of separation, the more likely it was to show freezing or escape behaviours when subsequently in the auction ring as a yearling.

(ii) 'Isolated' group

When just the seven yearlings who had been assessed in the 'isolated' group in the separation study were investigated, a correlational analysis performed on the same variables as above, found four significant results. With a total of 60 (5 x 12) correlations performed on the scores from the 'isolated' group one would expect 3 to be significant at the 5% level by chance.

The percentage of time spent moving about the stable while separated from their dam during covering was related to the amount of locomotory behaviour ($r_s=.954$; $N=7$; $p=.001$) shown in the auction ring as a yearling and whether or not the yearling exhibited any locomotory behaviours ($r_s=.866$; $N=7$; $p<.05$) in the ring. The amount of time a foal spent pawing in the stable during the separation period was related to both the amount of locomotory behaviour ($r_s=.932$; $N=7$; $p<.01$) subsequently shown in the ring as a yearling and to whether or not the animal exhibited any of the locomotory behaviours ($r_s=.899$; $N=7$; $p<.01$) while in the ring.

These results suggest that (i) the more time a foal spent moving about the stable if isolated when separated from its dam during covering the more likely it was to exhibit locomotory behaviours when in the auction ring as a yearling, and (ii) the amount of time a foal spent pawing in the stable during that period

of separation the more likely it was to exhibit locomotory behaviours in the ring as a yearling.

5.4 Summary and Discussion

As with the foals discussed in Chapter 4, this study investigated whether or not a number of independent variables could be related to reactivity shown by thoroughbred yearlings during their experience of going through the auction ring. Tentative links were found with several of these variables though, once again, these links may be unreliable in some cases. The findings are discussed in the order in which they are presented above and many of the points raised in the previous chapter apply here too.

5.4.1 Age

As an animal gets older and, thereby, acquires more life experience, it is reasonable to assume that it will be better able to handle stress-invoking situations or stimuli. This, of course, will largely depend upon the type of life experience the animal has had and what lessons it has learned. When feeling threatened a prey animal will either show a flight or fight response or will respond according to what it has learned from life. As thoroughbred sales yearlings are typically intensively handled in the months leading up to their appearance in the auction ring, the relationship between the yearling and its regular handler also has the potential to affect how the animal responds in the auction ring. Assuming somewhat similar experiences during the preparation for the yearling sales - procedures and training methods do not vary much - then one would expect to see the older yearling producing fewer behavioural responses to the often stressful experience of going through the auction ring.

The Kruskal-Wallis test showed that locomotory behaviours ($\chi^2=20.84$; $df=5$; $p=.001$), freezing ($\chi^2=22.21$; $df=5$; $p<.001$) and the total reactivity score ($\chi^2=25.15$; $df=5$; $p<.001$) decreased with age. The amount of vocalisation also decreased with age (in months) and while this was not significant on the Kruskal-Wallis, there was a significant correlation between these two variables ($r_s=-.829$; $N=6$; $p<.05$). The correlational analysis also showed the strength of the linear relationship between decreasing age and the amount of locomotory behaviours ($r_s=-.943$; $N=6$; $p<.01$), freezing behaviours ($r_s=1.000$; $N=6$; $p<.001$)

and total reactivity ($r_s = -.943$; $N=6$; $p < .01$) shown. Locomotory and freezing behaviours represent part of the flight or fight response and, as such, could be reasonably expected to decrease as an animal gets older and gains more experience of being handled and being led. Learning to trust the judgement of another takes time and a horse that will allow itself to be led across, around or through an obstacle or situation that it finds uncomfortable showing that it has learned to trust the judgement of either this particular handler or human handlers in general.

While the amount of vocalisation and the total amount of reactivity shown in the ring increased with age in foals (Chapter 4), these decreased with age in the yearlings. The decrease in the overall reactivity score in the yearlings is a reflection of the degree to which three of the six behavioural categories showed a decrease. The decrease in vocalisation, however, is a reflection of the increasing maturity and independence of the animals. Horses whinny when separated from conspecifics (McDonnell, 2003) and it tends to increase in both volume and quantity when the animal is highly motivated (Fraser, 1992). The thoroughbred sales yearling has been weaned for over a year, has had its own individual stable for quite some time, may have changed ownership (and hence stable yard) at least once previously, and has, therefore, learned to be more independent. As a result, one would expect to see the amount of vocalisation in the auction ring decrease.

5.4.2 Gender

While there was no significant gender difference in the total amount of reactivity shown in the auction ring, there were differences in how the genders scored in the emotionality ($\chi^2=36.67$; $df=2$; $p < .001$), freezing ($\chi^2=38.78$; $df=2$; $p < .001$) and escape ($\chi^2=13.72$; $df=2$; $p < .01$) categories. Geldings had a higher mean rank score than colts or fillies in both the freezing and escape categories, indicating that they were the gender most likely to exhibit these behaviours. As 294 of the geldings represented the national hunt sector, these results may reflect the differences between flat and national hunt bred horses, which had been shown earlier to have a significantly higher amount of freezing ($z=-9.03$; $p < .001$) and escape behaviours ($z=-4.86$; $p < .001$) than was shown in the flat yearlings. The issues relating to management for moderate

to rapid growth, which represents a considerable difference between the flat and national hunt breeding industries, have been discussed in section 4.4.4.

In the case of emotionality, colts had the highest mean rank score. As 1198 of the colts represented the flat sector, this apparent gender difference again could reflect the difference found between the two sectors ($\chi^2=12.37$; $df=2$; $p<.01$). Defecating and sweating are often seen as a stress response in animals though colts are also known to defecate as an indication that they were present at this location. Horses have an excellent sense of smell and learn a great deal about who has been where and what sort of emotional state they were in at the time through the scents left behind. An attendant clears away the solid droppings left in the ring by each horse but, as McGreevy (2000) noted, “smells can also speak of recent fear and exertion” (p.59). It is not known how many yearlings may have been affected by smells left behind by previous occupants of the ring.

5.4.3 Coat Colour

Though Keeler (1947, p.271) stated that “light-skinned horses, such as the Palomino or Pinto, are gentle; dark-skinned chestnuts are unruly” there is no real evidence of coat colour being related to temperament in horses. For example, Mills *et al.* (2002) found no relationship between coat colour and stereotypic behaviours in thoroughbreds. With the exception of a handful of white thoroughbreds, all members of the breed are dark-skinned. Though some people mistakenly call pale grey horses white, these animals are grey - they were born with a dark coat, or as often happens a bay or chestnut coat that changed colour. All foals' coats change over the first few months of life, but usually to just a darker shade of their foal coat colour - a grey parent can result in that coat colour changing to grey but these foals can usually be identified from birth as they will typically have grey hairs around their muzzle or eyes. Even superstar steeplechaser Desert Orchid, whose coat was snow white when he started his chasing career, was born with a dark coat. In fact he looked almost black when he was a young horse. The distinguishing feature between greys and whites is the colour of their skin: greys have black skin, just like chestnuts, bay/browns and blacks, while white horses have pink skin.

Although coat colour was not found to have any relationship to either scores or whether or not foals showed behaviours in any of the six categories, one significant result was found with the yearlings. This was that a greater than expected proportion of flat-bred greys ($N=69$; $p<.01$) exhibited freezing behaviours while in the auction ring. Though no reason could be found to explain why a significantly greater than expected proportion of grey flat-bred yearlings would show at least one freezing behaviour, it seems unlikely that having this coat colour could really have an impact on whether or not a horse exhibits this particular behaviour. No relationship was found in flat-bred foals though the proportion of such foals (6 out of 37) who froze at least once was similar (16.2% compared to the overall proportion of 19.5%) to that of the yearlings. Caution is therefore warranted as to claim greys are more reactive than yearlings of other colours could be to commit a Type I error.

5.4.4 Flat - v - National Hunt

Horses being aimed at the flat market are bred and reared to be more precocious than those being aimed at the national hunt market. This is particularly evident, to the naked eye, when observing sales yearlings in both categories. Those in the flat market tend to be more physically developed and to look more like two-year-olds than yearlings. Those on offer at national hunt markets, on the other hand, often look like young yearlings and some of them still have their distinctive foal's tail. Auctioneers' comments from the rostrum with regard to how the animal looks for its foaling date also tend to differ with national hunt yearlings who look physically immature often being described as 'good for his date' when a flat yearling of the same age would be passed over as 'backward' if seeming to be at a similar stage of its development. The physical risks involved in managing for rapid growth have been discussed in section 4.4.4 above, while the findings for each yearling group and the differences between the two sectors have been discussed in 5.4.1 and 5.4.2 above.

5.4.5 Sires and Paternal Grandsires of Flat-bred yearlings

Wolff, Hausberger and Le Scolan (1997) and Wolff and Hausberger (1994) found evidence of inheritance of temperamental traits through the sire though these studies were performed with small numbers, thereby making it difficult to draw any real conclusions. Houpt and Kusunose (2000), on the other

hand, reported on behavioural responses of 9644 thoroughbreds split between two major training centres in Japan where it was found that there was a significant correlation between how the progeny of the 62 stallions who were represented by animals in both centres behaved on the three handling tests. However, as three-quarters of the whole sample achieved maximum marks across these tests, consistency in the results of progeny of different sires may just as easily reflect an overall breed consistency rather than the specific input of these sires.

A total of 21 of the 77 individual stallions, who had ten or more yearlings represented by auction ring yearlings, had a greater than expected proportion of their yearlings scoring either 0 or 1 on at least one of the six categories. Seven of these had 20 or more representatives. Fourteen of the 32 paternal grandsires, with ten or more yearlings assessed and who had at least two stallion sons each of which had at least two yearlings scored, had a greater than expected proportion of their descendents scoring 0 or 1 on at least one of the six categories. Two of these had more than 100 representatives. While these results suggest that progeny or descendents of some stallions are more likely than those representing others to exhibit certain types of behaviours in the auction ring, or not to exhibit them, there are, as discussed in Chapter 4, some points of caution that must be mentioned.

As before, the question of representative samples is important. Many thoroughbred stallions sire between 50 and 200 foals every year, not all of which will end up in an auction ring. Indeed with the more expensive stallions it is quite likely that the majority of his representatives will be bred by private breeders and, hence, will not appear in an auction ring until a later age, if at all. A more important consideration may be the need to apply stringency to the significance levels. As before (Chapter 4) this can be done by dividing .05 by the number of tests performed. For flat-bred yearlings, on which there were 462 binomial tests performed, this would mean that in order for a result to be significant at the 5% level the p-value would actually have to be $p < .0001$. This would eliminate all individual stallions from consideration. For the paternal grandsires one would have to divide .05 by 192, thereby requiring a p-value of $p < .0003$ to be significant at the 5% level. This would mean that the only significant findings were that yearlings by sons of

Machiavellian (N=38) were more likely to whinny in the ring while a greater than expected proportion of those by sons of Sadler's Wells (N=169) exhibited at least one defensive behaviour.

A paternal grandsire may owe his position on Table 5.6 to the results of just one of his sons and while no stallion son of Sadler's Wells, with ten or more representatives, had a greater than expected proportion of his progeny scoring 0 or 1 in the defensive category, Machiavellian's sons Almutawakel (N=13; $p<.01$) and Vettori (N=21; $p<.05$) both had a greater than expected proportion of their yearlings whinnying at least once while in the auction ring. While these two stallions are responsible for their sire's result in the paternal grandsire category, it is interesting that Machiavellian himself, as an individual sire, had a greater than expected proportion of his own yearlings (N=31) who whinnied in the ring. Indeed it is this result that sees his sire Mr Prospector (N=60) with a greater than expected proportion of his descendents whinnying.

These considerations aside, allowing for 5% of results obtained to have been significant by chance (see 5.3.4.1 above) it is possible that to accept most of the significant results found in this section would be to commit a Type I error. This calculation showed that, based on the number of binomial tests performed, one would expect about 23 significant results from the individual sires and 10 from the paternal grandsires to have occurred by chance. The actual numbers were, respectively, 20 and 16. Of course the opposite is also potentially true, that no results have been found where there should in fact significant findings and, hence, a Type II error is committed.

Published evidence (e.g. Houpt & Kusunose, 2000; Wolff, Hausberger & Le Scolan, 1997; Wolff & Hausberger, 1994) and a considerable amount of anecdotal evidence suggest that some temperamental traits are passed on by stallions, and while the evidence presented here suggests caution in drawing similar conclusions in relation to behavioural reactivity shown by young thoroughbreds in the auction ring, it would probably be unwise to dismiss the possibility. Further investigation is warranted.

5.4.6 Sires and Paternal Grandsires of National hunt-bred yearlings

Only six of the 12 individual stallions, who had ten or more of their yearlings assessed, had a greater than expected proportion of their stock scoring either 0 or 1 in any of the behavioural categories. Only two of these had 20 or more representatives. Of the paternal grandsires only two of the six who had at least ten representatives and at least two stallion sons that had, in turn, at least two of their yearlings assessed, had a greater than expected proportion scoring either 0 or 1 in any of the categories. Numbers in all cases were very small, particularly when it is considered that some of these stallions sire between 100 and 300 foals a year. There is the obvious question with regard to how representative of the stallions the assessed animals truly are.

Calculating the expected number of potential falsely significant results from the binomial tests suggested that one would expect to see four for the individual sires and two for the paternal grandsires and with six and two, respectively, it appears likely that in reality no stallion was a factor in how national hunt yearlings responded in the ring, particularly as seven of these results had been only just significant at the 5% level. By applying the more stringent significance level described above, it would have been necessary for an individual sire to produce a p-value of $p < .007$ and a paternal grandsire to produce a p-value of $p < .002$ in order to have been significant at the 5% level. No stallion met this criterion.

5.4.7 Broodmare Sires of Flat and National hunt-bred yearlings

Of the 53 broodmare sires who had ten or more representatives amongst the flat-bred yearlings, only 11 had a greater than expected proportion of their descendents scoring either 0 or 1 in any of the six behavioural categories. The numbers involved were very small in all cases with only one stallion represented by 20 or more yearlings. Only one of the seven national hunt broodmare sires had a greater than expected proportion of his representatives scoring 0 or 1 in any of the six categories. Once again the numbers involved were very small, though this single broodmare sire was noted in three of the six categories. If the more stringent significance level was applied as described above, then flat broodmare sires would have had to produce a p-value of $p < .0003$ to be significant at the 5% level whereas national hunt broodmare sires would have needed a p-value of $p < .002$. No broodmare sire,

in either category, met this criterion. Additionally, given the number of binomial tests performed, one could have expected to find about seven false positives with the flat broodmare sires and two with the national hunt broodmare sires. The number of significant results found were, respectively, 11 and three. On the balance of the evidence, therefore, it would appear unlikely that the broodmare sire, of either flat or national hunt yearlings, is a factor in how they respond to being in the auction ring.

5.4.8 Female and 'male' families

Lowe (1895) classified families by a figure system based on the number of pre-1890 classic winners that came from each female line (see Chapter 2 for details). Though the usefulness of this system as a predictor of racing or broodmare merit was considered debatable within 50 years of its creation (Miller, 1939), the system has been used by some breeders to the current day. There does not appear to have been any research done, however, to determine whether or not the figure system actually has any merit or value. If traits, such as racing ability, can be linked to this system then it is possible that other traits may also be inheritable. However, the results in this study, and the similar one reported in Chapter 4, do not provide any reliable evidence of this.

Two female families and four 'male' families produced a significant result on a single behavioural category. The 'male' families, of course, are the stallions who come from a particular female family. However, given the number of binomial tests performed it could have been expected that eight results for female families and seven for 'male' families would be significant at the 5% level by chance. Additionally, if applying a more stringent significance level, as described above, then a female family would have to produce a p-value of $p < .0003$ to be significant at the 5% level while a 'male' family would have to produce a p-value of $p < .0004$. No female family met this criterion. While it was found that a greater than expected proportion of yearlings by stallions from Family 5 vocalised in the ring ($N=79$; $p < .001$), it is not known if this result would remain significant at the more stringent level as *SPSS 11.0* only reports p-values to three decimal places.

Taking a closer look at the Family 5 result one finds that of the 11 stallions representing this Family, the two with the greatest number of representatives were Sadler's Wells ($n=30$; $p<.01$) and Vettori ($n=21$; $p<.05$) and both of these horses had a greater than expected proportion of their yearlings who vocalised at least once in the auction ring. As only two of the other stallions in the Family had more than three yearlings in the sample there is the possibility that this may indeed reflect a tendency for yearlings by other stallions from this family to exhibit this behaviour. However, it should be noted that 'male' Family 5 did not produce a significant result with its foals (Chapter 4).

The more likely answer, and the more prudent conclusion, is that neither the female family from which a yearling comes nor the family from which its sire comes is a factor in how the animal will behave in the auction ring.

5.4.9 Pedigree Diversity Scores (PDS)

As noted in Chapter 4, inbreeding to animals thought to be influential is often seen as a way to maximize the chance of producing a high-class racehorse. There has not, however, been any research done to determine whether or not there is any basis in fact for this approach. Inbreeding research tends to focus on aspects such as morphological traits, fertility and meat quality and behavioural measures are sometimes linked to these (e.g. Zechner *et al.*, 2002; Burrow, 1998; Ecranbrack & Knight, 1993; MacNeil *et al.*, 1989; Dinkel *et al.*, 1972). The inbreeding coefficient is generally used in these types of studies but, as explained in Chapter 2 above, use of Wright's coefficient of inbreeding is inappropriate for use in the study of thoroughbred horses. This is why inbreeding was investigated in terms of a Pedigree Diversity Score (PDS) for the purposes of this thesis.

Expressing the amount of inbreeding, within the first five and four generations of the pedigrees of each of the flat-bred yearlings, in terms of a this PDS found three significant results. Freezing behaviours ($r_s=-.609$; $N=12$; $p<.05$) increased as a five-generation pedigree became more inbred while both freezing behaviours ($r_s=-.900$; $N=5$; $p<.05$) and signs of emotionality ($r_s=-.900$; $N=5$; $p<.05$) increased as a four-generation pedigree became more inbred.

As noted in section 4.4.9 above, there is a popular perception that the more inbred an animal is, the more 'highly strung' he will be (but see section 6.4.5 in the next chapter). While freezing behaviours were not found to be related to the amount of inbreeding in foals (Chapter 4), two of the other types of fight or flight responses, namely defensive and escape behaviours, had been found to increase as the amount of inbreeding increased. Those results combined with those from the yearlings would suggest that although the type of behaviour young thoroughbreds exhibit in this often-stressful setting differ in terms of specific responses shown, it does appear that, overall, the more inbred the animal the more likely it is to display some form of the fight or flight response. Further research is warranted but it may be that certain levels of inbreeding may reduce the animal's ability to apply what it has learned to times of stress, thereby allowing some of its innate tendency to fight or flee to come to the surface.

Showing signs of emotionality, that is defecating and/or sweating, was also related to increasing levels of inbreeding within the first four generations of a pedigree. If increased inbreeding does, as popularly suggested, make an animal more 'highly strung' then this would also be reflected in increased physiological arousal. Defecating and sweating were the only measures of physiological arousal recorded here as the nature of the auction ring setting and the numbers of animals involved made it impractical to apply any other methods, such as taking cortisol readings or using heart rate monitors. Setting up an experiment whereby cortisol or heart rate readings could be taken from young thoroughbreds going through the auction ring would represent a considerable project as it would involve the cooperation of a lot of people within the bloodstock industry and would need to be carried out during a genuine auction session rather than as an experiment set up on the premises for an afternoon. Going through the ring is just the culmination of a day, or several days, of stimuli or stressors that the entire experience of going to the sales presents.

5.4.10 Horses scored as a foal and as a yearling

Visser *et al.* (2001) found significantly high correlations between the behavioural responses of 41 Dutch Warmblood foals on two trials at a handling test and all but two items in a novel object test. The handling test

involved being led across a bridge; the novel object test consisted of an open umbrella being lowered from the ceiling. First exposure to the two tests was at nine months and the second at ten months of age. However, when the animals were given the same tests at ages 21 and 22 months, only the 'flightiness' response proved to be consistent.

The study presented in this chapter, however, found a significant linear relationship between foal and yearling scores ($r=.238$; $N=407$; $p<.001$), when outliers were removed, and that more than three-quarters of the yearlings scored within ± 5 of what they had done as a foal. This would suggest that this form of assessment, that is recording behavioural responses to being in the auction ring, does tap into some underlying temperamental trait with the wider variation in scores most likely to reflect the influence of situational factors that may produce a temporary effect. If this is the case then applying this method of assessment to investigation of a young horse's reactive nature would clearly need to be done on more than one occasion, preferably with a gap of at least several months between testing sessions so as to minimise any practice or learning effects.

While further data collection would be necessary to determine the stability of the percentages outlined above, the difference in test scores would provide an indication of reliability. The nature of the reactivity shown, that is whether it is classed as 'fear' or 'good spirits' or 'bad temper', can be largely interpreted from *how* the animal displays the various behaviours, for example, with ears pricked or pinned back, fluid movement or rigid stance, etc. There is, of course, an issue of whether or not specific behaviours can be equated to each other. For example, do three whinnies and two incidences of breaking into a trot shown as a foal equate to three bucks and two kicks given as a yearling? This will depend on the purpose of the scoring. The total reactivity score consists of the total *number* of behavioural reactions shown by the animal in the ring rather than a numerical expression of the amount of stress the animal was under. If the number of responses shown, or whether or not an animal showed any behavioural response within any of the categories, are the items of interest then a total of five responses as a foal is similar to a total of five responses as a yearling, even if the type of responses differ.

Another point of interest was that there was a significant relationship between age and the change in reactivity score ($r_s=.15$; $N=438$; $p<.01$), that is between the score obtained as a foal and the score obtained as a yearling. The mean ranks suggested that the greatest change in score occurs in yearlings aged from 19 to 21 months while the least change occurs in yearlings aged from 15 to 18 months. This appears to be an artefact of the earlier finding (section 5.3.2) that vocalisation ($r_s=-.829$; $N=6$; $p<.05$), freezing behaviours ($r_s=-.943$; $N=6$; $p<.01$), locomotory behaviours ($r_s=-.943$; $N=6$; $p<.01$), and total reactivity score ($r_s=-.943$; $N=6$; $p<.01$) decrease with age. This is related to maturity.

5.4.11 Separation study animals

Only 13 of the 57 animals who had been observed in the separation study (Chapter 3) were available for assessment as yearlings in the auction ring. Even so three measures from the initial study were found to be significantly related to four categories scored in the auction ring.

The more close together a horse's whinnies are the greater is its motivation to communicate with another of its kind, to reduce its sense of isolation. In the auction ring, as yearlings, it was found that for the 13 animals that were assessed in both studies, the less frequently they had vocalised in the stable, the more likely they were to exhibit escape behaviours ($r_s=.559$; $N=13$; $p<.05$) in the auction ring. There does not appear to be any logical reason why these two variables should be related in this way and it may be that the small numbers of subjects involved, combined with the number of correlations performed and the fact that escape behaviours were not related to vocalisation when the 13 were split into the 'accompanied' and 'isolated' groups, led to a false positive.

During the separation study the foals in the 'accompanied' group had a greater interval between their whinnies than those in the 'isolated' group ($z=3.88$; $p<.001$). This was presumably because they were not totally alone during their time of stress - the observer was in the stable with them. In the auction ring it was found that the less frequently the 'accompanied' group had vocalised in the stable, the more likely they were to vocalise ($r_s=.880$; $N=6$; $p<.05$) in the ring but the less likely they were to defecate or sweat ($r_s=-.845$; $N=6$; $p<.05$). As yearlings are accompanied by a handler while in the auction

ring one might have presumed that these animals, having demonstrated the tendency before, would be less likely to vocalise while in the ring.

The motivation for the whinnying, however, is different between the two situations. In the original study the animal was very young and as it had not yet been weaned it was still totally dependent upon its mother. Its cries were for her and were presumably out of a sense of loss, abandonment and fear - a young prey animal on its own is an easy target. The presence of a handler during this time was a source of some comfort for many of these foals - they were not totally isolated and hence the threat was reduced. The fear or stress reactions of horses going through the auction ring are more an indication of fear of the unknown, or neophobia, and if there is not a sufficient degree of trust in the handler leading them into and around this strange environment, the animal will be highly motivated to reach out to others of its kind. The decreased likelihood of these animals either defecating or sweating while in the ring may be further evidence of the different level or kind of stress these situations generate - the yearlings were more likely to call out to conspecifics but less likely to show signs of physiological arousal.

Pacing or moving around the stable during a time of stress is a form of displacement behaviour and it was found that the greater the percentage of time those from the 'isolated' group had spent pacing or moving about the stable during the period of separation, the more locomotory behaviours ($r_s=.954$; $N=7$; $p=.001$) they subsequently showed in the auction ring as a yearling. This is part of the flight response - a prey animal on the move is harder to catch than one who remains motionless. With such a high correlation between the two events, one could speculate that these animals who choose locomotion as a way of dealing with stress may be candidates for subsequent development of locomotory stereotypic behaviours. They may also be more likely than others to bolt on the way to the start of a race or to fail to settle and relax during the early stages of the contest thereby expending valuable energy and reducing their chances of being successful as racehorses.

In the case of the 'accompanied' group it was found that the more time they had spent pacing or moving about in the stable during the separation period, the less likely they were to vocalise ($r_s=-.941$; $N=6$; $p<.01$) in the auction ring

but the more likely they were to either sweat or defecate ($r_s=.845$; $N=6$; $p<.05$) while there. Vocalising is hard to do while on the move but, again, the motivation behind vocalising and pacing or moving about is very different. As a displacement behaviour pacing or moving about the stable is a sign of frustration; performance of a desired behavioural response is being thwarted. In the case of the foals in the separation study this desire was to follow their mother; being locked into a stable prevented this. Vocalisation in the ring is less likely to occur if the animal's main motivations at the time do not include the need to seek out the presence of conspecifics. As the greater the time they spent pacing in the stable was related to the more signs of emotionality that they showed in the auction ring it appears that these yearlings were experiencing some physiological arousal when in the ring but not showing any behavioural signs of this. With such small numbers of subjects involved further research is needed but it is possible that these yearlings have learned that a human handler can be trusted during a time of uncertainty.

Pawing is a displacement behaviour and a sign of frustration in horses and it was found that, in those from the 'accompanied' group, the amount of time they had spent engaged in this behaviour during the period of separation, the greater the amount of freezing ($r_s=.880$; $N=6$; $p<.05$) or escape behaviours ($r_s=.898$; $N=6$; $p<.05$) they showed while in the auction ring as yearlings. These behaviours typically represent the flight response but perhaps the motivation behind their freezing and escape behaviours was to get away from what was a frustrating or annoying environment. The auction ring is noisy, brightly lit and surrounded by people. This may also be the case with those from the 'isolated' group. Their pawing in the stable was related to the amount of locomotory behaviours ($r_s=.932$; $N=7$; $p<.01$) shown and, again, the motivation may have been to get away from an annoyance.

Overall the number of subjects involved was very small and it is much easier to find significant correlations when the value of N is small. With this in mind, combined with the findings from Seaman *et al.* (2002), which indicated that horses vary widely in how they respond to artificial behavioural tests, caution is advised when trying to interpret the results discussed above. Also the number of correlations performed was sufficient that one would expect to find several results that were significant at the 5% level by chance. When the

13 yearlings were examined together, for example, the number of tests performed suggested that one could expect three results to be significant at the 5% level by chance: just two were found to be significant. Similarly four significant results were found with the 'isolated' group where three could have been expected by chance. As there were ten results found amongst the 'accompanied' group, again where three could have been expected by chance, the findings from these animals may be the most reliable, even though there were just six subjects involved.

Of the pair who had also been assessed in the auction ring as a foal, it was notable that neither was amongst the 75% who had scored within a range of ± 5 . Subject C07/G646/G1325 had produced a total reactivity score of 12 as a foal but only 1 as a yearling, thereby placing him amongst the 5.7% whose difference was greater than 10. The other colt, subject C17/T493/G1282 had scored 3 as a foal but 10 as a yearling, placing him amongst 4.4% with a ± 7 difference.

With only two subjects one cannot draw any reliable conclusions but one possible explanation for the individual responses of these colts is that the first named, whose auction ring experiences were both in the same venue, may have recognised his surroundings and been calmed by this. The other colt had his first experience in a larger, more brightly lit arena than he had his second auction ring experience and this may have been a factor.

5.5 Conclusions

While age and gender, and possibly having a grey coat, seem to be factors in the amount of reactivity thoroughbred yearlings show in the auction ring, the differences found between the flat and national hunt divisions suggest that husbandry practices may also be involved. Prior experience of the auction ring, as a foal, did not result in a difference between how these animals responded as yearlings compared to all other yearlings assessed, other than to whinny less, though one could not rule out the possibility that it may have been an important factor for some of the animals.

There is, as there was with the foals, some tentative evidence to suggest that sire or paternal grandsire may be a factor in some cases though application of

more stringent significance levels throws this into doubt. With quite a lot of anecdotal evidence typically claimed to support inheritance of temperamental traits in thoroughbreds, it would be perhaps unwise to dismiss the possibility based on the findings of this study.

There is some evidence to suggest that employing the assessment method, described here, for measuring reactivity in the auction ring may have value as a tool for assessing part of a young thoroughbred's underlying temperament though further research on this would be advisable.

Finally, as was found with the auction foals, reactivity shown in the ring as a yearling appears to be related to how the animals reacted to the separation from their dam during covering, with differences found between how those from the 'accompanied' and 'isolated' groups responded. With very small numbers involved in this particular part of the investigation, however, caution in the interpretation the results is advised.

Chapter 6: Horses-in-Training

Temperament Questionnaire

6.1 Introduction

Momozawa *et al.* (2003) note that while there are no methods considered to be standard in assessing temperament in horses, there are two that are commonly applied: (i) analysing behavioural reactions to stimuli and (ii) getting handlers to complete a temperament questionnaire. Both present some difficulty in terms of reliability. Tests used to elicit behavioural reactions tend to involve some degree of stress, for example having a falling open umbrella suddenly appear or, as Momozawa *et al.* (2003) used, balloons rotating while suspended from the ceiling. Some writers, however, caution against relying on behavioural indicators of stress. As Rushen (2000) states, these responses are often difficult to interpret. Is the horse that jumps back from the umbrella one who is highly reactive and will respond in a similar way to other stimuli? Or was it just a momentary startle response, a transient reaction that any one of us may have shown in similar circumstances?

Seaman *et al.* (2002) used three typical behavioural response tests - an arena test, respond to person test and respond to object test - with a group of 33 horses and found that there was no relationship between how the animals responded in one test compared to how they responded in another even though there was consistency in how they responded to repeated trials on one of the individual tests, namely the arena test. Each test had been repeated three times with an average of nine days between each trial. They concluded that it was not possible to classify any of the horses as being either 'active' copers or 'passive' copers, that horses vary widely in how they respond to artificial behavioural tests, and that only an open field test appears to be useful in identifying core temperament traits in a horse.

The problems with temperament questionnaires vary. The fact that the responses given on the questionnaire are the subjective interpretations of the animal's behaviour by the handler and, therefore, may be coloured by prejudices about colour, gender, age or breed, for example, or may reflect the mood of the assessor or the current state of relations between handler and

animal, are just a few of the difficulties. Another is the question of honesty. A handler may not wish to paint his charge in a negative light or to indicate that it has behavioural problems, such as stereotypies. This may be particularly true in the case of thoroughbreds whose future sale value may be adversely affected if problems exist - stereotypies must be declared at auction.

Momozawa *et al.* (2003) had handlers rate the temperament of horses (N=86) with which they were familiar and then tested the reliability of the assessment by analysing the three factors that emerged - 'anxiety', 'novelty seeking' and 'understanding' - in relation to the behavioural responses of the animals on a reactivity test. Defecation and greater heart rate increases during the test were found to be related to 'anxiety' on the temperament questionnaire. The 17 items on their questionnaire were all on scales and included terms such as 'playfulness', 'curiosity', 'friendliness', 'nervousness' and 'excitability' but did not include any stereotypies or many 'problem' behaviours.

Like that of Momozawa *et al.* (2003) and others, the present study sought to determine whether or not there was a link between how handlers assessed the temperament of the horses in their care and how the animals had responded in behavioural response tests. The major difference between this study and those reported in the literature, however, is that the behavioural response tests were not artificial ones - they recorded the reactions of the horses to real life situations as they happened. Additionally, the temperament questionnaire was completed many months after the animal's behavioural reactions had been assessed and by handlers who almost certainly had no knowledge of the animals before they arrived in the yards for training.

6.2 Methods and Procedures

6.2.1 Design

A questionnaire based study requiring the handlers of the subjects, now aged two (and a few from the separation study who were aged three) and in training as racehorses, to indicate which, if any, of a series of behavioural terms listed could be applied to the horse in their care.

6.2.2 Subjects

A total of 1558 horses of racing age, which had been scored in at least one of

the previous three studies, were tracked down. These were spread out amongst a total of 225 racing stables, 177 of which were located in the UK, 35 in Ireland and 13 in France. When questionnaires had been returned, this total was reduced to 395 horses (m=235; f=160). At least 23 of the males had been gelded since entering training. As the questionnaires were returned anonymously, it is not known which trainers replied, though only a handful of questionnaires was received from Irish or French yards.

6.2.3 Materials

Letters of information (Appendices 2 & 3) and a short questionnaire (Appendix 4) were designed. These were translated into French before being sent to the French stables (see Appendices 5, 6 & 7). The first letter served the purpose of explaining the purpose of the study and the questionnaire to the trainer, listed the subjects that were believed to be in training with him/her, and made the request that he/she give a copy of the questionnaire to each of the staff members with one of the target horses in their care. The voluntary nature of the participation of both the trainer and the yard staff was stressed, as was the issue of confidentiality. The second letter was very similar but directed at the handler whom, it was hoped, would complete the attached questionnaire. The voluntary nature of any participation, and the issue of confidentiality, were again stressed.

The questionnaire, presented in two parts, required the handler to give the name of the dam of the horse, so that the animal to which the document referred could be ascertained. It then required the handler to indicate whichever of the behavioural terms provided could be applied to the horse in their care. These were designed to give a picture of the temperament of each individual horse and they covered seven categories of behaviour.

The first part of the questionnaire consisted of three short scales relating directly to temperament. The first one measured excitability on a four-point scale ranging from laid-back to very excitable. The second was a three-point scale rating how friendly the animal was judged to be, while the third scale related to how often the horse whinnies. The second part of the questionnaire contained 22 items. These included the major stereotypic behaviours (cribbing, weaving, boxwalking and windsucking) and a number of behaviours

usually classified as 'problem' behaviours. These were bed-eating, rug-chewing, hay-dipping, pawing while eating, door/wall kicking, rushing into/out of the stable and frequently bucking or shying/ducking when ridden. Bucking or rearing when being saddled, rearing or raising the head while being bridled, biting/kicking when being saddled or brushed and pinning back the ears when approached were included as defensive behaviours. The items lazy worker and enthusiastic worker were included as indicators of work style.

6.2.4 Procedure

The 1558 horses in training were tracked down using Raceform's *Horses in Training 2004* book, auction ring returns for the 2003 yearling sales and 2004 two-year-olds in training sales, and early-season race entries. Letters of information, for both the trainer and the relevant yard staff, were sent to each racing stable that had at least one subject, along with a single questionnaire for each horse, to be completed by the handler responsible for its daily care. Each pack sent to trainers in Ireland and the UK included stamped addressed envelopes to facilitate the return of the completed questionnaires. As it was not possible to obtain French postage stamps, the packs sent to the 13 French trainers included envelopes with a return address only.

6.3 Results

6.3.1 General

All 395 (m=235; f=160) horses for which questionnaires were returned (25%) were flat-bred and 393 of them had been assessed at least once in the auction ring. The other two, both three-year-old fillies, had been previously only assessed in the separation study (Chapter 3). Only 5 (m=2; f=3) of the 395 had been subjects in that study, 235 (m=137; f=98) had been assessed in the auction ring only as a yearling (Chapter 5), 93 (m=55; f=38) had been scored in the auction ring only as a foal (Chapter 4), while 65 (m=43; f=22) had been assessed in the ring as both a foal and as a yearling (Chapter 5). All the males had been colts when previously assessed and while it is known that at least 23 of the 395 had been gelded in the interim, it is not known exactly how many geldings there were in total. Gender was omitted from the questionnaire. A small proportion of questionnaires returned did not have all the scales completed in part one. In some questionnaires work style was not indicated

because the horse was not yet at a stage of its training where it was cantering or galloping. A racehorse is only considered to be ‘in work’ when cantering and galloping are a part of its regimen.

6.3.2 Gender

Given the uncertainty over how many of the colts had been gelded, the genders were initially compared as just male (N=235) and female (N=160). The frequency with which each of the behaviours was indicated is shown in Table 6.1. The table also shows the number of males and females who showed each of the different behaviours and the percentage of males and females, for whom information on these behaviours was provided, who showed them.

Table 6.1: Frequencies (total and by gender) with which each of the 24 descriptions/ behaviours were marked on the questionnaires. Also shown are the total proportion and proportion of males and females that were described as showing each of these and results of the Mann Whitney (z) and chi-square tests. Chi-square tests were only performed in cases where the minimum expected count per cell was 5.

	N total	% of total	N male	N female	% male	% female	χ ²
excitability	393	99.5	235	158	59.8	40.2	(z = 1.16)
‘friendliness’	391	99.0	233	158	59.6	40.4	(z = .918)
vocalisation	345	87.3	200	145	58.0	42.0	20.64***
enthusiastic work style	363	91.9	212	151	58.4	41.6	4.73 ^a
stereotypies							
crib-biter	4	1.0	2	2	0.9	1.3	
windsucker	12	3.0	6	6	2.6	3.8	
boxwalker	9	2.3	7	2	3.0	1.3	
weaver	8	2.0	5	3	2.1	1.9	
‘problem’ behaviours							
eats bedding	18	4.6	13	5	5.5	3.1	1.27
chews rug	75	19.0	59	16	25.1	10.0	14.12***
paws when eating	56	14.2	37	19	15.7	11.9	1.17
kicks wall/door	37	9.4	20	17	8.5	10.6	.50
dips hay in water	11	2.8	5	6	2.1	3.8	
rushes out of stable	16	4.1	12	4	5.1	2.5	1.66
rushes into stable	9	2.3	5	4	2.1	2.5	
often bucks when ridden	53	13.4	34	19	14.5	11.9	.55
often shies/ducks when ridden	52	13.2	32	20	13.6	12.5	.10
defensive							
bucks being saddled	7	1.8	4	3	1.7	1.9	
rears being saddled	2	.5	1	1	0.4	0.6	
rears being bridled	1	.3	0	1	0.0	0.6	
raises head being bridled	45	11.4	27	18	11.5	11.3	.01
bites/kicks being saddled	42	10.6	31	11	13.2	6.9	4.00*
bites/kicks being brushed	69	17.5	45	24	19.1	15.0	1.14
pins back ears when approached	34	8.6	11	23	4.7	14.4	11.37** ^a

*p<.05; **p<.01; ***p<.001; ^a a greater proportion of females than males

A series of chi-square tests and Mann-Whitney tests was performed to see if there was a significant gender difference in any of these behaviours. With a total of 22 chi-square tests performed one would expect one result to be significant at the 5% level by chance. There were five significant results found and these are also indicated in Table 6.1 above.

It was found that females were more likely than males to pin back their ears when approached ($\chi^2=11.37$; $df=1$; $p=.001$) and to be enthusiastic workers ($\chi^2=4.73$; $df=1$; $p<.05$). Females were less likely than the males to be rated as a rug-chewer ($\chi^2=14.12$; $df=1$; $p<.001$), a frequent whinnier ($\chi^2=20.64$; $df=1$; $p<.001$), or to bite or kick while being saddled ($\chi^2=4.00$; $df=1$; $p<.05$).

Gender was then examined after splitting the males into colts ($N=212$) and geldings ($N=23$). Kruskal-Wallis tests were used to see if there was a relationship between gender and ratings on either the excitability or 'friendliness' scales. A series of Mann-Whitney and chi-square tests was then performed comparing colts to fillies. As the number of geldings who were identified as showing any of the behaviours was usually very small, binomial tests were used to compare colts to geldings and fillies to geldings. With a total of 22 chi-square tests performed one would expect one to be significant at the 5% level by chance. There were five significant results found. With a total of 44 binomial tests performed one could expect two to be significant at the 5% level by chance. There were nine significant results found. A summary of the results is presented in Table 6.2 below.

The Kruskal-Wallis tests showed no relationship between gender and ratings on either the excitability or 'friendliness' scales. The Mann-Whitney tests showed no difference between colts and fillies, colts and geldings, or fillies and geldings on either the excitability or 'friendliness' scales. The chi-square tests found that colts were more likely than fillies to be described as whinnying often ($\chi^2=21.24$; $df=1$; $p<.001$), as chewing their rug ($\chi^2=15.01$; $df=1$; $p<.001$) and of biting or kicking when being saddled ($\chi^2=4.92$; $df=1$; $p<.05$). They were less likely than fillies to pin their ears back when approached ($\chi^2=9.23$; $df=1$; $p<.01$) and of being an enthusiastic worker ($\chi^2=4.94$; $df=1$; $p<.05$).

Table 6.2: Results of the chi-square tests comparing colts to fillies, and the binomial tests comparing colts to geldings and fillies to geldings, on each of the 24 descriptions/behaviours. χ^2 values are only shown in cases where the minimum expected count per cell was 5.

	colts v fillies χ^2	colts v geldings p	fillies v geldings p
excitability			
'friendliness'			
vocalisation	21.24***		
enthusiastic work style	4.94*a		
stereotypies			
crib-biter			
windsucker		<.01 ^b	
boxwalker		<.01 ^b	<.01 ^b
weaver		<.05 ^b	
'problem' behaviours			
eats bedding	1.34		
chews rug	15.01***		
paws when eating	.80		
kicks wall/door	.75		
dips hay in water			
rushes out of stable	1.24		
rushes into stable			
often bucks when ridden	.15		<.05 ^b
often shies/ducks when ridden	.01		
defensive			
bucks being saddled			
rears being saddled			
rears being bridled			
raises head being bridled	.19	<.05	
bites/kicks being saddled	4.92*		
bites/kicks being brushed	2.34	<.01	<.05 ^a
pins back ears when approached	9.23***a		<.05 ^a

*p<.05; **p<.01; ***p<.001; a greater proportion of fillies; b greater proportion of geldings

The binomial tests found that geldings were more likely than colts to be a windsucker (p<.01), weaver (p<.05) or boxwalker (p<.01). They were less likely than colts to raise their heads when being bridled (p<.05) or to bite or kick while being brushed (p<.01). Geldings were also more likely than fillies to be a boxwalker (p<.01) and to buck frequently when ridden (p<.05). They were less likely than fillies to bite or kick while being brushed (p<.05) or to pin back their ears when approached (p<.05).

Within the categories of stereotypies, 'problem' behaviours and defensive behaviours, a single score of 0 or 1 was computed to indicate absence or presence of any behaviours within the category. A total score for each of these categories was also computed.

A Kruskal-Wallis test found that there was a significant gender difference in the total number of stereotypies ($\chi^2=21.20$; $df=2$; $p<.001$), problem behaviours ($\chi^2=7.09$; $df=2$; $p<.05$) and defensive behaviours ($\chi^2=9.85$; $df=2$; $p<.01$) reported in individual animals. The mean rank scores indicated that geldings were most likely than colts or fillies to have more stereotypies, geldings had the highest number of problem behaviours, while geldings showed fewer defensive behaviours than colts or fillies (Table 6.3). A chi-square test found that gender was also significantly related to whether or not any problem ($\chi^2=6.29$; $df=2$; $p<.05$) or defensive behaviours ($\chi^2=10.02$; $df=2$; $p<.01$) were reported. There were insufficient numbers to perform the chi-square on gender and presence or absence of stereotypic behaviours.

Table 6.3: Mean rank scores on the total number of stereotypies, problem behaviours and defensive behaviours reported, shown by gender (N=395). The results of the Kruskal-Wallis test are also shown.

gender	N	stereotypies	problem behaviours	defensive behaviours
colt	212	193.26	205.50	205.53
filly	160	197.58	182.95	196.29
gelding	23	244.57	233.61	140.54
	χ^2	21.20***	7.09*	9.85**

* $p<.05$; ** $p<.01$; *** $p<.001$

6.3.3 Coat colour

A series of chi-square tests were performed to see if there was a significant difference between bay/brown horses (N=308) and chestnuts (N=75) in the behaviours that were reported. With a total of 24 chi-square tests performed one could expect to see one result significant at the 5% level by chance. There was a single significant result; chestnuts were more likely than bay/browns to be reported as biting or kicking while being saddled ($\chi^2=5.21$; $df=1$; $p<.05$). As there were only 12 greys amongst the sample, binomial tests were used to see if they differed from either bay/brown horses or chestnuts on any of the behaviours. With a total of 48 binomial tests performed one could expect two to be significant at the 5% level by chance. There were no significant results found.

A Kruskal-Wallis test found that there was no significant coat colour difference in either the total number of stereotypic behaviours, total number of

'problem' behaviours or total number of defensive behaviours reported. There were insufficient numbers to perform the chi-square on coat colour and presence or absence of either stereotypic, 'problem' or defensive behaviours.

6.3.4 Sire / paternal grandsire / broodmare sire

6.3.4.1 Sire

There were a total of 136 individual stallions represented by the 395 horses in training but only two, Namid (N=19) and Spectrum (N=11), of these had 10 or more representatives. A series of binomial tests was performed to see if either of these stallions had a greater than expected proportion of their progeny reported as showing any of the behaviours or whether they had a greater than expected proportion of progeny who reportedly exhibited any of the stereotypic, 'problem' or defensive behaviours. For the excitability, 'friendliness', vocalisation and work style scales the binomial test was calculated using the proportion that scored above or below the median score on each scale. With a total of 54 binomial tests performed one could expect two or three to be significant at the 5% level by chance. There was a single significant result found: a greater than expected proportion of those by Namid were reported as showing at least one problem behaviour (N=19; $p<.05$).

6.3.4.2 Paternal Grandsire

There were a total of 71 paternal grandsires of whom 14 were represented by 10 or more yearlings and had at least two stallion sons that were responsible for at least two yearlings. A series of binomial tests was performed to see if any of these stallions had greater than expected proportions of their descendents reported as showing any of the behaviours or whether they had a greater than expected proportion who reportedly exhibited any of the stereotypic, 'problem' or defensive behaviours. For the excitability, 'friendliness', vocalisation and work style scales the binomial test was calculated using the proportion that scored above or below the median score on each scale. With a total of 378 binomial tests performed one could expect 19 results to be significant at the 5% level by chance. There were only 14 significant results found and they are presented in alphabetical order of paternal grandsires. The differing N-values for Indian Ridge are due to some details not being provided on the questionnaire for one of his representatives.

Chief's Crown had a greater than expected proportion of his descendents who raise their head while being bridled (N=11; $p<.05$) or buck when ridden ($p<.05$); Danzig had a greater than expected proportion of his representatives who scored at or below the median score on the excitability scale (N=18; $p<.05$) or who exhibited at least one defensive behaviour (N=18; $p<.05$); Darshaan had a greater than expected proportion of his representatives who rush into the stable (N=10; $p<.05$); Indian Ridge had a greater than expected proportion of his descendents who buck when ridden (N=25; $p<.05$) or who scored at or below the median score on the 'friendliness' scale (N=24; $p<.05$); Machiavellian had a greater than expected proportion of his descendents who pawed while eating (N=10; $p<.05$) or who windsuck (N=10; $p<.05$) and a greater than expected proportion of horses who exhibited a stereotypic behaviour (N=10; $p<.05$); Northern Dancer had a greater than expected proportion of his descendents who ate their bedding (N=15; $p<.05$), who often shy or duck when ridden (N=15; $p<.05$) and who exhibit a problem behaviour (N=15; $p<.05$); Nureyev had a greater than expected proportion of his representatives who often shy or duck away when being ridden (N=11; $p<.05$).

6.3.4.3 Broodmare Sire

There was a total of 229 individual broodmare sires represented amongst the 395 horses in training but only one of these, Persian Bold (N=10) had 10 or more representatives. A series of binomial tests was performed to see if a greater than expected proportion of this stallion's descendents were reported as showing any of the individual behaviours or any behaviours in the stereotypic, 'problem' or defensive categories. For the excitability, 'friendliness', vocalisation and work style scales the binomial test was calculated using the proportion that scored above or below the median score on each scale. With a total of 27 tests performed one could expect one result to be significant at the 5% level by chance. There were two significant results found. A greater than expected proportion of Persian Bold's descendents scored at or below the median on the 'friendliness' scale (N=10; $p<.05$) or were reported to be boxwalkers (N=10; $p<.05$).

6.3.5 Female family number / male family number

6.3.5.1 Female family number

There were 24 female families represented amongst the 395 horses in training though only 16 had 10 or more representatives. A series of binomial tests was performed to see if any of these families had a greater than expected proportion of their representatives reported as showing any of the individual behaviours or any behaviours in either the stereotypic, 'problem' or defensive categories. For the excitability, 'friendliness', vocalisation and work style scales the binomial test was calculated using the proportion that scored above or below the median score on each scale. With a total of 432 binomial tests performed one could expect to find 21 or 22 significant at the 5% level by chance. There were only seven significant results found.

A greater than expected proportion of those from Family 4 chew their rug (N=31; $p<.05$); a smaller than expected proportion of those from Family 5 scored at or below the median on the excitability scale (N=17; $p<.05$); a smaller than expected proportion of those from Family 10 scored at or below the median on the 'friendliness' scale (N=10; $p<.05$) while a greater than expected proportion of them windsuck (N=10; $p<.05$); a greater than expected proportion of those from Family 14 scored at or below the median score on the excitability scale (N=27; $p<.01$); a smaller than expected proportion of those from Family 16 scored at or below the median score on the excitability scale (N=21; $p<.05$); a greater than expected proportion of those from Family 19 paw when eating (N=10; $p<.05$).

6.3.5.2 Male family number

The male family number is the Bobinski number of the female line from which the stallions come. There were 23 'male' families represented amongst the 395 subjects of which 14 had 10 or more individuals amongst the horses in training with each number represented by at least two stallions that had two or more individuals to represent them. A series of binomial tests was performed to see if any of these families had a greater than expected proportion of their representatives reported as showing any of the individual behaviours or any behaviours in either the stereotypic, 'problem' or defensive categories. For the excitability, 'friendliness', vocalisation and work style scales the binomial test was calculated using the proportion that scored above

or below the median score on each scale. With a total of 378 binomial tests performed one could expect to find 19 results significant at the 5% level by chance. There were only ten significant results found.

A greater than expected proportion of those from Family 3 crib-bite ($N=25$; $p<.05$); a greater than expected proportion of those from Family 5 bite or kick while being brushed ($N=16$; $p<.05$) or windsuck ($N=16$; $p<.05$) or exhibit any stereotypic behaviour ($N=16$; $p<.05$); a greater than expected proportion of those from Family 8 dip their hay in water ($N=30$; $p<.05$); a smaller than expected proportion of those from Family 9 paw when eating ($N=46$; $p<.05$), while a greater than expected proportion raise their head while being bridled ($N=46$; $p<.01$) or boxwalk ($N=46$; $p<.01$); a smaller than expected proportion of those from Family 14 were described as being an enthusiastic worker ($N=27$; $p<.05$); a greater than expected proportion of those from Family 22 kick the door or wall ($N=10$; $p=.01$).

6.3.6 Pedigree Diversity Scores (PDS)

All 395 horses in training, for which a questionnaire was returned, were flat-bred. Therefore both a five-generation PDS and four-generation PDS was computed for each subject.

6.3.6.1 Five-generation pedigrees

Within five-generation pedigrees the range of different animals within any one pedigree was from 51 to 62 individuals. The mode value was 61, the median was 60 and the mean number of individuals in a pedigree was 59.47 (s.e.m.=.108). A total of 65 of the horses in training (16.5%) showed no inbreeding within five generations while a further 86 (21.8%) had only one duplication within those five generations.

As there were less than 10 horses with a PDS of 51, 52, 53 or 54 these were grouped together ($N=15$) before a correlation between PDS and the proportion of horses that were reported to exhibit any of the individual behaviours or any behaviours in the stereotypic, 'problem' or defensive categories could be calculated. For the excitability, 'friendliness', vocalisation and work style scales the correlation was calculated using the proportion that scored at or below the median score on each scale.

With a total of 27 correlations performed one could expect to find one or two results significant at the 5% level by chance. There were two significant results. The more inbred a pedigree the less likely a horse is to frequently shy or duck while being ridden ($N=9$; $r_s=.817$; $p<.01$) or to be reported as a boxwalker ($N=9$; $r_s=.771$; $p<.05$).

It was interesting, however, that no horse with a PDS of 56 or less ($N=38$), that is the 9.6% who were most inbred, was reported to dip their hay in water, rush into the stable, buck when being saddled, rear when being saddled, rear when being bridled, crib-bite, windsuck, boxwalk or weave.

6.3.6.2 Four-generation pedigrees

Within four-generation pedigrees the range of different animals within any one pedigree was from 25 to 30 individuals. The mode value was 30, the median was 30 and the mean number of individuals in a pedigree was 29.54 (s.e.m.=.037). A total of 256 of the horses in training (64.8%) showed no inbreeding within four generations while a further 111 (28.1%) had only one duplication within those four generations.

As there were less than 10 horses with a PDS of 25, 26 or 27 these were grouped together ($N=10$) before a correlation between PDS and the proportion of horses that were reported to exhibit any of the individual behaviours or any behaviours in the stereotypic, 'problem' or defensive categories could be calculated. For the excitability, 'friendliness', vocalisation and work style scales the correlation was calculated using the proportion that scored at or below the median score on each scale.

With a total of 27 correlations performed one could expect to find one or two results significant at the 5% level by chance. There was only one significant result: the more inbred a pedigree the more likely a horse was to frequently buck when ridden ($N=4$; $r_s=-1.000$; $p<.001$).

It was interesting, however, that no horse with a PDS of 25, 26, 27 or 28 ($N=28$), that is the 7% who were most inbred, was reported to dip their hay in water, rush into the stable, buck or rear when being saddled, rear when being bridled, crib-bite, windsuck, boxwalk or weave.

6.3.7 Horses assessed in the auction ring

A total of 393 (m=235; f=158) horses for which questionnaires had been returned had been scored in the auction ring (Chapters 4 & 5). The other two, both three-year-old fillies, had only previously been assessed in the separation study (Chapter 3).

6.3.7.1 Those assessed as foals

A total of 93 (m=55; f=38) subjects for whom questionnaires had been returned had been assessed in the auction ring as a foal. Of the males, seven were geldings. Of the 93 subjects, 65 were also later assessed in the ring as a yearling. To see if this group of 93 subjects differed from the overall group in terms of the proportions who were reported to exhibit any of the 24 descriptions/behaviours or to exhibit any behaviours in either the stereotypic, 'problem' or defensive categories, a series of binomial tests was performed. For the excitability, 'friendliness', vocalisation and work style scales the binomial test was calculated using the proportion that scored above or below the median score on each scale. With a total of 27 binomial tests one could expect one or two results to be significant at the 5% level by chance. There was a single significant result found: a smaller than expected proportion of the 93 who were assessed in the ring as foals were subsequently reported to buck frequently when ridden ($N=93$; $p<.01$).

In order to compare scores from the auction ring assessment with behaviours indicated on the questionnaires a number of tests were performed. These are described below.

(i) Excitability

As there were only six horses described as being very excitable, these were combined with those described as being fairly excitable. Kruskal-Wallis tests performed to see if there was a difference between total reactivity score or the total scores on any of the six behavioural categories in the ring and whether a horse was subsequently described as being either laid-back ($N=51$), a bit excitable ($N=26$) or fairly/very excitable ($N=16$) found that the excitability category was related to the amount of locomotory ($\chi^2=6.86$; $df=2$; $p<.05$) and freezing behaviours ($\chi^2=9.96$; $df=2$; $p<.01$) shown in the auction ring as a foal.

To see whether or not an animal showed any behaviours in any of the six categories used in Chapter 4, that is the recoded scores representing presence or absence of behaviour in a category, a Kruskal-Wallis test was performed using these recoded scores. It was found that excitability was related to whether or not any freezing behaviours ($\chi^2=10.29$; $df=2$; $p<.01$) were shown in the ring as a foal. The mean rank scores (laid-back = 44.65; bit excitable = 44.58; fairly/very excitable = 58.44) indicated that it was those who were described as being fairly/very excitable as horses in training were likely to have shown freezing behaviours in the auction ring as a foal.

(ii) 'Friendliness'

Kruskal-Wallis tests performed to see if there was a difference in total reactivity score or the total scores on any of the six behavioural categories in the ring depending upon whether a horse was subsequently described as being friendly (N=70), 'neither friendly nor unfriendly' (N=18) or unfriendly (N=3) found no significant results. As there were only three 'unfriendly' horses in the sample these were removed and a Mann-Whitney performed on the remaining two groups. No significant results were found. This scale was not completed on two questionnaires.

A Kruskal-Wallis test found no significant relationship between whether or not horses had exhibited any behaviours in any of the six behavioural categories as foals in the auction ring and whether they were subsequently described as being friendly, 'neither friendly nor unfriendly' or unfriendly. Performing a Mann-Whitney test on the same scores but leaving out the three unfriendly horses did not reveal a significant difference.

(iii) Vocalisations

A Mann-Whitney test to examine whether there was a relationship between the number of vocalisations emitted in the auction ring and whether a horse was subsequently described as one who either rarely whinnies (N=62) or often whinnies (N=15), found no significant difference between the two groups. There was also no significant relationship between whether or not they had vocalised at all in the ring and whether they were subsequently described as being either frequent or rare vocalisers while in training. The vocalisation scale had not been completed on 14 of the questionnaires.

(iv) Stereotypies / 'problem' / defensive behaviours

Total scores on the six behavioural categories and the total reactivity score from the auction ring were correlated with total scores in the stereotypies, 'problem' and defensive categories on the questionnaires and with the present/absent scores in each of those categories. With a total of 42 correlations performed one could expect two results to be significant at the 5% level by chance. There were five significant results. Total number of freezing behaviours ($r_s=.236$; $N=93$; $p<.05$) and escape behaviours ($r_s=.290$; $N=93$; $p<.01$) shown in the ring were related to whether or not defensive behaviours were reported on the questionnaire. The total number of freezing ($r_s=.207$; $N=93$; $p<.05$) and escape behaviours ($r_s=.271$; $N=93$; $p<.01$) in the ring were also related to the total amount of defensive behaviours reported in training. The total number of freezing behaviours ($r_s=.205$; $N=93$; $p<.05$) was related to whether or not any problem behaviours were reported on the questionnaire.

A series of correlations was then performed using the recoded scores, that is whether or not foals had exhibited any behaviours in the six behavioural categories. With 36 correlations performed one would expect one or two results to be significant at the 5% level by chance. There were four significant results found. Whether or not foals froze ($r_s=.226$; $N=93$; $p<.05$) or showed any escape behaviours ($r_s=.296$; $N=93$; $p<.01$) was related to whether or not they were reported as exhibiting any defensive behaviours when in training. Whether or not escape behaviours were shown in the ring was also related to the total number of defensive behaviours reported ($r_s=.275$; $N=93$; $p<.01$). Presence or absence of freezing behaviours in the ring was also related to whether or not problem behaviours were reported in training ($r_s=.205$; $N=93$; $p<.05$).

(v) Work style

Mann-Whitney tests performed to see if there was a difference between total reactivity score, the total scores on any of the six behavioural categories in the ring or whether or not a horse had shown any behaviours in those categories while in the auction ring, and whether a horse was subsequently described as being either a lazy ($N=18$) or enthusiastic worker ($N=66$) found no significant results. This scale was not completed on nine questionnaires.

6.3.7.2 Those assessed as yearlings

A total of 300 (m=180; f=120) subjects for whom questionnaires had been returned had been assessed in the auction ring as a yearling. Of the males 16 were geldings. To see if this group of 300 subjects differed from the overall group in terms of the proportions who were reported to exhibit any of the 24 descriptions / behaviours or to exhibit any behaviours in either the stereotypic, 'problem' or defensive categories, a series of binomial tests was performed. With a total of 27 binomial tests one could expect one or two results to be significant at the 5% level by chance. There were no significant differences found.

In order to compare scores from the auction ring assessment with behaviours indicated on the questionnaires a number of tests were performed. These are described below.

(i) Excitability

Kruskal-Wallis tests performed to see if there was a difference between total reactivity score, the total scores on any of the six behavioural categories in the ring or whether or not any behaviours in the categories had been shown, and whether a horse was subsequently described as being either laid-back (N=133), a bit excitable (N=101), fairly excitable (N=50) or very excitable (N=14) found no significant results. This scale was not completed on two questionnaires.

(ii) 'Friendliness'

Kruskal-Wallis tests performed to see if there was a difference between total reactivity score, the total scores on any of the six behavioural categories in the ring or whether or not any behaviours in the categories had been shown, and whether a horse was subsequently described as being friendly (N=206), 'neither friendly nor unfriendly' (N=74) or unfriendly (N=18) found no significant results. This scale was not completed on two questionnaires.

(iii) Vocalisations

A Mann-Whitney test to examine whether there was a difference between the number of vocalisations emitted in the auction ring and whether a horse was subsequently described as one who either rarely whinnies (N=211) or often

whinnies (N=56), found no significant difference between the two groups. This scale was not completed on 33 questionnaires.

A chi-square test found a significant relationship between whether or not horses had whinnied while in the auction ring and whether they were described as either rarely or often whinnying while in training ($\chi^2=5.87$; $df=1$; $p<.05$). A correlation ($r_s=.121$; $N=300$; $p<.05$) indicated that those who whinnied in the auction ring as yearlings were more likely to be subsequently described as a frequent whinnier than those who had not vocalised in the ring.

(iv) Stereotypies / 'problem' / defensive behaviours

Total scores on the six behavioural categories and the total reactivity score from the auction ring were correlated with total scores in the stereotypies, 'problem' and defensive categories on the questionnaires and with the present/absent scores in each of those categories. With a total of 42 correlations performed one could expect two results to be significant at the 5% level by chance. There were six significant results found. The higher the total reactivity score ($r_s=-.187$; $N=300$; $p=.001$), total number of defensive behaviours ($r_s=-.115$; $N=300$; $p<.05$) in the ring or the total number of locomotory behaviours ($r_s=-.168$; $N=300$; $p<.01$) in the ring as a yearling the fewer 'problem' behaviours reported while in training. Total reactivity score ($r_s=-.197$; $N=300$; $p=.001$), total number of defensive behaviours ($r_s=-.129$; $N=300$; $p<.05$) and total number of locomotory behaviours ($r_s=-.174$; $N=300$; $p<.01$) in the ring as a yearling were also related to a decreased likelihood of having any reported 'problem' behaviours while in training.

When the recoded scores on the six behavioural categories, recorded in the auction ring as yearlings, were correlated with the total scores in the stereotypies, 'problem' and defensive categories on the questionnaire and with whether or not any behaviours in those three categories were reported, eight significant results were found. With a total of 36 correlations performed one could expect two results to be significant at the 5% level by chance. The total number of problem behaviours reported was significantly related to horses that had vocalised ($r_s=-.154$; $N=300$; $p<.01$), shown any signs of emotionality ($r_s=-.125$; $N=300$; $p<.05$), shown any defensive behaviours ($r_s=-.115$; $N=300$;

$p < .05$) or exhibited any locomotory behaviours ($r_s = -.152$; $N = 300$; $p < .01$) while in the auction ring as a yearling.

Presence or absence of any problem behaviours reported in training was significantly related to whether or not the animals had vocalised ($r_s = -.167$; $N = 300$; $p < .01$), showed any signs of emotionality ($r_s = -.125$; $N = 300$; $p < .05$), showed any defensive behaviours ($r_s = -.129$; $N = 300$; $p < .05$) or exhibited any locomotory behaviours ($r_s = -.161$; $N = 300$; $p < .01$) while in the auction ring as a yearling.

(v) Work style

Mann-Whitney tests were used to see if there was a difference between total reactivity score or the total scores on any of the six behavioural categories in the ring and whether a horse was subsequently described as being either a lazy ($N = 73$) or enthusiastic ($N = 204$) worker. No significant differences were found. This scale was not completed on 23 questionnaires. Mann-Whitney tests found that whether or not horses had exhibited any behaviours in any of the six categories while in the auction ring was not related to whether they were subsequently as being lazy or enthusiastic in their work.

6.3.7.3 Those assessed as both a foal and yearling

A total of 65 ($m = 43$; $f = 22$) subjects for whom questionnaires had been returned has been assessed in the auction ring both as a foal and as a yearling. Of the males four were geldings. To see if this group of subjects differed from the overall group in terms of the proportions who were reported to exhibit any of the 24 descriptions/behaviours or to exhibit any behaviours in either the stereotypic, 'problem' or defensive categories, a series of binomial tests was performed. With a total of 27 binomial tests one could expect one or two results to be significant at the 5% level by chance. There were no significant results.

Of the 65 two-year-olds, 35 had shown a decrease in their total reactivity score as a yearling in the auction ring from what they had scored as a foal (range=1-14; mean=4.26; s.e.m.=.56). Seven had shown no change in total while 23 had shown an increase in their total reactivity score (range=1-17; mean=3.65; s.e.m.=.81).

Correlations between the differences between foal and yearling reactivity scores and excitability, 'friendliness', vocalisation, presence or number of stereotypies, presence or number of 'problem' behaviours, presence or number of defensive behaviours and whether a horse in training was described as being a lazy or enthusiastic worker found that this difference was related to the frequency with which a horse in training vocalised ($r_s = -.286$; $N=62$; $p < .05$), whether or not it was reported as showing any of the problem behaviours ($r_s = .336$; $N=65$; $p < .01$) or defensive behaviours ($r_s = .410$; $N=65$; $p = .001$) and to the total amount of both problem behaviours ($r_s = .374$; $N=65$; $p < .01$) or defensive behaviours ($r_s = .371$; $N=65$; $p < .01$) it was reported as showing.

Therefore an increase in the difference between foal and yearling reactivity scores was related to an increase in the amount of both problem and defensive behaviours reported when in training and also to an increased likelihood that a horse would be reported as showing at least one problem or defensive behaviour in training. A increase in the difference between foal and yearling reactivity scores was also related to a decreased likelihood of a horse being reported as a frequent whinnier when in training.

6.3.8 Separation study foals

Completed questionnaires were received for only five of animals who had been observed during the separation study (Chapter 3). Of these four had been in the 'accompanied' group and one in the 'isolated' group. The 'isolated' horse was a colt. One of the 'accompanied' group was also a colt; the rest were fillies. Two of the fillies were three-year-olds, one of which is now a successful, black-type placed racehorse.

Each of the five was described as being an enthusiastic worker. None of them eat their bedding, paw while eating, kick the door or wall, rush into or out of the stable, buck or rear when being saddled, rear or raise their head when being bridled, bite or kick when being brushed, crib-bite, windsuck, boxwalk, weave, pin back their ears when approached or shy/duck frequently when ridden. The single 'isolated' group horse was the only one to chew his rug, bite or kick when being saddled or dip his hay in water.

6.3.9 Relationships between the questionnaire items

To more closely examine the relationships between the questionnaire items, the 24 descriptions/behaviours were factor analysed. The analysis was based on a correlation matrix, the principal components method and varimax rotation were applied and eigenvalues of greater than 1.0 were taken as an indication of the number of factors to be extracted. This resulted in nine factors, which explained 57.38% of the variation. The factors and their loadings (.3 or greater) are shown in Table 6.4 below.

A total of six items loaded onto factor 1, which explained 11.80% of the variance. These were biting/kicking being saddled (.638) or brushed (.631), chewing the rug (.595), kicking the wall or door (-.363), excitability (.321) and frequent whinnying (.551). This factor was therefore designated as 'biting and kicking'.

As the three items that loaded onto factor 2 were unfriendliness (.777), pins back ears when approached (.761) and bites or kicks being brushed (.396) this factor was designated as 'unfriendliness'. Four items loaded onto factor 3. The two highest loadings were bucks being saddled (.696) and rears being saddled (.665) but as the other two were rushes into the stable (.639) and rushes out of the stable (.399) this factor was taken as an indication of a dislike of pressure on the sides or flanks rather than as a reaction to being saddled. The five items which loaded onto factor 4 were paws when eating (.474), dips hay in water (.639), kicks the door or wall (.511), rushes out of the stable (.502) and rushes into the stable (.432) and this was identified as 'problem behaviours'. Boxwalking (.797) and weaving (.788) were the only items to load onto factor 5 and this was clearly 'locomotory stereotypies'.

Four items loaded onto factor 6 and with rears being bridled (.671) and raises head being bridled (.527) having two of the highest loadings, this was labelled as 'reactions to bridling'. The other two items to load onto this factor were often shies/ducks when ridden (.529) and paws when eating (.447). Excitability (.568), enthusiastic work style (.805) and eats bedding (-.570) were the items that loaded onto factor 7 and so this factor was designated 'excitability and enthusiasm'. Cribbing (.775) and windsucking (.775) were the only items that loaded onto factor 8 and so this was clearly 'oral stereotypies'.

Table 6.4: The loadings (.3 or greater) of each of the 24 descriptions/behaviours on each of the nine factors extracted from the temperament questionnaire.

	F1 biting & kicking	F2 unfriendliness	F3 dislikes pressure on sides/flanks	F4 problem behaviours	F5 locomotory stereotypies	F6 reactions to bridling	F7 excitability & enthusiasm	F8 oral stereotypies	F9 bucking & ducking when ridden
excitability	.321						.568		
unfriendliness		.777							
whinnies frequently	.551								
enthusiastic work style							.805		
cribber								.775	
windsucker								.775	
boxwalker					.797				
weaver					.788				
eats bedding							-.570		
chews rug	.595								
paws when eating				.474		.447			
dips hay				.639					
kicks wall/door	-.363			.511					
rushes out of stable			.399	.502					
rushes into stable			.639	.432					
often bucks when ridden									.746
often shies/ducks when ridden						.529			.507
bucks being saddled			.696						
rears being saddled			.665						
rears being bridled						.671			
raises head being bridled						.527			
bites/kicks being saddled	.638								
bites/kicks being brushed	.631	.396							
pins back ears		.761							

Similarly the only items to load onto factor 9 were often bucks when ridden (.746) and often shies/ducks when ridden (.507). This factor was designated 'bucking/ducking when ridden'.

A closer look at the factors revealed a slight difficulty as the highest loading in factor 6 was for a behaviour exhibited by just one of the 395 subjects whereas the second-highest item to load on factor 3 had been exhibited by just two of the 395 subjects. As these three individuals appeared to be having an impact on the analysis, the items rears when being saddled and rears when being bridled were removed and a factor analysis computed on the remaining 22 items. As before, the analysis was based upon a correlation matrix, principal components and varimax rotation were applied and eigenvalues of greater than 1.0 determined the number of factors to be considered. The first eight factors extracted were similar to eight of those extracted above - the ninth did not appear to make much sense. These eight factors explained 60.63% of the variance and are shown in Table 6.5.

The five items that loaded onto factor 1, which accounted for 12.52% of the variance, were bites or kicks being saddled (.626) or brushed (.590), chews the rug (.450), whinnies frequently (.701) and excitability (.375). As before this factor was designated 'biting and kicking'. As unfriendliness (.789) and pins back ears when approached (.774) had the highest loadings on factor 2 this was designated 'unfriendliness'. The other two items that loaded onto factor 2 were dips hay in water (.309) and bites or kicks being brushed (.390).

With rearing being saddled having been removed from the analysis, only bucks being saddled (.490), rushes into the stable (.700) and rushes out of the stable (.839) loaded onto factor 3, which was again designated as 'dislikes pressure on the sides/flanks'. Chews rug (.742), kicks the door or wall (.593), paws when eating (.366) and often shies/ducks when ridden (.322) were the only items to load onto factor 4 and this was again identified as representing 'problem behaviours'. Boxwalking (.794) and weaving (.805) were the only items on factor 5 while cribbing (.770) and windsucking (.779) were the only items on factor 7. These were, respectively, designated as 'locomotory stereotypies' and 'oral stereotypies'. Enthusiastic work style (.830), excitability (.564) and eats bedding (-.517) loaded onto factor 6, which was

Table 6.5: The loadings (.3 or greater) of each of the remaining 22 descriptions/behaviours on each of the eight factors extracted from the temperament questionnaire.

	F1 biting & kicking	F2 unfriendliness	F3 dislikes pressure on sides/flanks	F4 problem behaviours	F5 locomotory stereotypies	F6 excitability & enthusiasm	F7 oral stereotypies	F8 bucks/ducks when ridden
excitability	.375					.564		
unfriendliness		.789						
whinnies frequently	.701							
enthusiastic work style						.830		
cribber							.770	
windsucker							.779	
boxwalker					.794			
weaver					.805			
eats bedding						-.517		
chews rug	.450			.366				
paws when eating				.742				
dips hay		.309						
kicks wall/door				.593				
rushes out of stable			.700					
rushes into stable			.839					
often bucks when ridden								.699
often shies/ducks when ridden				.322				.715
bucks being saddled			.490					
raises head being bridled								
bites/kicks being saddled	.626							
bites/kicks being brushed	.590	.390						
pins back ears		.774						

designated as ‘excitability and enthusiasm’. Only two items loaded onto the eighth factor - often bucks when ridden (.699) and often shies/ducks when ridden (.715) - and this factor was identified as ‘bucks/ducks when ridden’.

As eight factors is a large number in relation to the 22 original variables, factor scores were computed for each of the eight and a higher order factor analysis performed on these to see if it was possible to find a smaller number of underlying factors. Using the same method as before, four factors, which accounted for 52.86% of the variance and are shown in Table 6.6 below, were extracted.

Table 6.6: The loadings (.3 or greater) of each of the 8 factors described above when a subsequent factor analysis performed on their factor scores resulted in 4 factors.

FACTORS	F1 general unhappiness	F2 highly strung	F3 frustration	F4 feet & mouth
biting & kicking				.642
unfriendliness	.703			
dislikes pressure on sides/flanks		.700		
problem behaviours	.681		.346	
locomotory stereotypies			.737	
excitability & enthusiasm		.583	-.447	
oral stereotypies				.480
bucks/ducks when ridden		.389		.598

The factors ‘unfriendliness’ (.703) and ‘problem behaviours’ (.681) loaded onto the new factor 1 and this was designated as a measure of ‘general unhappiness’. The factors ‘dislikes pressure on sides/flanks’ (.700), ‘excitability and enthusiasm’ (.583) and bucks/ducks when ridden (.389) loaded onto the new factor 2 and this was taken to represent being ‘highly strung’. The factors ‘problem behaviours’ (.346), ‘locomotory stereotypies’ (.737) and ‘excitability and enthusiasm’ (-.447) made up the new factor 3, which was designated as frustration. The factors ‘bites and kicks’ (.642), ‘oral stereotypies’ (.480) and ‘bucks/ducks when ridden’ (.598) loaded onto the new factor 4 and as each behaviour involves either the mouth or the feet this was designated ‘feet and mouth’.

6.4 Discussion

Asking handlers to complete temperament questionnaires is a frequently-used method of assessing the temperamental traits of horses. Another is to attempt

to assess the personality of the animals through recording their behavioural responses on a number of tests. Morris *et al.* (2002) point out that there is an important difference between temperament and personality, namely that the former is apparent from birth while the latter is largely acquired, but found that stable personnel achieved a high level of inter-rater reliability when asked to assess the personality of the same ten horses. The most agreement came on the dimensions most closely related to the 'Big Five' dimensions Neuroticism and Extraversion (Costa & McCrae, 1992), suggesting that some traits are easier for handlers to identify than others. With the majority of the items on the questionnaire presented to the handlers of the 395 horses examined in this chapter being ones that are instantly recognisable and, therefore, requiring little, if any, subjective interpretation, one could reasonably expect that the items indicated for each horse would have been indicated regardless of which handler completed the form, even though this cannot be established quantitatively. Even so, it would have been desirable to have been able to obtain some measure of inter-rater reliability. It is felt, however, that had it been requested of trainers to ask two or more staff members to assess each horse, there would have been very few questionnaires returned: the study was conducted during a particularly busy part of the racing year. Prior experience or training in assessing the behaviour of horses could not be controlled for or arranged but, as Morris *et al.* (2002) also pointed out, "the fact that our raters, who were untrained in observation, were able to carry out the task of rating so effectively, demonstrates that cues to the personality of horses are readily accessible" (p.77).

The study presented in this chapter investigated whether or not a number of independent variables, including how horses in training had behaved in the auction ring as a foal and/or as a yearling, could be related to how, using the questionnaire provided, stable staff rated the horse in their care. Tentative links were found with some of these variables. The findings are discussed in the order in which they are presented above.

6.4.1 Gender

Mills *et al.* (2002) found that there was a higher prevalence of stereotypic behaviours amongst females and geldings than in colts when investigating prevalence rates of these behaviours amongst horses who passed through an

auction ring in England. That study was conducted by compiling information on declared stereotypies printed in the relevant auction catalogues with that provided by the auction company and involved horses of all ages and at various stages of their racing careers. The findings presented in this thesis, however, found that there was no significant difference in stereotypy rates between colts and fillies. The significant differences that did emerge were in relation to geldings: geldings were more likely than fillies to be boxwalkers ($p<.01$) and more likely than colts to windsuck ($p<.01$), be a boxwalker ($p<.01$) or to weave ($p<.05$). Though Mills *et al.*'s (2002) study covered horses of varying ages amongst their 4051 subjects, they reported an overall prevalence rate of 5.1% for stereotypic behaviours and that the prevalence was greatest in two-year-olds, at 16.4%. All but two of the 395 horses in training who were analysed in this chapter were two-year-olds and the overall prevalence rate for stereotypic behaviours was found to be 7.1%. The other pair were three-year-old fillies and neither was reported as exhibiting any stereotypic behaviours.

The other items on which there was a significant gender difference were vocalisation, work style, rug-chewing, biting or kicking when being saddled, biting or kicking when being brushed, raising the head being bridled, bucking when ridden and pinning back the ears when approached.

A horse who whinnies frequently is often described by handlers as being 'colty' and while there was no difference between colts and geldings or between fillies and geldings on the frequency with which they vocalised, there was a significant difference between the proportion of colts who were reported as whinnying often ($\chi^2=21.24$; $df=1$; $p<.001$) compared to fillies. It is certainly possible that any handlers who were familiar with this axiom may have rated the frequency with which their charge whinnies in a somewhat biased manner, but the difference between these groups was such that the difference found is likely to reflect a real gender difference in the performance of this behaviour.

The gender difference in rug chewing behaviour was striking, particularly as it has been suggested that this particular behaviour may be related to self-mutilation (Marsden, 1999), a behaviour that most often appears in stallions

or colts rather than fillies, mares or geldings (Dodman *et al.*, 1994). The difference found was only between colts and fillies ($\chi^2=15.01$; $df=1$; $p<.001$).

Although Morris (1997) includes rug-chewing as a stable vice and suggests that it is a sign of boredom, it is a behaviour that can also be a sign of cutaneous irritation and which may have an underlying biological cause. For example, administration of a narcotic antagonist (nalmefene) has been found to reduce self-mutilation behaviour in stallions (Dodman, *et al.*, 1988) but, even if this drug could be shown to reduce or eliminate instances of rug-chewing behaviour, it cannot be given to racehorses. Under the rules of racing, no substance that acts on the central nervous system can be administered to racehorses. An alternative treatment of simply reducing the grain in a stallion's diet and increasing both the amount of exercise he gets and the amount of roughage he eats has been suggested in eliminating self-mutilation behaviour (McClure, Chaffin & Beaver, 1992) but, of course, racehorses usually receive just short bursts of intense exercise and are on a controlled diet. Trainers may not wish to make such alterations for just one or two members of their string.

Rug-chewing is a problem that has been reported in 8.9% of horses in training (Prince, 1987 - cited in McBane, 1994), though 19% of the 395 assessed by questionnaire for this thesis were reported to chew their rug. With the associated costs involved in replacing damaged rugs, Prince (1987) also reported that trainers estimated a reduction of 1.1% in the value of any horse exhibiting this behaviour.

Of course, rug-chewing in thoroughbreds in training may easily be a sign of cutaneous irritation or, given that many of them spend up to 23 hours per day alone in their stable, a sign of boredom. If so then trying garments made of different materials or providing some sort of stable toy or stable companion may reduce or eliminate the behaviour. Henderson and Waran (2001), for example, found that providing horses with a feed-filled Equiball enrichment device resulted in a decrease in stereotypic behaviour.

The correlation matrix produced as part of the factor analysis of the questionnaire showed a significant relationship between rug-chewing and

biting/kicking being saddled ($r_s=.210$; $N=395$; $p<.001$) or brushed ($r_s=.253$; $N=395$; $p<.001$), frequently shying or duck away when being ridden ($r_s=.193$; $N=395$; $p<.001$) and as be described as either fairly excitable ($r_s=.154$; $N=393$; $p<.01$) or as often whinnying ($r_s=.158$; $N=345$; $p<.01$). This may indicate that at least some thoroughbreds chew their rug due to cutaneous irritation or, perhaps, being somewhat highly strung.

If it is an indication of a tendency towards a self-harm behaviour then it should be noted that horses are by no means alone in this regard. There are a variety of self-harm behaviours reported in humans, from cutting to substance abuse, and in other species such as pigs (tail-chewing) or monkeys (self-mutilation) (Moberg, 1985), to name just two. In dogs self-mutilation can occur, though is fairly rare, in cases of separation anxiety, that is when left alone in a house for hours on end (McCrave, 1991). All are typically regarded as the pathologies of stress (Moberg, 2000) though it has been noted that self-mutilation behaviours can occur during epileptic seizures in horses (Hahn, Mayhew & MacKay, 1999). This, however, would be rare.

Pinning back of the ears when approached is a well-recognised sign of aggression or defensive behaviour in the horse. It is a threat to whoever is approaching that a bite or kick is imminent if withdrawal is not immediate. By pinning the ears back against the head the horse is also protecting them from potential injury during a fight (Kiley-Worthington, 1987). It was found that fillies were more likely than colts to pin their ears back when approached ($\chi^2=9.23$; $df=1$; $p<.01$). This difference has not previously been reported in thoroughbreds but this may merely reflect the fact that thoroughbred colts and fillies are segregated from the time they are foals or yearlings and that beyond their yearling year, in flat-bred horses at least, colts rarely get the chance to mix freely with other horses, of either gender. There is some anecdotal evidence that fillies and mares will threaten whereas colts, geldings or stallions will just bite or kick and it could be argued that some of the findings here offer that claim some support. The fillies were the ones most likely to pin back their ears when approached and while they were more likely than geldings to bite or kick being brushed, there was no gender difference apparent, on this latter behaviour, between colts and fillies. Colts were, however, more likely than geldings to bite or kick while being brushed ($p<.01$).

They were also more likely to bite or kick when being saddled ($\chi^2=4.92$; $df=1$; $p<.05$) than were fillies.

Given the number of tests performed it could have been expected that at least one of the chi-square results and two of the binomial test results could have been significant at the 5% level by chance. This may or may not have been a factor in the remaining three gender-related results that were significant. For example, it was found that colts were more likely than geldings ($p<.05$) to raise their head when being bridled though there was no difference between colts and fillies or between fillies and geldings. Geldings were more likely than fillies ($p<.05$) to be reported as often bucking when ridden but there was no difference found between colts and geldings or between colts and fillies. The final result was on the work style scale: a greater proportion of fillies, than colts, were reported as being an enthusiastic worker ($\chi^2=4.94$; $df=1$; $p<.05$). This finding was interesting as there is a somewhat popular perception in racing circles that colts are more aggressive, more competitive and more excitable racehorses than fillies, who are more likely to be described as 'flighty' or 'a madam'.

6.4.2 Coat Colour

With 24 chi-square tests performed one would have expected to find one result to be significant at the 5% level by chance and given that coat colour differences in the temperament of horses tends to be little more than anecdotally-based, it is likely that the significant difference found between chestnuts and bay/ browns on the item 'bites/kicks while being saddled' ($\chi^2=5.21$; $df=1$; $p<.05$) represents that one result. Both colours have the same coloured skin beneath their hair and there is no evidence to suggest any greater sensitivity in either. Coat colour is not a factor often investigated in horses, presumably in part due to the often small numbers of subjects involved in studies, but the absence of a relationship between coat colour and stereotypic behaviours is in accordance with the findings of the auction ring study conducted by Mills *et al.* (2002).

6.4.3 Sire / paternal grandsire / broodmare sire

There were fewer significant results found for sires, paternal grandsires and broodmare sires than could have been expected by chance, suggesting that

while there is tentative evidence of a potential inheritance of some traits through some stallion lines, caution is warranted in interpreting the results. Wolff and Hausberger (1994) found evidence that suggested a possible link between sire and behaviour in French Standardbred foals but as there were just 13 subjects representing five stallions there were insufficient numbers for any reliable assertions to be made. Wolff *et al.* (1997), also investigating French Saddlebreds, found that young horses by the same sire tended to behave more similarly to each other on the different behavioural tests than to those by different stallions. This time there were 42 animals involved, all aged between one and three.

Haupt and Kusunose (2000) report the best published evidence for inheritance of traits through the sire in thoroughbred racehorses. A total of 9644 young thoroughbreds in training at one of two major training centres in Japan were assessed for behavioural responses to three handling procedures by vets. Though three-quarters of all the horses received the maximum marks awarded for tractability, there was a significant correlation ($r=.523$; $p<.001$) between how the progeny of the 62 stallions behaved in one centre and how the progeny of the same stallions responded in the other training centre. However, with just three responses recorded for each horse and such a large proportion of the subjects scoring the maximum possible score, it could be argued that a greater variety or number of tests would have provided more convincing evidence. The pedigree analyses presented in this thesis investigated whether or not progeny representing various stallions had a significantly greater or smaller proportion of their descendents exhibiting any of the target behaviours. If a stallion's progeny do not differ from those of the population as a whole, can it really be said with any confidence that the stallion is passing on a trait or tendency to his progeny? Perhaps the scores obtained by the subjects reflect nothing more than a tendency or trait that is typical to the breed as a whole.

Future investigations into the potential effect of sire or sire lines on behaviour or temperament thoroughbred horses could benefit greatly from an additional analysis of the actual stallions themselves. If they are passing on traits it may be easier to establish by identifying temperamental traits in the stallions and investigating whether or not a significant proportion of their progeny also

exhibit these traits. After all much of the anecdotal evidence for the inheritance of temperamental traits in thoroughbreds comes from reports by handlers of how the progeny of X share his general aggressive nature, or how the progeny of Y can be identified by the way they behave when being led, for example.

6.4.4 Female family number / male family number

Most research conducted on the inheritance of traits in animals looks at the sire line and various studies, some of which have been outlined above, have found some tentative evidence to support a relationship, in horses, between sire and temperament. This thesis also looked for potential evidence of inheritance of traits through the female line, using the family numbers originally designated by Lowe (1895). Genetic studies conducted by Hill *et al.* (2002) found evidence of flaws in the system, that some families have been incorrectly classified and while these potential inaccuracies were not taken into account for the purposes of this thesis, it may be that the failure to find a number of significant results greater than what could have been expected to have been significant by chance is as much a reflection of those potential inaccuracies rather than a failure to find convincing evidence of inheritance of traits through the distaff line of a pedigree. Another difficulty is that the number of representatives of each family was rather small: with larger numbers some stronger results may have emerged. Most of the items that did have a significant relationship to either a female family or progeny by stallions representing specific female families related to excitability, friendliness, problem behaviours and stereotypes. Further research is warranted.

6.4.5 Pedigree Diversity Scores (PDS)

Much of the research on inbreeding and animals appears to focus more on lab animals or on issues such as morphological traits, fertility or meat quality (e.g. Zechner *et al.*, 2002; Burrow, 1998; Ecranbrack & Knight, 1993; MacNeil *et al.*, 1989; Dinkel *et al.*, 1972). In such studies the degree of inbreeding is usually determined using the inbreeding coefficient but, as explained in Chapter 2 above, use of Wright's coefficient of inbreeding is inappropriate for use in the study of thoroughbred horses.

The Pedigree Diversity Score developed for the purposes of this thesis found only two significant results within five-generation pedigrees and just one within four-generation pedigrees, fewer than would have been expected by chance given the number of statistical tests performed. However, what was revealed by use of the PDS is that there does not appear to be any evidence to support the often popularly held belief that the more inbred a horse the more highly strung it will be or the more prone it will be to develop abnormal behaviours. Of the 38 most inbred horses (9.6%), based on inbreeding within five-generations, or 28 (7%) most inbred, based on inbreeding within four-generations, not a single horse was reported to dip their hay in water, rush into the stable, buck when being saddled, rear when being saddled or bridled, crib-bite, windsuck, boxwalk or weave. Could it be that a certain level of inbreeding 'protects' a thoroughbred from developing stereotypic behaviours?

6.4.6 Horses assessed in the auction ring

Seaman *et al.* (2002) found that there was no relationship between how horses performed on a variety of different behavioural tests, a finding also reported by Visser *et al.* (2003). However, Visser *et al.* (2003) did find that some aspects of the behaviours shown by 41 Dutch Warmblood horses, which they suggest represented different aspect of a horse's personality, made it possible to predict a substantial part of the future show-jumping performance of the animals. Whether or not scores obtained by subjects observed as part of this thesis will prove predictive of future racing ability remains to be seen: the majority have either raced no more than a couple of times or have not raced at all, though a number of those to have raced three or more times to date have done very well and have become well known racehorses. Such studies, however, have tended to look at how behavioural responses relate to performance: the findings presented in this chapter sought to determine how signs of temperament in very young horses would relate to signs of temperament shown by the same animals when they were older.

The findings presented in Chapter 5 showed that there was a relationship between how horses behaved in the auction ring as a foal and how they subsequently behaved in the ring as a yearling. This, of course, represented a consistency between two trials on very similar, if not identical, tests.

When the behavioural scores obtained in the auction ring were compared to temperament as reported when in training, several relationships were found. The more locomotory ($\chi^2=6.86$; $df=2$; $p<.05$) and/or freezing behaviours ($\chi^2=9.96$; $df=2$; $p<.01$) shown in the auction ring as a foal, the more likely the animal was to be rated as being fairly/very excitable as a two-year-old. While this would suggest that trainers could gain an idea of how excitable a horse may be in training by noting the amount of locomotory or freezing behaviours shown as a foal in the auction ring, the fact is that trainers rarely, if ever, buy horses as foals: trainers buy horses for their clients at the yearling sales and these relationships between behaviour and temperament were only found in the auction results of the foals. Pinhookers, that is people who buy foals with a view to selling them on for a profit as a yearling, may find this relationship between behaviour and temperament to be useful should they be also be concerned about becoming known for selling calm, relatively laid-back horses.

Friendliness of a two-year-old in training could not be predicted from their behavioural scores as either a foal or a yearling. Frequent vocalisation, on the other hand, was related to whether or not a horse whinnied in the auction ring as a yearling but was not related to vocalisation in the ring as a foal.

The amount of freezing and escape behaviours shown by foals was found to be related to both the number of defensive behaviours and to whether or not they would be reported as showing any of the defensive behaviours as a horse in training. The number of freezing behaviours shown as a foal was also related to whether or not the horse was subsequently reported as exhibiting any of the problem behaviours when in training. Although trainers are generally not likely to be overly concerned with defensive behaviours shown by a horse in its stable, the Prince (1987) study found that trainers estimated a 1.1% reduction in value of a horse who chews his rug. With 19% of the subjects being discussed in this chapter found to engage in this behaviour, the expensive habit of rug-chewing was the most prevalent of the problem behaviours. Horse rugs are costly. Horses who eat their bedding are also increasing costs for the trainer though this particular problem behaviour can usually be related to either a lack of roughage in the diet or the horse's attempt to deal with the fact he is biologically programmed to graze for up to 16 hours a day, something he is unable to do if confined to a stable.

With those assessed as yearlings it was found that the higher the total reactivity score obtained, the less likely it was that a horse would exhibit any of the problem behaviours when in training. This was also true with regard to both the number of defensive and locomotory behaviours shown in the auction ring. Looking at the recoded scores on the six auction ring behavioural categories, that is whether or not any behaviours within the categories had been shown, it was found that those who had either vocalised, sweated or defecated, shown any defensive behaviours or any locomotory behaviours while in the ring as a yearling, showed fewer problem behaviours in training than horses who had not exhibited any of these behaviours in the ring. The correlations were very low and, given the number of tests that had been performed, one or two results could have been expected to be significant at the 5% level by chance. Even so these findings were somewhat surprising as one would expect the relationship, if there was one, to be positive rather than negative.

Of the 65 horses who had been assessed in the auction ring both as a foal and as a yearling it was found that the greater the increase in their total reactivity score between the two assessment periods, the greater the likelihood that they would be reported as showing problem behaviours or defensive behaviours when in training. Life experience is a major factor in how horses handle various situations and it is possible that these horses, who showed greater signs of reactivity as a yearling than they had as a foal, may have had stressful lives in the interim between the two auction ring assessments. If they have not learned how to handle stress by the time they enter training this would, most likely, result in a greater number of problem behaviours and defensive behaviours being shown.

6.4.7 Separation study foals

It was disappointing that questionnaires were returned for only five of the separation study foals. Each of the quintet, four of which were in the 'accompanied' group and one in the 'isolated' group, appear to be well-adjusted young racehorses. One of the two three-year-olds, a black-type placed winner, has become a fairly well-known racehorse who even contested

one of this year's Classics. One of the two-year-olds won his maiden⁶ during the summer. None has developed stereotypic behaviours and only one, the 'isolated' colt, was among the 19% who chew their rug. As behavioural responses shown during the separation period had been found to be related to yearling scores in four of the six auction ring behavioural categories (Chapter 5), further research into whether aspects of a preweaned thoroughbred foal's behaviour can predict future temperament.

6.4.8 Relationships between the questionnaire items

The type of factors that emerge in a temperament study will, of course, depend on the type of measurements taken and the type of study being conducted. Most temperament studies measure behavioural responses to specific tests, some of which do not mirror real life experiences, and identify traits based on these. Though the auction ring is very much a real life situation, this is similar to what was presented in Chapters 4 and 5 above, an analysis of behavioural responses to a test. The temperament study presented in this chapter, however, listed a number of behaviours commonly seen in thoroughbreds as well as some basic temperamental traits, and used this questionnaire to identify which behaviours were most often reported together in the 395 racehorses in training. The factors extracted are necessarily different from those often seen in other temperament tests as they relate to how the animals typically handle everyday life rather than their responses to a specific test or scenario.

Visser *et al.* (2001) tested 41 Dutch Warmblood horses, at four different ages, on both a novel object test and a handling test: these are typical examples of the standard temperament tests used with animals. Items included in the analyses, therefore, included exploratory behaviours, attention, locomotory behaviour, vocalisations and, in the handling test which involved being led across a bridge, freezing, pawing, kicking, pulling away and so on. The two main factors extracted in the novel object test were 'sensitiveness' and 'flightiness' while the main two from the handling test were 'willingness to perform' and 'patience'. The authors based the naming of the factors on prior

⁶ A maiden is a race restricted to horses that have not previously won a race under that particular set of rules, ie. flat or national hunt. A winner on the flat is a maiden when he/she goes to race over hurdles or fences.

work done by Mills (1998). 'Anxiety', 'novelty seeking' and 'understanding' were the temperamental factors identified by Momozawa *et al.* (2003) when they attempted to match up handlers' assessments with scores on a novelty test - a rotating, suspended balloon. In an arena test study conducted by Wolff *et al.* (1997), where the animals are alone, a number of factors were extracted that related to various types of movement or attention, as well as an 'other' category, while the same researchers (Le Scolan *et al.* 1997) identified 'fearfulness when handled', 'fearfulness when ridden', 'learning abilities', 'gregariousness in familiar surroundings', 'gregariousness in unfamiliar surroundings' and 'nervousness when ridden' over four tests.

The items 'rears being saddled' and 'rears being bridled' were removed after the initial factor analysis of the questionnaire revealed that, even though only two of the 395 horses exhibited the former and just one the latter behaviour, two factors were being heavily influenced by their inclusion. When the analysis was rerun eight factors, which represented a mix of behavioural combinations and temperamental traits, were extracted. These were 'biting and kicking', 'unfriendliness', 'dislikes pressure on the side/flanks', 'problem behaviours', locomotory stereotypies, 'excitability and enthusiasm', 'oral stereotypies' and 'bucks/ducks when ridden'.

One can clearly see how some of these factors may go together rather than be viewed as separate items or traits within the temperament of a horse. Two factors, for example, are different types of stereotypies, while horses who bite and kick might reasonably be expected to also be described as being unfriendly. The subsequent analysis performed on the factor scores generated from the eight factors listed above revealed four underlying factors: 'general unhappiness', 'highly strung', 'frustration' and 'feet and mouth'.

Two of the original eight factors, based on the 22 descriptions/behaviours (Table 6.5) loaded onto 'general unhappiness'. These were 'unfriendliness' (.703) and 'problem behaviours' (.681).

The items that loaded onto 'unfriendliness' were unfriendliness (.789), paws when eating (.309), bites or kicks being brushed (.390) and pins back ears (.774), and the items that loaded onto 'problem behaviours' were chews rug

(.366), paws when eating (.742), kicks door or wall (.593) and shies or ducks being ridden (.322). Therefore, a horse that scored highly on the higher order factor 'general unhappiness' was likely to be rated as being unfriendly, to pin back their ears when approached, to shy or duck when being ridden, to paw when eating, bite or kick being brushed, chew their rug and/or to kick the door or wall. The first three of these behaviours/descriptions are suggestive of a horse that does not like human company. This could be just the particular human with whom it interacts on a daily basis, or it could be people in general, and it could, for example, be suggestive of experience of negative human-animal interaction, either now or in the past. The other four items (paws while eating, biting and kicking being brushed, chewing the rug and kicking the door/wall) and generally indicative of frustration. They are displacement activities that are usually classed as being problem behaviours.

Three of the factors on Table 6.5 loaded onto the second higher order factor, designated 'highly strung'. These were 'dislikes pressure on sides/flanks' (.700), 'excitability and enthusiasm' (.583) and 'bucks/ducks when ridden' (.389).

The items that loaded onto 'dislikes pressure on sides/flanks' were rushes into the stable (.700), rushes out of the stable (.839) and bucks being saddled (.490), the items that loaded onto 'excitability and enthusiasm' were excitability (.564), enthusiastic work style (.830) and eats bedding (-.517), while the items that loaded onto 'bucks/ducks when ridden' were often bucks when ridden (.699) and often shies/ducks when ridden (.715). Therefore a horse that scored highly on the higher order factor 'highly strung' was likely to be described as being excitable, to rush into and out of the stable, buck being saddled, buck being ridden, shy or duck being ridden and/or to be an enthusiastic worker. They were less likely to eat their bedding.

Three of the factors on Table 6.5 loaded onto the third higher order factor, designated 'frustration'. These were 'problem behaviours' (.346), 'locomotory stereotypies' (.737) and 'excitability and enthusiasm' (-.447).

The items that loaded onto 'problem behaviours' were chews rug (.366), paws when eating (.742), kicks door or wall (.593) and shies or ducks being ridden

(.322), the items that loaded onto 'locomotory stereotypes' were boxwalker (.794) and weaver (.805), while the items that loaded onto 'excitability and enthusiasm' were excitability (.564), enthusiastic work style (.830) and eats bedding (-.517). Therefore a horse that scored highly on the higher order factor 'frustration' was likely to chew its rug, paw when eating, kick the door or wall, be a boxwalker and/or weaver, shy or duck when ridden, be described as excitable and/or as an enthusiastic worker. They were less likely to eat their bedding. The first five of these are behaviours typically associated with frustration in the horse: the first three are displacement behaviours while the other two are stereotypes. The remaining behaviours/descriptions, namely shying or ducking when ridden, being described as excitable and being an enthusiastic worker had also loaded highly onto the higher order factor 'highly strung' and these, combined with the recognisable signs of frustration, are suggestive of a horse that is not at ease with its situation.

Three of the factors on Table 6.5 loaded onto the fourth higher order factor, designated 'feet and mouth'. These were 'biting and kicking' (.642), 'oral stereotypes' (.480) and 'bucks/ducks when ridden' (.598).

The items that loaded onto 'biting and kicking' were excitability (.375), whinnies frequently (.701), eats bedding (.450), bites/kicks being saddled (.626) and bites/kicks being brushed (.590). The items that loaded onto 'oral stereotypes' were cribber (.770) and windsucker (.779), while the items that loaded onto 'bucks/ducks when ridden' were often bucks when ridden (.699) and often shies/ducks when ridden (.715). Therefore a horse that scored highly on the higher order factor 'feet and mouth' was likely to be excitable, whinny frequently, eat its bedding, bite and kick being saddled and/or brushed, be a cribber and/or windsucker, buck frequently when ridden and/or shy or duck frequently when ridden.

While these may seem to be painting the life of a racehorse in a very negative light, it should be remembered that, other than a rating of excitability, friendliness, frequency of whinnying and work style, handlers were only asked to indicate the presence or absence of a series of 'negative' items, namely problem behaviours, defensive behaviours and stereotypes. Items were coded as 0 for absence of a behaviour and 1 for presence of a behaviour, thereby

awarding a higher score for 'negative' items. This is why the factors were given 'negative' names. Indeed, out of the 395 horses, 150 (38%) did not exhibit any of the target behaviours at all, while a further 97 exhibited just one of the 20 non-scaled items. This means that 83.7% of the horses examined scored a total of either 0 or 1 out of a possible maximum of 20 if a total score across the non-scaled items was computed. The highest score obtained was 11 while only 5.8% of the entire sample scored 5 or more. This suggests that, on the whole, young thoroughbred racehorses appear to be well-adjusted and content with their lives.

6.5 Summary

While there appear to be some fairly clear gender differences with regard to some behaviours or traits, the evidence for a potential genetic link is less clear. Evidence of a link with sires, paternal grandsires, broodmare sires and the female families from which the sire or the dam come was found but to a lesser degree than could have been expected by chance given the number of tests that were performed. Performance of some types of behaviours in the auction ring as a foal or as a yearling do appear to be predictive of some temperament items when later in training but further research is warranted. The most striking finding with regard to the amount of inbreeding in a pedigree comes from the fact that none of the most inbred horses were reported to have developed any of the stereotypic behaviours. Could it be that a certain level of inbreeding offers some sort of 'protection' against these major equine disorders? This is an intriguing question and further research is certainly warranted.

Finally, though the factors that emerged from analysis the questionnaire suggest, on face value, that racehorses are an unhappy and frustrated group of animals, the design and scoring of the questionnaire was purposely 'negative', hence the negative slant in the factors. A total of 83.7% of the 395 horses surveyed scored only 0 or 1 out of a possible maximum of 20 if a total score across the non-scaled items was computed, with only 5.8% of horses scoring 5 or above. This suggests that young racing thoroughbreds are fairly well-adjusted and content with their lives.

Chapter 7: Discussion

There were five research questions under investigation in this thesis, which were as follows:

1. Will accompanying a pre-weaned foal while it is separated from its dam during covering of the mare reduce the behavioural signs of distress exhibited by the foal?
2. Will behavioural signs of reactivity shown by young flat-bred horses in the auction ring differ from those shown by young national hunt-bred horses in the ring, thereby suggesting a potential role for husbandry practices in the development of equine psychological maturity?
3. Can the number of behavioural reactions shown by a yearling in the auction ring be predicted from the number of behavioural reactions it showed, as a foal, during its first experience of the auction ring?
4. Can temperamental traits in two-year-old racehorses, as assessed by their primary caregivers, be predicted from how they responded to what are typically stress-provoking stimuli as a foal and/or as a yearling?
5. Is there any evidence of potential inheritance of temperamental traits in thoroughbred horses?

Following a detailed examination of the data it was found that there is sufficient evidence to answer 'yes' to the first two and 'possibly' to the third, fourth and fifth questions. In order to present a coherent discussion of the findings the following format will be applied. Firstly, the findings will be discussed in relation to how they answer each of the research questions. This discussion will also show how the findings relate to previously published work and thereby demonstrate the contribution they make to what is known about behavioural reactivity and temperament in horses. It will also provide a framework for a multifaceted approach to the study of behaviour and welfare in horses, a review of the limitations and strengths of the current study and, finally some recommendations for future research.

7.1 Research Question One

Whether or not accompanying a pre-weaned foal while separated from its dam during covering of the mare would reduce the behavioural signs of distress exhibited by the foal was investigated in Chapter 3 and findings clearly showed that the simple intervention had a dramatic effect. Not only were behavioural signs of distress significantly reduced but none of the accompanied foals exhibited any of the self-harm behaviours, namely charging into a door or wall, that were shown by 17 of the 30 animals in the isolated group.

Though a recent study by Houpt (2002) looked at responses of 10 pony mares and their foals to brief weekly periods of separation at up to nine weeks of age, the study presented in Chapter 3 is the first to look at the potential effects of separation anxiety in preweaned thoroughbred foals. It is also the first study to investigate exactly what it is that preweaned foals do when shut into a stable by themselves. It also differs from Houpt's study in an important way - at no time during the observed period of separation could any of the thoroughbred foals see or hear their mother: they were completely isolated from her. In fact, depending upon the yard in which they were stabled and the time of day that the mare was sent for covering, some could not even see or hear any other horse. For a young prey animal this is likely to be more distressing than if there are conspecifics nearby. The pony foals in Houpt (2002) could hear their mother throughout their period of separation as she had only been moved to a nearby location rather than sent to a different stable yard.

Stress negatively effects the cognitive processes (e.g. Arnsten & Goldman-Rakic, 1998; McEwen & Sapolsky, 1995) and so it is debatable whether or not an isolated foal would be capable of learning some behavioural task during the experience of being separated from the dam during covering. However, with its attention directed towards the absence of its mother and its motivation being to become reunited with her, it is possible that, over the course of several trials, the foal can learn, through habituation, that when the mare is loaded into the horsebox and taken away, while the foal is left behind, she will return before long. It is also possible that the isolated foal can learn some problem or even stereotypic behaviours, through operant conditioning. If, for

example, the foal paces rapidly around the box and eventually the mare returns, the return of its mother may serve as a positive reinforcement for pacing, thereby making it more likely that the foal will pace the next time it is isolated. If a second such trial proves 'successful' to the foal, the pacing response may generalise to other stressful situations, thereby potentially leading to the development of boxwalking. This particular stereotypy is one that must be declared at a thoroughbred auction - failure to do so can result in the animal being returned to the vendor under the conditions of sale of the particular auction company.

The simple intervention of having a handler remain quietly with some of the foals, interacting only when the foal wished to interact, was found to significantly reduce the behavioural signs of distress in the animal. This finding was in accordance with previous literature that showed the beneficial effects that positive human-animal interaction can have in reducing stress or anxiety in the animal (e.g. Baker, 2004; Baker *et al.*, 2003; Lensink *et al.*, 2001; Rushen *et al.*, 2001; Hennessy *et al.*, 1998; Bayne *et al.*, 1993). As the stress levels of these accompanied foals appeared to have been substantially reduced, it is reasonable to assume that those who chose to interact with the handler may have been capable of learning some behavioural task during this time.

With regard to the accompanied foals that chose not to interact there is an interesting question concerning what they might learn in terms of human-animal interaction during this stressful time. One filly foal, who had paid no obvious attention to the handler during her assessment period and had scored highly on some of the behavioural measures of separation anxiety taken, became available for a second observation period. This was not part of the experiment and data from a second observation were not used, but just an opportunity to observe how a foal might respond on a second occasion. When the handler entered the box on this second occasion, the foal immediately stopped whinnying and pacing, approached the handler and remained calmly by her side for the remainder of the separation period. Even though her behaviour on the first occasion suggested that she may not have derived any benefit from being accompanied during her time of distress, it appeared that

she had possibly learned that this human was not a threat and that her mother would return before the human left.

In summary, the study presented in Chapter 3 was the first to look at separation anxiety in preweaned thoroughbred foals while their dam is at the covering shed. When asked, stud farm workers often indicate that a foal whinnies a bit and sometimes kicks the door when it left alone while the mare has gone to the covering shed. They also advise that the top half of the door be closed over, on those stables where there is no grille on the door, to stop the foal jumping out of the box. Yet no attempt is made to alleviate the obvious distress of the foal. This study highlighted both the widely varying degree of stress exhibited by the foals, the types of behaviours, including self-harm behaviours, that they show, and how a simple intervention can significantly reduce this distress. It contributes, therefore, to what is known about separation anxiety in horses, effects of human-animal interaction, the literature on equine welfare and, potentially, stereotypy development.

7.2 Research Question Two

The second research question sought to establish whether or not behavioural signs of reactivity shown by young flat-bred horses in the auction ring would differ from those shown by young national hunt-bred horses in the ring. The rationale for this question was the different husbandry practices employed in both sectors with regard to handling and rearing for precocity and maturity.

Though animals from these two sectors, as explained in Chapter 4, come from the same gene pool, there are management differences that lead to those from one sector being precocious enough to race by the age of two while those from the other sector may not even be broken to saddle or bridle until the age of four. There are also physical differences that are obvious to the naked eye: some flat-bred foals turn up in the auction ring looking like yearlings while some national hunt-bred yearlings turn up in the auction ring looking like foals. An American study by Gibbs and Cohen (2001) found that “weanlings and yearlings were reportedly managed for moderate growth on 74% of farms and for rapid growth on 26% of farms” (p.280). Though there does not appear to have been a similar study conducted in Ireland or the UK, there is little doubt that a considerable number of foals and yearlings are being managed

for moderate to rapid growth. As noted in Chapter 4, this managing for rapid growth may have short-term commercial benefits to the individual selling the foal or yearling but may lead to osteochondrosis (OCD), a developmental disorder characterised by abnormal growth of bone and cartilage, which is commonly seen in young thoroughbreds and may result in two-year-olds having to undergo surgery to remove bone chips from their knees.

The data presented in Chapters 4 and 5 clearly showed that while there was no significant difference in the total number of behaviour responses shown, there were significant differences in the type of behavioural responses shown by flat-bred and national hunt-bred foals and yearlings when they were in the auction ring. These differences appeared to be related to maturity: national hunt-bred foals were more likely than flat-bred foals to show defensive, freezing and escape behaviours, while national hunt-bred yearlings more likely than flat-bred yearlings to exhibit both freezing and escape behaviours. In both age groups the flat-bred stock were more likely than the national hunt-bred stock to sweat or defecate in the ring, suggesting, perhaps, that they were at least as 'stressed' by the experience - an inference supported by the fact that there was no difference between the two sectors in terms of the total amount of reactivity shown - but that they were better able to control their behavioural responses.

Freezing and escape behaviours represent the 'flight' part of the 'flight or fight' response while defensive behaviours are clearly part of the 'fight' part of the response. Budd (1996, p.51) states that any horse that "steps out without hesitation on to a strange, untested surface is showing a degree of trust and confidence that goes against a deeply ingrained rule of thumb" and so a foal or yearling that willingly enters and navigates the auction ring is showing a degree of trust in the handler. This is only possible if there has been a positive experience of human-animal interaction. The animal that panics or exhibits signs of distress in this somewhat unusual environment has not learned this degree of trust, which may be due to poor or negative experiences of human-animal interaction, poor or limited training and handling, a highly reactive temperament, or because it is psychologically immature. It is also possible that the animal has experienced a number of 'traumas', such as those outlined in Chapter 1, and may be in either a chronic state of stress or

have been experiencing what Moberg (1985, 2000) calls subclinical stress. Subclinical stress relates to stress levels that are building up but have not yet reached the surface and, hence, are not immediately apparent to the handler. The experience of being at the sales complex and going through the auction ring may be, therefore, the proverbial straw that triggers the obvious stress reaction.

As flat-bred stock are reared and managed for precocity so that they can race at the age of two or three, they tend to be more intensively handled than their national hunt counterparts. Therefore, they have presumably had greater opportunities for learning, for development of the afore mentioned degree of trust that can emerge from positive experiences of human-animal interaction, and have potentially been exposed to a greater number of stressful situations than the national hunt foal or yearling.

A rather striking effect for age was seen in the flat-bred yearlings though absent in their national hunt-bred counterparts. This was with regard to the amount of locomotory and freezing behaviours shown in the ring, which showed a steady decrease with age. This trend also led to a consistent decrease in the total reactivity scores, with age, of the yearlings. The yearlings were between 16 and 21 months of age and it would appear that there is a steady maturation process occurring during this time. As this effect was only seen in the flat-bred stock, this suggests that the maturation is largely as a result of husbandry practices rather than an entirely natural maturational process in young thoroughbreds.

There were some gender differences found within the two sectors. Within flat-bred foals, but not yearlings, it was found that colts were more likely than fillies to show escape behaviours in the auction ring. Gender is not usually considered in equine studies and where a gender breakdown of subjects is given there is often no corresponding analyses (e.g. Momozawa *et al.*, 2003; Visser *et al.*, 2001). Visser *et al.* (2003) did report some gender differences in reactivity on a performance test but this was with three-year-old showjumpers in training rather than with foals or yearlings. Interestingly, however, the gender difference they reported was that geldings refused to jump significantly more than fillies though there was no reason evident as to why this should be.

Refusing to jump could be interpreted as an escape behaviour and so the finding that flat-bred colt foals were more likely than flat-bred filly foals to show escape behaviours in the auction ring may be related, though, as stated above, this effect was not apparent in the yearlings.

Within national hunt-bred foals, fillies were more likely than colts to whinny in the auction ring. Again, this gender difference was not found amongst the yearlings though yearling national hunt fillies were the most likely of the national hunt-bred yearlings to freeze in the ring. Vocalisation rates increase as an animal is motivated to make contact with conspecifics (McDonnell, 2003) but in a weaned foal or yearling that has been learning, due to husbandry practices, to become more independent, vocalising when faced with a stressful situation can be a sign of immaturity. Freezing behaviour shown in the auction ring, as noted above, is also a sign of immaturity and so the findings within national hunt stock suggest that fillies are less mature psychologically than colts or geldings.

This can potentially be explained through differences in stockperson attitudes to the young animals - attitudes towards the animals can influence their behaviour (Hemsworth & Coleman, 1998). Within flat racing circles both fillies and colts compete at the highest levels. In Europe the fillies will often race against the colts in the best races and there is now a considerable number of extra top level races restricted to their gender. In America and Canada, in contrast, fillies rarely ever race against the colts - with such a comprehensive racing programme open to fillies only, there is little need for them to be pitched into open company. In national hunt racing, however, there are very few fillies or mares that reach the highest levels of competition - historic Gold Cup heroine Dawn Run and Champion Hurdle winner Flakey Dove are rare examples. As a result, young national hunt males are viewed as being considerably more valuable than young national hunt females - this is also obvious from a look at the sales returns for any such national hunt auction. Some national hunt fillies are never even broken to saddle and 'retire' to stud unraced. If the stockperson responsible for the care of a national hunt filly foal or yearling views his/her charge as being unlikely to succeed as a racehorse, he/she may be less motivated to provide the young animal with the necessary teaching and handling. Hence, the young national

hunt filly may be more likely than the colts or geldings to show signs of immaturity while in the auction ring.

In summary, horses being aimed at the flat racing sector rather than the national hunt sector are often managed for moderate to rapid growth. This can result in the risk of the young horse developing the orthopaedic developmental disorder known as osteochondrosis (OCD), an abnormal growth of bone and cartilage that may result in horses as young as two having to undergo surgery for the removal of bone chips in their joints, typically the knees. Managing for physical precocity also appears, from the findings presented here, to have implications for psychological maturity with national hunt-bred stock, which are typically not even broken to saddle until they are three or four years old, showing greater signs of immaturity than their flat-bred counterparts in the auction ring. There also appear to be some minor gender differences within the two sectors, rather than between them, and these too may reflect aspects of husbandry practices.

The auction ring studies presented in Chapters 4 and 5 are the first to use a practical, commonly experienced situation as a form of novel situation or arena test. Much of the published literature on behavioural reactivity in horses (e.g. Momozawa *et al.*, 2003; Visser *et al.*, 2003; Seaman *et al.*, 2002; Visser *et al.*, 2001) used artificial situations as the test material and these often involve stimulus situations such as the dropping of an open umbrella in front of a horse that is alone in an arena, or noting its responses to rotating balloons that are suspended from the ceiling. These types of tests may indeed enable a reliable measure of reactivity in a horse but they can hardly be said to reflect the type of situation the horse may encounter in the course of its normal life. Seaman *et al.* (2002) concluded that horses vary widely on how they respond to artificial behaviour tests though they suggested that an open field/arena test does appear to be useful in identifying core temperamental traits in the species.

The auction ring studies also make an important contribution in highlighting that there can be marked differences in how animals of the same breed can show differences in behavioural reactivity, possibly as a result of management practices and quality of human-animal interaction and learning opportunities

provided to the animals. Most equine studies are based on horses of varying breeds (exceptions include: Houtp & Kusunose, 2000; Wolff *et al.* 1997; Wolff & Hausberger, 1994), even though temperament and behaviour differences have been reported in different equine breeds (e.g., Houtp & Kusunose, 2000).

7.3 Research Question Three

The third research question was whether behavioural reactions shown by a yearling in the auction ring can be predicted from the behavioural reactions it shows, as a foal, during its first experience of the auction ring (Chapter 5). When Visser *et al.* (2001) compared behavioural responses, on both a handling test and a novel object test, of 41 Dutch Warmblood yearlings they found that only 'flightiness' proved to be consistent with how they had scored on the same tests as a foal. The analyses comparing the scores of horses who were assessed in the auction ring as both a foal and as a yearling were presented in Chapter 5 and only looked at the total number of behavioural responses rather than at the types of responses shown. It was found that the yearling score of more than three-quarters (75.7%) of the doubly-assessed animals was within ± 5 of what they had scored as a foal and that there was a significant linear relationship, after outliers were removed, between overall foal scores and yearling scores ($r_s=.238$; $N=407$; $p<.001$). With an R^2 value of .0566, however, this suggests that the foal score predicts less than 6% of the variance in the yearling score.

The overall range in scores was from -25 to +17, suggesting that while a large proportion of yearlings will produce a similar number of behavioural responses in the ring as they did when they were foals, it cannot be predicted, with any certainty, which animals will be amongst them. Age, however, appears to be a factor as it was found that the change in score increased as the yearling was older ($r_s=.15$; $N=438$; $p<.01$). This change in score was due to the significant relationship found between increasing age (based on age group in months) and a decrease (based on mean rank scores) in vocalisation ($r_s=-.829$; $N=6$; $p<.05$), freezing behaviours ($r_s=-.943$; $N=6$; $p<.01$), locomotory behaviours ($r_s=-.943$; $N=6$; $p<.01$) and, necessarily, total reactivity score ($r_s=-.943$; $N=6$; $p<.01$). A reduction in these behaviours performed in the auction ring reflects a growing maturity in the animal, as vocalisation reflects a need or motivation to communicate with conspecifics (McDonnell, 2003), while

freezing and locomotory behaviours suggest inexperience and that the animal may not yet developed the level of trust in its caregiver that others have done.

Seaman *et al.* (2002) reported that there was no relationship between how a group of 33 horses performed in three different but typical behavioural response tests - an arena test, respond to person test and respond to object test. They concluded that horses vary widely in how they respond to artificial tests though they found that the animals did show consistency between the repeated trials on the arena test, thereby suggesting that this form of assessment may be useful in identifying core temperament traits in a horse.

The foals and yearlings in the auction ring studies were presented with a real-life situation rather than a contrived experiment and yet there appeared to be considerable variation in how some of them responded on the two occasions. There are some potential explanations for this. Firstly, this was not an experimental group of animals living and working in controlled conditions but an observation of more than 3000 individual animals who just happened to be consigned to the auction on any given day. Therefore, it is unknown what sort of experiences they had encountered between the two assessment periods. They may have had to travel on several occasions and possibly over considerable distances, been moved around to different yards or farms, experienced a number of stressful veterinary procedures, poor health, negative human-animal interaction or acquired some maladaptive behaviour patterns, for example. Alternatively they may have experienced a more positive and enriching year between their two auction ring appearances than they had in the time before their first assessment. There is, clearly, an enormous potential for confounding variables. However, it would certainly be worth applying this method of assessment to a smaller and controlled experimental group to see if the relationships found are stronger.

Another reason why there may have been such variation between foal and yearling scores is the venue in which the assessments took place. Many of the yearlings were auctioned at a different venue to the one in which they had been assessed as a foal. It is possible, therefore, that the environments may have appeared different enough to the animal, who was being presented with these two situations nearly a year apart, that this had the effect of making

them seem like two unrelated situations. If so, this could mirror what Seaman *et al.* (2002) found with regard to an inconsistency in behavioural responses between different tests. The auction ring in Newmarket, for example, is much larger and brighter than the one in Goffs. It is a larger oval with an entrance at one end and exit at the other; there is a single entrance/exit in Goffs. Also, while both venues have loudspeakers in operation continuously throughout the auction, the bid-spotters in Newmarket do not shout or wave their arms about in the over-enthusiastic manner displayed by some of the bid-spotters in Goffs. The relative position of the rostrum to the spotters' locations in Newmarket makes this sort of behaviour, designed to attract the auctioneer's attention, unnecessary. In addition to an extra source of sudden noise and movement, the spotters at Goffs have occasionally been seen to accidentally strike the passing foal or yearling.

Thirdly, there was a year between the two testing sessions and so experiences connected with going through an auction ring as a foal may not have generated any long-term learning. Some horses do sometimes learn in a single trial (McDonnell, 1999; Kiley-Worthington, 1997) but this does not always happen. Also their initial experience may have been sufficiently stressful to impair learning - stress negatively effects the cognitive processes (e.g. Arnsten & Goldman-Rakic, 1998; Ewan & Sapolsky, 1995). Alternatively the initial experience may have been so unremarkable to the animal that its motivation to learn something from the experience may not have been high. The nature of the study made it impossible to assess the animals at any other time and, as noted above, it was impossible to control for any potential confounding variables.

In summary, the findings suggest that while there is a significant relationship between the behavioural reactivity of an auction ring yearling and the way it behaved as a foal, the predictive power of the relationship is weak. There are, however, a number of potential confounding variables, particularly as the subjects were not part of a controlled experimental group and, therefore, it is unknown what sort of life experiences they have had in the year between testing sessions. The fact that many of the yearlings were auctioned at a different venue the previous year may have been a factor as, potentially, might

have been the year-long gap between the two testing sessions. A number of factors may have led to little or nothing having been learned during their first encounter with the auction ring. The findings, however, contribute to prior research in that they show that there is a relationship between how a young thoroughbred will respond in two trials, spaced a year apart, on the same type of non-contrived arena test. This suggests that their behavioural responses reflect some underlying temperamental trait(s).

7.4 Research Question Four

The fourth research question concerned whether temperamental traits in two-year-old racehorses, as assessed by their primary caregivers, could be predicted from how they responded to what are typically stress-provoking stimuli as a foal and/or as a yearling, namely being separated from their dam during covering and/or going through the auction ring as either a foal or as a yearling. Unfortunately there were insufficient numbers of separation study subjects, for whom questionnaires were returned, in order to be able to perform any useful analyses. From the auction ring studies, however, results found were somewhat mixed (Chapter 6).

Neither 'friendliness', as rated by handlers, nor stereotypy development, for example, could be predicted from the behavioural reactivity shown by a horse in the auction ring as either a foal or a yearling, while frequent vocalisation was found to be related to whether or not a horse whinnied in the ring as a yearling but was not related to vocalisation in the ring as a foal. It was found in Chapter 5 that vocalisation decreased with age in auction ring yearlings, suggesting that this behaviour is related to levels of maturity and that two-year-olds who are whinnying frequently may also still be somewhat immature. Horses vocalise out of a need or motivation to communicate with conspecifics (McDonnell, 2003).

Auction ring locomotory ($\chi^2=6.86$; $df=2$; $p<.04$) and freezing behaviour ($\chi^2=9.96$; $df=2$; $p<.01$) of foals, but not yearlings, was related to subsequent reports of 'excitability', that is, the greater the amount of locomotory or freezing behaviours shown by the auction ring foal, the more likely it was to be rated as either 'fairly excitable' or 'very excitable' when it was a two-year-old in

training. This may prove a useful temperament guide for foal buyers, though people who purchase foals usually do so in order to sell them on the following year, hopefully for a profit, rather than to put them into training. Of course preparing a yearling for the sales is a task made somewhat easier if he/she is reasonably laid-back as, other than being more difficult to handle, highly excitable horses are harder to teach than are more laid-back individuals. Their heightened state of arousal is akin to a stress response and, as noted earlier, stress negatively affects the cognitive processes (e.g. Arnstern & Goldman-Rakic, 1998; McEwan & Sapolsky, 1995).

Freezing ($r_s=.236$; $N=93$; $p<.05$) and escape behaviours ($r_s=.290$; $N=93$; $p<.01$) shown by foals were related to the number of defensive behaviours the animal was reported as showing as a two-year-old. The number of freezing behaviours ($r_s=.205$; $N=93$; $p<.05$) shown by a foal was also related to whether or not it was reported as exhibiting any of the problem behaviours when in training. Freezing and escape behaviours represent part of the 'fight or flight' response and are shown by the immature foal who has not yet learned to trust the human handler. The fact that they were found to be related to subsequent reports of exhibiting problem behaviours suggests that these animals are still having some difficulty coping with stressful situations. Whether this is due to immaturity, temperamental traits or poor learning is unknown.

With yearlings the total number of defensive ($r_s=-.115$; $N=300$; $p<.05$) or locomotory behaviours ($r_s=-.168$; $N=300$; $p<.01$) exhibited in the ring and the greater their total reactivity score ($r_s=-.187$; $N=300$; $p=.001$), the less likely they were to be reported as showing any of the problem behaviours when in training as a two-year-old. The total number of problem behaviours reported was found to be related to whether or not a yearling had vocalised ($r_s=-.154$; $N=300$; $p<.01$) or shown any defensive behaviours ($r_s=-.115$; $N=300$; $p<.05$), any locomotory behaviours ($r_s=-.152$; $N=300$; $p<.01$) or either of the signs of emotionality (sweating or defecation) while in the ring ($r_s=-.125$; $N=300$; $p<.05$). These findings indicate that yearlings who exhibited these various behaviours in the auction ring were less likely to be reported with problem behaviours when in training. It would appear that they have either become more mature or, perhaps, they are horses who have an outlet for their stress other than through performance of any of the problem behaviours.

In summary, with regard to the ability of any of the auction ring measures to predict temperamental traits in two-year-olds it should be noted that the correlations in all cases were quite low, in most cases accounting for somewhere between only 1% to 8% of the variance. This suggests that while there is a relationship between how young animals respond to being in the auction ring and how their temperament and behaviour is subsequently reported when they are two-year-olds in training, one cannot reliably predict the other.

Despite this, however, the temperament study has made some important contributions in that it has, as demonstrated in Chapter 6, identified some gender differences in temperamental traits in young thoroughbred racehorses, highlighted what appears to be a somewhat alarming increase in the prevalence rate of rug-chewing, showed that inbreeding may offer some sort of 'protection' against stereotypies and found evidence to suggest that young racing thoroughbreds are fairly well-adjusted and content with their lives.

7.5 Research Question Five

The fifth research question sought to determine whether there is any evidence of potential inheritance of temperamental traits in thoroughbred horses. Several prior studies (e.g. Houpt & Kusunose, 2000; Wolff, *et al.* 1997; Wolff & Hausberger, 1994) have found tentative evidence of possible inheritance of traits through the sire but this study also sought to investigate the possibility of inheritance of traits through the distaff side of the family, through paternal grandsires or maternal grandsires, and whether or not there would be evidence to suggest that inbreeding may play a role in temperament. While there were a lot of results found to be significant at conventional levels, the sheer number of tests performed suggested caution and that more stringent significance levels be applied. Application of the more stringent levels eliminates almost every otherwise significant result from consideration and so evidence of potential inheritance of temperamental traits in thoroughbred horses is tentative at best. There is evidence, however, that the amount of inbreeding in a pedigree may offer some sort of 'protection' against the development of stereotypic behaviours.

A number of sires, paternal grandsires and broodmare sires had a significantly greater or smaller than expected proportion of their foals or yearlings scoring 0 or 1 in the different auction ring behavioural categories, though application of more stringent significance levels, to take account of the number of tests that were performed, suggested that there was no effect for any of these. Nevertheless, it was interesting that both the foals and yearlings by Josr Algarhoud contained a smaller than expected proportion of those who showed locomotory behaviours in the ring but he was the only stallion with this type of result, that is a consistent result for both his foals and his yearlings.

Of the paternal grandsires a greater than expected proportion of both the foals and the yearlings descended from Danzig vocalised in the ring, a smaller than expected proportion of all those by Darshaan stallions either sweated or defecated in the ring. All three stallions (Danzig, Darshaan and Josr Algarhoud) are flat sires. Interestingly Josr Algarhoud is a son of Darshaan. Of the female and male families the only one with a consistent result with both their foals and yearlings was 'male' family 4, which had a smaller than expected proportion of its representatives who whinnied in the ring.

The afore mentioned studies that found tentative evidence of genetic inheritance of traits in horses reported their findings based on conventional significance levels. In Wolff and Hausberger (1994) and Wolff *et al.* (1997) there was a small number of subjects and tests so such considerations were unnecessary. In Houpt and Kusunose (2000), however, there were over 9000 horses involved and they represented more than 60 individual stallions. Even so findings were reported based on conventional significance levels. Had the current study accepted conventional significance levels there would have been at least one significant result to report for each of 48 sires, paternal grandsires, broodmare sires, female families or male families of foals (Chapter 4), and for 61 sires, paternal grandsires, broodmare sires, female families or male families of yearlings (Chapter 5).

With only 395 subjects in the temperament study (Chapter 6) there was insufficient representation of most sires, paternal grandsires and broodmare sires to be able to conduct any analyses. Of the few who did have sufficient

numbers, there was evidence found that suggested one (of two) sire, seven out of 14 paternal grandsires, the only broodmare sire with sufficient numbers, six female families and five 'male' families may be transmitting some traits to their progeny. The numbers of tests performed, however, suggested that these may all have occurred by chance.

The findings with regard to inbreeding were somewhat unexpected. Inbreeding studies normally use Wright's Coefficient of Inbreeding but, as explained in Chapter 2, this is not suitable for use with the pedigrees of thoroughbred horses. Most published studies have also tended to focus on physical features and traits rather than psychological ones. The method developed for the purposes of this thesis was the Pedigree Diversity Score (PDS), which represented the number of different animals present within the first five or four generations of a pedigree. There is a notion amongst some in the thoroughbred industry, though seemingly no evidence to confirm or deny the position, that the more inbred a horse is the more highly reactive it will be. This was supported by some of the auction ring findings.

In foals, although vocalisation decreased as a pedigree became more inbred within five generations, escape behaviours increased. When the pedigrees of the foals were examined to four generations it was found that both defensive and escape behaviours increased as the amount of inbreeding increased (Chapter 4). In yearlings freezing behaviours increased as inbreeding within five generations increased while within four generations both freezing behaviours and signs of emotionality were found to increase as inbreeding increased (Chapter 5). Defensive, escape and freezing behaviours are all part of the 'fight or flight' stress response. It was found, in the earlier chapters, that these behaviours tended to be less evident as the animals got older, suggesting that their performance was a sign of immaturity. With the more inbred foals and yearlings more likely to have exhibited these behaviours in the auction ring, this suggests that inbreeding in thoroughbred horses may indeed effect temperament and behaviour.

However, in the temperament study (Chapter 6) it was found that those two-year-olds whose pedigrees were most inbred within either five or four generations, showed no stereotypic behaviours and almost none of the

problem behaviours. This is a potentially important finding but it suggests that perhaps the more inbred foals and yearlings just take a little longer than less inbred, or outcross animals, to reach the level of maturity whereby they are less likely to resort to 'fight or flight' behaviours at a time of stress.

So, in summary, while the evidence for potential inheritance of temperamental traits in thoroughbred horses is tentative at best, there is evidence to suggest that the amount of inbreeding in a pedigree, as measured by the PDS score, may be important. Foals and yearlings who have the more inbred pedigrees are more likely than less inbred individuals to resort to 'fight or flight' behaviours in the auction ring but two-year-olds with the most inbred pedigrees were found to have no reported stereotypies and almost no problem behaviours. This is an important contribution to the previous literature on the subject of inbreeding in animals.

7.6 Summary of the Main Findings

This thesis produced a number of interesting findings but the main ones were in the form of answers to the five research questions posed. These findings are as follows:

1. Accompanying a preweaned foal while it is separated from its dam during covering reduces the behavioural signs of distress exhibited.
2. Management practices that appear to be responsible for the physical differences evident in flat-bred foals and yearlings compared to national hunt-bred foals and yearlings, may also be responsible for the apparent earlier (than national hunt stock) psychological maturity of flat-bred stock.
3. There is a significant relationship between the behavioural reactivity shown by an auction ring yearling and the amount of behavioural reactivity it showed in the ring as a foal, though, probably due to a number of potentially confounding variables, the predictive power of the relationship is weak.
4. Some temperamental traits of two-year-olds in training may be predicted from aspects of the behavioural reactivity they showed in the auction ring

as a foal or as a yearling, though the predictive power of the relationship is weak.

5. The evidence for inheritance of traits through stallions, paternal grandsires, broodmare sires, female families and 'male' families is tentative at best but there is evidence to suggest that the level of inbreeding in a pedigree, as measured by the PDS score, may influence temperament development in young thoroughbred horses.

7.7 What are the Implications for the Well-being of Young Thoroughbreds?

Four issues related to well-being also emerged from the results of the various studies conducted in this thesis and these are as follows:

1. Forcibly separating a preweaned foal from its dam when she is being sent to the stallion yard causes considerable distress in the foal. More than half of the 'isolated' group studied engaged in self-harm behaviours during this period of separation while none of those in the 'accompanied' group did so.
2. Some foals and, to a lesser extent, yearlings find the process of going through the auction ring to be very stressful, if one judges from the number of behavioural reactions they show in the ring. Perhaps it would be possible to find a different way of exhibiting them that would be less stressful.
3. Though stereotypy rates were in keeping with those reported in other studies, a somewhat alarming 19% of horses for whom temperament questionnaires were returned were said to be rug chewers. This contrasts sharply with a prevalence rate of just 8.9% reported by Prince (1987).
4. The evidence suggests that most young thoroughbred racehorses are laid-back, well-adjusted and content with their lives.

A simple intervention, having a handler remain quietly with the foal during the time its mother was gone to the stallion yard, significantly reduced the behavioural signs of distress and eliminated performance of self-harm behaviours. The self-harm typically comes in the form of charging into a door or wall but there was one other foal observed for whom recording was terminated for fear she was about to break both her forelegs. The filly, the result of a €50,000+ covering fee from the previous year, had been assigned to the 'isolated' group but became so distressed after several minutes alone that she began rearing, putting her forelegs through the metal bars on the top part of the door, and then bringing her legs down with considerable force on the metal-topped lower half of the door. Observation terminated immediately and the observer entered the stall with the purpose of checking her for injury, calming her down and preventing her from doing herself any serious harm. This foal was wide-eyed, sweating heavily, hyperventilating, trembling, whinnying with great frequency and, at first, appeared to not even notice the handler. It took about ten minutes just to calm her down enough that she stopped trying to charge into the door (through the handler) and a further five minutes or so before she would stand reasonably calmly beside the handler. Luckily the only physical damage this expensively-produced foal sustained was lacerations to her face, muzzle, chest, knees and legs: had there been no intervention she could have broken both her forelegs.

This filly foal produced the most violent reactions to her separation of all the foals observed but she was not the only one to sustain injuries or to work herself into such an exhausting frenzy. One 'isolated' group colt charged the door 67 times during his period of separation, sustaining numerous lacerations in the process. Another 'isolated' filly flung herself about to the point of near exhaustion, got her second wind and started flinging herself about again until the mare was returned. If stud farms choose to separate the mare and foal when the mare is to be covered then it is recommended that a calm and empathetic staff member remain with the foal.

Some yearlings showed a strongly aversive reaction to being brought into the auction ring but some of the most distressed animals were foals. These animals gave all the signs of being absolutely terrified and their situation was often not helped by the actions of the handler leading them around the ring or

the interference of bystanders. Pulling, slapping, poking in the ribs, waving catalogues, hitting the passing foal's rump with a brush, hand or catalogue or firing gravel at it may have the effect of making the foal jump forward but these actions have probably just confirmed the animal's fears that this is a frightening and aversive place to be. More work clearly needs to be done in training these animals - and I stress that they are in the minority - so that they can better handle the experience. Some handlers also need to be instructed as to how a horse learns and shown that some of these methods of 'showing him who's boss' and 'not letting him get away with it' are potentially doing more harm than good.

A surprising 19% of horses for whom questionnaires were returned were reported to chew their rug. As discussed in Chapter 6, this behaviour is a rather costly one for the owner or trainer but, more importantly, it speaks of a problem the horse is having. This may be cutaneous irritation, in which case alternative forms of clothing should be investigated, or it may be a sign of boredom, in which case some form of environmental enrichment should be provided. Colts were the most likely to perform the behaviour, just as stallions are most likely to engage in self-mutilation (Dodman *et al.* 1994), a disorder to which rug chewing has tentatively been linked (Marsden, 1999). If so, perhaps there is a veterinary problem causing the behaviour. As with all problem behaviours, the issue needs to be investigated rather than just accepted.

As stated above, despite the initial impression one could get about the well-being of young racehorses from the factors that were extracted following analysis of the questionnaire, 38% of the 395 animals surveyed were reported as showing none of the 20 non-scaled behaviours while a total of 83.7% showed no more than one of the 20. The majority of young racehorses, therefore, appear to be fairly laid-back, well-adjusted and content with their lives.

7.8 An Integrative Framework

Although there is a considerable amount of biologically-based work on equine behaviour the focus of this thesis has been psychological. It is recommended, however, that the most complete approach to the study of equine behaviour is

to work within an integrative framework. This framework is simple: biological, psychological and social factors are integrated, with behaviour just the tip of the iceberg, the part we can see (Figure 7.1). There is some overlapping between the three perspectives as biological, psychological and social factors influence each other.

Figure 7.1: A biopsychosocial approach to equine behaviour

Within the biological side are aspects such as physiology, biochemistry, physical health and genetics. Within the social side are aspects such as human-animal interaction, life experience and circumstances and intraspecies relationships, while within the psychological side are aspects such as temperament, learning, stress, and so on. Using stereotypies as an example of behaviour, the biological side may talk about the involvement of endogenous opioids (e.g. Pell & McGreevy, 1999), a genetic susceptibility to stress (e.g. Vecchiotti & Galanti, 1986), changes in thermal threshold, heart rate, plasma B-endorphin and serotonin (e.g. Lebelt, Zanella & Unshelm, 1998) or excess acid production (e.g. Mills & MacLeod, 2002). The psychological side may talk about stress and coping mechanisms and

frustration (e.g. Kiley-Worthington, 1987) or about the potential role of operant conditioning in the development of abnormal behaviour patterns. The social side may talk about housing and management (e.g. Bachmann *et al.*, 2003) or the effects of human-animal interaction (e.g. Hemsworth & Coleman, 1998). The integrated approach will look at all sides.

7.9 Limitations and Strengths of the Studies

The studies presented in this thesis represent discrete investigations in themselves but also come together as a somewhat complex whole that looks at how a number of variables may related to behavioural reactivity and temperament in young thoroughbred horses. As one might expect, there were also some limitations or difficulties encountered:

- (i) The number of foals assessed during the separation study was sufficient for analysis in itself but was too small to enable adequate follow-up of subjects - quite a few of the subjects were either homebreds (therefore not going to go through the ring) or went abroad, for example, while at least one or two of them died before the temperament study. The small numbers were partly due to the travel restrictions imposed during the foot and mouth crisis of 2001 - hence the tiny number of three-year-olds involved in the final study.
- (ii) With the auction ring studies there was no way to control for prior life experiences of the animals, or differences in handling practices, or feed regimens, or how the animal was handled in the ring - particularly in the case of those who panicked, or outside interference from those who chose to wave catalogues or hit or chase the (usually) foals.
- (iii) Similarly, with the horses in training there was no way to control for prior life experiences of the animals, or differences in handling practices, or feed regimens, or training regimens, or the level of work the horse was doing.
- (iv) Most questionnaire studies have inherent limitations in that one has to rely on the honesty of the respondents. This could have been particularly pertinent with regard to reports of stereotypic and/or problem behaviours

in Chapter 6 - presence of stereotypies has been shown to reduce the horse's perceived value. There is also a difficulty with regard to return rates - the questionnaire was sent out for completion during Classic and Classic trial season, a very busy time - though a return rate of 25% for this study exceeded expectations.

However, the merits of the studies far outweigh the limitations and they also broke new ground or had strength in that:

- (i) There was the first investigation of what happens to preweaned thoroughbred foals when they are left alone in a stable when their dam has been sent for covering.
- (ii) The behavioural reaction test selected represented a real life experience, happening in real time, and which thousands of young thoroughbreds go through each year.
- (iii) Rigorous methodological procedures were consistently applied.
- (iv) The nature of the auction ring study meant that a single observer could assess over 3700 individual animals, both providing ample numbers for statistical analyses and follow-ups. The same person also did all the data entry and data analyses.
- (v) All the animals studied were of the one breed, thereby enabling an extensive series of bloodlines analyses and eliminating any concern with regard to breed differences confounding results.
- (vi) A simple method of calculating inbreeding that is applicable to the pedigrees of thoroughbred horses was developed after it had been shown that established methods of inbreeding calculation are not suitable.

7.10 Potential Applications of the Findings of this Thesis and Directions for Future Research

Clearly the most important potential application of findings from this thesis is to ensure that, on farms where the foal cannot be brought to the stallion yard to stay with the mare when she is being covered, a quiet, patient and empathetic handler will stay with the foal for the duration of the separation period. The distress experienced by the foals who are just shut into a stable by themselves is considerable and, if it hasn't happened somewhere already, it is surely only a matter of time before a foal sustains serious or life-threatening injuries during this period.

As some behavioural responses shown in the auction ring by a foal and/or a yearling have been shown to be related to some temperamental traits reported when the animal is a two-year-old in training, it may also be possible to link some of these responses to racing performance, just as Visser *et al.* (2003) found some temperamental traits could predict future showjumping performance.

It was hoped to be able to investigate potential links between how foals handled the separation experience and how their temperament was assessed when two-year-olds in training. Unfortunately only five questionnaires were received for separation study subjects. Repeating the separation study with a greater number of foals may make it possible to get enough responses, two years later, for statistical purposes.

There is some tentative evidence of inheritance of traits through sire lines. By assessing the temperament and behaviour of individual stallions and then assessing that of their offspring, more conclusive results may be found. There is, after all, a considerable amount of anecdotal evidence to suggest that some traits, particularly aggression, are inherited through the sire or sire line in thoroughbred horses.

Results from the temperament questionnaire study suggest that the amount of inbreeding in a horse's pedigree may somehow 'protect' it from developing stereotypies. This clearly warrants further investigation. A good place to start

would be to record all the thoroughbred horses, of any age, who have gone through the auction ring in, say, the past decade (to get enough numbers) and who were declared as having one or more stereotypies. Their pedigrees can then be analysed to see if this inbreeding effect is robust.

7.11 Concluding Remarks

This thesis assessed behavioural reactivity and ensuing temperamental traits in young thoroughbred racehorses (*Equus caballus*) and produced a number of potentially valuable findings, both for the horse and for the racing and bloodstock industry, as well as highlighting some important issues with regard to well-being and providing some clear directions for future research.

References

- Alexander, G., Stevens, D. & Bradley, L.R. (1987). Fostering in sheep: fostering lambs onto ewes whose lambs have died soon after birth. *Australian Journal of Experimental Agriculture*, 27, 765-769.
- Allen, J.P., Allen, C.F., Greer, M.A. & Jacobs, J.J. (1973). Stress-induced secretion of ACTH. In A. Brodish & E.S. Redgate (Eds.) *Brain-Pituitary-Adrenal Interrelationships*. pp99-127. Basel: Karger.
- American Psychiatric Association (1994). *Diagnostic and Statistical Manual of Mental Disorders*. (4th Ed.) Washington, DC: American Psychiatric Association.
- Appleby, M.C. (1984). Factors affecting floor laying by domestic hens: a review. *World Poultry Science Journal*, 84, 241-247.
- Arnsten, A.F.T. & Goldman-Rakic, P.S. (1988). Noise stress impairs prefrontal cortical cognitive function in monkeys. *Archives of General Psychiatry*, 55, 362-368.
- Askew, H.R. (1996). *Treatment of behaviour problems in dogs and cats*. Oxford: Blackwell Science.
- Bachmann, I., Audige, L. & Stauffacher, M. (2003). Risk factors associated with behavioural disorders of crib-biting, weaving and box-walking in Swiss horses. *Equine Veterinary Journal*, 35(2), 158-163.
- Baker, K.C. (2004). Benefits of positive human interaction for socially housed chimpanzees. *Animal Welfare*, 13, 239-245.
- Baker, K., Blooms Smith, M., Griffis, C. & Gierhart, M. (2003). Self-injurious behaviour and response to human interaction as enrichment in rhesus macaques. *American Journal of Primatology*, 40, 283-291.
- Ball, S., Simpson, H. & Howard, J. (2001). *Emotional Healing for Horses and Ponies*. Saffron Walden, Essex: The C W Daniel Company Ltd.

- Bandura, A., Cioffi, D., Taylor, C.B. & Brouillard, M.E. (1988). Perceived self efficacy in coping with cognitive stressors and opioid activation. *Journal of Personality and Social Psychology*, 55, 479-88.
- Barnosky, A.D., Koch, P.L., Feranec, R.S., Wing, S.L. & Shabel, A.B. (2004). Assessing the causes of Late Pleistocene extinctions on the continents. *Science*, 306(5693), 70-75.
- Bayley, L. (2002). *What is my horse thinking?* London: Hamlyn.
- Bayne, K.A., Dexter, S.L. & Strange, G. (1993). The effects of food treat provisioning and human interaction on the behavioural well-being of rhesus monkeys (*Macaca mulatta*). *Contemporary Topics in Laboratory Animal Science*, 32, 6-9.
- Beattie, V.E., Walker, N. & Sneddon, I. (1995). Effect of past experience on later behaviour. In S.M. Rutter, J. Rushen, H.D. Randle & J.C. Eddison (Eds.) *Processings of the 29th Interntional Congress of the International Society for Applied Ethology*, 3-5 August 1995, Exeter, UK. Universities Federation for Animal Welfare.
- Bell, R.J. & Bristol, F. (1987). Fertility and pregnancy loss after delay of foal estrus with progesterone and estradiol-17 β . *Journal of Reproductive Fertility*, 35, 667-668.
- Blecha, F. (2000). Immune System Response to Stress. In G.P. Moberg & J.A. Mench (Eds.) *The Biology of Animal Stress: Basic Principles and Implications for Animal Welfare*. pp111-121. Wallingford: CABI Publishing.
- Boakes, R. & Panter, D. (1985). Secondary imprinting in the domestic chick blocked by previous exposure to a live hen. *Animal Behaviour*, 33, 353-365.
- Bobinski, K. & Zamoyski, S. (1953). *Family Tables of Racehorses*. London.

Boissy, A. & Le Neindre, P. (1997). Behavioral, cardiac and cortisol responses to brief peer separation and reunion in cattle. *Physiology and Behavior*, 61, 693-699.

Breuer, K., Coleman, G.J. & Hemsworth, P.H. (1998). The effect of handling on the stress physiology and behaviour of nonlactating heifers. *Proceedings of the Australian Society for the Study of Animal Behaviour, 29th Annual Conference Palmerston North, New Zealand*. pp8-9. Massey University, NZ: Institute of Natural Resources.

Broom, D.M. (1991). Assessing welfare and suffering. *Behavioural Processes*, 25(2-3), 117-123.

Broom, D.M. & Johnson, K.G. (1993). *Animal Stress and Welfare*. London: Chapman & Hall.

Bubnalittitz, H., Weinberger, H. & Windischbauer, G. (1995). Determination of the upper auditory threshold in horses by operant conditioning. *Wein Tierarztl. Monatsschr*, 82, 259-263.

Budd, J. (1996). *Reading the Horse's Mind*. Gloucestershire: Ringpress Books Ltd.

Budiansky, S. (1997). *The Nature of Horses: Their Evolution, Intelligence and Behaviour*. London: Phoenix.

Burrow, H. (1998). The effects of inbreeding on productive and adaptive traits and temperament of tropical beef cattle. *Livestock Production Science*, 55, 227-243.

Cabib, S. (1993). Neurobiological basis of stereotypies. In A.B. Lawrence & J. Rushen (Eds.) *Stereotypies: fundamentals and applications to welfare*. pp119-145. Oxford: CAB International.

- Colborn, D.R., Thompson, D.L., Jr Roth, T.L., Capehart, J.S. & White, K.L. (1991). Responses of cortisol and prolactin to sexual excitement and stress in stallions and geldings. *Journal of Animal Science*, 69, 2556-2562.
- Colman, A.M. (2003). *A Dictionary of Psychology*. Oxford: Oxford University Press.
- Cooper, J.J. & Nicol, C.J. (1996). Stereotypic behaviour in wild caught and laboratory bred bank voles (*Clethrionomus glareolus*). *Animal Welfare*, 5, 245-257.
- Cooper, J.J. (1998). Comparative learning theory and its application in the training of horses. *Equine Veterinary Journal Supplement*, 27, 39-43.
- Cooper, S.J. & Dourish, C.T. (Eds.) (1990). *Neurobiology of Stereotyped Behaviour*. Oxford: Clarendon Press.
- Corstall, A. (1993). How Lloyd Morgan's canon backfired. *Journal of the History of the Behavioural Sciences*, 29, 113-122.
- Costa, P.T. & McCrae, R.R. (1992). *Revised NEO Personality Inventory (NEO-PI-R) and NEO Five Factor Inventory (NEO-FFI) professional manual*. Odessa, FL: Psychological Assessment Resources.
- Costa, P.T. & McCrae, R.R. (1999). A Five-Factor Theory of Personality. In L.A. Pervin & O.P. John (Eds.) *Handbook of Personality: Theory and Research*. (2nd Ed.) pp139-153. New York, NY: Guilford Press.
- Creighton, E. (2004). Matching horses for courses: development of robust tests of equine temperament to address equine welfare. Proceedings of the UFAW International Symposium 'Science in the Service of Animal Welfare', Edinburgh, 2003. *Animal Welfare*, 13, S239.
- Cronin, G.M., Wiepkema, P.R. & van Ree, J.M. (1985). Endogenous opioids are involved in abnormal stereotyped behaviours of tethered sows. *Neuropeptides*, 6(6), 527-530.

Dantzer, R. (1986). Behavioural, physiological and functional aspects of stereotyped behaviour: a review and a re-interpretation. *Journal of Animal Science*, 62, 1776-1786.

Darwin, C. (1871). *The decent of man and selection in relation to sex*. (Vol .2) London: J Murray.

De Passillé, A.M., Rushen, J., Ladewig, J. & Petherick, C. (1996). Dairy calves' discrimination of people based on previous handling. *Journal of Animal Science*, 74, 969-974.

De Waal, F.B.M. & Tyack, P.L. (Eds.) (2003). *Animal social complexity: intelligence, culture, and individualized societies*. Cambridge, Mass: Harvard University Press.

Dinkel, C.A., Anderson, L.M., Parker, W.R. & Trevillyan, W.R. (1972). Effects of inbreeding on fertility and livability in beef cattle. *Journal of Animal Science*, 35, 725-729.

Dodman, N.H., Normile, J.A., Shuster, L. & Rand, W. (1994). Equine self-mutilation syndrome (57 cases). *Journal of the American Veterinary Medicine Association*, 204, 1219-1223.

Dodman, N.H., Shuster, L., Court, M.H. & Dixon, R. (1987). An investigation into the use of narcotic antagonists in the treatment of a stereotypic behaviour pattern (crib-biting) in the horse. *American Journal of Veterinary Research*, 48, 311-319.

Dodman, N.H., Shuster, L., Court, M.H. & Patel, J. (1988). Use of a narcotic antagonist (nalmefene) to suppress self-mutilation behaviour in a stallion. *Journal of the American Veterinary Medicine Association*, 192, 1585-1587.

Dunn, A. (1988). Nervous system-immune system interaction: an overview. *Journal of Receptor Research*, 8, 589-607.

Dwyer, C.M. (2004). How has the risk of predation shaped the behavioural responses of sheep to fear and distress? *Animal Welfare*, 13, 269-281.

Dyson, S. (1987). The Joints. In P.D. Rossdale (Ed.) *Veterinary Notes for Horse Owners*. (17th Ed.) pp172-205. London: Stanley Paul. First edition by M.H. Hayes, 1877.

Ecranbrack, S.K. & Knight, A.D. (1993). Ten-year linear trends in reproduction and wool production among inbred and non inbred lines of Rambouillet, Targhee and Columbia Sheep. *Journal of Animal Science*, 71, 341-354.

Epstein, R. (1987). Reflections on thinking in animals. In G. Greenberg & E. Tobach (Eds.) *Cognition, language and consciousness: Integrative levels*. Hillsdale, NJ: Lawrence Erlbaum.

Epstein, R. (1998). Anthropomorphism. In G. Greenberg & M.M. Haraway (Eds.) *Comparative Psychology: A Handbook*. pp71-73. New York: Garland Publishing Inc.

Fitzwygram, F. (1911). *Horses and Stables*. (5th Ed.) London: Longmans, Green & Co.

Ford, B.J. (1999). *Sensitive Souls: Senses and Communication in Plants, Animals and Microbes*. London: Little, Brown & Company.

Fraser, A.F. (1980). *Farm Animal Behaviour*. (2nd Ed.) London: Baillière Tindall.

Fraser, A.F. (1992). *The Behaviour of the Horse*. Wallingford: CABI Publishing.

French, J.M. (1993). Assessment of donkey temperament and the influence of home environment. *Applied Animal Behaviour Science*, 36, 249-257.

Galef Jr., B.G. (1996). Introduction. In C.M. Heyes & B.G. Galef, Jr (Eds). *Social Learning in Animals: The Roots of Culture*. San Diego, CA: Academic Press Inc.

Garcia, J. & Riley, A.L. (1998). Conditioned Taste Aversions. In G. Greenberg & M.M. Haraway (Eds.) *Comparative Psychology: A Handbook*. pp549-561. New York: Garland Publishing Inc.

Gibbs, P.G. & Cohen, N.D. (2001). Early management of race-bred weanlings and yearlings on farms. *Journal of Equine Veterinary Science*, 21(6), 279-283.

Gosling, S.D. & Bonnenburg, A.V. (1998). An integrative approach to personality research in anthrozoology: ratings of six species of pets and their owners. *Anthrozoös*, 11, 148-156.

Hahn, C.N., Mayhew, I.G. & Mackay, R.J. (1999). Diseases of the Forebrain. In P.T. Colohan, J.G. Mayhew, A.M. Merritt, & J.N. Moore, (Eds.) *Equine Medicine and Surgery - Volume I*. (5th Ed.) pp904-913. St Louis, MI: Mosby Inc.

Hanggi, E.B. (1999). Categorisation learning in horses (*Equus caballus*). *Journal of Comparative Psychology*, 113(3), 243-252.

Hanggi, E.B. (2003). Discrimination learning based on relative size concepts in horses (*Equus caballus*). *Applied Animal Behaviour Science*, 83, 201-213.

Hardiman, J. (2000). Coefficient of Inbreeding: An investigation into Wright's Equation and Hardiman's Method. <http://www.highflyer.supanet.com/coefficient.htm>. (accessed August 2004)

Harlow, H.F. (1961). The development of affectional patterns in monkeys. In B.M. Foss (Ed.) *Determinants of Infant Behaviour*. London: Methuen.

Harlow, H.F. & Harlow, M.K. (1962). Social deprivation in monkeys. *Scientific American*, 207(5), 136-146.

- Harlow, H.F. & Zimmerman, R.R. (1959). Affectional responses in infant monkeys. *Science*, 130, 421-432.
- Heird, J.C., Lennon, A.M. & Bell, R.W. (1981). Effects of early experience on the learning ability of yearling horses. *Journal of Animal Science*, 53, 1204-1209.
- Hemsworth, P.H. & Barnett, J.L. (1987). Human-animal interactions. *Veterinary Clinics of North America, Food Animal Practice*, 3, 339-356.
- Hemsworth, P.H. & Coleman, G.J. (1998). *Human-Livestock Interactions: The Stockperson and the Productivity and Welfare of Intensively Farmed Animals*. Wallingford: CAB International.
- Hemsworth, P.H. & Gonyou, H.W. (1997). Human contact. In M.C. Appleby & B.O. Hughes (Eds.) *Animal Welfare*. pp205-217. Wallingford, UK: CAB International.
- Henderson, J.V. & Waran, N.K. (2001). Reducing equine stereotypies using an equiball. *Animal Welfare*, 10(1), 73-80.
- Hennessy, M.B., Williams, M.T., Miller, D.D., Douglas, C.W. & Voith, V.L. (1998). Influence of male and female petters on plasma cortisol and behaviour: can human interaction reduce the stress of dogs in a public animal shelter? *Applied Animal Behaviour Science*, 61, 63-77.
- Heyes, C.M. & Galef, Jr, B.G. (Eds). (1996). *Social Learning in Animals: The Roots of Culture*. San Diego, CA: Academic Press Inc.
- Hill, E.W., Bradley, D.G., Al-Barody, M., Ertugrul, O., Splan, R.K., Zakharov, I. & Cunningham, E.P. (2002). History and integrity of thoroughbred dam lines revealed in equine mtDNA variation. *Animal Genetics*, 33, 287-294.
- Hoffman, R. (1985). On the development of social behaviour in immature males of a feral horse population (*Equus przewalski f. caballus*). *Zeitschrift Saugetierkunde*, 50, 302-314.

- Hosoda, T. (1950). On the heritability of susceptibility to wind-sucking in horses. *Japanese Journal of Zootechnical Science*, 21, 25-27.
- Houpt, K.A. (1998). *Domestic Animal Behaviour for Veterinarians and Animal Scientists*. (3rd Ed.) London: Manson Publishing Ltd.
- Houpt, K.A. (2002). Formation and dissolution of the mare-foal bond. *Applied Animal Behaviour Science*, 78, 319-328.
- Houpt, K.A. & Kusunose, R. (2000). Genetics of Behaviour. In A.T. Bowling & A. Ruvinsky (Eds.) *The Genetics of the Horse*. pp281-306. Wallingford, UK: CAB International.
- Houpt, K.A., Parsons, M.S. & Hintz, H.F. (1982). Learning ability of orphan foals, of normal foals and of their mothers. *Journal of Animal Science*, 55, 1027-1031.
- Houpt, K.A., Zahorik, D.M. & Swartzman-Andert, J.A. (1990). Taste aversion learning in horses. *Journal of Animal Science*, 68, 2340-2344.
- Johnson, R.W., Von Borell, E., Anderson, L.L., Kojic, L.D. & Cunnick, J.E. (1994). Intracerebroventricular injection of corticotropin-releasing hormone in the pig: acute effects on behavior, adrenocorticotropin secretion, and immune suppression. *Endocrinology*, 135, 642-648.
- Keeler, C.E. (1947). Coat colour, physique and temperament; materials for the synthesis of hereditary behaviour trends in the lower mammals and man. *Journal of Heredity*, 38, 271-277.
- Kiley-Worthington, M. & Randle, H.D. (2000). *Animal educational psychology: a comparative study of teaching four mammals of different mammalian species*. Okehampton: Eco Research Centre.
- Kiley-Worthington, M. (1983). Stereotypes in horses. *Equine Practice*, 5, 34-40.

Kiley-Worthington, M. (1987/1997). *The Behaviour of Horses in Relation to Management and Training*. London: J.A. Allen.

Kiley-Worthington, M. (1997). *Equine Welfare*. London: J.A. Allen.

Kusunose, R. & Sawazaki, H. (1984a). The behavioural development of thoroughbred foals and the relationship between dams and foals. *Japanese Journal of Zootechnical Science*, 55(4), 263-271.

Kusunose, R. & Sawazaki, H. (1984b). Individual differences in the behaviour of thoroughbred dams and their foal. *Japanese Journal of Zootechnical Science*, 55(4), 272-278.

Kvetnansky, R. (1980). Recent progress in catecholamines under stress. In E. Usdin, R. Kvetnansky & I. Kopin (Eds.) *Catecholamines and stress: Recent advances*. pp7-18. Amsterdam: Elsevier.

Lansade, L., Bertrand, M., Boivin, X. & Bouissou, M-F. (2004). Effects of handling at weaning on manageability and reactivity of foals. *Applied Animal Behaviour Science*, 87(1-2), 131-149.

Lazarus, R.S. & Folkman, S. (1984). *Stress, appraisal and coping*. New York, NY: Springer.

Le Scolan, N., Hausberger, M. & Wolff, A. (1997). Stability over situations in temperamental traits of horses as revealed by experimental and scoring approaches. *Behavioural Processes*, 41, 257-266.

Lebelt, D., Zanella, A.J. & Unshelm, J. (1998). Physiological correlates associated with cribbing behaviour in horses: changes in thermal threshold, heart rate, plasma B-endorphin and serotonin. *Equine Clinical Behaviour, Equine Veterinary Journal Supplement*, 27, 21-27.

Lensink, B.J., Raussi, S., Boivin, X., Pyykkönen, M. & Veissier, I. (2001). Reactions of calves to handling depend on housing condition and previous experience with humans. *Applied Animal Behaviour Science*, 70, 187-199.

- Lowe, B. (1895). *Breeding Racehorses by the Figure System*. London: Horace Cox.
- Loy, R.G. (1980). Characteristics of postpartum reproduction in mares. *Veterinary Clinics of North America: Large Animal Practice*, 2, 345-349.
- Luescher, U.A., McKeown, D.B. & Dean, H. (1998). A cross-sectional study on compulsive behaviour (stable vices) in horses. *Equine Clinical Behaviour, Equine Veterinary Journal Supplement*, 27, 14-18.
- Luescher, U.A., McKeown, D.B. & Halip, J. (1991). Reviewing the causes of obsessive-compulsive disorders in horses. *Veterinary Medicine*, 89, 527-530.
- MacKay, N. (1997). *Spoken in Whispers: The Autobiography of a Horse Whisperer*. Edinburgh: Mainstream Publishing
- Mackenzie, S.A., Oltenacu, E.A.B. & Leighton, E. (1985). Heritability estimate for temperament scores in German Shepherd dogs and its genetic correlation with hip dysplasia. *Behavioural Genetics*, 15, 475-482.
- Mackintosh, N.J. (Ed.) (1994). *Animal Learning and Cognition*. San Diego, CA: Academic Press Inc.
- MacNeil, M.D., Dearborn, D.D., Cundiff, L.V., Dinkel, C.A. & Gregory, K.E. (1989). Effects of inbreeding and heterosis in Hereford females on fertility, calf survival and preweaning growth. *Journal of Animal Science*, 67, 895-901.
- Mader, D.R. & Price, E.O. (1982). Discrimination learning in horses: Effects of breed, age and social dominance. *Journal of Animal Science*, 50, 962-965.
- Mahon, G.A.T. & Cunningham, E.P. (1982). Inbreeding and the inheritance of fertility in the thoroughbred mare. *Livestock Production Science*, 9, 743-754.
- Mal, M.E. & McCall, C.A. (1996). The influence of handling during different ages on a halter training test in foals. *Applied Animal Behaviour Science*, 50, 115-120.

- Mal, M.E., McCall, C.A., Cummins, K.A. & Newland, M.C. (1994). Influence of preweaning handling methods on post-weaning learning ability and manageability of foals. *Applied Animal Behaviour Science*, 40, 187-195.
- Mal, M.E., McCall, C.A., Newland, M.C. & Cummins, K.A. (1993). Evaluation of a one-trial apparatus to test learning ability in weanling horses. *Applied Animal Behaviour Science*, 35, 305-311.
- Marinier, S.L. & Alexander, A.J. (1994). The use of a maze in testing learning and memory in horses. *Applied Animal Behaviour Science*, 39, 177-182.
- Marsden, M.D. (1999). Behavioral Problems (Stable Vices). In P.T. Colohan, J.G. Mayhew, A.M. Merritt & J.N. Moore (Eds.) *Equine Medicine and Surgery - Volume I*. (5th Ed.) pp914-931. St Louis, MI: Mosby Inc.
- Mason, G.J. (1991). Stereotypies: a critical review. *Animal Behaviour*, 41, 1015-1037.
- Mason, G.J. (1993). Forms of stereotypic behaviour. In A.B. Lawrence & J. Rushen (Eds.) *Stereotypic Animal Behaviour - Fundamentals and Applications to Welfare*. pp7-40. Wallingford, UK: CAB International.
- Mason, W.A. (2000). Early developmental influences of experiences on behaviour, temperament and stress. In G.P. Moberg & J.A. Mench (Eds.) *The Biology of Animal Stress: Basic Principles and Implications for Animal Welfare*. pp269-290. Wallingford: CABI Publishing.
- May, J. (1995). *Equus caballus: On horses and handling*. London: J.A. Allen.
- Mayhew, E. (1888). *The Illustrated Horse Doctor*. (16th Ed.) London: W.H. Allen & Co.
- McAfee, L.M., Mills, D.S. & Cooper, J.J. (2002). The use of mirrors for the control of stereotypic weaving behaviour in the stabled horse. *Applied Animal Behaviour Science*, 78, 159-173.

McBane, S. (1994). *Behaviour Problems in Horses*. Devon: David & Charles.

McBride, S.D. & Cuddeford, D. (2001). The putative welfare-reducing effects of preventing equine stereotypic behaviour. *Animal Welfare*, 10, 173-189.

McCall, C.A., Salters, M.A. & Simpson, S.M. (1993). Relationship between number of conditioning trials per training session and avoidance learning in horses. *Applied Animal Behaviour Science*, 36, 291-299.

McCarty, R. (1983). Stress, behaviour and the sympathetic-adrenal medullary system. In L.A. Pohorecky & J. Brick (Eds). *Stress and Alcohol Use*. pp7-22. New York, NY: Elsevier

McClure, S.R., Chaffin, M.K. & Beaver, B.V. (1992). Nonpharmacologic management of stereotypic self-mutilative behaviour in a stallion. *Journal of the American Veterinary Medicine Association*, 200, 1975-1977.

McCrave, E.A. (1991). Diagnostic criteria for separation anxiety in the dog. *Veterinary Clinics of North America: Small Animal Practice - Vol. 21(2)*, 247-255.

McCubbin, J.A. (1993). Stress and endogenous opioids: Behavioural and circulatory interactions. *Biological Psychology*, 35, 91-122.

McDonnell, S. (1999). *Understanding Horse Behavior*. Lexington, KY: The Blood-Horse Inc.

McDonnell, S. (2003). *A Practical Field Guide to Horse Behavior: The Equid Ethogram*. Lexington, KY: The Blood-Horse Inc.

McEwen, B.S. & Sapolsky, R.M. (1995). Stress and cognitive function. *Current Opinions in Neurobiology*, 5, 205-216.

McGee, S. & Smith, H.V. (2004a). Accompanying pre-weaned Thoroughbred (*Equus caballus*) foals while separated from the mare during covering reduces behavioural signs of distress. *Applied Animal Behaviour Science*, 88(1-2), 137-147.

McGee, S. & Smith, H.V. (2004b). Age, gender and coat colour do not predict reactivity in Thoroughbred (*Equus caballus*) foals' first experience of the auction ring. *Proceedings of the BSAS Annual Meeting, University of York, April 2004*, 142. Nottingham, UK: British Society of Animal Science.

McGreevey, P.D., Richardson, J.D., Nicol, C.J. & Lane, J.G. (1995). Radiographic and endoscopic study of horses performing an oral based stereotypy. *Equine Veterinary Journal*, 27, 92-95.

McGreevey, P.D. & Nicol, C.J. (1998a). The effect of short-term prevention on the subsequent rate of crib-biting in Thoroughbred horses. *Equine Veterinary Journal Supplement*, 27, 30-34.

McGreevey, P.D. & Nicol, C.J. (1998b). Prevention of crib-biting: a review. *Equine Veterinary Journal Supplement*, 27, 35-38.

McGreevey, P.D. (2000). *Why Does My Horse...?* London: Souvenir Press.

McGreevey, P.D., Cripps, P.J., French, N.P., Green, L.E. & Nicol, C.J. (1995). Management factors associated with stereotypic and redirected behaviour in the Thoroughbred horse. *Equine Veterinary Journal*, 27, 86-91.

Meyer-Holzapfel, M. (1968). Abnormal behaviour in zoo animals. In M.W. Fox (Ed.) *Abnormal Behaviour in Animals*. pp476-503. Philadelphia, PA: W.B. Saunders Co.

Miller, M. (1939). *How to Breed a Racehorse*. London: Knapp, Drewett & Sons Ltd.

Miller, R.M. (1991). *Imprint Training of the Newborn Foal*. Colorado Springs, CO: The Western Horseman Inc.

Mills, D. (1998). Personality and individual differences in the horse, their significance, use and measurement. *Equine Veterinary Journal Supplement*, 27, 10-13.

Mills, D. (2001). An approach to behaviour problems in the horse. *Ippologia Anno*, 12(4), 1-10.

Mills, D.S. & MacLeod, C.A. (2002). The response of crib-biting and windsucking in horses to dietary supplementation with an antacid mixture. *Ippologia Anno*, 13(2), 1-9.

Mills, D.S., Alston, R.D., Rogers, V. & Longford, N.T. (2002). Factors associated with the prevalence of stereotypic behaviour amongst thoroughbred horses passing through auctioneer sales. *Applied Animal Behaviour Science*, 78, 115-124.

Minor, T.R., Chang, W-C. & Winslow, J.L. (1994a). Stress and adenosine: I. Effect of methylxanthine and amphetamine stimulants on learned helplessness in rats. *Behavioural Neuroscience*, 108, 254-264.

Minor, T.R., Chang, W-C. & Winslow, J.L. (1994b). Stress and adenosine: II. Adenosine analogs mimic the effect of inescapable shock on shuttle-escape performance in rats. *Behavioural Neuroscience*, 108, 265-276.

Mirowsky, J. & Ross, C.E. (1989). *Social Causes of Psychological Distress*. New York, NY: Aldine de Gruyter.

Moberg, G.P. (1985). Biological response to stress: key to assessment of animal well-being? In G.P. Moberg (Ed.) *Animal Stress*. pp27-49. Bethesda, MD: American Physiological Society.

Moberg, G.P. (2000). Biological response to Stress: Implications for Animal Welfare. In G.P. Moberg & J.A. Mench (Eds.) *The Biology of Animal Stress: Basic Principles and Implications for Animal Welfare*. pp1-21. Wallingford: CABI Publishing.

Moberg, G.P. & Mench, J.A. (Eds.) (2000). *The Biology of Animal Stress: Basic Principles and Implications for Animal Welfare*. Wallingford: CABI Publishing.

Momozawa, Y., Ono, T., Sato, F., Kikusui, T., Takeuchi, Y., Mori, Y. & Kusunose, R. (2003). Assessment of equine temperament by a questionnaire survey to caretakers and evaluation of its reliability by simultaneous behaviour test. *Applied Animal Behaviour Science*, 84, 127-138.

Morgan, C.L. (1894/1977). An Introduction to Comparative Psychology. In D Robinson, Preface to *Volume II of Significant Contributions to the History of Psychology 1750-1920, series D, Comparative Psychology*, C.L. Morgan. Washington, DC: University Publications of America.

Morris, A.A.M. & Lightowlers, R.N. (2000). Can parental mtDNA be inherited? *The Lancet*, 355, 1290-1291.

Morris, D. (1997). *Illustrated Horsecatching*. London: Ebury Press.

Morris, P.H., Gale, A. & Duffy, K. (2002). Can judges agree on the personality of horses? *Personality and Individual Differences*, 33, 67-81.

Munksgaard, L., De Passillé, A.M., Rushen, J., Thodberg, K. & Jensen, M.B. (1995). The ability of dairy cows to distinguish between people. *Proceedings of the 29th International Congress of the International Society of Applied Ethology, Exeter, 3-5 August*. pp19-20. Universities Federation for Animal Welfare.

Murphy, J., Waldmann, T. & Arkins, S. (2004). Sex differences in equine learning skills and visuo-spatial ability. *Applied Animal Behaviour Science*, 87(1-2), 119-130.

Nicol, C.J. (1995). The social transmission of information and behaviour. *Applied Animal Behaviour Science*, 44, 79-98.

Nicol, C.J. (1999). Stereotypies and their relationship to management. In P.A. Harris, G. Gomarsall, H.P.B. Davidson & R. Green (Eds). *Proceedings of the BEVA Specialist Days on Behaviour and Nutrition*. pp11-14. Newmarket, UK: Equine Veterinary Journal.

Nicol, C.J. (2002). Equine learning: progress and suggestions for future research. *Applied Animal Behaviour Science*, 78, 193-208.

Nurnberg, H.G., Keith, S.J. & Paxton, D.M. (1997). Consideration of the relevance of ethological animal models for human repetitive behavioural spectrum disorders. *Biological Psychiatry*, 41, 225-229.

Page, G. (1999). *The singing gorilla: understanding animal intelligence*. London: Headline.

Pell, S.M. & McGreevy, P.D. (1999). A study of cortisol and beta-endorphin levels in stereotypic and normal Thoroughbreds. *Applied Animal Behaviour Science*, 64, 81-90.

Porter, R.H., Romeyer, A., Levy, F., Krehbiel, D. & Nowak, R. (1994). Investigations of the nature of lambs' individual odour signatures. *Behavioural Processes*, 31, 301-308.

Pottinger, T.G. (2000). Genetic Selection to Reduce Stress in Animals. In G.P. Moberg & J.A. Mench (Eds.) *The Biology of Animal Stress: Basic Principles and Implications for Animal Welfare*. pp291-308. Wallingford: CABI Publishing.

Powell, S.B., Newman, H.A., McDonald, T.A., Bugenhagen, P. & Lewis, M.H. (2000). Development of spontaneous stereotyped behaviour in deer mice: effects of early and late exposure to a more complex environment. *Developmental Psychobiology*, 37, 100-108.

Price, E.O., Dally, M.R., Erhard, H., Gerzevske, M., Kelly, M., Moore, N., Schultze, A. & Topper, C. (1998). Manipulating odor cues facilitates add-on fostering in sheep. *Journal of Animal Science*, 76, 961-964.

Prince, D. (1987). Stable vices. In S. McBane (Ed) *Behaviour Problems in Horses*. pp115-122. Devon: David & Charles

- Rapaport, J.L., Ryland, D.H. & Kriete, M. (1992). Drug treatment of canine acral lick: An animal model of obsessive-compulsive disorder. *Archives of General Psychiatry*, 49, 517-521.
- Reader, S.M. & Laland, K.N. (2003). *Animal innovation*. Oxford: Oxford University Press.
- Reber, A.S. (1995). *The Penguin Dictionary of Psychology*. (2nd Ed.) London: Penguin Books Ltd.
- Redbo, I., Redbo-Tortensson, P., Ödberg, F.O., Hedendahl, A. & Holm, J. (1998). Factors affecting behavioural disturbances in race-horses. *Animal Science*, 66, 475-481.
- Robert J Goffs & Co Plc. (2000). Catalogue for Goffs Orby Sale 2000.
- Rollin, B.E. (1989). *The Unheeded Cry: Animal Consciousness, Animal Pain and Science*. Oxford: Oxford University Press
- Romanes, G.J. (1882). *Animal Intelligence*. London: Keegan, Paul, Trench & Co.
- Romanes, G.J. (1884). *Mental Evolution in Animals*. New York: AMS Press.
- Ruefenacht, S., Gebhardt-Henrich, S., Miyake, T. & Gaillard, C. (2002). A behaviour test on German Shepherd dogs: heritability of seven different traits. *Applied Animal Behaviour Science*, 79, 113-132.
- Rushen, J. (2000). Some Issues in the Interpretation of Behavioural Responses to Stress. In G.P. Moberg & J.A. Mench (Eds.) *The Biology of Animal Stress: Basic Principles and Implications for Animal Welfare*. pp23-42. Wallingford: CABI Publishing
- Rushen, J., Munksgaard, L., Marnet, P.G. & De Passillé, A.M. (2001). Human contact and the effects of acute stress on cows at milking. *Applied Animal Behaviour Science*, 73, 1-14.

- Salzen, E. A. (1998). Imprinting. In G. Greenberg & M.M. Haraway (Eds.) *Comparative Psychology: A Handbook*. pp566-575. New York: Garland Publishing Inc.
- Samraus, H.H. & Radtke, K. (1989). Zum 'weben' des Pferdes. *Deutsche Tierärztliche Wochenschrift*, 96(5), 248-255.
- Sappington, B.F. & Goldman, L. (1994). Discrimination learning and concept formation in the Arabian horse. *Journal of Animal Science*, 72, 3080-3087.
- Saslow, C.A. (2002). Understanding the perceptual world of horses. *Applied Animal Behaviour Science*, 78, 209-224.
- Schmajuk, N.A. (1997). *Animal learning and cognition: a neural network approach*. Cambridge: Cambridge University Press.
- Schwartz, M. & Vissing, J. (2002). Parental inheritance of mitochondrial DNA. *New England Journal of Medicine*, 347, 576-580.
- Scoble, R. (2004). (Ed.) *The Statistical Record: Flat Annual Issue 2003*. Wellingborough: Weatherbys Group Limited.
- Seaman, S.C., Davidson, H.P.B. & Waran, N.K. (2002). How reliable is temperament assessment in the domestic horse (*Equus caballus*)? *Applied Animal Behaviour Science*, 78, 175-191.
- Seligman, M.E.P. (1968). Chronic fear produced by unpredictable electric shock. *Journal of Comparative and Physiological Psychology*, 66(2), 402-411.
- Seligman, M.E.P. (1975). *Helplessness: On depression, development and death*. San Francisco, CA: W.H. Freeman.
- Seyle, H. (1973). The evolution of the stress concept. *American Scientist*, 61, 692-699.
- Seyle, H. (1976). *Stress in Health and Disease*. Boston: Butterworth.

- Sherry, C.J., Walters, T.J., Rodney Jr, G.G. & Henry, P.J. (1994). Behavioural chaining in the goat (*Capra hircus*). *Applied Animal Behaviour Science*, 40, 241-251.
- Shirai, T. (1990). *Family Tables of Racehorses Vol III*. Tokyo: Thoroughbred Pedigree Center Ltd.
- Showalter, E. (1985). *The female malady: Women, madness and English culture, 1830-1980*. London: Virago Press.
- Simpson, B.S. (2002). Neonatal foal handling. *Applied Animal Behaviour Science*, 78, 303-317.
- Skipper, L. (1999). *Inside Your Horse's Mind: A Study of Equine Intelligence and Human Prejudice*. London: J A Allen.
- Slabbert, J.M. & Odendaal, J.S.J. (1999). Early prediction of adult police dog efficiency - a longitudinal study. *Applied Animal Behaviour Science*, 64, 269-288.
- Smith, S. & Goldman, L. (1999). Colour discrimination in horses. *Applied Animal Behaviour Science*, 62, 13-25.
- Staddon, J.E.R. & Ettinger, R.H. (1989). *Learning: an introduction to the principles of adaptive behaviour*. San Diego, CA: Harcourt Brace Jovanovich.
- Stein, D.J. (2000). Neurobiology of the obsessive-compulsive spectrum disorders. *Biological Psychiatry*, 47, 296-304.
- Stein, D.J., Schoulberg, N., Heiton, K. & Hollander, E. (1992). The neuroethological approach to obsessive-compulsive disorder. *Comprehensive Psychiatry*, 33, 274-281.
- Tattersalls (Ireland) Ltd. (2000). Catalogue for September Yearling Sale 2000.
- Tattersalls Ltd. (2000). Catalogue for Houghton Yearling Sales 2000.

Thorndike, E.L. (1898). Animal intelligence: An experimental study of the associative processes in animals. *Psychological Review Monographs*, 2 (Whole No.8).

Timney, B. & Keil, K. (1992). Visual acuity in horses. *Vision Research*, 32, 2289-2293.

Toates, F. (1995). *Stress: Conceptual and Biological Aspects*. Chichester: John Wiley & Sons.

Toates, F. (2000). Multiple Factors Controlling Behaviour: Implications for Stress and Welfare. In G.P. Moberg & J.A. Mench (Eds.) *The Biology of Animal Stress: Basic Principles and Implications for Animal Welfare*. pp199-226. Wallingford: CABI Publishing.

Ulbrich, R. (2003). *Family Numbers: Their Derivation and Significance*. <http://tbpedigree.homestead.com/files/femalefamilynumbers.html> (accessed August 2003)

Ursin, H. (1988). Expectancy and activation: an attempt to systematize stress theory. In D. Hellhammer, I. Florin & H. Weiner (Eds.) *Neurobiological Approaches to Human Disease*. pp313-334. Toronto: Hans Huber.

Vaez Torshizi, R., Nicholas, F.W. & Tier, B. (1998). Inbreeding in Australian thoroughbred horses and the implications of 'shuttle' stallions. In *Proceedings of the 6th World Congress on Genetics Applied to Livestock Production*, 11-16 January, Armidale, Australia, 24, 440-443.

Varola, F. (1974). *Typology of the Racehorse*. London: J.A. Allen.

Vecchiotti, G.G. & Galanti, R. (1986). Evidence of heredity of cribbing, weaving and stall-walking in Thoroughbred horses. *Livestock Production Science*, 14, 91-95.

Visser, E.K., Van Reenen, C.G., Engel, B., Schilder, M.B.H., Barneveld, A. & Blokhuis, H.J. (2003). The association between performance in show-jumping and personality traits earlier in life. *Applied Animal Behaviour Science*, 82, 279-295.

Visser, E.K., Van Reenen, C.G., Hopster, H., Schilder, M.B.H., Knaap, J.H., Barneveld, A. & Blokhuis, H.J. (2001). Quantifying aspects of young horses' temperament: consistency of behavioural variables. *Applied Animal Behaviour Science*, 74, 241-258.

Waring, G.H. (1983). *Horse Behaviour: The behavioural traits and adaptations of domestic and wild horses, including ponies*. New Jersey: Noyes Publishers.

Waters, A.J., Nicol, C.J. & French, N.P. (2002). Factors influencing the development of stereotypic and redirected behaviours in young horses: findings of a four year prospective epidemiological study. *Equine Veterinary Journal*, 34(6), 572-579.

Weatherbys Group Ltd. (2003). *The Statistical Record: Return of Mares 2003*. Wellingborough: Weatherbys Group Ltd.

Williams, J.L., Friend, T.H., Collins, M.N., Toscano, M.J., Sisto-Burt, A. & Nevill, C.H. (2003). Effects of imprint training procedure at birth on the reactions of foals at age six months. *Equine Veterinary Journal*, 35(2), 127-132.

Williams, J.L., Friend, T.H., Toscano, M.J., Collins, M.N., Sisto-Burt, A. & Nevill, C.H. (2002). The effect of early training sessions on the reactions of foals at 1, 2 and 3 months of age. *Applied Animal Behaviour Science*, 77, 105-114.

Wilsson, E. & Sundgren, P.-E. (1997). The use of a behaviour test for the selection of dogs for service and breeding. II. Heritability for test parameters and effect of selection based on service dog characteristics. *Applied Animal Behaviour Science*, 54, 233-239.

Wolff, A. & Hausberger, M. (1994). Behaviour of foals before weaning may have some genetic basis. *Ethology*, 96, 1-10.

Wolff, A., Hausberger, M. & Le Sclan, N. (1997). Experimental tests to assess emotionality in horses. *Behavioural Processes*, 40, 209-221.

Würbel, H., Freire, R. & Nicol, C.J. (1998). Prevention of stereotypic wire-gnawing in laboratory mice: effects on behaviour and implications for stereotypy as a coping response. *Behavioural Processes*, 42, 61-72.

Young, R.J. & Cipreste, C.F. (2004). Applying animal learning theory: training captive animals to comply with veterinary and husbandry procedures. *Animal Welfare*, 13, 225-232.

Zanchetti, A. (1972). Expectancy and the pituitary-adrenal system. In *Physiology, Emotion and Psychosomatic Illness*. Amsterdam: Ciba Foundation Symposium 8 - Elsevier.

Zechner, P., Sölkner, J., Bodo, I., Druml, T., Baumung, R., Achmann, R., Marti, E., Habe, F. & Brem, G. (2002). Analysis of diversity and population structure in the Lipizzan horse breed based on pedigree information. *Livestock Production Science*, 77, 137-146.

Zentall, T.R. & Galef Jr., B.G. (1988). *Social learning: Psychological and biological perspectives*. Hillsdale, NJ: Lawrence Erlbaum Associates Inc.

Appendix 1

Scoring sheet for recording behavioural reactivity in the auction ring

ID No.	Lot No.	Price
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DoB: duration:

Pedigree:

ID No.	Lot No.	Price
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DoB: duration:

Pedigree:

	exit - accelerate towards	
	exit - accelerate from	
	exit - hesitate towards	
	exit - hesitate from	
	exit - try to leave	
	freeze - entering	
	freeze - exiting	
	freeze - at exit	
	freeze - in ring	
	move forwards - trot/jog	
	move forwards - pull	
	move forwards - reluctant	
	move forwards - rearing	
	move forwards - bucking	
	move backwards - walk	
	move backwards - trot/jog	
	move backwards - pull	
	move backwards - rearing	
	move backwards - bucking	
	foal/yearling - whinny	
	foal/yearling - deficate	
	foal/yearling - sweat (legs)	
	foal/yearling - stamp / kick	
	foal/yearling - tail slap	
	foal/yearling - stereotypy	

Appendix 2

Letter of information sent to the trainers of the horses in training (in English - for single horse or multiple horses)

Department of Psychology

University of Dublin, Trinity College

Dublin 2, Ireland

Tel: +353 1 608 1886

Fax: +353 1 671 2006

Head of Department: Professor Ruth Byrne

26 April 2004

RE: Final part of a four-year study on Thoroughbreds

Dear

I'd be very grateful if you would assist me in the collection on some information concerning one of the horses in your charge. I am a PhD student in the Department of Psychology in Trinity College Dublin and have previously worked on a stud farm and in a small racing yard. I know, therefore, how busy you are.

The questionnaire that I would like your staff to complete relates to the final, and very important, leg of my research. Over the course of the past three years I have conducted a major study on thoroughbred foals and yearlings, using their reactions to going through the auction ring as a means of assessing their temperament.

It is important that I follow-up on these horses now that they are in training and the animal previously scored, and to whom the questionnaires refer, is listed below.

Your cooperation, and that of your staff, would be entirely voluntary, i.e. if you don't want to help then there is no obligation on you to do so.

For this final part of the study I really need the handler/lad/lass who looks after the horse listed below to fill out and return (as soon as possible) the attached questionnaires. Your assistance would be of tremendous benefit to my work and would be very much appreciated.

The data previously collected, combined with the results from the current study, will be used to track development of temperament and, where applicable, problem behaviour (for example, weaving, cribbing, boxwalking) in young thoroughbred racehorses. Data collected so far also include details of their pedigrees in an effort to determine whether or not there may be evidence of inheritance of tendencies or traits through various male and female lines. There has never previously been a study of this kind. The work is being supervised by Dr Howard Smith (hsmith@tcd.ie).

All information provided will be used only for statistical purposes and will remain completely confidential: only I will see the completed questionnaire, only I will have access to the individual identity of any of the animals and information concerning individuals will not be disclosed to anyone else. This is accordance with the Psychological Society of Ireland's ethical guidelines on research.

Each of the horses in the study has already been assigned a unique code number to protect his/her identity.

In accordance with the Freedom of Information Act (1977) you are entitled to free and full access to any records that relate to you, held on public record. Should you require it, I will be happy to make the findings and the results of this study available to you when it is completed. The provisional thesis submission date is September/October 2004 though this part of the research needs to be completed by June. Both I and Dr Smith can be contacted at the above address. My e-mail address is mcgees@tcd.ie.

As you and your staff may be aware, I have worked as a bloodstock correspondent for many years and, since 2000, have been the Irish flat breeding correspondent for *The Irish Field*. I assure you that this research has absolutely nothing to do with my work for the paper and that nothing from this research will be used in *The Irish Field* or any other bloodstock or racing publication.

If you require any further information, please do not hesitate to contact me.

Yours sincerely

SIEGLINDE McGEE, B.A., P.Dip.Stat.

The horse who has been scored previously as part of this four-year study and who is believed to be in training with you, is as follows:

name	sex	sire	dam
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Department of Psychology

University of Dublin, Trinity College

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It is important that I follow-up on these horses now that they are in training and those animals previously scored, and to whom the questionnaires refer, are listed below. There is one questionnaire for each of the horses listed.

Your cooperation, and that of your staff, would be entirely voluntary, i.e. if you don't want to help then there is no obligation on you to do so.

For this final part of the study I really need the handler/lad/lass who looks after each of the horses listed below to fill out and return (as soon as possible) the attached questionnaires. There is one questionnaire per horse. Your assistance would be of tremendous benefit to my work and would be very much appreciated.

The data previously collected, combined with the results from the current study, will be used to track development of temperament and, where applicable, problem behaviour (for example, weaving, cribbing, boxwalking) in young thoroughbred racehorses. Data collected so far also include details of their pedigrees in an effort to determine whether or not there may be evidence of inheritance of tendencies or traits through various male and female lines. There has never previously been a study of this kind. The work is being supervised by Dr Howard Smith (hsmith@tcd.ie).

All information provided will be used only for statistical purposes and will remain completely confidential: only I will see the completed questionnaires, only I will have access to the individual identity of any of the animals and information concerning individuals will not be disclosed to anyone else. This is accordance with the Psychological Society of Ireland's ethical guidelines on research.

Each of the horses has already been assigned a unique code number to protect his/her identity.

In accordance with the Freedom of Information Act (1977) you are entitled to free and full access to any records that relate to you, held on public record. Should you require it, I will be happy to make the findings and the results of this study available to you when it is completed. The provisional thesis submission date is September/October 2004 though this part of the research needs to be completed by June. Both I and Dr Smith can be contacted at the above address. My e-mail address is mcgees@tcd.ie.

As you and your staff may be aware, I have worked as a bloodstock correspondent for many years and, since 2000, have been the Irish flat breeding correspondent for *The Irish Field*. I assure you that this research has absolutely nothing to do with my work for the paper and that nothing from this research will be used in *The Irish Field* or any other bloodstock or racing publication.

If you require any further information, please do not hesitate to contact me.

Yours sincerely

SIEGLINDE McGEE, B.A., P.Dip.Stat.

The horses who have been scored previously as part of this four-year study and who are believed to be in training with you, are as follows:

name	sex	sire	dam
-------------	------------	-------------	------------

Appendix 3

**Letter of information sent to the handlers of the horses
in training (in English)**

Department of Psychology

University of Dublin, Trinity College

Dublin 2, Ireland

Tel: +353 1 608 1886

Fax: +353 1 671 2006

Head of Department: Professor Ruth Byrne
Letter of Information

I'd be very grateful if you would assist me in the collection on some information concerning the horses in your charge. I am a PhD student in the Department of Psychology in Trinity College Dublin and have previously worked on a stud farm and in a small racing yard. I know, therefore, how busy you are.

The questionnaire that I would like you to complete relates to the final, and very important, leg of my research. Over the course of the past three years I have conducted a major study on thoroughbred foals and yearlings, using their reactions to going through the auction ring as a means of assessing their temperament. It is important that I follow-up on these horses now that they are in training.

Your cooperation is entirely voluntary, i.e. if you don't want to help then there is no obligation on you to do so.

For this final part of the study I really need you fill out and return (as soon as possible) the attached questionnaire. Your assistance would be of tremendous benefit to my work and would be very much appreciated.

The data previously collected, combined with the results from the current study, will be used to track development of temperament and, where applicable, problem behaviour (for example, weaving, cribbing, boxwalking) in young thoroughbred racehorses. Data collected so far also include details of their pedigrees in an effort to determine whether or not there may be evidence of inheritance of tendencies or traits through various male and female lines. There has never previously been a study of this kind. The work is being supervised by Dr Howard Smith (hsmith@tcd.ie).

All information provided will be used only for statistical purposes and will remain completely confidential: only I will see the completed questionnaires, only I will have access to the individual identity of any of the animals and information concerning individuals will not be disclosed to anyone else. This is accordance with the Psychological Society of Ireland's ethical guidelines on research.

Each of the horses has already been assigned a unique code number to protect his/her identity. It is *very important*, however, that you write the dam of your horse in the space provided - otherwise I cannot know which questionnaire refers to which horse.

In accordance with the Freedom of Information Act (1977) you are entitled to free and full access to any records that relate to you, held on public record. Should you require it, I will be happy to make the findings and the results of this study available to you when it is completed. The provisional thesis submission date is September/October 2004 though this part of the research needs to be completed by June. Both I and Dr Smith can be contacted at the above address. My e-mail address is mcgees@tcd.ie.

As you may be aware, I have worked as a bloodstock correspondent for many years and, since 2000, have been the Irish flat breeding correspondent for *The Irish Field*. I assure you that this research has absolutely nothing to do with my work for the paper and that nothing from this research will be used in *The Irish Field* or any other bloodstock or racing publication.

Finally, I would like to take this opportunity to thank you once again for your participation in this study. If you require any further information, please do not hesitate to contact me.

SIEGLINDE McGEE, B.A., P.Dip.Stat.

Appendix 4

Temperament questionnaire (in English)

Department of Psychology

University of Dublin, Trinity College

Dublin 2, Ireland

Tel: +353 1 608 1886

Fax: +353 1 671 2006

Head of Department: Professor Ruth Byrne

Dam of this horse (very important): _____

PART 1

Please shade in the **O** below the item, on each of these scales, that would describe this horse.

laid-back

☐

a bit excitable

☐

fairly excitable

☐

very excitable

☐

friendly

☐

neither friendly
nor unfriendly

☐

unfriendly

☐

rarely whinnies

☐

often whinnies

☐

PART 2

Please shade in the **O** below all the individual items below that would describe this horse.

eats his/her bedding

☐

chews his/her rug

☐

paws when eating

☐

kicks the wall/door

☐

rushes when being led
out of the stable

☐

rushes when being led
into the stable

☐

bucks when being
saddled

☐

rears when being
saddled

☐

rears when being
bridled

☐

raises his/her head high
when being bridled

☐

bites or kicks when
being saddled

☐

bites or kicks when
being brushed

☐

crib-biter

☐

windsucker

☐

boxwalker

☐

weaver

☐

pins back ears when
approached

☐

often bucks when
being ridden

☐

often shies/ducks away
when being ridden

☐

dips his/her hay
in water

☐

lazy worker

☐

enthusiastic worker

☐

THANK YOU!

Appendix 5

Letter of information sent to the trainers of the horses in training (in French - for single horse and multiple horses)

Department of Psychology

University of Dublin, Trinity College

Dublin 2, Ireland

Tel: +353 1 608 1886

Fax: +353 1 671 2006

Head of Department: Professor Ruth Byrne

26 avril 2004

RE : La dernière phase d'une étude, de quatre années, sur les chevaux de pur-sang

Cher

Je vous remercie part avance de l'aide que vous pourriez me fournir dans ma collecte d'informations concernant un de vos chevaux. Je suis une étudiante en doctorat (PhD) dans le département de psychologie a Trinity College a Dublin. J'ai précédemment travailler dans un haras et un champs de courses, je sais donc combien votre temps est précieux.

Le questionnaire que je vous sou mets est la dernière (et très importante) phase de ma recherche. Ces trois dernières années, j'ai conduis mes recherches principalement sur les poulains et yearlings pur-sang, édu d iant leurs réactions lors des ventes aux enchères afin d'évaluation leur tempérament.

Il importe que je suivre ces chevaux maintenant parce que ils sont à l'entraînement. L'animal qui fut précédemment évaluer dans les quatre années et qui, je pense, est à l'entraînement avec vous, est sur la liste en dessous.

Pour cette dernière partie de ma recherche, j'ai vraiment besoin que le palefrenier qui prendre soin de ce cheval complétiez et renvoyez le formulaire joint le plutôt possible (avant fin Juin). En effet, ma thèse doit être soumise entre Septembre et Octobre 2004. Votre aide, est l'aide de votre palefreniers, est indispensable pour mener à bien mon doctorat et sera grandement apprécier. Cependant, votre collaboration est entièrement basée sur le volontariat, c'est à dire que vous n'avez aucune obligation.

Mes précédents résultats, combinés avec ces nouveaux résultats, seront utilisés pour suivre le développement du tempérament et , où applicables aux problèmes de comportement chez les jeunes pur-sang de course. Les résultats collectés jusqu'à présent inclus le pedigree de chaque cheval afin d'établir une filiation entre son propre caractère et ceux maternels et paternels. Une telle analyse n'a jamais encore été menée. Elle est sous la responsabilité de mon superviseur le Dr. Howard Smith (hsmith@tcd.ie).

Les informations ne seront utilisées que dans un but statistique et resteront strictement confidentielles. Je serais la seule à voir les réponses au questionnaires en accord avec les directives éthiques de la *Psychological Society of Ireland*. Chaque cheval ayant déjà un code d'identification personnel lui donnant un total anonyme.

En accord avec la Freedom of Information Act, 1977 (le droit de jouir d'une approche aux informations), vous pouvez accéder à toutes les informations vous concernant. De plus je serais ravi de vous fournir la conclusion de mes recherches, sur simple demande de votre part (mon adresse électronique est: mcgees@tcd.ie).

Comme vous devez le savoir, j'ai travaillé en tant que correspondant pour *The Irish Field* responsable de la rubrique «pur-sang» et depuis l'année, 2000 responsable de la rubrique «élevage Irlandais». Je vous garantis que ma recherche m'a aucun lien avec ce journal et aucun document ne sera reproduit dans *The Irish Field* ou d'autre revues spécialisées.

Au final, je voudrais grandement vous remercier de prendre part à mon étude. De plus je reste à votre entière disposition pour toutes informations complémentaires.

SIEGLINDE McGEE, B.A., P.Dip.Stat.

Le cheval qui fut précédemment évaluer dans les quatre années et qui, je pense, est à l'entraînement avec vous, se suivre :

nom	sexe	père	mère
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Department of Psychology

University of Dublin, Trinity College

Dublin 2, Ireland

Tel: +353 1 608 1886

Fax: +353 1 671 2006

Head of Department: Professor Ruth Byrne

26 avril 2004

RE : La dernière phase d'une étude, de quatre années, sur les chevaux de pur-sang

Cher/Chère

Je vous remercie part avance de l'aide que vous pourriez me fournir dans ma collecte d'informations concernant vos chevaux. Je suis une étudiante en doctorat (PhD) dans le département de psychologie a Trinity College a Dublin. J'ai précédemment travailler dans un haras et un champs de courses, je sais donc combien votre temps est précieux.

Les questionnaires que je vous soumet est la dernière (et très importante) phase de ma recherche. Ces trois dernières années, j'ai conduis mes recherches principalement sur les poulains et yearlings pur-sang, étudiant leurs réactions lors des ventes aux enchères afin d'évaluation leur tempérament.

Il importe que je suivre ces chevaux maintenant parce que ils sont à l'entraînement. Les animaux qui furent précédemment évaluer dans les quatre années et qui, je pense, sont à l'entraînement avec vous, sont sur la liste en dessous. Il y a une questionnaire pour chaque cheval sur la liste.

Pour cette dernière partie de ma recherche, j'ai vraiment besoin que le palefrenier qui prendre soin de chaque cheval sur la liste en dessous complétiez et renvoyez le formulaire joint le plutôt possible (avant fin Juin). En effet, ma thèse doit être soumise entre Septembre et Octobre 2004. Votre aide, est l'aide de votre palefreniers, est indispensable pour mener à bien mon doctorat et sera grandement apprécier. Cependant, votre collaboration est entièrement basée sur le volontariat, c'est à dire que vous n'avez aucune obligation.

Mes précédents résultats, combinés avec ces nouveaux résultats, seront utilisés pour suivre le développement du tempérament et , où applicables aux problèmes de comportement chez les jeunes pur-sang de course. Les résultats collectés jusqu'à présent inclus le pedigree de chaque cheval afin d'établir une filiation entre son propre caractère et ceux maternels et paternels. Une telle analyse n'a jamais encore été menée. Elle est sous la responsabilité de mon superviseur le Dr. Howard Smith (hsmith@tcd.ie).

Les informations ne seront utilisées que dans un but statistique et resteront strictement confidentielles. Je serais la seule à voir les réponses au questionnaires en accord avec les directives éthiques de la *Psychological Society of Ireland*. Chaque cheval ayant déjà un code d'identification personnel lui donnant un total anonymat.

En accord avec la Freedom of Information Act, 1977 (le droit de jouir d'une approche aux informations), vous pouvez accéder à toutes les informations vous concernant. De plus je serais ravi de vous fournir la conclusion de mes recherches, sur simple demande de votre part (mon adresse électronique est: mcgees@tcd.ie).

Comme vous devez le savoir, j'ai travaillé en tant que correspondant pour *The Irish Field* responsable de la rubrique «pur-sang» et depuis l'année, 2000 responsable de la rubrique «élevage Irlandais». Je vous garantis que ma recherche m'a aucun lien avec ce journal et aucun document ne sera reproduit dans *The Irish Field* ou d'autre revues spécialisées.

Au final, je voudrais grandement vous remercier de prendre part à mon étude. De plus je reste à votre entière disposition pour toutes informations complémentaires.

SIEGLINDE McGEE, B.A., P.Dip.Stat.

Les chevaux qui furent précédemment évaluer dans les quatre années et qui, je pense, sont à l'entraînement avec vous, se suivre :

nom	sexe	père	mère
-----	------	------	------

Appendix 6

**Letter of information sent to the handlers of the horses
in training (in French)**

Department of Psychology

University of Dublin, Trinity College

Dublin 2, Ireland

Tel: +353 1 608 1886

Fax: +353 1 671 2006

Head of Department: Professor Ruth Byrne

Lettre d'information

Je vous remercie par avance de l'aide que vous pourriez me fournir dans ma collecte d'informations concernant vos chevaux. Je suis une étudiante en doctorat (PhD) dans le département de psychologie à Trinity College à Dublin. J'ai précédemment travaillé dans un haras et un champs de courses, je sais donc combien votre temps est précieux.

Le questionnaire que je vous soumet est la dernière (et très importante) phase de ma recherche. Ces trois dernières années, j'ai conduit mes recherches principalement sur les poulains et yearlings pur-sang, étudiant leurs réactions lors des ventes aux enchères afin d'évaluer leur tempérament.

Pour cette dernière partie de ma recherche, j'ai vraiment besoin que vous complétiez et renvoyez le formulaire joint le plus tôt possible (avant fin Juin). En effet, ma thèse doit être soumise entre Septembre et Octobre 2004. Votre aide est indispensable pour mener à bien mon doctorat et sera grandement appréciée. Cependant, votre collaboration est entièrement basée sur le volontariat, c'est à dire que vous n'avez aucune obligation.

Mes précédents résultats, combinés avec ces nouveaux résultats, seront utilisés pour suivre le développement du tempérament et, où applicable aux problèmes de comportement chez les jeunes pur-sang de course. Les résultats collectés jusqu'à présent incluent le pedigree de chaque cheval afin d'établir une filiation entre son propre caractère et ceux maternels et paternels. Une telle analyse n'a jamais encore été menée. Elle est sous la responsabilité de mon superviseur le Dr. Howard Smith (hsmith@tcd.ie).

Les informations ne seront utilisées que dans un but statistique et resteront strictement confidentielles. Je serais la seule à voir les réponses au questionnaire en accord avec les directives éthiques de la *Psychological Society of Ireland*.

Chaque cheval ayant déjà un code d'identification personnel lui donnant un total anonymat. C'est *très important* que vous notiez la mère du cheval sur le questionnaire. Sans le nom de la mère, je ne sais pas quel questionnaire est pour quel cheval.

En accord avec la Freedom of Information Act, 1977 (le droit de jouir d'une approche aux informations), vous pouvez accéder à toutes les informations vous concernant. De plus je serais ravi de vous fournir la conclusion de mes recherches, sur simple demande de votre part (mon adresse électronique est: mcgees@tcd.ie).

Comme vous devez le savoir, j'ai travaillé en tant que correspondant pour *The Irish Field* responsable de la rubrique «pur-sang» et depuis l'année, 2000 responsable de la rubrique «élevage Irlandais». Je vous garantis que ma recherche m'a aucun lien avec ce journal et aucun document ne sera reproduit dans *The Irish Field* ou d'autres revues spécialisées.

Au final, je voudrais grandement vous remercier de prendre part à mon étude. De plus je reste à votre entière disposition pour toutes informations complémentaires.

SIEGLINDE MCGEE, B.A., P.Dip.Stat.

Appendix 7

Temperament questionnaire (in French)

Department of Psychology

University of Dublin, Trinity College

Dublin 2, Ireland

Tel: +353 1 608 1886

Fax: +353 1 671 2006

Head of Department: Professor Ruth Byrne

La mère du cheval est (*très important*): _____

PART 1

SVP colorier le O au-dessous de la définition, en ces échelles, pour décrire ce cheval

calme O	un peu nerveux O	passablement nerveux O	très nerveux O
amical O	ni amical ni hostile O	hostile O	
hennissement rare O	hennissement fréquent O		

PART 2

SVP colorier le O au-dessous de la définition pour décrire ce cheval

mange sa literie O	mâche sa couverture O	coups de pieds lorsqu'il mange O	coups de pieds dans la porte ou murs O
se rue lorsqu'il sort de l'écurie O	se rue pour retourner dans l'écurie O	résiste à être sellé O	se dresse lorsqu'il est sellé O
se dresse lorsqu'il est bridé O	lève la tête très haut lorsqu'il est bridé O	mord ou coup de pieds lorsqu'il est sellé O	mord ou coup de pieds lors du brossage O
cheval avec le tic rongeur O	cheval avec le tic à l'appui O	cheval avec le tic ambulateur O	cheval avec le tic de l'ours O
rabat les oreilles en arrière à l'approche O	se dresse souvent lorsqu'il est chevauché O	se hésite souvent lorsqu'il est chevauché O	trempe son foin dans l'eau O
paresseux O	aime travaillé O		

MERCI!