UNIVERSITY OF SOUTHAMPTON

OBJECT PLAY IN THE DOMESTIC HORSE

Carys Farrell Hughes

Thesis submitted for the Degree of
Doctor of Philosophy

Faculty of Science
School of Biological Sciences

June 2002

UNIVERSITY OF SOUTHAMPTON

ABSTRACT

FACULTY OF SCIENCE

SCHOOL OF BIOLOGICAL SCIENCES

Doctor of Philosophy

OBJECT MANIPULATION AND PLAY IN THE DOMESTIC HORSE

By Carys Farrell Hughes

The aims of this research were to investigate the development of object manipulation and play in domestic horse foals, in order to gain a better understanding of its ontogeny. Also to investigate which sensory characteristics of objects elicit object manipulation and play in juvenile and adult domestic horses.

Three groups of foals, one of a variety of breeds maintained in differing management regimens and two of Arabians maintained in similar management regimens, were studied. *These groups were studied to determine whether any pattern could be detected* in the development of object manipulation and play and what factors could affect this pattern. To ensure that all the foals had the opportunity to manipulate an object a Jolly Ball (Horseman's Pride, Ravenna, OH, USA) was placed in the field/stable during each observation. Object manipulation and play was observed throughout the first three months of life, suggesting that it is an important component of foals' behavioural repertoire for acquiring information about their environment and handling skills. Object manipulation and play did not appear to follow a definite pattern of progressive development during the first three months of life. It is likely that the development of object manipulation and play is different in each individual and is affected by factors including: breed, management factors, personality (boldness), social environment and experience. Bolder foals were more willing to investigate objects than more timid foals and socially isolated foals displayed more object manipulation and play than socially kept foals. This suggests that object manipulation and play may function as a substitute for social play for foals reared in isolation from other foals.

The responses of two groups of yearlings to the Jolly Ball were also studied. One group had prior experience of the object during the first three months of life, as part of the foal study, and the other group had no experience of the object. No significant difference was detected between the levels of object manipulation and play displayed by each group. This suggests that prior experience of an object during the first three months of life is not necessary to elicit object manipulation and play at one year of age.

Seven trials were conducted in order to investigate the importance of the sensory characteristics of objects in eliciting object manipulation and play in juvenile and adult horses. However, in these trials it was not possible to identify individual sensory characteristics that elicited more object manipulation and play than the others tested. It is likely that this is due to horses exhibiting individual preferences for different combinations of stimuli. Larger sample sizes could reduce the effects of this individual variation. Age was observed to significantly affect the durations of object play observed. Younger horses displayed more object play than older horses. Therefore, in future research of this nature it would be more appropriate to study juveniles. In future research larger sample sizes would be required to reduce the effects of variation due to individual differences.

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Acknowledgements

These acknowledgements appear in no particular order of importance. Those people whose help and support has been invaluable to me over the past three or so years hopefully already know how grateful I am. However, I would particularly like to thank the following people for their help and support throughout this PhD:

WALTHAM Centre for Pet Nutrition for funding the project, my industrial supervisor Dr Pat Harris and also Nell Davidson for their help and support.

Dr Debbie Goodwin for supervising me and for her endless enthusiasm for the project.

Dr John Bradshaw, Dr John Allen and Rachel Casey for their help and support.

Past and present members of the Anthrozoology Institute, particularly the staff of the Equine Behaviour Centre, for their help with fieldwork and putting up with me.

All the very kind horse owners and breeders who allowed me to study their horses and kept me supplied with cups of tea! There are too many of you to list by name, but I'm grateful to you all. However, I have to say a special thank you to Caroline Sussex for allowing me to study her horses, helping me with recruiting Arabian foals and helping me find my car keys in a large field!

Sparsholt Agricultural College for allowing me to study horses at their facility.

Mum, for all your help with editing and looking after my horse, Glynn. Dad, for your encouragement and never failing to believe that I will eventually find a job. Dave, for being a good friend, as well as a great brother.

Lastly, I would like to thank all my friends who have listened patiently when I've had problems and celebrated with me when things have been going well! Cheers!

Structure of the Thesis

This thesis consists of four chapters, followed by an appendix, a glossary of terms and a list of references. The chapters are structured as follows:

Chapter 1. – Introduction and Aims

This chapter consists of the introduction (Section 1), which reviews the scientific literature available concerning play behaviour, equine behaviour and the role of object play as environmental enrichment. It also discusses the aims and limitations of the thesis (Sections 2 and 3).

Chapter 2. – Object Manipulation and Play in Domestic Horse Foals

This chapter consists of three studies of the development of object manipulation and play in domestic horse foals (Sections 4 to 6). The results of the studies are summarised in Section 6.

Chapter 3. – Sensory Characteristics of Objects and Object Manipulation and Play in Adult and Juvenile Horses

This chapter consists of five sections, reporting the results of seven trials that investigated which sensory characteristics of objects could be important in eliciting object manipulation and play in juvenile and adult domestic horses (Sections 7 to 11). The results of the seven trials are summarised in Section 11.

Chapter 4. – Discussion and Conclusions

This chapter discusses the results of the research presented in Chapters 2 and 3 with respect to the aims, and a general discussion of additional findings.

CHAPTER 1

Introduction and Aims

1. Introduction

1.1 Play

1.11 What is Play?

Play has been described in around 45 bird species and 140 mammalian species (Bekoff 1976). However, the first question usually asked when studying play is; what is the definition of play? This in itself presents a problem, as authors tend to use different definitions and some do not even acknowledge play as a distinct behavioural category. The probable reason for these discrepancies is that play is difficult to define without including subjective elements. Even the definitions of play given by the Concise Oxford Dictionary (9th Edition 1995) are rather vague:

" Occupy or amuse oneself pleasantly with some recreation, game, exercise etc"
"Act light-heartedly or flippantly"

Many authors simply do not attempt to define play. For example, Lorenz (1956) considered play to be a vacuum activity and stated:

"Do not ask me to give a definition of play."

And suggests instead that we

" ...use the word "play" just as every man in the street would use it naively when talking of the play of kittens or even little children."

The effectiveness of using this approach to describe play is limited in that it is subjective and does not define a set of behaviour patterns that could be consistently identified as play. It does however have some use when play signals may not be obvious and the behaviour patterns observed are generally considered playful. Defining behaviour objectively is of more value than subjective definitions as it ensures that research can be more rigorously assessed and replicated by other researchers.

Many authors have attempted to objectively define play behaviour. The following are some examples of these.

Hall (1968) defines play as follows:

"Play is a very broad term which includes almost any activity which, to the observer, seems to have no immediate objective. It, therefore, includes the manipulation of non-food objects, and the whole variety of sensorimotor performances that are "exploratory." It also includes the complex social interactions that take place among young animals and sometimes between young animals and adults, these being thought to be highly important in the process of socialisation of the young and possibly in establishing relative ranks amongst the young which might carry over into the adult hierarchy."

This definition implies that object manipulation can be play. However, as Rasa (1971) states in his definition of play

"Play is behaviour with no immediate reward other than its performance"

The initial exploration of an object could be considered an immediate function of object manipulation, and therefore the behaviour has the immediate reward of obtaining information about the object. Therefore, object manipulation could not be included in a definition of play.

Wilson's (1971) definition focuses on the link between play and adult behaviours.

"In mammals play is comprised largely of rehearsals performed in a non-functional context of the serious activities of searching, fighting, courtship, hunting and copulation."

Play behaviour often appears to be versions of "serious" adult behaviour patterns such as those described above by Wilson. The movements seen in play behaviour are peculiar to each species. For example, horses nip, bite and kick during play and adult horses bite and kick during fights and in defence against predators; calves head-butt in play and adult cows head-butt their opponents (Brownlee 1984). In play the exact sequence seen in the "serious" adult behaviour patterns may be re-ordered and the individual movements exaggerated. Movements within a sequence may also be

repeated. In some cases a sequence may be broken off altogether and resumed later. This is known as fragmentation (Loizos 1966). Thompson (1996) also suggests that play is best characterized by the absence of the end points in which the "serious" versions of the behaviours culminate.

The working definition of play that will be used throughout this thesis is as follows:

"Behaviour patterns that have no apparent immediate function and no reward other than their performance. Play may occur in a solitary or social context"

This is a general definition encompassing the main theme of the definitions stated above, that play has no immediate reward or obvious function, and that it may occur in different contexts.

1.12 Why do Animals Play?

Play behaviours represent 1-10% of the total time budget of almost every species in which it has been studied (Fagen 1981) and occur most frequently in juveniles (Fagen 1976). The fact that play does not occupy a large part of the time budget in most animals, appears to have no immediate function and is difficult to objectively define, may explain why play has not generally been considered to be an important part of an animal's behavioural repertoire and, therefore, not worthy of study.

The costs associated with play seem at first sight to be high. Play includes behaviour patterns, or sequences of behaviour patterns, which also occur in high-risk adult activities, such as predation, copulation and fighting, but the outcomes of these activities are not gained through play. Time and energy expended during play activities cannot be allocated to growth, fat deposition, predator avoidance, or non-play social behaviour (Fagen 1981). However, some authors, for example Martin and Bateson (1984), suggest that the energy expended during play is slight; in kittens it does not exceed 9% of total energy expenditure. Play can also result in injury (Berger 1979), or even death (Welles and Welles 1961) and can, therefore, have serious consequences.

In order for play to be maintained in the behavioural repertoire of animals there must be a selective advantage in its performance. It is thought that play can improve physical

ability later in life by improving strength, endurance and skill (Brownlee 1954). This could in turn contribute to reproductive success. However, Martin and Caro (1985) suggest that the physical training effects of play are immediate and transitory and so there are no delayed physical benefits of locomotor play.

Animals may develop skills through play such as locomotor and postural control, tool handling skills and controlling and manipulating objects (Fagen 1981). This could be true for juvenile play, but adults could also practice behaviour patterns by performing them rather than playing (Loizos 1966, Biben 1979). In adult animals play would be unnecessary for practicing instinctive motor patterns, but could improve overall proficiency (Poole 1966, Fagen 1981). If this were the case, play would be expected to appear in animals with more complex behavioural repertoires, which would necessitate perfection of more skills (Bateson and Young 1979). A further suggestion is that play is motivationally related to exploration and that play may, therefore, have some function in exploration (Wood-Gush and Vestergaard 1991). Sylva (1977) describes child's play as a "self initiated experiment in exploration." Animals can learn about their environment through play and assess the properties of their environment by including it in games and therefore learning through play. An example of this is locomotor and social play in juvenile and adult red squirrels (*Tamiasciurus hudsinicus*) (Ferron 1975). It was suggested that running along paths may contribute to the learning of the squirrel's terrirtory. However, play does not necessarily lead to learning. For example, a chimpanzee (*Pan troglodytes*) was given a stick to retrieve food and despite playing with the stick, did not learn to retrieve food, even after food deprivation (Schiller 1957). Sylva (1977) distinguishes play and exploration in human children by describing exploration as being the investigation of the properties of the environment and play as behaviours oriented toward the potential use of the properties of the environment in self-devised "plans", or games.

It has been suggested that social play is necessary for bonding and cohesion in Type I (non-territorial and harem-forming) equid social groups (Fraser 1992). This is supported by Klingel (1974) who reported that young Plains zebra (*Equus burchelli*) stallions often leave their natal band earlier if they have no playmates and would then find playmates in another band. However, this is not the case for all social animals. Social groups of St Kitts vervet (*Ceropithecus aethiops*) have been observed to be playful, but non-cohesive

(McGuire 1974). In contrast, social groups of squirrel monkeys (*Saimiri*) have been observed to be cohesive, but non-playful (Baldwin and Baldwin 1974).

The poet Schiller (Eibl-Eibesfeldt 1970) suggests that animals play when an excess of energy provides the motivation. This has been termed the "surplus energy theory" (Bekoff 1976). It is based on the fact that, in general, juvenile animals have more excess energy than adults, because they do not take part in adult maintenance behaviours such as hunting, foraging, fighting and reproducing. This energy is then released through play (Bekoff 1976). Play deprivation experiments can test this hypothesis, to see if play increased after a period of deprivation. Several such studies have been conducted (goat (*Capra hircus*): Chepko 1971; squirrel monkey: Baldwin and Baldwin 1974), but no significant results were obtained. Therefore, they suggested that animals do not play in order to relieve excess energy. Indeed, domestic cats are reported to play more when they are hungry (Hall and Bradshaw 1998) and children often continue to play after they are exhausted, when their surplus energy should have been dissipated (Evans and Pellegrini 1997).

The most recent theory to be published is that play has evolved to enhance the development of the brain. The levels of brain growth between birth and maturity reflect the amount of play displayed by different species of non-human primates. A strong positive correlation has been found between brain size and playfulness in mammals in general (Iwaniuk, Nelson and Pellis 2001). However, this correlation was not detectable within the orders primates, marsupialia or rodentia. The model proposed to explain this result is that the relationship between brain size and play is stepwise, in that an increase in brain size over a threshold level leads to an increase in play prevalence and complexity.

Byers (1998) suggests that larger brains are more sensitive to developmental stimuli than smaller brains and so require more play to develop to adulthood. However, domestication has been reported to lead to a reduction in the size of animals' brain; for example, the brain of the domestic horse is reported to be as much as 30% smaller than that of its wild ancestors (Rohrs and Ebinger 1993). Domestic animals would, therefore, be expected to play less than their wild counterparts. In fact, domestic animals are reported to play more than wild animals (Burghardt 1988). This could be explained by

heterochrony, which is defined as a change in the timing of rate of developmental events relative to the same events in the ancestor (Sheldon 1993). Some parts of the brain may pass through fewer stages of growth in domestic animals and therefore only develop to that of a juvenile stage of the ancestor. This has been reported to occur in morphological features in the domestic dog (Goodwin, Bradshaw and Wickens 1997). It has been suggested that it is not the overall brain size that is related to play, but the relative size of the neocortex (Fagen 1981). However, removal of the neocortex at birth does not affect levels of play in juvenile hamsters (Murphy, Maclean and Hamilton 1981) or juvenile rats (Panksepp, Normansell, Cox and Siviy 1994).

Bekoff suggests (see Furlow 2001) that play creates a brain that has greater behavioural flexibility and improved potential for learning later in life.

It is clear from the array of literature concerning the theory of play that there is no one theory that can explain why the occurrence of play in all the species of animals that perform play behaviour patterns.

1.13 Why do Juveniles Play More Than Adults?

Play has costs and benefits, but the costs appear to be immediate and the benefits delayed. This may explain why young animals usually play more than adults of the same species. Once an animal has developed its physical capacity through juvenile play, which is facilitated by protection and food provision by the mother or social group, vigorous activities such as predator avoidance, social interaction, reproduction and care of offspring may be sufficient to maintain an adult animal's physical condition. However, when food is abundant and predator pressure is low, adult animals might still play, possibly to maintain their physical capacity (West 1974).

Byers (1998) suggested several explanations for why play occurs more in juveniles than adults. The first of these is that there are delayed permanent effects on physical training (Fagen 1977). However, as discussed above, this has been disputed. Secondly, play may immediately increase juvenile survival. This is also unlikely because of the immediate costs involved with play and the associated risks, which may be fatal. The third explanation for the age distribution of play is that the age at which animals play

most frequently is a sensitive period of behavioural development. A sensitive period is described by Byers (1998) as:

"a window in development during which specific types of experience permanently alter the course of development of the brain, or of other systems that support behaviour."

He suggests that the postnatal development of parallel fibre synapses on Purkinje dendrites in the mouse cerebellum (studied by Larramendi 1969) mirrors the age distribution of play in mice. So, play occurred when it was possible for motor activity to alter the terminal phase of synapse formation and elimination (terminal synaptogensis) in the cerebellum, the area of the brain that controls co-ordinated motor output. Byers and Walker (1995) tested this theory by observing whether the distribution of play was correlated with the development of the cerebellum in cats, rats and mice. In all three species play was most intense when synaptogenesis peaked. Byers (1998) concludes that the fact that play is most intense when synaptogenesis peaks is a likely explanation for play occurring more frequently in juveniles than in adults.

1.2 Object Play

Object play is the involvement of an inanimate object in an animal's play activities (Hall 1998) and is the subject of this thesis. Object play usually involves exploratory manipulation of an object, for example: chewing, biting, kicking, nudging and throwing. It has been observed in many animals' behavioural repertoire, both juvenile and adult, in captivity and in the wild.

Object play has been reported in mammals, marsupials as well as reptiles and birds (Fagen 1981). The two latter groups of animals do not have a limbic system, the group of structures in the brain believed to enable animals to experience and express emotions (Bear, Connors and Paradiso 2001). This has led to a suggestion that object play is a more primitive form of play controlled by the basal ganglia and that control of more complex forms of play, such as social play, may depend more on limbic structures and therefore does not occur in these more primitive animals (Siviy 1998). This concurs with the theory put forward by Pellis (1991) who suggests that different forms of play are controlled by different parts of the central nervous system. However, social play has

been observed in birds, for example woodpeckers (Kilham 1974), corvids (Heinrich and Smolker 1998) and parrots (Diamond and Bond 1999; Skeate 1985), so Siviy's suggestion that complex play is controlled by the limbic structures may not be justified.

Object play has been referred to as "diversive exploration" (Hutt 1966), in an attempt to clarify the difference between exploration of an object and playing with an object. However, it appears to be notoriously difficult to differentiate between initial exploration and diversive exploration (Hall 1998). Throughout this thesis the definition of object play will be

"Manipulation of an inanimate object with no obvious purpose or reward"

1.3 Object Play in Herbivores

As this thesis will be studying herbivorous ungulates the following sections concentrate on this group of animals, although examples from other groups of animals are used to illustrate certain points.

Object play is regularly displayed by carnivores (e.g. cats); omnivores (e.g. dogs and bears), non-human primates and other frugivores (Hall 1998). Object play in these animals appears to be similar to behaviour patterns involved in food manipulation, such as predation and manipulation of awkward foodstuffs (e.g. Biben 1982). This could be why object play is not often associated with grazing herbivores such as equids, as they do not need to catch their food as the previous groups of animals do.

Object play has been observed in juvenile kangaroos, wallabies and rat-kangaroos (Watson 1998). They have semi-prehensile lips and forepaws, which they use for food handling and object play. Under field and captive conditions they have been seen to manipulate or bite at sticks, bark and grass stems; grab at falling leaves; throw sticks against their chests and wrestle with bushes. In addition, captive animals have been observed to manipulate other novel objects accidentally left in their enclosures.

Juvenile gazelle have also been seen to perform object play (Gomiendo 1988). The same behavioural patterns are shown as in play fighting, but directed toward an

inanimate object, i.e. sparring, butting, clashing, pushing and neck fighting. It was performed at low and fairly constant rates up to seven months of age, but was observed slightly more frequently during the first two months. The author suggests that play might be a means by which juveniles deal with current problems and needs in relation to both the social and physical world around them.

An example of object play in a domestic herbivore species has recently been reported in calves (Jensen, Vestergaard and Krohn 1998). Although no objects were added to the pens, the calves were seen to butt familiar fixtures of the pen. Play occurred mainly at the morning feed and also peaked at the afternoon and evening feed. The authors suggest, therefore, that play occurred most when the calves were highly stimulated, excited and alert. It may be, however, that the behaviours observed are not true object play, but re-directed frustration behaviours caused by the anticipation of feeding. This has been reported to occur in the domestic horse. Odberg (1973) observed that domestic horses (*E. caballus*) pawed when they could see food that was out of their reach or could hear the sound of feed being prepared.

Therefore, in herbivores object play seems to be directed towards exploration, manipulation and as a substitute for social play, perhaps when no suitable playmate is available.

1.4 Domestication, Welfare and Play

Domestication has had many effects on the behaviour, physiology and morphology of animals. It has been predicted that play behaviour should occur more often in well-cared-for domestic animals, than in their wild counterparts (Burghardt 1988) because maintenance pressures, such as avoiding predators and seeking food, are lower. This has been shown to be the case when domestic horses are compared to feral horses (Farrelly 1998). It has also been suggested that increased play in adult domestic animals may represent the retention of an infantile state (Thompson 1996). This is termed paedomorphism. Behavioural, as well as morphological, paedomorphism is seen in signalling by domestic dogs (Goodwin *et al* 1997) where juvenile behaviour patterns are exhibited in the adult, and this may also be true for play.

Play is thought to be a low priority behaviour that does not occur in sub-optimal conditions, when the animals may be stressed, hungry or tired (Pellis 1991, Sommer and Mendoza-Granados 1995, Suomi 1982). This appears to contradict the evidence of Hall and Bradshaw (1998) that domestic cats play with objects more when they are hungry and that of Evans and Pellegrini (1997) that children play after they are exhausted. However, in these subjects the conditions of hunger and tiredness were short-term. If they persisted, however, sub-optimal conditions that would inhibit play would be reached. In adult animals play is sometimes considered as evidence of physical and mental well-being (Michael 1968). Therefore, it may be a useful indicator of a domestic animal's welfare. If play is absent from a domestic animal's behavioural repertoire, part of the animal's environment may be sub-optimal. However, this would only be the case if play were part of the animal's adult behavioural repertoire for each species under observation.

1.5 Object Play as a Means of Environmental Enrichment

In a domestic environment exploration of the environment is often prevented, leading to abnormal behaviour or redirected behaviour (Wood-Gush and Vestergaard 1991). An example of this is a study in which piglets preferred an environment that contained novel objects. Interest waned after five minutes of each test, emphasizing the importance of novelty (Wood-Gush and Vestergaard 1991). Studies such as this suggest that providing novel stimuli in a restrictive environment, and so breaking the monotony of a domestic environment, may be a means of facilitating highly motivated behaviour patterns, overcoming frustration and, therefore, reducing the development and exhibition of abnormal behaviour patterns.
Many domestic environments are severely restricted in comparison with the environments in which ancestral species evolved, and therefore,

" The greater the propensity for inquisitive exploration, the greater the need for the abolition of monotonous environments." (Wood-Gush and Vestergaard 1989).

Animals are known to attempt to vary their sensory input. For example, when given the choice between "free" food and obtaining food by depressing a lever, rats preferred to "work" for food by depressing the lever (Singh 1970). This is referred to as

contrafreeloading and has also been reported to occur in birds (e.g parrots: Coulton, Waran and Young 1997; domestic fowl (*Gallus gallus domesticus*): Duncan and Hughes 1972), fish (Siamese fighting fish (*Betta splendens*): Baenninger and Mattleman 1973) and primates (e.g. Rhesus macaques (*Macaca mulatta*): Reinhardt 1994). This enables animals to exert a degree of perceived "control" over part of their environment and therefore vary their sensory input. In sub-optimal welfare conditions animals may attempt to vary their sensory input by displaying abnormal behaviour patterns, often referred to as stereotypies. Mason (1991) describes a stereotypy as

"a behaviour pattern that is repetitive, invariant and has no obvious goal or function"

Performance of these behaviours may give the animal perceived control of part of their environment and may be self-rewarding as it causes the release of endogenous opiates, such as dopamine (Houpt 1987), which are involved in pain tolerance and pleasurable sensations. This enhances and reinforces stereotypic behaviour patterns (Dodman, Shuster, Court and Dixon 1987) and can lead to the emancipation of the stereotypy from the original causal factors. Examples of stereotypic behaviours include box walking in horses, in which the horse continually paces around its stable, and whirling in dogs, in which the dog continually spins in circles. If a monotonous environment prevents environmental exploration, animals may not display stereotypies, but may instead display apathy and inactivity (Wood-Gush and Vestergaard 1989) if they are unable to cope with a restrictive environment. This has been observed in sows confined in stalls (Broom and Kennedy 1993) and horses, when it is referred to as "star gazing" (Luescher, McKeown and Halip 1991).

It is plausible that in certain situations a monotonous environment may be preferable to a novel environment because it is predictable. Animals which have been reared in a restrictive environment, or are a prey species, may be fearful of novelty. In order to study object play in horses it will, therefore, be necessary to be aware of previous experience of novel objects.

Several studies have reported the use of object play as a form of environmental enrichment. For example, rhinoceros have been observed performing object play in captivity in two studies. Inhelder (1955) provided an isolated male rhinoceros with a

large rubber ball that the rhino manipulated with its feet and head. Interestingly, an isolated female rhino was also presented with the ball on numerous occasions and, apart from an initial investigation, did not play with the ball. This may represent a sex difference or individual variation. Another group of rhinoceri were provided with a swinging boxing bag that they would rub and butt with their heads (Carlstead 1996). It was suggested that this object elicited a high response because it moved unpredictably when manipulated by the animal.

It has been suggested that object play could have a role as a substitute for social play, when no suitable play partner is available (Eibl-Eibesfeldt 1950). This has been termed "response transference" (Muller-Schwarze 1978). More recent studies have indeed shown that some of the behaviour patterns directed toward objects are similar to those seen in social play (Gomiendo 1988, Jensen *et al* 1998).

1.6 Ethology of the Horse

1.6.1 Social Groups

Two types of social organisation have evolved within *Equus* (Klingel 1974). The first is Type I, which are equids that are non-territorial and form harems. The domestic horse, Mountain zebra (*E. zebra*) and Plains zebra have adopted this social system. The second is Type II, which are equids that are territorial and do not form harems. This social system has been adopted by the Asiatic ass (*E. hemonius*), African ass (*E. africanus*) and Grevy's zebra (*E. grevyi*). These different social systems are likely to be adaptations to variation in ecological conditions (Pollock 1987).

Equine Type I social groups usually consist of one stallion, one to six mares and their foals (Bruemmer 1967, Feist and McCullough 1976, Klingel 1974). Young, free-ranging New Forest Pony fillies typically leave their dams in their third or fourth year to form new harem groups, or to join an existing group (Tyler 1972). A study of feral Camargue horses reported that a quarter of the fillies were abducted by stallions (Monard, Duncan and Boy 1996). Colts leave their natal group when they are around three years of age, either of their own accord to form harems or because they are driven away by older

males (Tyler 1972). Surplus and young males form bachelor groups (Bruemmer 1967, Klingel 1974).

Horses have evolved a variety of behaviour strategies that maintain cohesion and stability in social groups, such as mutual grooming (Crowell-Davis 1993) and social play (Fraser 1992). As the domestic horse is a Type I equid it may be, therefore, that play is a more important part of their behavioural repertoire than it is for Type II equids. Social groups can provide protection against predators and biting insects (Duncan and Vigne 1979) and facilitate social transfer of information (Dawkins 1976).

1.6.2 Weaning

In free-ranging horses the weaning process is completed when the foal is about 40 weeks of age if the mare is pregnant, i.e. shortly before the mare gives birth to her next foal. If the mare is not pregnant the current foal may continue to suckle for a year, or longer (Duncan 1980). The weaning process begins with nursing bouts becoming shorter as the dam increasingly restricts nursing by becoming more aggressive toward the foal (Mills and Nankervis 1999). The foal increasingly initiates separation between itself and the dam, and the dam becomes increasingly responsible for bringing them back together (Tyler 1972). This continues gradually until weaning is complete. Therefore, under free-ranging conditions, both the foal and dam play a role in the weaning process.

1.6.3 Feeding Behaviour

Free-ranging horses spend approximately 60% of the 24-hour time budget feeding (Duncan 1979). Horses walk while grazing, cropping about two mouthfuls between each step (Fraser 1992). They choose to eat many species of grass, the preferred species being timothy, white clover and perennial ryegrass (Archer 1973). Horses also browse, eating small trees, branches, leaves and bark (Fraser 1992).

1.7 Domestication of the Horse

Domestication is an evolutionary process that results from changes in the selection pressures on a species or population living in association with humans, releasing that

species or population from the effects of natural selection. An animal is considered domesticated when its breeding, care and feeding are more or less controlled by man (Kretchmer and Fox 1975).

Before their domestication wild horses were an important provider of meat and hides for the human population of Western Europe (Anthony 1991, Clutton-Brock 1992). Evidence of domestic horses has been found in various regions worldwide, but the earliest was found from 6000 years ago at Dereivka in the Ukraine (Levine 1999). In China the domestic horse has been traced back to 2000BC (Chow 1989). At this time the domestic horse was also spreading throughout western Asia, Europe and the British Isles (Clutton-Brock and Burleigh 1991). Horse riding is not thought to have been commonplace until 1000BC (Clutton-Brock 1992), although it is likely that horses were ridden before this time (Levine 1999).

Domestication and management have led to many changes in the horse's environment. Today most owners regularly stable their horses. The stable is not a natural environment for the horse as it restricts locomotion as well as exploration and may restrict feeding and social contact (Goodwin 1999). Both Greek and Roman civilisations kept horses stabled to prevent theft (Barclay 1980). The Romans also believed that horses

> "Should be kept apart lest they hurt one another when furious" (Palladius 134AD).

However, horses are a social, herding species and injury caused by horses within established groups is rare (Houpt and Keiper 1982). This is because social behaviour patterns are retained during domestication and functions to reduce the incidence of aggression (Price and King 1968). Stabling also affects the feeding behaviour of domestic horses. The time they spend feeding is reduced to 40% of their time budget if fed on hay and to 4% if fed exclusively on concentrates (Fraser 1992). This reduction in the time spent feeding has been reported to be the most important factor in the development of abnormal behaviours in stabled horses (Marsden 1993).

Domestication has also led to changes in the weaning process of foals (Section 1.6.2). Most domestic horse foals are artificially weaned at four to six months of age, which is earlier than natural weaning would occur (Apter and Householder 1996). The most

common method of weaning in Western countries is to remove the foal from the dam abruptly, without a period of gradually spending more time away from the dam. This method of weaning is more stressful for foals than gradual weaning (Apter and Householder 1996). In a recent study of 225 domestic horses the abruptness, feeding and social isolation of the conventional weaning method was reported to be a contributing factor to 43.7% of these horses developing abnormal behaviours (Waters, Nicol and French *in press*).

1.8 Development of Play in Equid Foals

Foals are precocial in their development, as they need to be capable of following their dams soon after birth. Within as little as 140 minutes after parturition exaggerated movements resembling locomotor play have been observed in Thoroughbred foals (Bhuvanakumar and Satchidanandam 1992). Typically within the first six hours after birth foals move to and from their dam, or in small circles around her (Waring 1983). They exhibit galloping, swerving, bucking, jumping, striking and kicking. Similar activities have been reported in Przewalski (Waring 1983) and feral ass foals (Moehlman 1998). This is referred to as solitary-locomotor play through the remainder of this thesis and constitutes over 70% of vigorous exercise in foal development during the first six weeks of life (Fagen and George 1977).

Neonates also orient play activities towards their dam, biting at her legs and sides as well as pulling and chewing on the mane and tail. In addition foals may strike, kick and mount the dam (Powell 1978, Moehlman 1998 and Waring 1983).

As foals mature they tend to play further away from the dam and the levels of solitary and dam-oriented play decrease (Bhuvanankumar and Satchidanandam 1992). Tyler (1972) reports that during the first week post partum foals were engaged in these types of play for 56% of observation time. This was reduced to 7.4% in the seventh and eighth week.

In equid species which form stable social groups, social play between foals begins to develops between two and four weeks of age (Bhuvanakumar and Satchidanandam

1992, Waring 1983). After this age social play increases and solitary play decreases (Gunjima 1997, Moehlman 1998, Tyler 1972). Social interactions usually begin with visual investigation and touching each other's muzzles. This may eventually lead to social play (Waring 1983). Many of the play behaviour patterns displayed in social play are agonistic behaviour patterns, i.e. kicking, rearing and biting (Francis-Smith 1979).

Play behaviour is similar between colts and fillies for the first month after birth, except that mounting frequency is greater in colts (Waring 1983). After this time play differs markedly between colts and fillies. Colts of a similar age will often pair up and spend long periods of time play fighting (Tyler 1972). If they belong to the same social group colts and fillies may become play partners, but play fighting is not as rough as colt-colt pairings (Waring 1983). Play between fillies is relatively uncommon (3% of play bouts), compared to playful interactions between colts and fillies (18% of play bouts) and between colts (74% of play bouts) (Schoen, Banks and Curtis 1976, Wells and Goldschmidt-Rothschild 1979). It has been suggested (Tyler 1972) that the increased play seen by colts is due to their precocious sexual nature. Indeed, sexual elements, such as colts nibbling the hind-legs and rump and attempting to mount fillies, are evident in colt-filly play interactions. Locomotor play is most commonly seen between fillies. One filly may approach or move away from another using exaggerated movements. They may also gallop side by side which may lead to chases (Waring 1983).

Manipulative, or object, play has been reported as early as 2 hours of age in foals (Waring 1982). Objects are manipulated with the muzzle and by pawing. This leads to nibbling, biting, pulling and lifting objects in the foal's environment, which may be accompanied by approach-withdrawal movements. The movements are often exaggerated and do not form complete sequences, so after brief contact the foal may shift to other motor patterns.

1.9 Object Play in Equids

Object play has been reported in domestic horse foals (Crowell-Davis, Houpt and Kane 1987, Fraser 1989) and free-ranging New Forest Pony foals (Tyler 1972) and is a normal feature of foal play (Tyler 1972). It was reported to constitute 7±2% of all play bouts (Crowell-Davis *et al* 1987) in Welsh pony foals. These foals were observed playing with

sticks, leaves, clods of dirt, stones and pieces of paper. Play consisted of picking objects up in the mouth, carrying objects in the mouth, tossing the head with the object in the mouth, tossing the object in the air and pawing at objects on the ground. This occurred with novel and familiar objects, suggesting that exploration was not the only aim. Crowell-Davis *et al* (1987) also reported some evidence of preference for specific objects by a domestic foal colt. This foal dragged a small dried-up cut evergreen branch around the field during play bouts for several days.

There is anecdotal evidence of adult horses engaging in object play (Waring 1983). This seems to occur particularly in stabled horses who appear to play with sticks, boards, rags, pieces of paper, buckets and many other objects. They were observed picking up these objects and swinging or tossing them. This is usually repeated several times in each bout of play. Activities such as these and the manipulation of door and gate latches appear to be forms of solitary object play and stimulation for the domestic horse (Waring 1983) as they increase environmental variability.

Although domestic horses appear to play with objects an explanation for why they do this is not clear. It is possible that it is a means by which a horse can explore its environment. Horses appear to be naturally inquisitive (Fraser 1992), exploring new fields and novel objects. Object play may also be a means of learning manipulative skills, such as handling awkward foodstuffs. New Forest Ponies have been reported to eat gorse and holly (Gill 1988) that requires practiced manipulation in order to consume it. It has been suggested that object play could even have a role in tool use in horses (Crowell-Davis *et al* 1987), as horses have been seen to use sticks to rake snow, to scratch their flanks and to hit other horses.

1.10 Why Study Object Play in Domestic Horses?

Several studies have observed object play in foals. However, this has been incidental to the studies and no researcher has previously focused on how object play develops in foals and why it should occur. At present no studies have been published which describe object play in adult equids. There are many anecdotal reports of object play being performed by adult domestic horses, but these fail to consider the role of object play in

adults and whether it could have any relevance in environmental enrichment for stabled horses. Also, as they are anecdotal reports it is not certain that the behaviour being reported is true object play, or initial exploration of an object.
It is not know what the consequences are of preventing object play behaviour in the horse. An improved understanding of the motivation for foals and adult horses to play with objects may aid reducing other problems, such as the performance of abnormal behaviour patterns. If play is indeed involved in the development of the brain it is necessary to determine what role play has in this development and the consequences of preventing it.

Several horse "toys" are available through equestrian retailers for use as environmental enrichment for adult domestic horses. However, there is no published scientific assessment regarding their design or their efficacy. Also, many of the anecdotal reports of object play in adult domestic horses involve objects not intended as play objects for horses However, these reports do not attempt to suggest why these objects might be selected as play objects by horses.

The idea that play is an important part of the horse's behavioural repertoire, especially for juveniles, has been reported in non-scientific publications (Simpson 2001) and so horse-owners may look for further justification for providing their horses with suitable companions and objects to play with. If object play is important then preventing it, or no allowing for it may lead to a deprivation which could lead to displacement behaviours or a fear of novel objects. Understanding the causes and importance of object play may be use in reducing other problems, such as stereotypic behaviours.

2. Aims

2.1 Object Manipulation and Play in Domestic Horse Foals

In order to gain a better understanding of the development and function of object manipulation and play behaviour in domestic horses three observational studies of play in domestic horse foals were carried out.
The aims of these were to determine:

1. The development of object manipulation and play behaviour and its relation to the development of social play and solitary-locomotor play
2. Whether "boldness" could be identified as a personality trait in domestic horse foals and how the "boldness", or "inquisitiveness", of the foals affects the ontogeny of object play
3. How the social environment of the foal affects the ontogeny of object play and whether object play could have a role as a substitute for social play in socially isolated foals

2.2 Object Play in Adult and Juvenile Domestic Horses

A variety of studies were carried out in order to investigate object play in adult and juvenile domestic horses. These were carried out by observing horses at an Equine Behaviour Centre, at the stables of an Agricultural College and at a yard of horses owned by different private owners.
The main aims of these studies were to determine:

4. Which sensory characteristics of objects are important in eliciting object play in adult and juvenile domestic horses
5. How age affects the object manipulation and play exhibited by domestic horses

3. Constraints on the Work

The research presented in this thesis was restricted by a number of factors.

1. **Sample Size**

   The sample sizes of the studies reported in this thesis are small, ranging from six to 14 horses. This is due to the difficulty in recruiting large numbers of privately owned horses to take part in trials on their owners' premises. This was despite extensive recruiting efforts. For example, advertising in the appropriate breed society magazines and newsletters, in local saddlers and feed merchants and travelling long distances to study individuals. There were progressively fewer foals available to study in each year as horse breeders were breeding less horses due to a decline in the UK market.

   During the final year of my research the UK suffered a Foot and Mouth Disease outbreak, which limited the number of horses that could be recruited from certain areas and restricted the access to horses grazed on farmland. This further restricted the number of foals available for study in the 2001 foal study group (Section 7).

2. **Management Conditions**

   The management of all the horses observed during this research, except for the horses kept at the Equine Behaviour Centre, was under the owners' control throughout data collection. Where management conditions have changed during studies it has been noted and its implications for the results of the study discussed.

3. **Breeds**

   Domestic horses (Hafez 1969) and other domestic species (e.g. dogs: Goodwin *et al* 1997) have been reported to exhibit breed differences in behaviour patterns. This was observed in the first year of this thesis when studying a mixed breed group of foals (Sections 4). Therefore, in the second and third years the foal studies were restricted to Arabian horses (Sections 5 and 6). This makes results of these studies most appropriate to Arabian

horses, as it is generally accepted that behaviour differs between breeds. However, as this breed has been used to cross breed with many others, for example, Thoroughbred and Welsh, the results could also be relevant to a much wider section of the general domestic population.

The trials reported in Sections 7 to 11 observed different breeds and types of horses, which may have introduced variations in the data.

CHAPTER 2

Object Manipulation and Play in Domestic Horse Foals

4. Factors Affecting the Ontogeny of Object Manipulation and Play in Domestic Horse Foals - A Preliminary Study

4.1 Introduction and Aims

Object play in domestic horses has not previously been thoroughly investigated. Therefore, a study of object play in foals was first necessary to improve the understanding of how object play develops and possibly give some clues to its function in the domestic horse.

Lewis (2000) has suggested that in primates different parts of the brain control different types of play and that different types of play emerged at different stages of development, but with some overlap. Fraser (1992) suggests that solitary-locomotor play decreases at two months of age in domestic horse foals and that at this time social play increases. Gunjima (1997) also reports that in Thoroughbred foals social play increases and solitary play decreases during the first two months of life. Gazelles have been observed to perform object play at a low, but constant, rate up to seven months of age, but it was slightly more frequent during the first two months of life (Gomiendo 1988), as solitary forms of play appear to be in domestic horse foals. Object play is usually a form of solitary play. It would be of interest, therefore, to determine whether its development follows that of other types of solitary play.

The aims of this study were:

1. To determine when object manipulation develops in domestic horse foals.
2. To determine whether a relationship exists between the development of object manipulation and play and the development of social play.

4.2 Methods

4.2.1 Subjects

Ten foals were recruited to take part in this study. As many studs were not breeding at the time of the studies, due to low sale prices, it was not possible to select for an even sex ratio, breed or social environment. The foals and their social environments during the study are described in Table 4.1. Six males and four females representing three breeds and four cross breeds were studied. Of these, one female and one male were completely isolated from other foals and juveniles (i.e. individuals between one and four years of age) for at least the first three months after birth. The remaining foals had varying degrees of contact with other foals or juveniles. Those foals that were observed with other foals/juveniles for more than 50% of observations were termed "social" and those observed with other foals/juveniles for less than 50% of observations were termed "mainly isolated."

Table 4.1. Details of the 1999 foal study group

Foal	Date of Birth	% of Observations Stabled	Sex	Breed	Social Environment (% of observations with social contact)
Sway	02/06/99	0%	Male	Hackney	Social (100%)
Jess	19/04/99	9.3%	Female	¾ Thoroughbred ¼ Irish Draught	Social (88%)
Edward	20/06/99	0%	Male	½ Quarter Horse ¼ New Forest ¼ Appaloosa	Social (84%)
Jack	16/04/99	6.67%	Male	Welsh Cob x Arab	Social (78%)
Beech	27/05/99	2.27%	Male	New Forest	Mainly isolated (45%)
Valeta	02/05/99	44.19%	Female	New Forest	Mainly isolated (38%)
Sabrea	01/06/99	44.19%	Female	Arab x Thoroughbred	Mainly isolated (29%)
Teddy	25/06/99	0%	Male	New Forest	Mainly isolated (7%)
Tinnar	16/04/99	16.28%	Female	Arab	Isolated (0%)
Gametime	13/05/99	0%	Male	New Forest	Isolated (0%)

4.2.2 Observations

Each observation session lasted for 30 minutes and was carried out where the dam and foal were normally kept at that time of the day (either in the stable or at pasture), to

minimise any disturbance to the horses and the owners. During each observation a Jolly Ball (Horseman's Pride, Ravenna, OH, USA, Figure 4.1.) was placed either in the centre of the stable or, when at pasture, as close to the foal as possible without disturbing the dam and foal. This object was used to ensure that all the foals had the opportunity to manipulate an object in their environment. From the 1st – 18th observation a 15cm diameter Jolly Ball was used, as the loop of the handle was not large enough for a small foal to trap its hoof in. A 25cm diameter Jolly Ball was used, from the 19th observation for all subsequent observations.

Figure 4.1. The 15cm Jolly Ball (left) and the 25cm Jolly Ball (right)

All observations were recorded using a hand-held Video8 format video camera and transferred to VHS format for data collection.

When filming a dam and foal in a stable a wide-angle lens was fitted to the camera and they were filmed from outside the stable door. Wall-mounted cameras were not used, as the owners did not want the brackets fitted in the stables and the foals were not always in the same stable during observations. A tripod-mounted camera was not used because it was not possible to position it in a location where the whole stable could be filmed, and the camera would be inaccessible to the dam and foal. Also, as an observer was present during observations at pasture it was necessary for the observer to be present during observations in the stable, to control for any effects associated with the presence of the observer.

Filming started after the Jolly Ball had been placed on the ground and the observer had either left the stable or reached a suitable position in the field to film. The Jolly Ball was removed after the 30 minute observation had been completed.

During observations the observer did not interact with the foal or other horses in its social group. However, it has been reported that the presence of an observer can affect the behaviour of horses being observed (Crowell-Davis 1992), although this has not been quantified.

4.2.3 Timetable for Observations

Birth – three months of age

Each foal was observed on alternate days, from one-three days *post partum* until three months of age. Individual observation sessions were carried out according to the following rota, so that any diurnal effects could be studied:

0730-0800 hours
0900-0930 hours
1200-1230 hours
1330-1400 hours
1630-1700 hours
1800-1830 hours

Therefore, at each observation each foal was observed at a different time.
The times for the morning observations (0730-0800 hours and 0900-0930 hours) were chosen because they are in the middle of a morning activity period (between 0700 and 1000 hours), described in the Hartmann zebra (*Equus zebra hartmannae*) (Joubert 1972a,b), when play behaviour was reported to be observed in the zebra foals. The evening observations (1630-1700 hours and 1800-1830 hours) were included as there is evidence of horses displaying most play during the late afternoon and early evening (Schoen *et al* 1976). The observations in the middle of the day (1200-1230 hours and 1330-1400 hours) were included as an intermediate between these two reported activity periods in order to determine whether play activity did actually differ at this time of the day.

Three months of age – weaning

Play behaviour is reported to be most intensive during the first three months of life (Zharkikh 1999). Also at two months of age it has been reported that solitary-locomotor play in domestic horse foals decreases (Fraser 1992). To ensure that this period was observed intensively, observation on alternate days continued until the foals were three months old. At this age observations were carried out using the same procedure, but the frequency was reduced to every six-eight days until the foals were completely weaned. All the foals were weaned by being removed from their dam abruptly. Each weekly observation was carried out at the same time for each foal as detailed in Table 4.2, for the convenience of the owners.

Table 4.2. Times of weekly and monthly observations for each foal from three months to one year of age

Foal Name	Time of weekly and monthly observations
Beech	1630hours
Edward	0900hours
Gametime	1630hours
Jack	1630hours
Jess	1200hours
Sabrea	0900hours
Sway	1330hours
Teddy	1200hours
Tinnar	1200hours
Valeta	1200hours

Weaning – one year of age

All the foals in this study were weaned abruptly as described in Section 1.7. In the case of Teddy, Valeta and Sabrea the dam was moved to another premises. The dams of the remaining foals were moved to a different part of the owners' property. The foals were observed once a month, until they reached one year of age. Observations began between one week and two weeks after weaning because it was not possible to observe some of the foals directly after separation from the dam. The observations were carried out at the same time of day as the weekly observations (see Table 4.2).

4.2.4 Data Recording

All observations were viewed on VHS format. The duration of each object manipulation, social interaction and solitary-locomotor play behaviour (see Tables 4.3, 4.4 and 4.5) displayed, was timed using a stopwatch and recorded on check sheets. The percentage of time spent during each observation displaying these two behaviour categories was calculated for further analysis.

Meteorological data, including air temperature, relative humidity, rainfall and wind speed, for the Southampton area were obtained from the Met Office, enabling the effects of these factors on object manipulation to be analysed.

Table 4.3 Object manipulation and play ethogram

Behaviour	Description of the Behaviour
Orient towards	The horse turns its head and/or whole body towards the object, with its ears pointing towards the object
Approach	The horse moves towards the object with the head and ears pointing towards the object
Sniff	The horse appears to sniff the objects and the nostrils flare
Nuzzle	The horse touches the object with the muzzle and may simultaneously sniff the object
Lick	The horse licks the object with its tongue
Bite/attempt to bite	The horse mouths or bites the object
Pick up object	The horse picks the object up in its mouth
Pick up object and toss head	The horse picks up the object in its mouth and tosses its head whilst holding onto the object
Paw object	The horse paws at or around the object with its hooves
Paw and mouth	The horse paws at the object or around the object with its hooves and either nuzzles, licks or bites the object simultaneously

Table 4.4 Social interactions ethogram

Behaviour	Description of the Behaviour
Orient towards	The horse turns its head and/or whole body toward a conspecific with its ears pointing toward the conspecific
Approach	The horse approaches the conspecific with its ears pointing towards the conspecific
Nose-nose greeting	The horse touches the muzzle of the conspecific with its muzzle
Bite/attempt to bite	The horse appears to bite the conspecific
Hind kick at	The horse kicks at the conspecific using its hind limbs
Fore strike at	The horse kicks at the conspecific using its fore limbs
Mount/attempt to mount	The horse mounts or attempts to mount any part of the conspecifics
Allogroom	The horse grooms the conspecific using the mouth
Chase and charge	The horse canters or gallops with the conspecific
Mock fight	The horses face each other and attempt to bite the head and the legs of their opponent

Table 4.5 Solitary-locomotor play ethogram

Behaviour	Description of the Behaviour
Canter	A three-beat gait
Gambol	The horse canters interspersed with hind kicks, sudden stops and high speed turns
Gallop	A four-beat gait
Sudden stop	The horse stops suddenly for no apparent reason whilst cantering, gambolling or galloping
High speed turn	The horse turns suddenly whilst cantering, gambolling or galloping

4.2.5 Statistical Methods

Due to the small sample size of this study the results for each foal were analysed individually and treated as single case studies. All statistical analysis was carried out using SPSS v.8.0. The following analyses were used in this study:

Kruskal-Wallis Test

The Kruskal-Wallis test compares the scores for a continuous variable between three or more groups. The scores are converted to ranks for each group and the mean rank of each group is compared. As the Kruskal-Wallis test is a between-groups test the groups must be mutually exclusive. The parametric alternative to this test is a one-way between-groups analysis of variance.

Friedman Test

The Friedman test is used to compare three or more groups each consisting of the same subjects. This test compares the ranks of the scores for the groups being compared. The parametric alternative to the Friedman test is a one-way repeated measures analysis of variance.

Wilcoxon Signed Ranks Test

The Wilcoxon signed ranks test is used to compare two groups consisting of the same subjects. This test converts the scores of the two groups to ranks and compares the ranks. The parametric alternative to the Wilcoxon signed ranks test is a repeated measures t-test.

4.3 Results

4.3.1 Ontogeny of Object Manipulation and Play, Social Play and Solitary-Locomotor Play: Social Foals

Sway (Social: 100%)

Sway displayed object manipulation towards the Jolly Ball, gate latches and sticks during observations. Object manipulation was first observed at four days of age (observation 2). Social play was first observed at six days of age (observation 3). The progress of object

manipulation and social and solitary-locomotor play development during the first three months of life is displayed in Figure 4.2.

Friedman analysis detected a significant difference (X^2=7.8, *df* =2, P<0.05) in the duration of object manipulation displayed between the first three months *post partum*. Wilcoxon analysis showed that the duration of object manipulation displayed was significantly greater in the second month of life than in the first and third (Z=-2.69, P<0.01; Z=-2.22, P<0.05). Friedman analysis detected no significant differences in the duration of social play (X^2=1.54, *df*=2, NS) or solitary-locomotor play (X^2=2.00, *df*=2, NS) displayed between the first three months after birth.

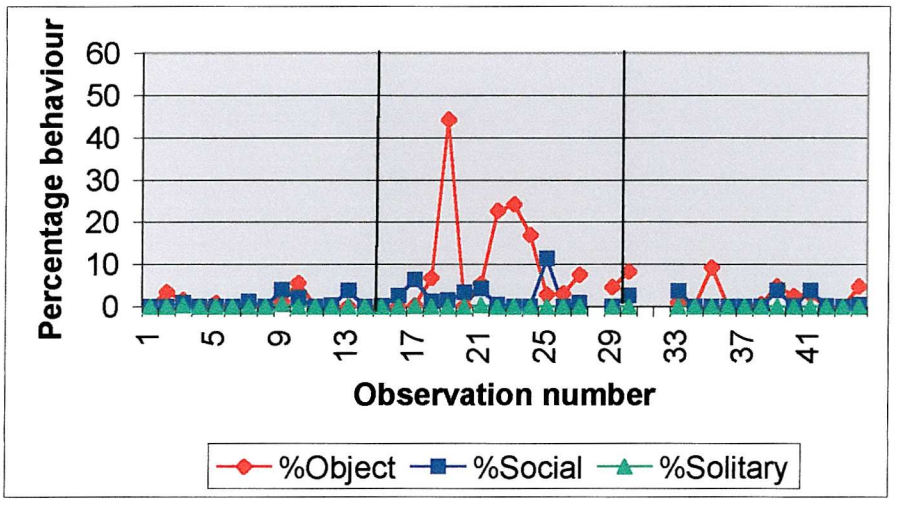


Figure 4.2. Sway – Percentage of time spent in object manipulation (Object) and social (Social) and solitary-locomotor (Solitary) play during observation periods between birth and three months of age. Vertical lines indicate the end of each month of life

After three months of age this foal was observed once a week until weaned at five months of age. Social play was observed once at three months of age (1% of observation) and object manipulation was observed once at four months of age (8% of observation).

There was no significant correlation between object manipulation and social play (Spearman's rho: 0.253, NS) or between object manipulation and solitary-locomotor play (Spearman's rho:0.079, NS).

After weaning Sway was observed once a week until he was 12 months old. He was kept at pasture with his half brother and half sister of the same age. At five months of age Sway displayed object manipulation for 8% of the observation. At seven months of age object manipulation was displayed for 9% of the observation. At nine months of age object manipulation was displayed for 1.5% and social play for 1.5% of the observation. At 12 months of age object manipulation was displayed for 1% of the observation.

Jess (Social: 88%)

Jess displayed object manipulation towards the Jolly Ball, bedding, baler twine, gate latches, clods of dirt, a wheelbarrow, ropes, electric fence wire and chains during observations. Object manipulation was first observed at two days of age (observation 1). The opportunity to interact with a colt foal was first available from 10 days of age (observation 5). Social play was first observed at 12 days of age (observation 6). The progress of object manipulation and social and solitary-locomotor play development during the first three months of life is displayed in Figure 4.3.

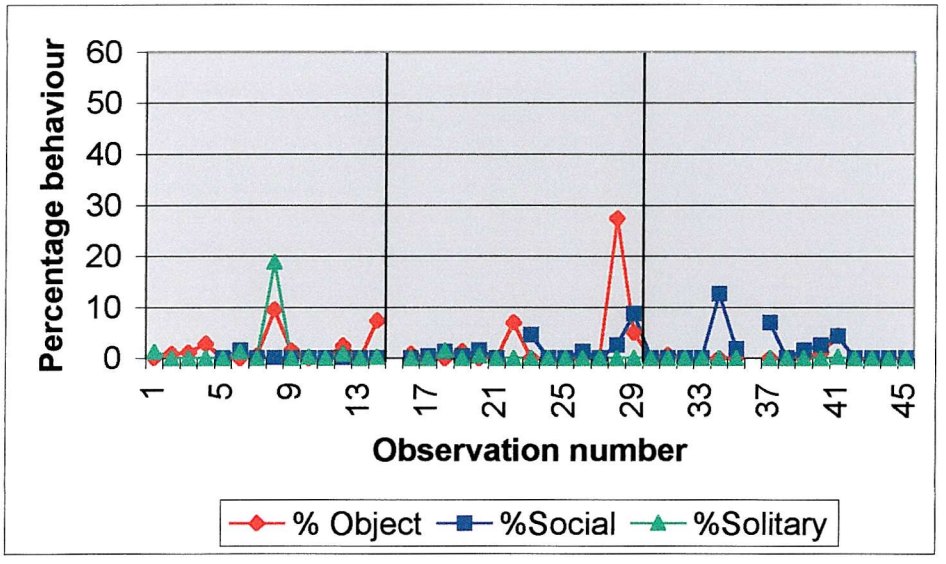


Figure 4.3. Jess – Percentage of time spent in object manipulation (Object) and social (Social) and solitary-locomotor (Solitary) play during observation periods between birth and three months of age. Vertical lines indicate the end of each month of life

Friedman analysis detected no significant difference (X^2=3.65, *df*=2, NS) in the duration of object manipulation displayed between the first three months *post partum*.

Friedman analysis detected no significant differences in the duration of social play (X^2=5.30, *df*=2, NS) or solitary-locomotor play (X^2=3.25, *df*=2, NS) displayed between the first three months after birth.

There was no significant correlation between object manipulation and social play (Spearman's rho: 0.089, NS) or object manipulation and solitary-locomotor play (Spearman's rho: 0.197, NS).

After three months of age Jess was observed once a week until weaned at eight months of age. Object manipulation was observed at seven and eight months of age (1% and 2% of observations).

After weaning Jess was observed once a month until she was 12 months old. She was kept at pasture with a two year old gelding. Object manipulation was displayed at low levels (0.5-1%) until Jess was 12 months when object manipulation was displayed for 4.5% of the observation. No social play was observed.

Edward (Social: 84%)

Edward displayed object manipulation towards the Jolly Ball and clods of dirt during observations. Object manipulation was first observed at four days of age (observation 2). The opportunity to interact with a filly foal was first available from 12 days of age (observation 6) and this was when social play was first observed. The progress of object manipulation and social and solitary-locomotor play development during the first three months of life is displayed in Figure 4.4. Friedman analysis, detected no significant difference (X^2=3.43, *df*=2, NS) in the duration of object manipulation displayed between the first three months of life. Friedman analysis detected no significant differences in the duration of social play (X^2=0.10, *df*=2, NS) or solitary-locomotor play (X^2=0.74, *df*=2, NS) displayed between the first three months after birth.

There was no significant correlation between object manipulation and social play (Spearman's rho: 0.160, NS) or object manipulation and solitary-locomotor play (Spearman's rho: 0.107, NS).

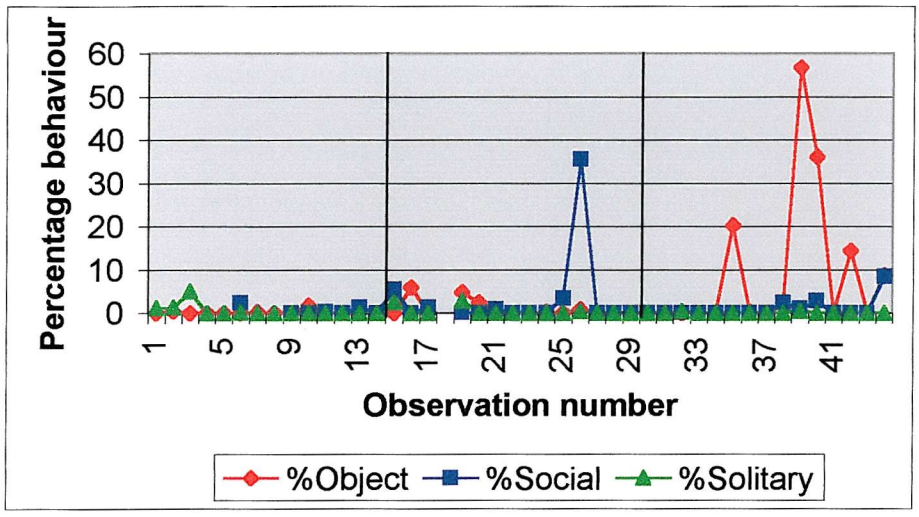


Figure 4.4. Edward – Percentage of time spent in object manipulation (Object) and social (Social) and solitary-locomotor (Solitary) play during observation periods between birth and three months of age. Vertical lines indicate the end of each month of life

Edward was observed once a week until he was weaned at nine months of age. During this time, although he had the opportunity to play with two fillies, no social play was observed. Object manipulation was observed three times during the seventh and eighth month of age (4%, 1% and 14% of observations).

After weaning Edward was kept with two fillies of a similar age and observed once a month until he was 11 months old. One month after weaning he manipulated the jolly ball for 8% of the observation. After this Edward did not manipulate objects during observations until he was observed at eleven months of age when he spent 0.5% of the observation approaching and sniffing the Jolly Ball. No social play was observed with the two half sisters with whom he was kept.

Jack (Social: 78%)

Jack displayed object manipulation towards the Jolly Ball, gate latches, a bridle, sticks, an electric fence battery box, lead-ropes, bedding, clods of dirt, a drain cover, buckets, a chain, baler twine and headcollars during observations. Object manipulation was first observed at two days of age (observation 1). The opportunity to interact with a filly foal was first available from 20 days of age (observation 10). Social play was first observed at 24 days of age (observation 12). The progress of object manipulation and social and

solitary-locomotor play development during the first three months of life is displayed in Figure 4.5.

Friedman analysis, comparing the percentage of each observation spent displaying object manipulation in each of the first three months of life, detected a significant difference in the duration of object manipulation between the first three months of life (X^2=8.98, *df*=2, P<0.05). Friedman analysis compares the ranking of the data, so does not reveal which of the months differ from each other. Wilcoxon analysis of the same data showed that the level of object manipulation was greater in the first month of life than in the third month of life (Z=-3.12, P<0.01). Friedman analysis detected no significant differences (X^2=1.29, *df*=2, NS) in the duration of social play displayed between the first three months of life. Friedman analysis detected a significant difference in the duration of solitary-locomotor play displayed between the first three months of life (X^2=11.90, *df*=2, P<0.01). Wilcoxon analysis showed that the level of solitary-locomotor play was greater in the first month of life than in the second and third month of life (month one vs. month two: Z=-2.40, P<0.05; month one vs. month 3: Z=-2.90, P<0.01).

Object manipulation and social play were positively correlated (Spearman's rho: 0.420, P<0.05). Object manipulation and solitary locomotor play were not significantly correlated (Spearman's rho: 0.147, NS).

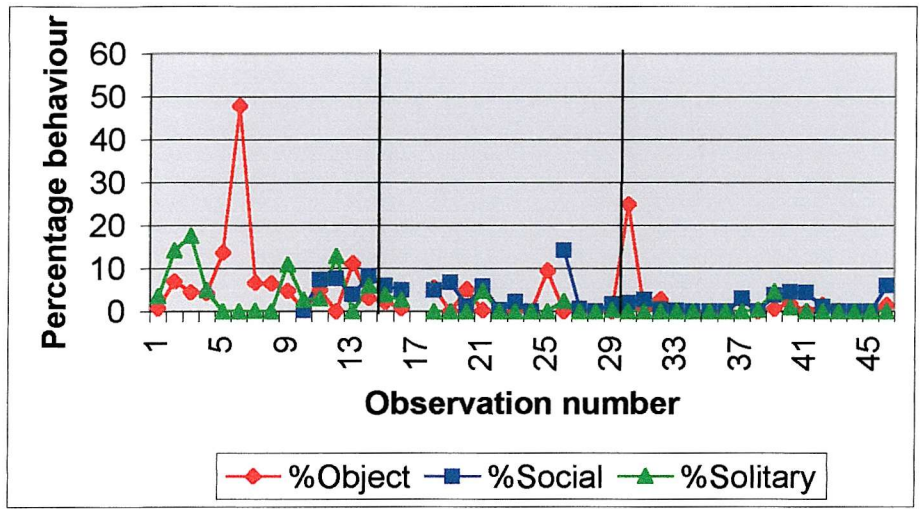


Figure 4.5. Jack – Percentage of time spent in object manipulation (Object) and social (Social) and solitary-locomotor (Solitary) play during observation periods between birth and three months of age. Vertical lines indicate the end of each month of life.

After three months of age Jack was observed once a week until he was weaned at four and a half months of age. No social interactions were observed, although he still had the opportunity. Object play was displayed throughout this period (1.5% - 29% of observations).

After weaning Jack was observed once a month until he was 12 months old. He was kept at pasture with three juvenile geldings. No play was displayed during observations until Jack was seven months old when he displayed object manipulation for 4% of the observation and social play for 8% of the observation. At eight months of age he displayed object manipulation for 8% and social play for 1% of the observation. No object manipulation or social play were then observed until Jack was 12 months old when he displayed object manipulation for 2% and social play for 1% of the observation.

4.3.2 Ontogeny of Object Manipulation and Play, Social Play and Solitary-Locomotor Play: Mainly Isolated Foals

Beech (Mainly isolated: 45%)

Beech displayed object manipulation towards the Jolly Ball and baler twine during observations. Object manipulation was first observed at six days of age (observation 3).

The opportunity to interact with a filly foal was first available at 32 days of age (observation 16) and social play was first observed at 34 days of age (observation 17). The progress of object manipulation and social and solitary-locomotor play development during the first three months of life is displayed in Figure 4.6.

Friedman analysis detected no significant difference in the duration of object manipulation (X^2=1.67, *df*=2, NS) or solitary-locomotor play (X^2=1.87, *df*=2, NS) displayed between the first three months of life.

Object manipulation and social play were positively correlated (Spearman's rho: 0.550, P<0.05). Object manipulation and solitary-locomotor play were not significantly correlated (Spearman's rho: 0.93, NS).

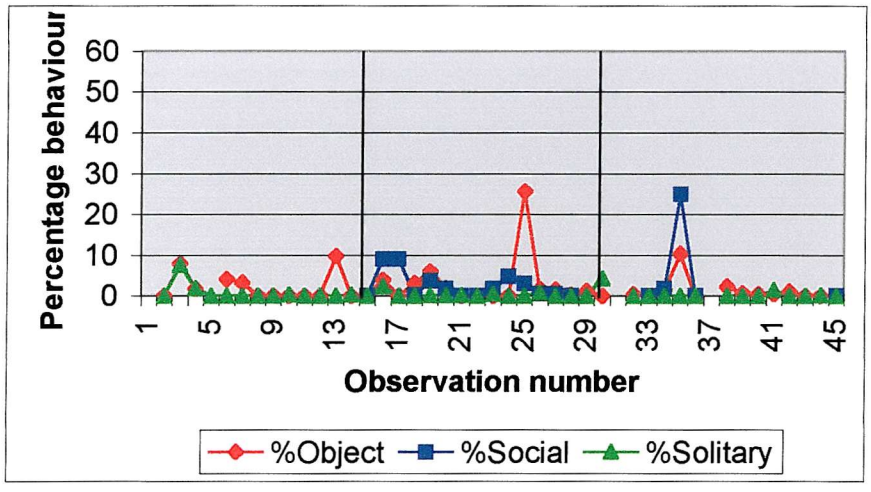


Figure 4.6 Beech – Percentage of time spent in object manipulation (Object) and social (Social) and solitary-locomotor (Solitary) play during observation periods between birth and three months of age. Vertical lines indicate the end of each month of life.

After three months of age Beech was observed once a week until he was weaned and sold at five months of age. During these two months no object play was displayed and social play was only displayed twice (3% and 4% of the observations).

Valeta (Mainly isolated: 38%)

Valeta displayed object manipulation towards the Jolly Ball, gate latches, headcollars, bedding, baler twine, a manger, sticks, a tap and a bag, during observations. Object

manipulation was first observed at two days of age (observation1). The opportunity to interact with a yearling filly was first available from 18 days of age (observation 9). Social play was first observed at 26 days of age (observation 13). The progress of object manipulation and social and solitary-locomotor play development during the first three months of life is displayed in Figure 4.7.

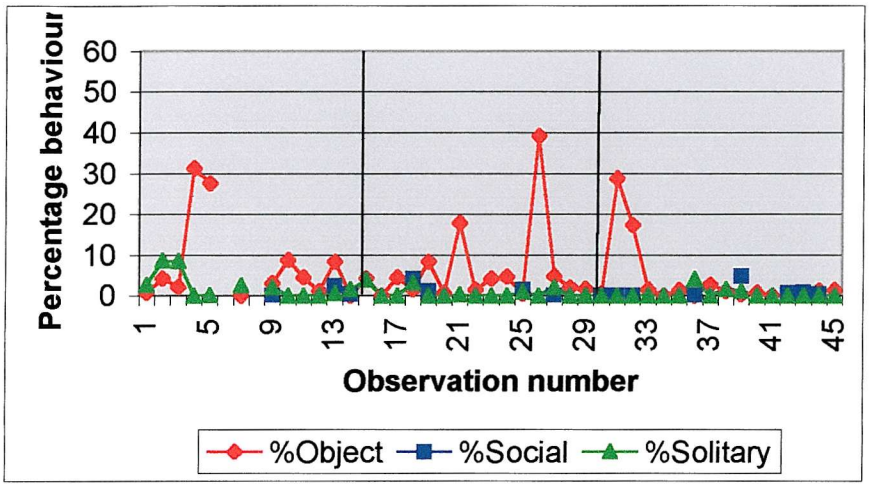


Figure 4.7. Valeta – Percentage of time spent in object manipulation (Object) and social (Social) and solitary-locomotor (Solitary) play during observation periods between birth and three months of age. Vertical lines indicate the end of each month of life.

Friedman analysis detected no significant difference (X^2=1.22, *df*=2, NS) in the duration of object manipulation displayed between the first three months of life. The difference in the duration of social play and solitary-locomotor play between the first three months of life could not be analysed because not enough data was available.

The durations of object manipulation and social play were not significantly correlated (Spearman's rho=-0.168, NS).

After three months of age Valeta was observed once a week, in the same environment, until weaned at five months of age. Object manipulation was observed twice; once in the fourth month of life (4%) and once in the fifth month of life (1%). Social play was observed twice at low levels (less than 1%).

After weaning Valeta was observed once a month until she was 12 months old. She was kept with an unfamiliar colt of a similar age until she was 11 months old and was then kept isolated. At seven months of age object manipulation was displayed for 3% and social play for 4% of the observation. At 12 months of age object manipulation was displayed for 1.5% of the observation.

Sabrea (Mainly isolated: 29%)

Sabrea displayed object manipulation towards the Jolly Ball, bedding, a tyre, buckets, a hosepipe, gate latches, baler twine, a coat and clods of dirt during observations. Object manipulation was first observed at two days of age (observation 1). The opportunity to interact with a colt foal was first available at 36 days of age (observation 18). Social play was first observed at 42 days of age (observation 21). The progress of object manipulation and social and solitary-locomotor play development during the first three months of life is displayed in Figure 4.8.

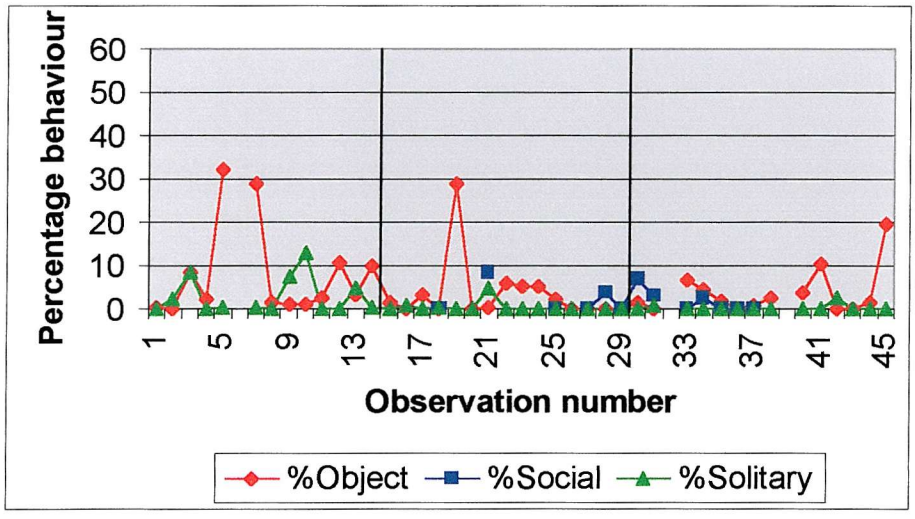


Figure 4.8. Sabrea – Percentage of time spent in object manipulation (Object) and social (Social) and solitary-locomotor (Solitary) play during observation periods between birth and three months of age. Vertical lines indicate the end of each month of life.

Friedman analysis detected no significant difference (X^2=1.83, *df*=2, NS) in the duration of object manipulation between the first three months of life. Friedman analysis detected no significant difference (X^2=4.85, *df*=2, NS) in the duration of solitary-locomotor play

between the first three months of life. Insufficient data was available to analyse the difference in the duration of social interactions between the first three months of life.

There was no significant correlation between the duration of object manipulation and social play (Spearman's rho: 0.22, NS) or object manipulation and solitary-locomotor play (Spearman's rho: -0.142, NS). Object manipulation was significantly greater when Sabrea was stabled ($Z=-3.13$, $P<0.01$).

After three months of age Sabrea was observed once a week until weaned at five months of age. No social interactions were observed because the foal was stabled with her dam during observations. Object play was observed in two observations. Once at three months of age (2%) and once at five months (5%).

After weaning Sabrea was observed once a month until she was 11 months old. For most observations she was stabled with only visual contact with other horses. At five months of age Sabrea displayed object manipulation for 54.45% of the observation. At six months of age she displayed object manipulation for 8% of the observation. At nine months of age Sabrea was at pasture with a filly foal and displayed social interactions for 5.5% of the observation. At ten months of age Sabrea was observed in the stable and displayed object manipulation for 8% of the observation.

Teddy (Mainly isolated: 7%)

Teddy displayed object manipulation towards the Jolly Ball, sticks and bark during observations. Object manipulation was first observed at two days of age (observation 1). The opportunity to interact with a filly foal was first available at 26 days of age (observation 13) and this was when social play was first observed. The progress of object manipulation and social and solitary-locomotor play development during the first three months of life is displayed in Figure 4.9.

Friedman analysis detected no significant differences ($X^2=3$, $df=2$, NS) in the duration of object manipulation displayed between the first three months of life. Friedman analysis detected no significant differences ($X^2=0.20$, $df=2$, NS) in the duration of solitary-locomotor play displayed between the first three months of life. Insufficient data was

available to analyse the difference in the duration of social play displayed between the first three months of life.

There was no significant correlation between object manipulation and social play (Spearman's rho: 0.00, NS) or object manipulation and solitary-locomotor play (Spearman's rho: 0.14, NS).

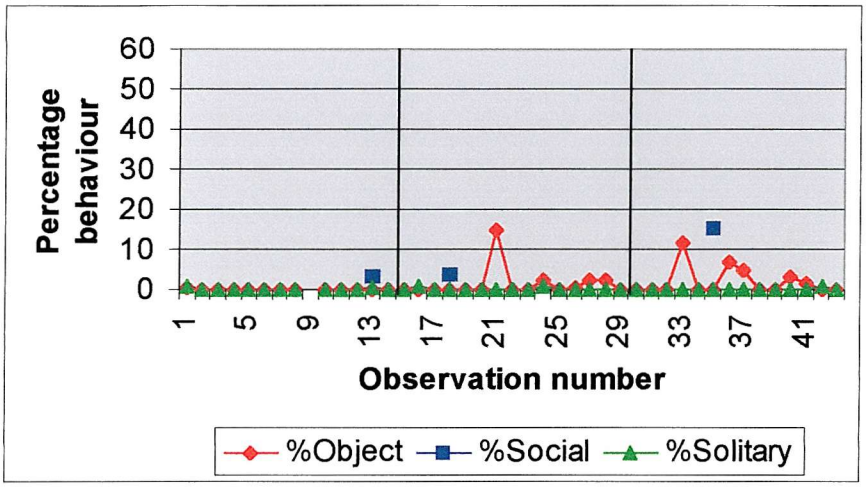


Figure 4.9. Teddy – Percentage of time spent in object manipulation (Object) and social (Social) and solitary-locomotor (Solitary) play during observation periods between birth and three months of age. Vertical lines indicate the end of each month of life.

Teddy was weaned at three months of age, so only post-weaning data was available. He was then kept at pasture with the filly foal that he had the opportunity to interact with on three previous occasions.

After weaning Teddy was observed once a month until he was 12 months old. He was kept with a filly of a similar age until he was 10 months old and was then kept with an elderly gelding. Object manipulation was displayed for 2.3% and social play for 2% of the observation when Teddy was eight months old. At nine months old object manipulation was displayed for 6.61% of the observation. At 11 months old object manipulation was displayed for 10% of the observation.

4.3.3 Ontogeny of Object Manipulation and Social Interactions: Isolated Foals

Gametime (Isolated)

Gametime displayed object manipulation towards the Jolly Ball, sticks, buckets, a gate latch and baler twine during observations. Object manipulation was first observed at two days of age (observation 1). The progress of object manipulation and solitary-locomotor play development during the first three months of life is displayed in Figure 4.10.

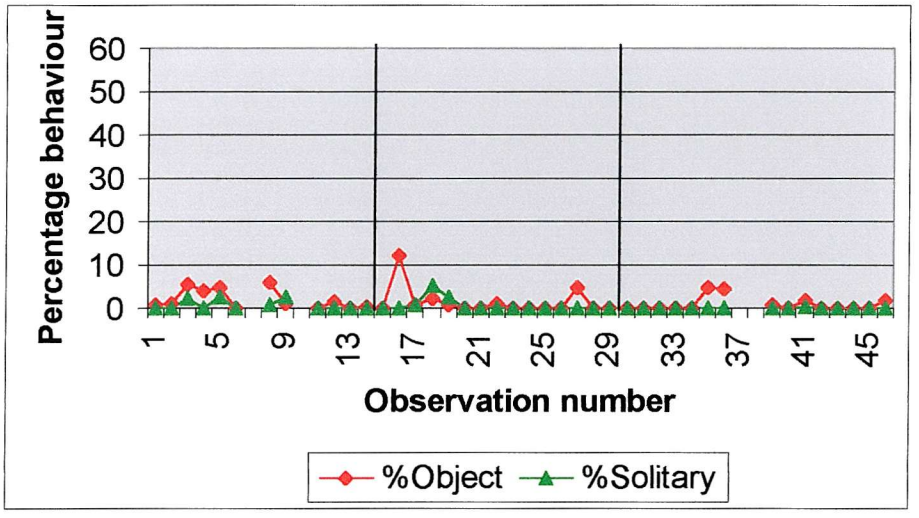


Figure 4.10. Gametime – Percentage of time spent in object manipulation (Object) and solitary-locomotor play (Solitary) during observation periods between birth and three months of age. Vertical lines indicate the end of each month of life.

Friedman analysis detected no significant difference (X^2=5.6, *df*=2, NS) in the duration of object manipulation displayed between the first three months of life. Friedman analysis detected no significant difference (X^2=1.23, *df*=2, NS) in the duration of solitary-locomotor play displayed between the first three months of life.

The durations of object manipulation and solitary-locomotor play displayed were positively correlated (Spearman's rho: 0.445, P<0.01).

After three months of age Gametime only displayed object manipulation during one observation at four months old (3% of the observation). He was then weaned at four months old and sold.

Tinnar (Isolated)

Tinnar displayed object manipulation towards a Jolly Ball, buckets, bedding, baler twine, electric fence wire, clods of dirt, a plastic bag and a padlock during observations. Object manipulation was first observed at four days of age (observation 2). The progress of object manipulation and solitary-locomotor play development during the first three months of life is displayed in Figure 4.11.

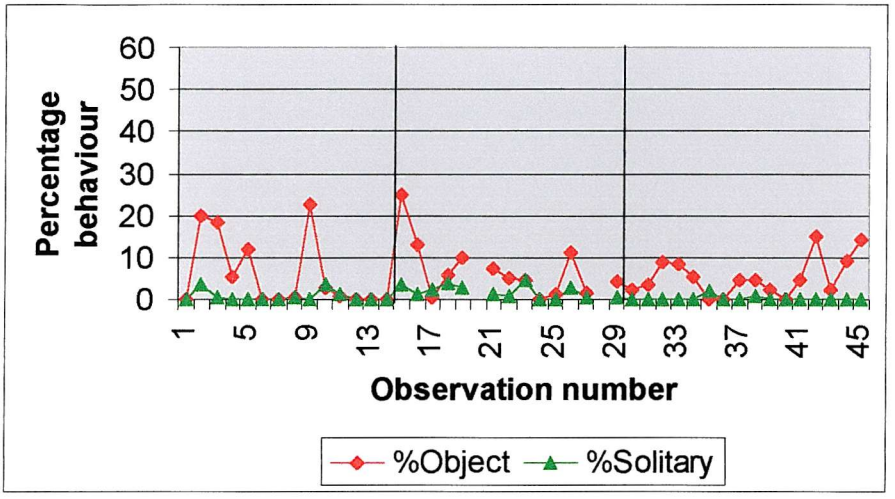


Figure 4.11. Tinnar – Percentage of time spent in object manipulation during observation periods between birth and three months of age. Vertical lines indicate the end of each month of life.

Friedman analysis detected no significant differences (X^2=0.15, *df*=2, NS) in the duration of object manipulation displayed between the first three months of life. Object manipulation was significantly greater when Tinnar was stabled (Z=61, P<0.05). Friedman analysis detected a significant difference in the duration of solitary-locomotor play displayed between the first three months of life (X^2=12.63, *df*=2, P<0.01). Wilcoxon analysis showed that solitary-locomotor play was displayed for longer in the second than the third month of life (Z=-2.93, P<0.01).

The durations of object manipulation and solitary-locomotor play displayed were not significantly correlated (Spearman's rho:0.270, NS).

After three months of age Tinnar was observed once a week until weaned and sold at eight months of age. Object manipulation was observed throughout this period, but at lower durations than during the first three months after birth (1% - 7.5% of observations).

Summary of Results

All of the foals displayed object manipulation and play and solitary-locomotor play. All of the "Social" and "Mainly isolated" foals displayed social play (see Table 4.6).

Table 4.6 Summary of the results

Foal	Social Environment	Average object play as a percentage of total observation time	Average social play as a percentage of total observation time	Average solitary play as a percentage of total observation time
Sway	Social	4.54%	1.42%	0.03%
Jess	Social	1.71%	1.36%	0.58%
Edward	Social	3.59%	1.80%	0.33%
Jack	Social	3.89%	2.98%	2.10%
Beech	Mainly Isolated	2.16%	3.21%	0.48%
Valeta	Mainly Isolated	5.67%	1.07%	1.01%
Sabrea	Mainly Isolated	4.97%	1.9%	1.07%
Teddy	Mainly Isolated	1.20%	7.35%	0.09%
Gametime	Isolated	1.47%	-	0.42%
Tinnar	Isolated	5.93%	-	0.81%

4.3.4 Diurnal Variations

The data from all ten foals was collated for each time period. A Friedman test did not detect any significant diurnal variations in the duration of object manipulation exhibited (X^2=2.97, *df*=5, NS).

4.3.5 Meteorological Effects

Spearman Rank correlation detected no significant meteorological effects on the duration of object manipulation displayed during the first three months of life. The results

of these analyses are detailed in Table 4.7. This analysis was performed only on the data from the six foals that were observed at pasture for every observation.

Table 4.7 The results of Spearman Rank correlations between the level of object manipulation displayed and meteorological factors

Meteorological Factor	Spearman's rho	Significance
Air temperature °C	-0.065	NS
Relative humidity %	-0.022	NS
Rainfall mm	0.013	NS
Wind speed knots	-0.055	NS

4.4 Discussion

4.4.1 Object Manipulation: Birth-Three Months of Age

Every foal in this study displayed object manipulation and play. It was first observed at between two and six days of age and was observed throughout the first three months of life. This suggests that object manipulation and play is an important part of the foals' behavioural repertoire, allowing them to acquire information about their environment and handling skills and resembles that previously recorded in gazelles (Gomiendo 1988). Two of the ten foals studied exhibited significantly more object manipulation during the first and/or second month of life. No significant increase or decrease in object manipulation was detectable in the remaining eight foals. This suggests that object manipulation and play do not follow the same pattern of development as solitary-locomotor play suggested by Fraser (1992). He suggested that solitary play decreases after the first two months of life. However, the breeds, management and handling regimens and social environments of the foals in this study varied a great deal, which could explain why a similar pattern in the development of solitary-locomotor play was not observed in the majority of the foals. Fraser's pattern of the development of solitary-locomotor play was displayed by two of the foals (Tinnar and Jack). It is possible that object manipulation and play do not show the same pattern of development as solitary-locomotor play. This could be because they are controlled by different parts of the brain, as has been suggested for social play (Pellis 1991 and Siviy 1998).

There were no effects of diurnal variation on the duration of object manipulation displayed during the first three months of life. This is not in agreement with Joubert's (1972a,b) study of zebra which suggests that play peaks in the early morning. This may be because the extreme changes in temperature during the day seen in the zebra's environment do not occur in more temperate Britain. The results also differ from those of Schoen *et al* (1976) who observed that most play occurred in the early morning and evening.

There appeared to be no significant effect of weather (air temperature, rainfall, relative humidity and wind speed) on the levels of object manipulation displayed. This may be because these observations were conducted mainly in the summer months, so there was not as great a variation in meteorological factors as there may have been over an entire year. The frequency and duration of social and object play are reported to be lower in the winter than in the summer (Capps 1999). Any developmental changes in the foals' behaviour may have masked meteorological effects and *vice versa*.

A positive correlation between object manipulation and social play for Beech and Jack and between object manipulation and solitary-locomotor play for Gametime suggests that if the foals displayed one type of play during an observation then they were likely to also display another. Therefore, play bouts may be interspersed with more than one type of play behaviour. This is agreement with Thompson (1998) who reports that solitary-locomotor play in sable antelope (*Hippotragus niger*) calves may segue into a complex chase involving several other calves. There is no evidence from this study to suggest that as object play decreases social play increases. This may be due to the small sample size of the study. However, the two "isolated" foals and two of the "mainly isolated" foals showed relatively constant levels of object play throughout the first three months of life. This may suggest that object play has a role as a substitute for social play in foals isolated from social contact with other foals and juveniles during the first three months of life.

4.4.2 Object Manipulation: Three Months-Weaning

The results of the three months – weaning data suggest that object manipulation decreases after three months of age in foals in various social and management

environments. Very little social play was observed which could suggest that at this age object manipulation may not be a substitute for social play.

4.4.3 Object Manipulation: Post Weaning

The post weaning data indicates an increase in object manipulation and social play after weaning. The increase in object manipulation could be due to relative novelty, as the foals are only exposed to the Jolly Ball once a month during this period of observation. It could also be an effect of weaning, which is a stressful experience for foals and may lead to changes in their behaviour (Water *et al*, in press). It is generally accepted that sub-optimal welfare conditions inhibit play behaviour (Sommer and Mendoza-Granados 1995; Suomi 1982). It would be expected, therefore, that less play would be observed directly after weaning. However, after weaning play may increase again to pre-weaning durations and, in this study, to higher durations. This may signify a developmental change. If foals are placed in a new social group they may engage in more social play to form bonds within the new social group. More object manipulation may be observed if the foals are also in a different environment. In the case of Sabrea, all her post-weaning observations were conducted in the stable. It has been shown that in the first three months of life more object manipulation was displayed during observations in which the foal was stabled, so this may explain this increase in object manipulation.

4.4.4 Effects of Social Environment

Although there appeared to be no difference in the development of object manipulation between socially isolated and socially kept foals it is difficult to draw any firm conclusions because the foals had varying degrees of social contact throughout the study. Some effects of social environment were evident, however. Sway was unable to manipulate the Jolly Ball during his first month of life because his elder half brother, who appeared to be dominant, monopolised the Jolly Ball during observations and there were not any other opportunities for object manipulation. At approximately one month of age either Sway became more confident or his half brother's interest in the Jolly Ball waned, and he started to manipulate the Jolly Ball. It is likely, therefore, that conspecifics affect the development of object manipulation of foals.

The sex of the conspecifics may also affect the development of play. Colts are reported to play more than fillies (Tyler 1972), so a filly at pasture with a colt for a companion may

be encouraged to play more than she may have done with a female companion. An investigation in the domestic cat of the influence of male siblings on the object play of their female siblings showed that females that had a brother in their litter made significantly more contact with objects than females that had no brother in their litter (Bateson and Young 1979). It was suggested that male siblings have a long acting influence on their sisters' development. Another explanation put forward was that the uterine environment of the kittens in all-female litters was different from that of the other kittens. Although none of the foals in this study were full siblings, it could be possible that the presence of male half siblings or conspecifics affects the development of object manipulation and play in female foals. It has also been suggested that play content may also be affected by the sex ratio of the social group (Thompson 1996). Females in groups containing many males may display rougher social play than females with fewer male playmates. Further research would be required to determine whether this does occur.

The relatedness of the conspecifics may also affect the level of competition observed between the foals. If domestic horse foals possess mechanisms for recognising related conspecifics then this may affect the levels of competition for resources displayed. In several species kin are reported to play more than unrelated individuals (Japanese Macaques: Glick, Eaton, Johnson and Worlein 1986; Koyama 1985; Siberian ibex: Byers 1980; big horn sheep: Berger 1979). Stallions have also been reported to play more with their sons; six times more than with unrelated, similarly aged colts (Berger 1986).

The size of the group in which the foal is maintained may also affect the levels of play observed. Play has been observed to be more frequent in large groups of squirrel monkeys (Baldwin and Baldwin 1977), and in big horn sheep lambs play becomes more complex with increasing group size (Berger 1979). Leyhausen (1979) reports that increasing group size has a positive effect on play in domestic cats, but that overcrowding inhibits play. In these examples effects on social play have been reported. In small groups, that may not be conducive to social play, the performance of forms of solitary play, such as solitary-locomotor and object play may be positively affected. Therefore, in future research the size of the social group in which foals are maintained may also need to be taken into consideration.

4.4.5 Effects of Handling and Socialisation

The handling regimens of the foals varied greatly. Human handling of young mother-reared mammals at an early age has been shown to have effects on subsequent adult behaviour, which includes acceleration of the taming process (Carlstead 1996). Laboratory rat pups were handled at various stages of their early development exhibited reduced emotional reactivity in behavioural tests and in the presence of humans (Denenberg 1964, 1967). The foals that were handled regularly by their owners and introduced to lots of new experiences (Jess, Jack, Sabrea, Tinnar and Valeta) appeared to be bolder and manipulated objects more than more timid foals. Whether this is due to experience, or whether boldness, or inquisitiveness is a personality trait of foals could be investigated, by studying foals that were all regularly handled. Interestingly, Sway and his half brother both received little handling, but the half brother appeared to the observer to be much bolder than Sway. This could be an inherited characteristic. In domestic cats paternity has been shown to influence kittens' responses to novel objects (McCune 1995). Those with "friendly" fathers were quicker to interact with novel objects than those with "unfriendly" fathers. It is possible that the result seen in this study is an effect of the influence of the dam's temperament on their foals, or an inherited maternal effect.

4.4.6 Effects of the Dam's Behaviour

The dams of Gametime and Teddy were very foal proud, i.e. they kept their foals close to them and would not allow humans or other horses close to them. This was the reason that these foals received very little handling. The dams would also prevent their foals from investigating objects by placing themselves between the object and the foal, so this could explain why these foals displayed little object manipulation. Once Teddy was weaned he appeared to become bolder and manipulated objects more and would approach the observer, which he did not do before weaning. This suggests that his dam may have influenced his behaviour prior to weaning, or that the weaning process itself had affected his behaviour.

4.4.7 Effects of Stabling

The foals that were stabled regularly displayed more object manipulation and play during the observations in which they were stabled with their dam. This increase in object manipulation and play could be a redirection toward objects of other play behaviours,

namely solitary-locomotor and social play, which are restricted in the stable environment. It is also possible that the foals simply came across objects more often in the relatively restricted confines of the stable and so were stimulated to play more frequently.

4.5 Conclusions

These results suggest that object manipulation and play develop very early in the life of foals, though there was insufficient data to determine an overall definitive pattern in the ontogeny of object manipulation and play. However, this is not surprising as the foals were of different breeds and came from vastly differing management and handling regimens. In future studies it will be necessary to recruit foals from a single breed, which are kept in similar management conditions, social environment and handling regimens. This study has, however, yielded some very interesting insights into the ontogeny of object, solitary-locomotor and social play.

The increase in the levels of object manipulation and social interactions displayed post-weaning could be due to novelty, or a development change associated with weaning.

The construction of the social group in which the foal is reared may affect the development of object manipulation and play.

Stabling appears to cause an increase in the display of object manipulation and play in foals. This could be because the foal encounters objects more frequently, due the small area of the stable, or a re-direction of social and solitary-locomotor play behaviours towards the objects.

5. The Ontogeny of Object Manipulation and Play in a Single Breed of Domestic Horse Foals: The Arabian

5.1 Introduction and Aims

For the 1999 foal study group (Section 4), it was necessary to analyse individually the data from each foal, because the foals were of different breeds, differing social environments and management regimens. Thus, it was difficult to draw any general conclusions about the ontogeny of object manipulation in domestic horse foals and which factors may affect it. Different breeds of horses are reported to show different behaviour patterns (Hafez 1969). Breeds such as Arabians may behave more nervously than a calmer horse, such as a Quarter Horse, when placed in the same environment (Wolski 1984). Breed effects have also been detected in the exhibition of stereotypic behaviours with Thoroughbreds displaying more crib-biting and weaving, whereas Arabians displayed more stall-walking (Luescher *et al* 1998). It was hypothesised that using a single breed, kept in similar management regimens and social environment, would reduce the effects of these factors.

The foals studied in the 1999 foal study also appeared, subjectively, to vary in how bold or willing to take risks they were. This may suggest that this aspect of foals' personalities affects their propensity to manipulate and play with objects.

Another point worthy of investigation was to determine how foals that had not been introduced to novel objects would respond to novel objects when they were older. Measuring the response of children and non-human species to novel objects has previously been used successfully to determine boldness (Wilson, Clark, Coleman and Dearstyne 1994). However, as this study observed foals' normal reactions to objects another factor had to be used to assess boldness. In order to test whether the boldness, defined as the willingness to take risks, of individual foals affects their propensity to manipulate objects, their behaviour toward both the observer and the object was scored

This would indicate whether previous experience of an object, as a foal, affects the responses of older juveniles to this object.

Therefore the aims of this study were:

1. To collect data from a larger sample of a single breed of domestic horse foals with similar management regimens and social environments in order to reduce possible variation due to differences in behaviour and development, social environment and management practices.
2. To assess whether the boldness of individual foals affects their propensity to play with objects.
3. To determine whether exposure to an object during the first three months *post partum* affected the foals' responses to the same object at one year of age.

5.2 Methods

5.2.1 Subjects

2000 Foal Study Group

Fourteen purebred Arabian foals, eight females and six males, were observed in the first part of this study. Details of the subjects are shown in Table 5.1. A single breed was used in order to minimise error due to breed differences. Arabian foals were chosen because of their availability locally and because they had similar management regimens. The Arabian breed of horse is bred for several different purposes. The horses included in these studies were bred for showing, endurance riding or Arab racing. Arabians are categorised as a warmblood type breed. They are characteristically intelligent, high spirited and energetic (Archer 1992). During the study the foals were turned out to pasture with at least one other foal during the day and stabled with their dam at night. They were handled twice a day by staff at the studs, and were therefore accustomed to people. Data were analysed as a group, rather than individually as in the foal 1999 study.

2001 Yearling Study Group

A further group of Arabian foals born in 2000, the same year as the 2000 foal study group, were recruited at one year of age. None of these yearlings had been exposed to

a Jolly Ball as foals and were observed, as described below for the 2000 foal study group, at one year of age. This group was compared with the main group at one year of age to determine whether previous experience of an object affected the foals' responses to the object at a later date.

Table 5.1 Details of the 2000 foal study group

Foal's Name	Stud Number	Date of birth	Sex	Age at Weaning
Dulciya	1	22.3.00	Female	5½ months
Spiros	1	5.4.00	Male	5 months
Sholto	1	10.4.00	Male	5 months
Bhavna	1	25.5.00	Female	Not studied post weaning
Melissa	1	25.5.00	Female	Not studied post weaning
Percy	2	10.4.00	Male	6½ months
Thomas	2	24.4.00	Male	6½ months
Daisy	2	7.5.00	Female	6 months
Jimmi	3	22.4.00	Male	6 months
Fizz	3	1.5.00	Female	6 months
Suki	4	31.3.00	Female	Not studied post weaning
Ruby	4	30.5.00	Female	6½ months
Emmy	4	21.5.00	Female	6½ months
Freddy	4	23.5.00	Male	6½ months

Table 5.2 Details of the 2001 yearling study group

Yearling's Name	Stud Number	Date of Birth	Sex
L-1	5	May 2000	Colt
L-2	5	May 2000	Colt
L-3	5	May 2000	Filly
P-I 1	6	May 2000	Filly
P-I 2	6	May 2000	Filly

5.2.2 Observations

The behaviour of each foal was observed once a week for 30 minutes, at the same time of the day, with all observations taking place between 10.00hours and 14.00hours, when the foals were at pasture. In order that all foals had an opportunity to manipulate an object, a 6" Jolly Ball (see Figure 4.1) was placed in the field before the start of each

observation. The object was removed, washed with disinfectant and rinsed at the end of each observation.

The foals were observed once a week from one week *post partum* until they were three months of age. Eleven of the foals (those whose age at weaning is recorded in Table 5.1) were then observed twice, on one occasion each week, during the two weeks before they were weaned. The foals were not observed directly after weaning because in the 1999 foal study this had proven to be difficult when foals were weaned abruptly and stabled. Seven of the foals (Dulciya, Spiros, Sholto, Melissa, Jimmi, Fizz and Freddy; details in Table 5.1) were also observed, once a week for two weeks, when they were one year of age. The foals were not observed directly after weaning, as the 1999 foal study group was, because different studs used different weaning methods.

The group of yearlings was observed only at one year of age. They were observed on two occasions, once a week for two weeks, as described above. The yearlings from stud number 5 were observed at liberty in an indoor school due to a shortage of grazing. The indoor school was 40m x 20m in size, surfaced with wood chippings, had straw bales around the edges and contained no food or water. The yearlings were accustomed to being in the indoor school.

5.2.3 Data Recording

All the observations were filmed using a Hi8 format video camera. They were then transferred to VHS format for data recording. The video of each observation was viewed and the duration of the behaviour patterns described in the ethograms in Tables 4.3 and 4.4 was timed using a stopwatch and recorded, as was the frequency, on check sheets for each foal.

"Boldness" Scale

The boldness of the foals was determined by comparing the response of the foals to the observer with the response of the foals to objects on the following scale:

0 = foal appears to show no interest in observer/object
1 = foal orientates towards observer/object
2 = foal approaches observer/object
3 = foal sniffs observer/object (no physical contact)
4 = foal makes physical contact with observer/object

The behaviours used in this scale were as defined in Table 4.3, i.e. "orient towards", "approach" and "sniff". "Physical contact" included "nuzzle", "lick", "bite", "pick up", "paw" and "paw and mouth". The foals' willingness to interact with the observer was measured as a means of determining the boldness of each foal. This could then be correlated with the object score, which gave a measure of the foals' willingness to manipulate objects with an observer present. The result of this correlation could then be used to determine whether boldness affects the level of object manipulation displayed in the presence of an observer. During each observation each foal was scored once on each scale. The score assigned was the highest score achieved during each observation.

5.2.4 Statistical Analysis

As exploratory analysis of the data showed that they did not follow a normal distribution the following non-parametric tests were used to analyse these results: Kruskal-Wallis, Mann-Whitney, Friedman, Wilcoxon signed ranks and Spearman Rank Correlation. The details of these tests are given in Section 4.2.4. Kolmogorov-Smirnov analysis was used to compare the distribution of the data between this and previous studies. This is a test of whether two samples come from the same distribution. All statistical analyses were performed using SPSS v.10.

In all the box-plots presented in this section outlying values (those cases with values between 1.5 and three box lengths from the upper or lower edge of the box, where the box length is the interquartile range) are labelled with a circle (O) and extreme values (those cases with values more than three box lengths from the upper or lower edge of the box, where the box length is the interquartile range) are labelled with an asterisk (*). The interquartile range contains 50% of the recorded values. The whisker lines that extend from each box are drawn between the highest and lowest values, excluding outliers. The thick black line across the box indicates the median.

5.3 Results

5.3.1 Ontogeny of Object Manipulation

Friedman analysis was used to compare the duration of object manipulation displayed during observations in months one, two and three *post partum*. No significant difference was detected (X^2=2.17, *df*=2, NS) (see Figure 5.1).

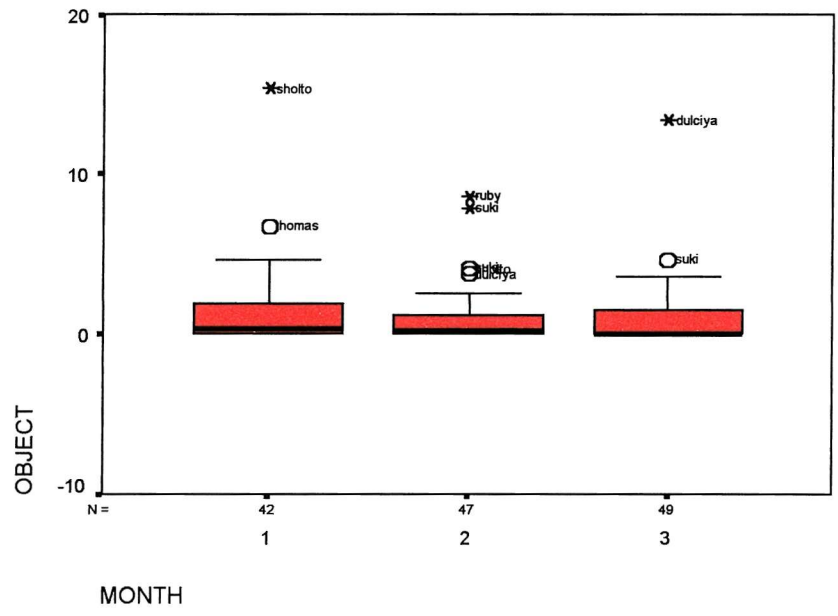


Figure 5.1 The duration, as a percentage of observation time, of object manipulation (OBJECT) displayed during months one, two and three *post partum*. Outlying values are labelled with the name of the foal involved.

5.3.2 Study Group Differences

Kruskal – Wallis analysis detected no significant difference between the four studs (X^2=5.84, *df*=3, NS) in the duration of object manipulation displayed.

5.3.3 Individual Differences

Kruskal – Wallis analysis was used to compare the duration of object manipulation displayed by each foal over the trial. Significant individual differences in the duration of object manipulation displayed were detected (X^2=27.21, *df*=10, NS) (see Figure 5.2).

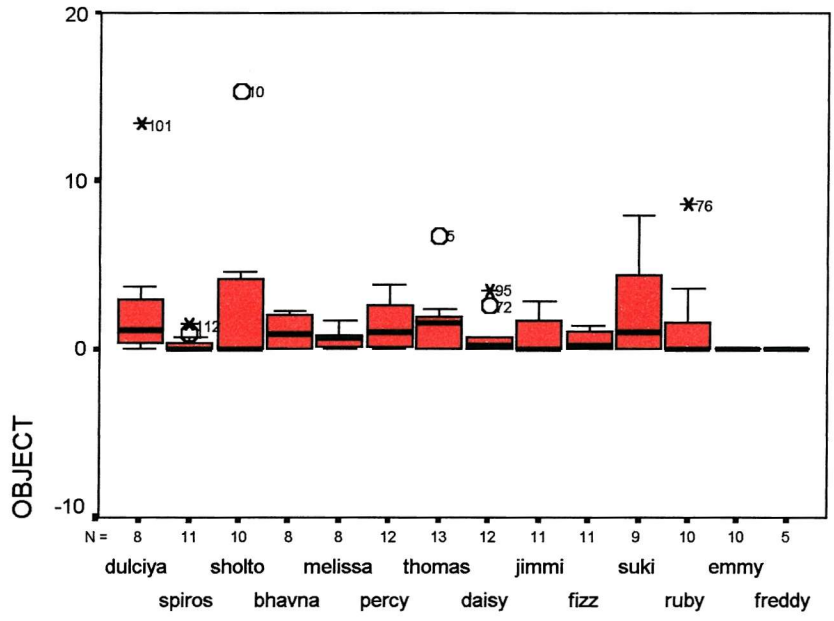


Figure 5.2 Individual differences in the duration, as a percentage of observation time, of object manipulation (OBJECT) displayed

5.3.4 Sex Differences

Mann – Whitney analysis detected no significant difference between males and females (Z=-0.48, NS) in the duration of object manipulation displayed. The difference in the frequency that males and females displayed each object manipulation behaviour was also analysed using Mann-Whitney analysis. No significant differences were detected (see Table 5.3).

Table 5.3 The results of Mann-Whitney analysis comparing the frequency of the object manipulation displayed by males and females

Object Manipulation Behaviour	Mann-Whitney Z	Significance
Total	-0.84	NS
Orient toward	-0.87	NS
Approach	-0.97	NS
Sniff	-0.53	NS
Nuzzle	-0.91	NS
Lick	0	NS
Bite	-0.26	NS
Paw	-1.24	NS
Pickup	-1.70	NS
Paw and mouth	-0.48	NS

5.3.5 Social Interactions and Object Manipulation

The correlation between the duration of social interactions and object manipulation displayed was tested using a non-parametric Spearman rank correlation. A positive correlation (Spearman rho: 0.177, NS) was detected.

5.3.6 Boldness

The correlation between observer score and object score was tested using a non-parametric Spearman rank correlation. A positive correlation (Spearman rho: 0.349, $P<0.01$) was detected. Kruskal – Wallis analysis detected significant individual differences between foals in the object score ($X^2=32.09$, $df=13$, $P<0.01$) and the observer score ($X^2=43.54$, $df=13$, $P<0.001$) (see Figures 5.3 and 5.4 respectively).

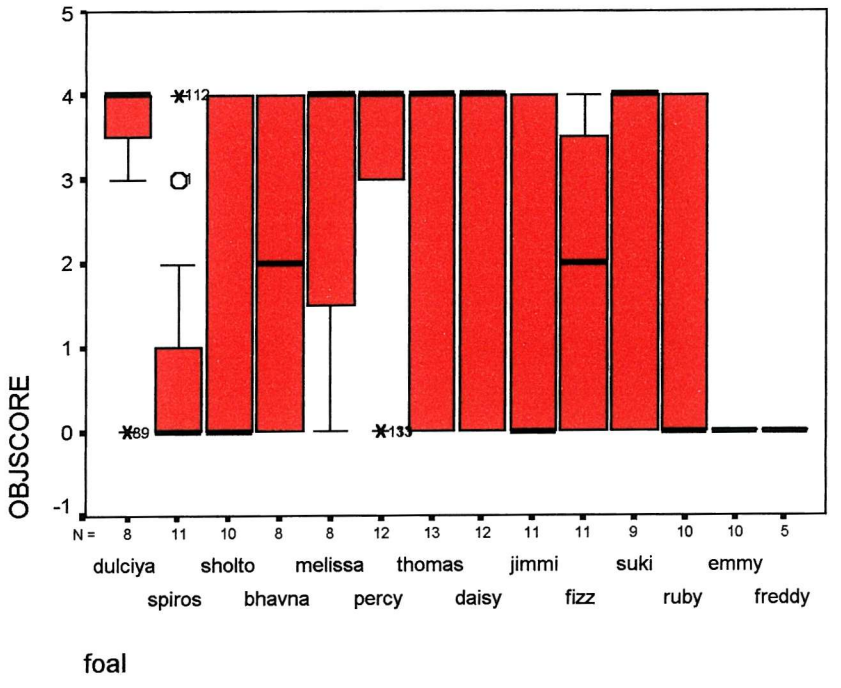


Figure 5.3 Individual differences in Object Score (OBJSCORE)

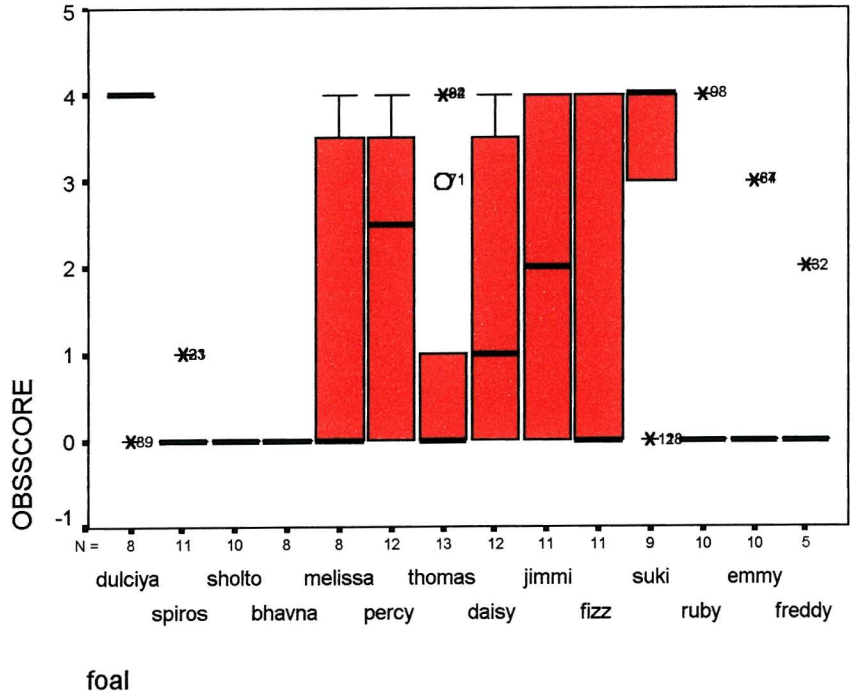


Figure 5.4 Individual differences in Observer Score (OBSSCORE)

5.3.7 Pre-Weaning Observations

Object Score

Kruskal-Wallis detected no significant individual differences in the average object score of each foal pre-weaning (X^2=10, *df*=10, NS).

Wilcoxon analysis detected no significant difference between the average object score pre-weaning and the average object score at three months of age (Z=-1.59, NS).

Observer Score

Kruskal-Wallis detected no significant individual differences in the average object score of each foal pre-weaning (X^2=10, *df*=10, NS).
Wilcoxon analysis detected no significant difference between the average observer score pre-weaning and the average observer score at three months of age (Z=-1.48, NS).

The pre-weaning object scores and observer scores were positively correlated (Spearman's rho: 0.635, P<0.05).

5.3.8 Yearling Observations

Object manipulation and play

The average duration of object manipulation displayed by the yearlings with previous experience of the Jolly Ball was 5.36 (SD10.99)%. The average duration of object manipulation displayed by the yearlings without previous experience of the Jolly Ball was 1.86 (SD1.5)%. Kruskal-Wallis analysis detected no significant individual differences in the duration of object manipulation and play displayed (X^2=11.3, NS) (see Figure 5.5).

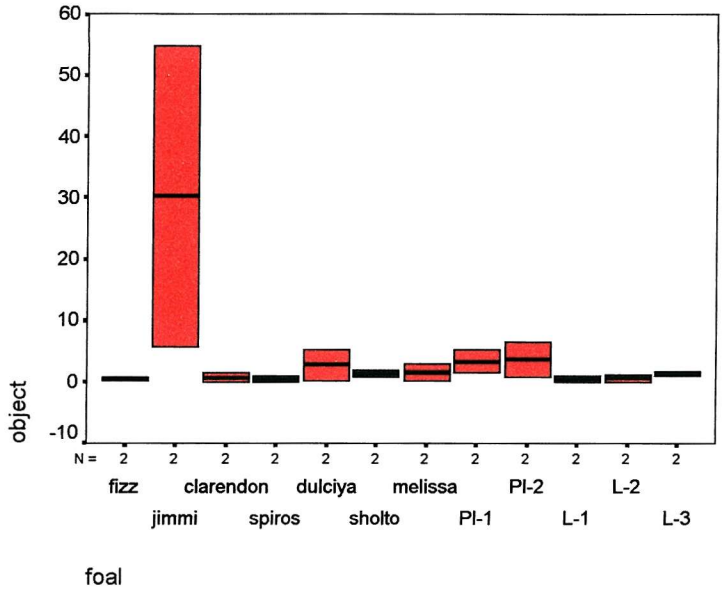


Figure 5.5 Boxplot to illustrate individual differences in the duration, as a percentage of observation time, of object manipulation (object) displayed.

Mann-Whitney analysis detected no significant difference between the duration of object manipulation displayed by the yearlings with and without prior experience of the Jolly Ball (Z=-0.81, P>0.05).

Object score

The average object score at one year of age for those foals that had been observed from one week post partum were significantly higher than that at three months of age (Z= -2.23, P<0.05), but not significantly different from the average pre-weaning object score (Z=-0.27, NS).

Mann-Whitney analysis detected no significant difference between the average object score of the main group of yearlings and those of the group of yearlings which had not been exposed to the Jolly Ball as foals (Z=-0.17, NS).

Observer score

The average observer score at one year of age for the foals that had been observed from one week post partum was not significantly different from the average observer

score at three months of age (Z= -1.90, NS), and not significantly different from the average pre-weaning observer score (Z=-0.54, NS).

The object and observer scores at one year of age were not significantly correlated (Spearman's rho=0.543, NS)

Mann-Whitney analysis detected no significant difference between the average observer score of the main group of yearlings and the group of yearlings that had not previously been exposed to the Jolly Ball (Z=-0.51, NS).

5.4 Discussion

5.4.1 Ontogeny of Object Manipulation in Foals

Object manipulation and play was observed at a relatively constant level throughout the first three months of life. This is in agreement with the foal 1999 study (Section 4) and again implies that object manipulation and play is an important part of the behavioural repertoire of domestic horse foals. That there were no significant increases or decreases in the duration of object manipulation during the first three months of life is, therefore, not surprising. The significant individual differences between the Arabian foals in the duration of object manipulation displayed imply that the differences in the ontogeny of object manipulation seen in the mixed-breed 1999 foal study group were due, in part, to individual differences rather than restricted to breed management effects. It is possible that the development of object manipulation and play does follow a pattern like that suggested by Fraser (1992) for solitary-locomotor play, but that it is not detectable by comparing the data for each of the three months using the methods employed in this study. The graphs for each foal, however, did not show any similarity, suggesting that the development of solitary-locomotor play is different in each foal. It could also be that the foals in this study were not observed frequently enough or for long enough to detect any subtle changes in their behaviour, as observations only took place once a week.

5.4.2 The Relationship Between Social Interactions and Object Manipulation

The positive correlation between object manipulation and play and social interactions suggests that both these groups of behaviour patterns were likely to be displayed during observations. Therefore, it is likely that play bouts consist of both these types of play behaviours. This is in agreement with the results of the 1999 foal study and those of Thompson (1998), discussed in Section 4.

5.4.3 Boldness

The positive correlation between the observer score and object score suggests that the bolder foals, those who were more willing to interact with the observer, were more likely to display object manipulation. It is possible that the individual differences seen in the levels of object manipulation were due to differences in the personalities of individual foals and that some foals were bolder, or more willing to take risks, than others. This pattern could be due to a genetic or experience effect, as suggested in the domestic cat (*Felis silvestris catus*) by Lowe and Bradshaw (2001). Genetically bold foals could initiate more interactions with people and therefore receive more handling, or foals could become bolder when interacting with people because they are offered more handling.

The boldness score used in this thesis is relatively crude and could be improved in future research projects. For example, if a foal had previous aversive experience of humans the presence of the observer may have made it apprehensive and therefore inhibited play behaviour, including object manipulation and play. The presence of the observer may also have distracted the foals from engaging in play behaviour and investigating the observer instead. A novel object test, in which the foals are exposed to objects without the presence of an observer, may more accurately determine boldness, defined as the willingness to take risks. It was not possible to conduct such a test in this study due to time constraints.

5.4.4 Yearling Study

Experience of a particular object, in this case the Jolly Ball, during the first three months *post partum*, does not appear to significantly affect the response to the object at one year of age. There did appear to be a trend for the yearlings that had prior experience of

the Jolly Ball to display more object manipulation and play. This was, however, driven by the high durations of object manipulation and play displayed by one yearling (Jimmi). The results of this study suggest that domestic horses can be introduced to objects at one year of age and will engage in object manipulation and play, even if they have not been introduced to objects as a foal. Therefore, there may be no "sensitive period" during which object play develops in foals. The sample size was small, however, which makes generalization difficult and the foals were only observed once a week, which may not have been often enough to detect a pattern. Also, although the yearlings were not intentionally introduced to novel objects when they were foals, it is highly likely that their environment was sufficiently diverse and contained enough novel objects to influence their reaction to the Jolly Ball. Therefore, it is not possible to accept or reject the hypothesis that there is no "sensitive" period, until further studies have been conducted. In future research it may be of more use to introduce a novel object response test. This would judge how the foals' reactions change to novel objects, with and without being introduced to play objects, over the first year of life. The foals in the group that were exposed to play objects could be introduced to the several different objects in a controlled manner by the observer to ensure that they took notice of the objects. Both groups of foals could then undergo the novel object response test at different stages of development to determine whether they differed in their response.

The increased boldness of the main group of foal 2000 foals toward objects between three months *post partum* and one year of age could be an effect of novelty, as they had not seen the Jolly Ball for around six months. However, although the foals had not been exposed to the Jolly Ball for six months, it was not an entirely novel object. As there was no significant increase in the observer score, it is unlikely that the foals had become bolder. However, if the effect was due only to a real novelty, there would have been a significant difference between the object score at three months of age and before weaning, which was not the case. Therefore, this increase in interest in the Jolly Ball at one year of age may be due to a developmental change in the foals' behaviour. This may also be associated with the weaning process. To test this it would have been necessary to observe the foals shortly after they had been weaned. This was not possible in this study because the foals were weaned abruptly and shut in stables, which made filming observation difficult. The foals in the 1999 foal study group did show an increase in object manipulation and play post weaning, so it is possible that weaning

influences these behaviours. If the increase in object manipulation and play is due to a developmental change, it is unlikely to be linked to sexual development, as both colts and fillies do not reach sexual maturity until they are approximately two years of age (Tyler 1972). There is anecdotal evidence that in addition to a "sensitive period" of development between 2½ and 9 to 13 weeks of age, young wolves also experience a second phase of heightened sensitivity to fear-arousing stimuli at four to six months of age (Serpell and Jagoe 1995). This may occur in other animals and a similar period, occurring at around six months of age has also been anecdotally suggested in the domestic horse (Simpson 2001). As it is not known what breed this was observed in, or for how long this period persisted, it is possible that this period could extend to around one year of age in the Arabian horse. This could lead to the yearlings being more motivated to investigate objects during this period. Another explanation for the increased levels of object manipulation and play is that it may have been a re-direction of frustrated social play behaviour. For example, Jimmi spent a great deal of time manipulating the Jolly Ball during observations (an average of 30.22% of observation time) at one year of age. During this time Jimmi was out at pasture with an elderly gelding and so had no outlet for social play with conspecifics.

Observations at one year of age were only carried out twice, which may not have been sufficient to accurately determine the yearling's responses to objects. Other factors, such as weather and the behaviour of other horses in the field may have affected their responses. In future research more observation sessions would be prudent. It would also be of interest to observe the yearlings' reactions to a variety of different objects. This may also give a more accurate impression of the effect of prior experience of play objects on the response of yearlings to play objects as the objects would be truly novel, eliminating any effects of habituation.

5.5 Conclusion

The results of the foal 2000 study describe the behaviour only of social kept foals, as no solitary kept foals were studied. A comparative study of solitary and socially kept foals would be necessary to accurately assess whether social environment affects the ontogeny of object manipulation with a single breed. The results did, however, suggest

that studying a single breed produces less variable data and, therefore, breed, management regimens and handling were likely to have affected the results of the 1999 foal study.

The study group of foals varied in their boldness, suggesting that this factor could be an individual personality trait of domestic horse foals, as in other species, e.g. domestic cat kittens (Lowe *et al* 2001) and humans (Wilson *et al* 1994). However, a larger sample size and a more refined boldness test would be required in order to further examine this result.

The finding that there was no significant difference in response to objects between yearlings with prior experience of the Jolly Ball and those with no experience suggests that novel objects could be introduced to juvenile horses and may elicit object manipulation and play whether or not they had prior experience of "toys". It would be interesting to compare the responses to novel objects of horses that had been actively encouraged, by provision of "toys" by their owners to manipulate objects, with those that had not.

The increased boldness and levels of object manipulation and play displayed by the yearlings, compared to the first three months of life cannot be adequately explained by the results of this study. It is likely to be linked to a developmental change. However, further studies would be required to determine the nature of this change.

6. The Effect of Social Environment on the Development of Object Manipulation in Arabian Foals

6.1 Introduction and Aims

In the 1999 foal study (Section 4) the foals had varying degrees of social contact, and in the 2000 foal study (Section 5) all the foals were kept in a social environment. Therefore, It was not possible to infer any effects of social environment on the development of object manipulation from the foal studies.

Several studies have suggested that object play could act as a substitute for social play in other species. For example, when a marmoset (*Callithrix jacchus*) twin died the survivor would display increased levels of object play (Jolly 1985). Bekoff (1974) observed that when free-roaming dogs were unable to elicit social play they often immediately engaged in object play. It is possible, therefore, that object manipulation could have provided an outlet for the expression of highly motivated play behaviour when social play is prevented. Therefore, object play may substitute for social play in solitary kept foals.

The aims of the foal 2001 study were:

1. To observe solitary and socially kept foals and compare the duration of object manipulation and play displayed and to describe its ontogeny.
   If object manipulation and play act as a substitute for social play in solitary kept foals it would be expected that the solitary kept foals would display more object manipulation and play than the socially kept foals.
2. To apply the "boldness" score used in Section 5 to determine whether the scores of this cohort are in agreement with those of the 2000 foal study group and whether any differences in boldness were detectable between solitary kept and socially kept Arabian foals.

6.2 Method

6.2.1 Subjects

2001 Foal Study Group

Foals were recruited for this study by advertising, through an article in the appropriate breed society magazines, posters in saddlers and feed merchants and by contacting breeders directly. Despite these recruitment attempts only three solitary kept Arabian foals and three socially kept Arabian foals were recruited for this study (see Table 6.1). The reasons for such a small sample size are outlined in Section 3. The solitary kept foals were kept at pasture during the day in groups, which comprised no other foals and were occasionally stabled with their dam at night. They were all, however, introduced to older juveniles at some points during the study. Details of individual foals are shown in Table 6.1. The socially kept foals were maintained at pasture with at least one other foal during the day and occasionally stabled with their dam at night. All the foals were handled at least twice each day by their owners.

Table 6.1 Details of the 2001 foal study group

Foal	Date of birth	Sex	Social environment
Gem	2/4/01	Female	**Solitary:** moved into a field with a yearling filly at four weeks of age
Clarendon	20/5/01	Female	**Social:** at pasture with four foals from birth
Shantih	22/5/01	Female	**Solitary:** moved into a field with two and three year old fillies at four weeks of age
W-H	24/5/01	Female	**Social:** at pasture with two foals from birth
William	14/6/01	Male	**Social**: at pasture with one other foal from birth
Boo	4/5/01	Female	**Solitary:** moved into a field with a two year old gelding at 10 weeks of age

6.2.2 Observations

The observations were carried out at pasture, as for the 2000 foal study of 14 Arabian foals (Section 5). However, in this study the foals were only observed from one week *post partum* until they were three months old.

6.2.3 Data Recording

As described in Section 5, the observations were filmed using a Hi8 format video camera and were then transferred to VHS for data collection. The duration of the behaviours described in the ethograms in Tables 4.3 and 4.4 was timed using a stopwatch and recorded on check-sheets. The boldness of the individual foals and how this affected their behaviour toward objects was scored using the observer score and object score described in Section 5.2.3.

6.2.4 Statistical Methods

All statistical analyses were performed using SPSS v.10. Non-parametric analysis was used, as the data did not follow a normal distribution. The tests used were: Kruskal-Wallis, Mann-Whitney, Friedman and Spearman Rank correlation. Details of these tests can be found in Section 4.2.5.

In all the box-plots presented in this section outlying values (those cases with values between 1.5 and three box lengths from the upper or lower edge of the box, where the box length is the interquartile range) are labelled with a circle (O) and extreme values (those cases with values more than three box lengths from the upper or lower edge of the box, where the box length is the interquartile range) are labelled with an asterisk (*). The interquartile range contains 50% of the recorded values. The whisker lines that extend from each box are drawn between the highest and lowest values, excluding outliers. The thick black line across the box indicates the median. The "N" value on the x-axis indicates the number of cases in each plot.

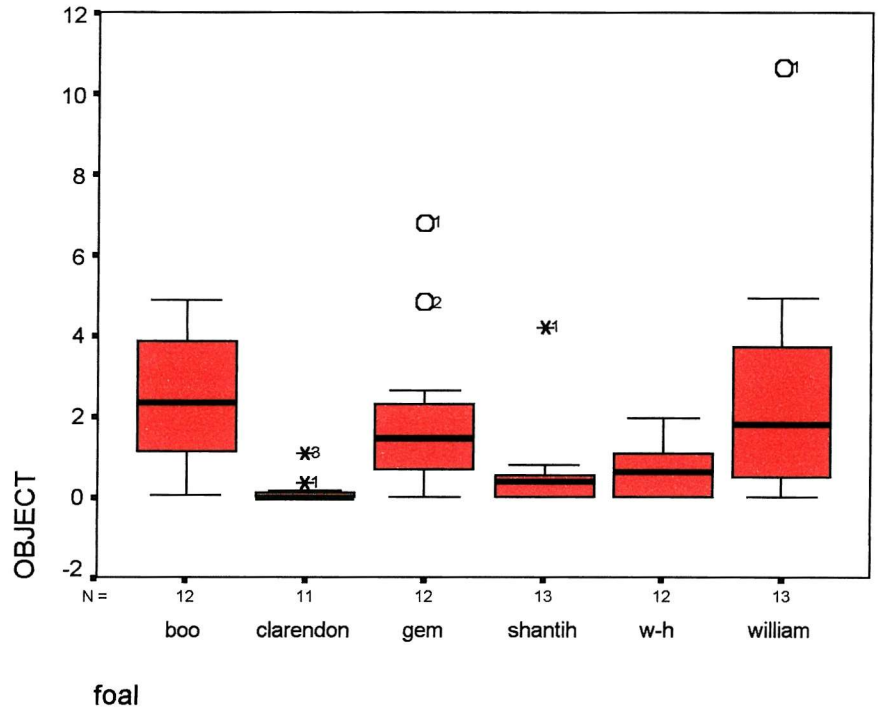


Figure 6.2 Duration, as a percentage of observation time, of object manipulation (OBJECT) displayed by each foal. Outlying values are labelled with the month *post partum*

6.3.2 Socially Kept Foals

Friedman analysis detected no significant difference in the duration of object manipulation (X^2=2.74, *df* 2, NS) and social interactions (X^2=3, *df* 2, NS) displayed between months one, two and three *post partum.*

The duration of object manipulation and social interactions displayed were not significantly correlated (Spearman's rho=0.126, NS).

6.3.3 Solitary Kept Foals

Friedman analysis detected no significant differences in the duration of object manipulation displayed by the solitary foals during months one, two and three *post partum* (X^2=3.56, *df* 2, NS).

No social interactions between the foals and the juveniles they were kept with were observed.

6.3.4 Comparison of Solitary and Socially Kept Foals

The solitary kept foals displayed significantly greater duration of object manipulation than the socially kept foals during the first three months *post partum* (Mann-Whitney Z=-2.04, P<0.05). (see Figure 6.3). Object manipulation accounted for an average of 1.64(SD1.77)% of observation time for solitary kept foals and 1.19(SD2.10)% for socially kept foals.

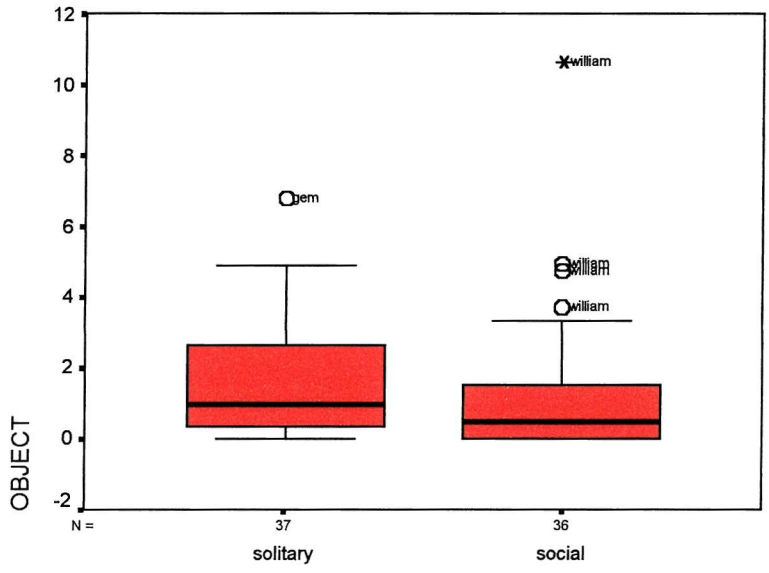
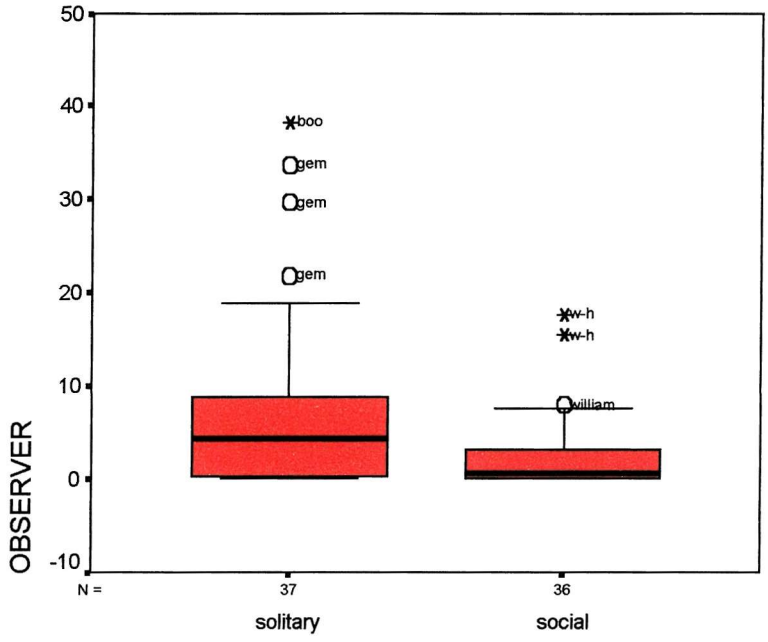


Figure 6.3 The duration, as a percentage of observation time, of object manipulation displayed by solitary kept (solitary) and socially kept (social) foals. Outlying values are labelled with the name of the foal

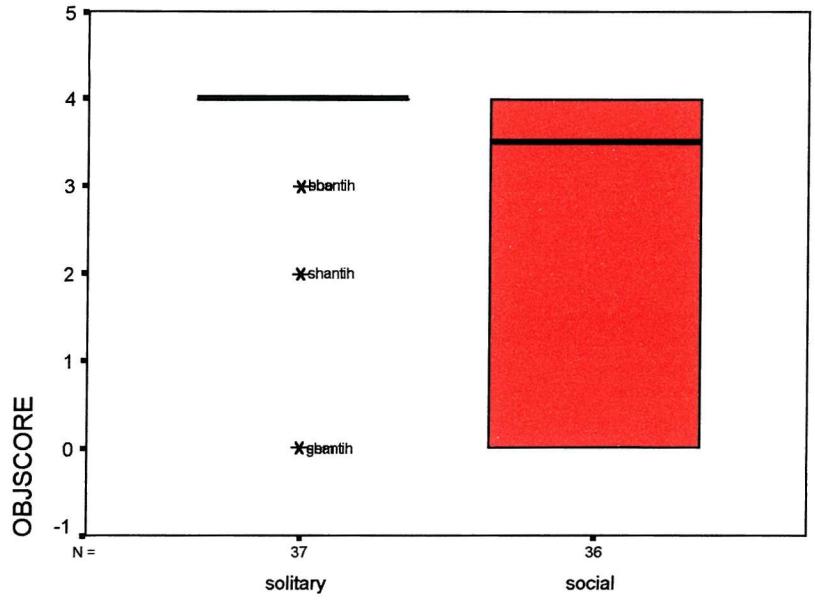
Mann-Whitney analysis detected significantly greater duration of interactions with the observer displayed by solitary kept foals than social kept foals (Z=-2.70, P<0.01) (see Figure 6.4). Interaction with the observer accounted for an average of 7.64(SD10.08)% of observation time for solitary kept foals and 2.76(SD4.26)% for socially kept foals.



social

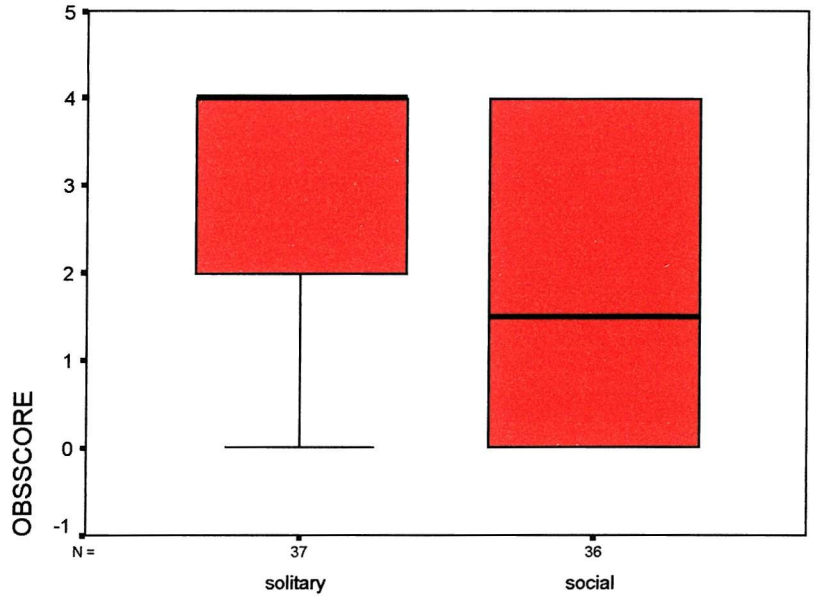
Figure 6.4 The duration, as a percentage of observation time, of interactions with the observer displayed by solitary kept (solitary) and socially kept (social) foals. Outlying values are labelled with the name of the foal

Mann-Whitney analysis detected significant differences in the object score ($Z=-2.51$, $P<0.05$) and observer score ($Z=-2.79$, $P<0.01$) between solitary kept and socially kept foals (see Figures 6.5 and 6.6).



social

Figure 6.5 The object scores of solitary kept (solitary) and socially kept (social) foals. Outlying values are labelled with the name of the foal



social

Figure 6.6 The observer scores of solitary kept (solitary) and socially kept (social) foals

6.4 Discussion

6.4.1 Ontogeny of Object Manipulation and Play

As found in the 2000 foal study group there was no difference in the duration of object manipulation displayed during months one, two and three of life. This suggests that in Arabian foals object manipulation does not significantly decrease in the first three months of life and is, therefore, an important part of the behavioural repertoire of domestic horse foals, as discussed in Section 4. This is in contrast to the development of solitary-locomotor play (Fraser 1992), which is reported to decrease dramatically at two months of age. This may indicate that the performance of solitary-locomotor play is an important part of foals' development during the first two months of life, but that it then becomes less significant. The breed of the foals studied by Fraser (1992) was not indicated and object play may develop differently from solitary-locomotor play and at different rates in different breeds. The fact that significant differences were detected between the duration of object manipulation displayed by individual foals indicates that the pattern of development is different in each foal and may be influenced by factors that could not be controlled for in this study. These may include the behaviour of the dam toward the object and the observer, the behaviour of conspecifics toward the object and the observer and any additional experiences that the foals may have encountered. The large individual differences observed in this small sample size may also be obscuring ontogenetic changes that may be more evident in a larger sample.

6.4.2 Boldness

The positive correlation between object score and observer score suggests that the bolder foals, those that interacted to a greater extent with the observer, were more likely to engage in object manipulation than more timid foals, those that interacted to a lesser extent with the observer. This reflects the results using the boldness scores in the 2000 foal study.

6.4.3 Effects of Social Environment

Although no social interactions were observed, during observations or by the owners, between the solitary kept foals and the juveniles that they were kept with, they could

have occurred at other times. Interactive play has been observed between foals and yearlings (Tyler 1972), but not with older juveniles.

The solitary kept foals spent longer manipulating objects during observations than socially kept foals. This could suggest that object manipulation and play substitutes for social interactions in solitary kept foals, as observed by Bekoff (1974) and Jolly (1985) in dogs and marmosets respectively. It is also possible that as the solitary foals had no competition from other foals, they had more opportunity to manipulate objects than socially kept foals. No such competition was observed amongst the socially kept foals during this study, although it was observed between two half siblings in the Section 4. The competition for objects resulted in the older half sibling monopolising the objects and so that the younger half sibling was unable to engage in object manipulation. So, as discussed in Section 4, the composition of the group may affect the play displayed by socially kept foals.

It would be interesting to compare the levels of social interactions of the socially kept group of foals in these studies with those of similar groups that were not provided with objects to manipulate. This approach could be useful in assessing the relative importance of object play and social interactions to the foals.

The foals kept without other foals appeared to be bolder than the socially kept foals, in that they had higher object scores and observer scores and spent more time interacting with the observer. It may be that the restricted social environment of the solitary foals led to frustrated social behaviour being expressed as interspecific interaction or manipulation of inanimate objects. As juveniles were at pasture with the solitary foals this may indicate the importance of the companionship of other foals during the first three months of life. It is also possible that the solitary foals had become bolder due to experience, as it was noted that their owners had more time to spend with them and so they were more accustomed to human contact.

As the sample size was small (see Section 3) a larger study would be necessary to confirm the results. It would also have been interesting to study the group of solitary kept foals for a longer period of time, as in the 2000 foal study, in order to further investigate the effects of social environment on the ontogeny of object manipulation and play.

6.5 Conclusion

The results of this study support those of the 1999 foal study group (Section 4) and the 2000 foal study group (Section 5), suggesting that the ontogeny of object manipulation is different in individual foals and may be influenced by internal and external factors.

The finding in this study that bolder foals manipulate objects more than the more timid foals concurs with that of the 2000 foal study group (Section 5).

There is an indication that social environment does affect the duration of object manipulation displayed during the first three months *post partum*. Foals kept with no other foals appear to be bolder than socially kept foals, but this could be because their owners spend more time with them. Foals kept with no other foals also spend more time manipulating objects, which could be a re-direction of social play behaviour. Therefore, object manipulation and play could have a role as a substitute for social play in solitary kept foals. Solitary kept foals may therefore benefit from being provided with objects towards which they can re-direct frustrated social behaviour.

Summary of Chapter 2

In this chapter the development of object manipulation and play was investigated in groups of foals consisting of different breeds (Section 4) and a single breed (Sections 5 and 6). The effects of social environment and the boldness of the foals on the development of object manipulation and play were also investigated. The following conclusions were drawn from these studies:

- Object manipulation and play was observed at relatively constant durations over the first three months of life, suggesting that it is an important part of the behavioural repertoire of domestic horse foals.
- Breed, management regimen and handling appear to affect the development of object manipulation and play.
- Object manipulation and play appears to be displayed for longer durations when foals are stabled.
- Boldness was identified as a personality trait in domestic horse foals. The bolder foals spent more time manipulating objects.
- Prior experience of object manipulation and play during the first three months of life does not appear to affect the duration of object manipulation and play displayed by yearlings.
- Social environment does appear to affect the duration of object manipulation and play displayed. Solitary kept foals display more object manipulation and play than foals reared with other foals. The sex ratio and relatedness of the social group may also affect the development of object manipulation and play.

CHAPTER 3

Sensory Characteristics of Objects and Object Manipulation and Play in Juvenile and Adult Domestic Horses

7. Which Sensory Characteristics of an Object Elicit Object Play in Adult Domestic Horses Under Trial Conditions?

Trial 1

7.1 Introduction and Aim

Although there are several commercially available "toys" for horses, no research has been published regarding which sensory characteristics of an object, i.e. colour, size, shape, texture and audibility, might make such an object successful at eliciting object play in horses. These "toys" include: a large, red, plastic, apple scented apple that hangs in the stable; rubber balls of various colours with handles to enable horses to pick them up and a plastic ball that hangs in the stable.

The domestic horse has been reported to possess colour vision. They appear to be able to reliably discriminate between blue and grey and red and grey (Pick, Lovell, Brown and Dail 1994). There is debate as to whether yellow and green (Macuda and Timney 1999) can be discriminated from grey. It is thought that in studies in which yellow has been discriminated from grey (Grzimek 1952) the yellow paint had a higher reflectance than the grey paint and that the discrimination observed was in the level of reflectance (Pick *et al* 1994). A recent study (Smith and Goldman 1999) found that horses could discriminate red, green blue and yellow from grey. Therefore, in the following trials it will be assumed that horses can discriminate red and blue from grey. Domestic horses have also been reported to be able to discriminate between circles, triangles and squares drawn on card (Popov 1956). Therefore, they are likely to be able to discriminate between different shaped three dimensional objects.

Horses have semi-prehensile lips, which they use to manipulate food and non-food objects. The area around the muzzle is covered in sensory hairs and so may be sensitive to the texture of objects manipulated (Fraser 1992). A further function of these hairs is thought to be to allow horses to judge the distance from the end of the nose to the surface of objects (Rees 1984). Horses have also been observed, anecdotally, to

test the current of electric fences with these sensory hairs before touching them with the rest of the body (Rees 1984).

The aim of this study was:

1. To determine whether any sensory characteristics of an object could be identified that could affect the response displayed toward that object by domestic horses.

7.2 Method

7.2.1 Objects

Eight objects (see Figures 7.1-7.8) constructed of plastic and rubber were chosen to test whether the characteristics that had been selected by the experimenter were similar to those used by horses when selecting a play object. The objects were chosen at a workshop, by a group who research dog play and equine behaviour, because they were thought to have characteristics that would appeal to horses, were thought to be safe for horses and allowed a matrix of sensory characteristics to be tested.

Figure 7.1 "Dumbell"

Figure 7.2 "Glove"

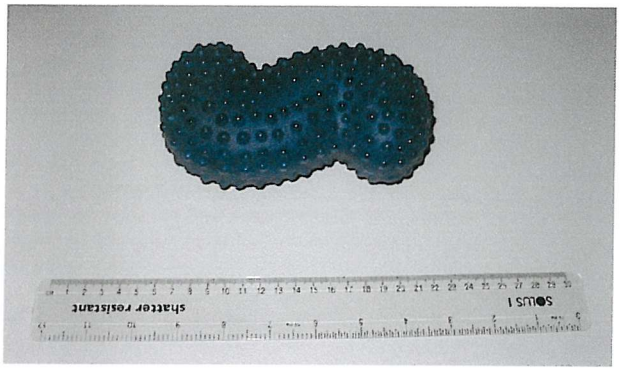


Figure 7.3 "Hercules"

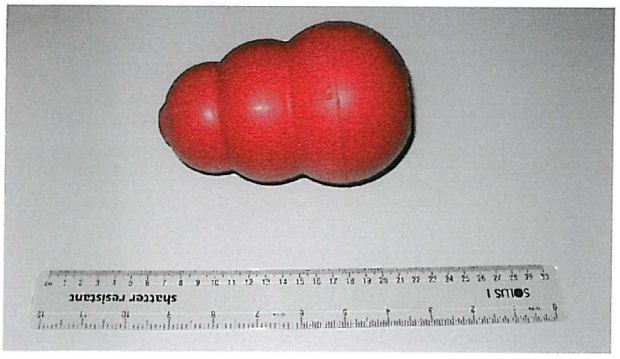


Figure 7.4 "Kong"

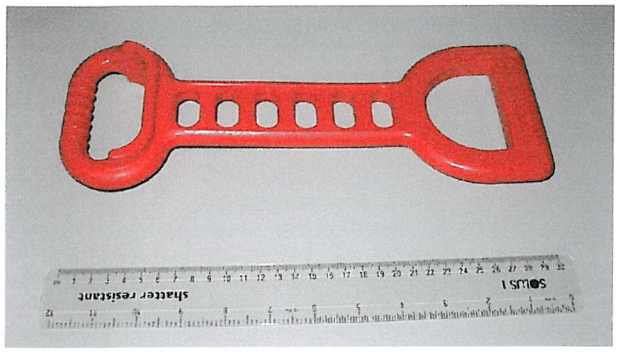


Figure 7.5 “Push me pull you”

Figure 7.6 “Saturn ball”

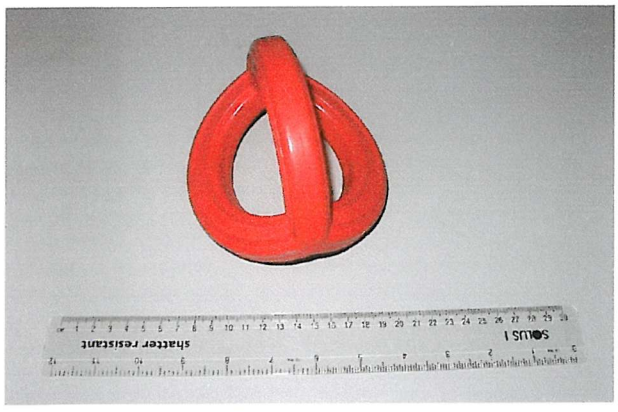


Figure 7.7 “Trefoil”

Figure 7.8 "Wing wong"

A variety of sensory characteristics of the objects were identified in order to investigate which are important in initiating object manipulation and play in the horse. The sensory characteristics tested were:

Colour: Red, blue, multi-coloured

Size: Small, medium

Texture: Smooth, spiky

Mobility: Stable, mobile

The colours chosen for testing were those that have been demonstrated, or thought to be distinguishable to the domestic horse (Pick *et al* 1994). The size of toys has been shown to be an important factor in eliciting object play in the domestic cats, with smaller toys eliciting more play (Hall 1995). Therefore, different sized objects were tested. As horses use their muzzles, which are covered in sensory hairs, to manipulate objects different textures were tested in order to determine whether this is an important factor in eliciting object play. The Kong, trefoil, Saturn ball and Wing wong moved easily when touched. The remaining objects required more force to move them. This property was included as mobility.

The objects were divided into four pairs, with each object in each pair having the same characteristics, although they were different visually to the experimenter. The pairs were as follows:

Pair 1. Dumbell and Push me pull you (Red, medium, smooth, stable)

Pair 2. Kong and Trefoil (Red, medium, smooth, mobile)

Pair 3. Saturn ball and Wing wong (Multi, small, smooth, mobile)

Pair 4. Hercules and Glove (Blue, medium, spiky, stable)

This would make it possible to determine whether the horses could distinguish between the sensory characteristics described above.

7.2.2 Subjects

Five male horses at an Equine Behaviour Centre were observed during this study. They are described in Table 7.1.

Table 7.1. Details of the subjects in Trial 1

	Sex	**Age**	**Breed**
Tom	Gelding	20	Welsh Cob/Arab
Del	Colt	3	Irish Draught
Ember	Colt	2	¾Thoroughbred ¼Irish Draught
Barney	Colt	3	Thoroughbred/ Irish Draught
Matisse	Colt	3	Connemara/ Thoroughbred

The horses were kept out at pasture for the duration of the trial except for being stabled when they were fed in the afternoons. On trial days the horses were stabled and fed before the trial started and were not stabled for longer than three hours on any day.

7.2.3 Observations

A video camera was set up in an empty stable with no bedding, so that the objects were in clear view during observations and distractions to the horse under observation were limited.

It has not been shown that observational learning of an operant response occurs in horses (Baer, Potter, Friend and Beaver 1983; Lindberg, Kelland and Nicol 1999). However, in a study of observational learning of food selection (Clarke, Nicol, Jones and McGreevy 1996) the horses appeared to learn something about the location of the food, although they were not able to discriminate accurately in a feed-related task. Therefore, in order to avoid any observational learning, the stable adjacent to the test stable was left empty. Also, during observations the area around the stables was kept as quiet as possible to limit any other distractions to the horses.

Each horse was led into the stable and given at least two minutes to familiarise itself with its environment. An object was then placed in the stable as in Figure 7.9. This position was chosen because as the horse approached the object it would be facing the video camera and therefore any reaction to the object would be clearly observed. The horses' behaviour was filmed using a remote Hi8 format video camera for 15 minutes. Each horse was presented with one object on each observation day according to a random design (see Table 7.2). Observations took place between 1400hours and 1700hours with at least one rest day between each observation day. The order in which the horses were observed on each observation day was also according to a random design (see Table 7.3).

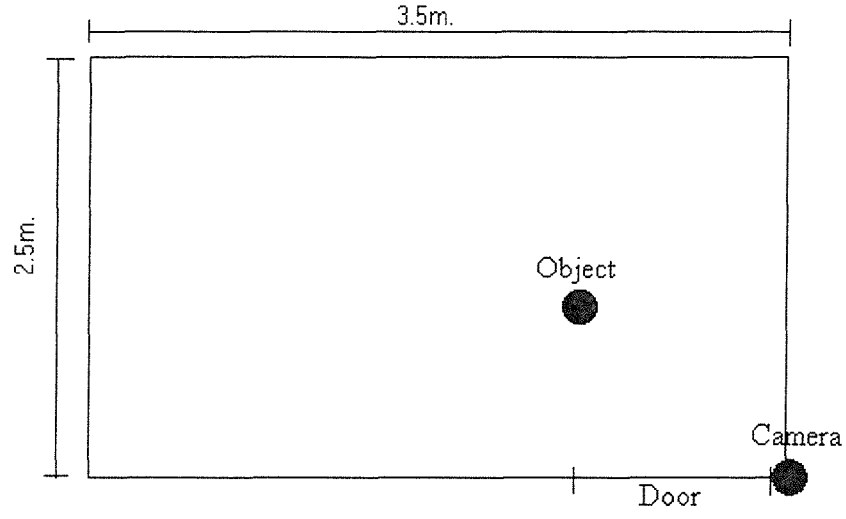


Figure 7.9. Layout of the observation stable

Table 7.2. Order of object presentation for each subject

	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
Tom	d	k	p	s	t	w	h	g
Del	k	d	h	w	g	s	p	t
Ember	p	h	d	t	s	g	k	w
Barney	s	w	t	d	p	k	g	h
Matisse	t	g	s	p	d	h	w	k

Object abbreviations: d = dumbell, g = glove, h = hercules, k = kong, p = push me pull you, s = saturn ball, t = trefoil, w = wing wong

Table 7.3. Order in which the horses were observed on each observation day

Day 1	Tom	Del	Ember	Barney	Matisse
Day 2	Del	Tom	Barney	Matisse	Ember
Day 3	Ember	Matisse	Tom	Barney	Del
Day 4	Barney	Ember	Del	Matisse	Tom
Day 5	Matisse	Del	Ember	Tom	Barney
Day 6	Tom	Matisse	Barney	Del	Ember
Day 7	Del	Barney	Tom	Ember	Matisse
Day 8	Ember	Barney	Matisse	Tom	Del

7.2.4 Data Recording

The Hi8 videotapes obtained from the study were transferred onto VHS format. These tapes were then observed. The durations of the object manipulation behaviours detailed in Table 4.3 were timed using a stopwatch and then recorded on check sheets.

7.3 Results

None of the horses displayed object manipulation toward the objects under trial. Therefore it was not possible to test the matrix of sensory characteristics.

7.4 Discussion

7.4.1 Effectiveness of the Objects

There could be a variety of reasons why the horses did not show an interest in the objects being tested. Some of the objects were small in comparison with the objects on the market as horse toys, so it may be that the horses did not notice the objects in the stable. This certainly appeared to be the case for some of the horse and object combinations. Hall (1995) suggested that domestic cats (a predator) played with small objects and avoided large objects because the small objects were similar to the size of their prey and the larger objects may have been more threatening. In the case of the domestic horse (a prey species) it may be that the objects were so small that they did not produce a significant change in the horses' environment and so were not investigated.

It is also, of course, possible that these objects simply do not elicit object manipulation in horses, as they were designed to stimulate play behaviour in dogs. They were also designed to be appealing to and induce play and purchase in humans. This may even partly explain why the working group chose these objects. The motivation for dogs and horses to play with objects is likely to be very different. Dogs are predators and so their motivation to play is likely to be similar to that of other predators such as cats and kestrels, whose motivation is reported to be predation (cats: Hall 1995, kestrels: Negro, Bustamante, Milward and Bird 1996). Horses' motivation to play with objects is not clear. It may be associated with feeding behaviour, which is obviously different from the purpose for which the toys were designed. Most of the dog toys were designed for object-oriented dog-human play, so a greater response may have been achieved if the horses had been introduced to the objects by the observer.

It is possible that not all horses manipulate objects. Thus, it may be that the five horses tested would not have manipulated or played with any objects. However, as they were male and four were juveniles, they were representative of a group of domestic horses that could be thought likely to play with objects, as colts are reported to engage in more play than fillies (Tyler 1972).

7.4.2 Observation Environment

The observation environment may also have contributed to the lack of object play. It has been reported that play is not displayed in sub-optimal welfare conditions (Sommer and Mendoza-Granados 1995; Suomi 1982). In order to reduce distractions to the horses during the observation period the observation stable did not contain anything edible and there was no horse in the adjacent stable. This would not be considered good welfare conditions for the long term management of domestic horse and this may have contributed to the lack of object play.

Some of the horses were observed to display object manipulation in the field, with buckets and sticks, by staff at the Equine Behaviour Centre. This suggests that the horses observed in this study do manipulate objects and therefore, either the objects presented in the trial, or the observation environment, were not optimal to induce object manipulation.

7.5 Conclusion

It was not possible to identify any sensory characteristics of these objects that could affect the response displayed toward that object by this group of domestic horses. This may have been because the objects were too small to elicit the horses' interest, or because the observation conditions were not optimal to induce object play.

A further trial would need to test a different set of objects, in the same test conditions, to determine whether the observation conditions were sub-optimal for play. The objects would also need to be more suitable for horses. They would need to be larger than the objects presented to the horses in this study to ensure that the horses would notice the objects.

8. Do the Objects Anecdotally Reported to Elicit Object Play in Adult Domestic Horses Elicit Object Play Under Trial Conditions?

In Trial 1 (Section 7) the toys designed for dogs did not elicit object manipulation and play. This was perhaps unsurprising as the motivation for object play is likely to be different in the two species as dogs are a predator species and horses are a herbivorous prey species. In other predator species, such as the domestic cat (Hall 1995) and kestrels (Negro *et al* 1996), object play is likely to be associated with predation behaviour. The function of object play in herbivorous species has yet to be elucidated conclusively.

The next logical step was to find out what objects horses were observed to play with by their owners and then to present these objects to horses during a trial under controlled conditions.

A questionnaire was constructed to find out about horse-owners' attitudes to object play in horses and what objects they had observed their horses playing with. The results of this questionnaire were then used to select five objects to present to the horses at the Equine Behaviour Centre to determine which, if any, sensory characteristics of objects made them successful at eliciting object manipulation and play in domestic horses.

Horse Play Questionnaire

8.1 Introduction and Aims

As there is only anecdotal evidence available about the objects that adult horses play with, it was necessary first to carry out a survey of local horse owners. A questionnaire was circulated to private horse owners in the New Forest.

The aims of this study were:

1. To gauge horse-owner's attitudes towards play exhibited by horses, specifically object play
2. To determine what objects horses have been observed to play with and how often object play was observed by owners.

8.2 Methods

8.2.1 Questionnaire Design

The first part of this questionnaire (see Appendix for full questionnaire) included questions about the owner's gender, age, the number of horses owned and the total length of time that they had owned horses. The aim of these questions was to assess the owner's experience of keeping horses.

The second part of the questionnaire (questions one to ten) included questions about the horse that the owner would be reporting on in the remainder of the questionnaire. The required information was: the age, sex and breed of the horse; how long it had been owned by the present owner; the stabling routine; the type of work for which the horse was used. The last two questions were open ended. This enabled a full range of answers to be obtained.

The main part of the questionnaire canvassed the owner's opinions on social play and object play in horses. It also asked about object play displayed by the horse and

observed by the owner. The aim of these questions (number five and six) was to find out where the horse had been observed playing with objects, whether the owner deliberately gave the horse objects to play with in the stable and whether the horse lost interest in these objects. If the owner did not provide objects in the stable the reasons were asked for.

Question seven was included to find out whether horse-owners were using object play as a means of reducing or preventing behaviour problems and how long object play was effective for. For the purposes of this questionnaire "behaviour problems" was rephrased as "unwanted behaviour", as some owners may not have been willing to answer a question phrased the former way. Question eight was included to find out whether horse owners were using any other methods to reduce or prevent problem behaviours and for how long these were effective.

Question nine and ten were included to determine the circumstances under which the horse-owners were willing to use stable toys.

A range of types of questions has been used in the design of this questionnaire. Open ended questions were used where it was not possible to give a full range of tick box options. The disadvantage of using this type of question is that coding the answers may not be possible. In the remaining questions the owners were given a choice of boxes to tick to answer the questions. This allowed easy analysis of the data. In order to prevent owners interpreting scales differently definite times were given as choices when determining how often object play was observed by owners.

8.2.2 Coding the Questionnaire Data

Numerical data from the returned questionnaires were assigned coding during the design of the questionnaire.

Data about stabling routine were collected in an open-ended question, so the total number of hours that each horse spent in a stable over the period of one year was approximated. The horses' stabling routines often differed between Winter and Summer.

To code the data about the breed of the horse each breed was categorised as a warmblood type, a part warmblood type or a non-warmblood type (Fraser 1992) (see Glossary for definitions).
Each answer from the "tick-box" style questions was assigned a number to enable analysis.

8.2.3 Statistical Analysis

All statistical analysis was performed using SPSS v.10. Contingency tables with chi-squared analysis were used to analysed differences in owner attitudes between the yards included in the study. This test allows the comparison of categorical data and tests the null hypothesis that the variables are statistically independent. Spearman rank correlation is a non-parametric correlation and was used to determine relationships between responses.

8.3 Results

Forty four questionnaires were returned from six livery yards constituting a 44% return rate.

8.3.1 Information About Horses

The average age of the horses in the questionnaire was 12.8 years. The sex ratio indicated an even distribution of mares and geldings. There was an even spread among the three breed categories. The horses were used for leisure riding, endurance, eventing, driving, in-hand or ridden showing, dressage, western riding, show jumping, schooling, cross country and hunting, or were retired.

The stabling routines of the horses are described in Table 8.1.

Table 8.1 The reported stabling routines of horses

Stabling Routine	Percentage of Horses Studied
Stabled at some time during the year	88.6
Stabled during the day in summer or over night in winter	38.6
Always stabled over night	36.4
Stabled all the time in the winter or during the day in summer and at night in winter	11.4
Stabled all the time	2.3

8.3.2 Owner Attitudes

All respondents were of the opinion that horses play and 97.8% felt that play was important for horses. Opinions about object play differed from those about play in general, in that only 84.4%, of the respondents thought that horses play with objects. A further 11.1% of respondents were unsure as to whether horses played with objects and 4.4% did not believe that horses played with objects. Only one respondent discouraged their horse from playing with other horses, and this was because of the risk of injury. The responses that the owners gave to the question on how they felt that horses benefited from playing with objects included: relieving boredom, satisfying curiosity and reducing fear of new objects. Eight of the owners were either unsure of how horses could benefit from object play, or did not respond to this question.

Regarding the use of stable toys, 91.1% of respondents would use a stable toy if they felt it would reduce unwanted behaviours. However, only 60% of respondents would consider using a stable toy if their horse had no problem. 20% of owners discourage their horses from playing with objects. The reasons given for this were to: stop crib-biting from developing, prevent injury, prevent bad habits and to prevent damage to objects.

8.3.3 Play Observations

Approximately half (51.1%) of respondents reported that they observed their horse to play with other horses every day. Approximately one quarter (26.7%) of respondents

indicated that they observed their horse play with objects every day. 11.1% reported that they had never observed their horse playing with objects.

Horses were observed to play with a wide variety of objects in the field and in the stable. Of the 37.8% of respondents who give their horse objects to play with in the stable, 62.5% reported that their horse lost interest in these objects.

29.5% of the owners reported that they had given their horse objects in the stable to reduce or prevent behaviour problems. 26.2% of the owners had used methods other than object play to reduce or prevent problem behaviour.

Horses were reported to play with a variety of objects. These included: haynets, a commercially available plastic scented apple toy, empty buckets, wooden sticks, rugs, the ballcock on water troughs, gates, bottles hanging up in the stable, keys, turfs of grass, brushes, door bolts, footballs, traffic cones, clothes, empty plastic and paper bags and sacks, a wooden spoon, headcollars, leadropes, fencing, chains, and tyres.

The objects that horse-owners deliberately gave to their horses to play with in the stable included: hanging plastic bottles, traffic cones, tyres, buckets, empty paper bags, balls, commercially available Horseball, commercially available plastic scented apple, wood, old grooming brushes and large twigs tied up outside the stable in proximity to the stable door.

8.3.4 Yard Differences

The responses to questions 1a, 1b, 2, 4a, 4b, 9 and 10 were compared between the six yards using contingency tables with Chi-squared analysis to compare the attitudes of horse-owners towards play in horses between the yards. No significant differences were detected.

8.3.5 Significant Correlations

Spearman rank correlation produced significant correlations between the responses to following questions:
"Do you think that horses play with objects?" and "Approximately how often do you see your horse play with objects?"(Spearman's rho: 0.468; $P<0.01$).

"Breed of horse" and "Approximately how often do you see your horse play with objects?" (Spearman's rho: 0.255; $P<0.05$).

8.3.6 Non-Significant Correlations

No significant correlation was detected between the age of the horse, sex of the horse, or the length of time that the horse was stabled and the reported frequency of object play (age: Spearman's rho= 0.173, NS; sex: Spearman's rho= -0.191, NS; length of time stabled: Spearman's rho= -0.018, NS).
The reported frequency of object play was not significantly correlated with the reported frequency of play with other horses (Spearman's rho= 0.083, NS).

There was also no significant correlation between the breed of the horse and the length of time that it was stabled (Spearman's rho= 0.059, NS).

8.4 Discussion

8.4.1 Owner Attitudes to Object Play

The results of this questionnaire suggest that horse owners do believe that play, as they perceive it, is an important part of the horses' behavioural repertoire. Although several owners were unsure as to whether horses played with objects, 84.4% of owners believed that they did. 18.2% of the owners either did not know how horses could benefit from object play, or did not respond to question 3b. This may suggest that despite the commercial availability of horse toys not all horse owners have explored their possible uses.

The results also suggest that the owners of horses that were reported to play frequently with objects were more likely to believe that horses engaged in object play. However, it may also be possible that owners who believe that horses play with objects may more readily interpret their horses' interactions with objects as play than those who do not believe that horses play with objects. This questionnaire did not define object play for the owners, so not all the behaviour reported as object play may actually have been play, but could have been investigation of objects or conditioned responses.

8.4.2 Effect of Breed Type, Sex and Age of the Horse

The significant correlation between the breed of the horse and how often owners see their horses playing with objects suggests that non-warmblood type horses play with objects more frequently than warmblood type horses. It may be that non-warmblood type horses are more inquisitive than warmblood type horses. This result is in agreement with the study by Lindberg A.C. *et al* (1999), in which non-warmblood type horses were reported to exhibit more investigative behaviour toward an inanimate object than warmblood type horses. Another explanation for the difference in the exhibition of play behaviour could have been the effect of the stabling routine. Non-warmblood type horses may be stabled less than warmblood type horses. However, there was no significant correlation between the length of time that the horses were stabled and their breed type. Also, there was no overall correlation between the length of time that the horses were stabled and how often they were observed playing.

The sex and age of the horse were not significantly correlated with the frequency of object play observed by the owner. It was expected that males would be reported to play more frequently than females, as Tyler (1972) reported that colts play more than fillies. It was also expected that younger horses would play more frequently than older horses, as juveniles of most species are reported to play more than adults (Fagen 1981). The small sample size of the questionnaire may have obscured these differences.

8.4.3 Design of the Questionnaire

Although the open-ended nature of many of the questions restricted statistical analysis, the qualitative information yielded by the questionnaire was utilized in future trials. The answers to the questions could be used to form statements that could be presented in a future questionnaire for horse-owners in which the response would be positive or negative. Also, in future questionnaires it would be necessary to rephrase some of the questions. For example, in question 2 (Do you think that it is important for horses to play?) it is not clear what aspect of play is being referred to. It might be better to ask instead; "Do you think that play is important for horses' well-being?" A definition of play, included at the beginning of the questionnaire, might not only aid the owners in answering the questions but also improve analysis and interpretation of the results. It is

possible that some of the behaviours reported were not true object play and were instead conditioned responses or initial investigation.

The number of questionnaires analysed represented a small sample size (44). In future research it would be necessary to increase this number to improve the reliability of the results.

8.5 Conclusions

The results suggest that play is exhibited across the general equine population.

Horse owners do believe that play is an important part of the domestic horses' behavioural repertoire and that horses do engage in object play.

The objects with which domestic horses appear to play included clothing, plastic bags and sacks, paper sacks, balls and wooden sticks. Therefore, these objects were chosen to be presented to horses under test conditions in order to determine whether object play is directed toward these objects by domestic horses.

Do the Objects Elicit Object Play Under Trial Conditions?

Trial 2

8.6 Introduction and Aims

There is anecdotal evidence to indicate that adult domestic horses play with a variety of objects. The objects chosen by the working group and presented to the horses in Trial 1 appeared to be ineffective at eliciting responses from the horses under study conditions. Therefore, those objects which had been reported to elicit responses in domestic horses in the horse play questionnaire were presented to the horse under the same study conditions as described in Trial 1.

As object play was not defined in the questionnaire it is possible that the behaviours reported by the horse-owners were not simply object play. If the owners had actively encouraged their horses to play with objects they may have intentionally or unintentionally rewarded them for this behaviour with praise or food rewards. So, this behaviour would then become a conditioned response. This may have elevated the amount of "object play" observed.

The aims of this study were:

1. To investigate whether it was the objects or the study conditions in Trial 1 that had influenced the responses of the horses.
2. To assess the effectiveness of objects reported by horse owners to elicit object play in domestic horses.

8.7 Method

8.7.1 Objects

In the questionnaire to horse-owners about object play in domestic horses object play with the following objects was reported; empty feed sacks, wooden sticks, a variety of balls and clothing.

Since empty feed sacks may retain the odour of the feed, paper sacks constructed for this trial from brown paper (86cm in length and 52cm in width when flat) were used as an alternative to the paper feed sacks. Yellow plastic incinerator sacks (96cm in length and 45cm in width when flat) were used as an alternative to the plastic feed sacks. The wooden sticks were Scots pine, approximately 30cm long and 3cm in diameter. The ball was a red Jolly Ball 25cm in diameter (as used in Section 4) that was designed for use as a horse "toy" and therefore considered safe to use. A dark blue towel (86cm in length and 52cm in width when flat) was used to simulate clothing. Figures 8.1 – 8.5 illustrate the objects and how they were presented during observations. The paper sack, plastic sack and towel were presented as three-dimensional objects for presentation.

Figure 8.1 Paper sack

Figure 8.2 Plastic sack

Figure 8.3 Wooden stick

Figure 8.4 Jolly Ball

Figure 8.5 Towel

Each paper sack, plastic sack and stick was discarded after being introduced to each horse so that the horses would not be influenced by any odours associated with other horses. After each test the towel was machine-washed and the Jolly Ball disinfected and rinsed.

8.7.2 Subjects

The objects were presented to 11 horses kept at the Equine Behaviour Centre. Their details are given in Table 8.2.

The male horses were maintained at pasture before and during the trial period. They were stabled on trial days for a maximum of three hours. The female horses were stabled for 22 hours per day and turned out to pasture for two hours per day for two weeks prior to the trial. This management regimen was then maintained throughout the trial period.

Table 8.2. Details of the subjects in Trial 2

Horse	Age (years)	Sex	Breed
Tom	18	Gelding	Welsh cob/Arab
Del	3	Colt	Irish Draught
Barney	3	Colt	Irish Draught/ Thoroughbred
Matisse	3	Colt	Thoroughbred / Connemara
Ember	2	Colt	¾Thoroughbred ¼ Irish Draught
Kato	3	Gelding	Irish Draught/Welsh cob
Krystal	2	Filly	Irish Draught/ Thoroughbred
Talia	2	Filly	Thoroughbred/ Connemara
Indie	3	Filly	Irish Draught/ Thoroughbred
April	20	Mare	Thoroughbred
Belle	5	Mare	Irish Draught/ Thoroughbred

8.7.3 Observations

As in Trial 1 (Section 7) the test observations took place in a stable containing only a water bucket and with no bedding (see Figure 7.9). This was to ensure that none of the objects became lost in any bedding and that the horses were not distracted by food. In order to limit distractions to the test horse and to avoid any opportunity for observational learning there was no horse in the adjacent stable. Any faeces produced during an observation were removed before the next horse was introduced.

The horses were given two minutes to acclimatise to the conditions of the stable before the object was introduced. One of the objects was then presented to the horse on the floor in a standard configuration (see Figure 8.1 – 8.5). The object was left in the stable for 15 minutes and the response of the horse was filmed using a wall - mounted video camera (see Figure 7.9). After this period the horse and the object were removed from the stable.

The order in which the objects were presented to each horse and the order in which the horses were observed on each observation day was according to a random design, detailed in Tables 8.3 and 8.4. There was at least one rest day between trial days.

Only one replicate was completed for this trial due to the lack of object play displayed.

Table 8.3. Order in which the objects were presented to the horses

Horse	Day 1	Day 2	Day 3	Day 4	Day 5
Tom	Plastic sack	Paper sack	Jolly Ball	Towel	Stick
Del	Paper sack	Towel	Plastic sack	Stick	Jolly Ball
Ember	Jolly Ball	Stick	Towel	Paper sack	Plastic sack
Barney	Towel	Jolly Ball	Paper sack	Stick	Plastic sack
Matisse	Stick	Plastic sack	Paper sack	Jolly Ball	Towel
Kato	Paper sack	Jolly Ball	Stick	Plastic sack	Towel
Krystal	Plastic sack	Paper sack	Jolly Ball	Towel	Stick
Talia	Paper sack	Towel	Plastic sack	Stick	Jolly Ball
April	Jolly Ball	Stick	Towel	Paper sack	Plastic Sack
Indie	Towel	Jolly Ball	Paper sack	Stick	Plastic Sack
Belle	Stick	Plastic sack	Paper sack	Jolly Ball	Towel

Table 8.4. Order in which the horses were observed on each observation day

Day 1	Tom	Del	Ember	Barney	Matisse	Kato
Day 2	Del	Matisse	Barney	Tom	Kato	Ember
Day 3	Ember	Kato	Tom	Matisse	Del	Barney
Day 4	Barney	Ember	Kato	Del	Tom	Matisse
Day 5	Kato	Tom	Barney	Kato	Ember	Del
Day 6	Krystal	Talia	April	Indie	Belle	-
Day 7	Talia	Belle	Indie	Krystal	April	-
Day 8	April	Krystal	Belle	Talia	Indie	-
Day 9	Indie	April	Talia	Belle	Krystal	-
Day 10	Belle	Indie	Krystal	April	Talia	-

8.7.4 Data Recording

The Hi8 videotapes obtained from the trial were transferred onto VHS format. Each tape was then observed using continuous sampling and the duration of the object

manipulation behaviours in the ethogram described in Table 4.3 were timed using a stopwatch and recorded on check sheets.

8.7.5 Statistical Analysis

All statistical analyses were performed using SPSS v.10. Several statistical tests were used to analyse the data from this trial. Non-parametric tests were used because the data did not follow a normal distribution. Mann-Whitney U tests were used to test for sex differences. Kruskal-Wallis tests were used to compare the levels of object manipulation and play displayed by individual horses. Friedman tests were used to test for differences between objects. Details of these statistical analyses are given in Section 4.2.5.

In all the box-plots presented in this section outlying values (those cases with values between 1.5 and three box lengths from the upper or lower edge of the box, where the box length is the interquartile range) are labelled with a circle (O) and extreme values (those cases with values more than three box lengths from the upper or lower edge of the box, where the box length is the interquartile range) are labelled with an asterisk (*).The interquartile range contains 50% of the recorded values. The whisker lines that extend from each box are drawn between the highest and lowest values, excluding outliers. The thick black line across the box indicates the median. The "N" value on the x-axis indicates the number of cases in each plot.

8.8 Results

8.8.1 Behaviour Patterns Observed

All of the horses studied displayed object manipulation toward at least one of the objects during the trial. The behaviour of the horses was observed before the data was recorded and six types of object manipulation were observed. Three of these behaviours were performed by all of the horses. These three behaviours, termed "exploratory behaviours" were; orient toward object, sniff object and nuzzle object. Three further behaviour patterns were not performed by all the horses and so were identified as "play behaviours". These were; paw at object, bite object and pick up object. All six behaviour patterns were included when analysing object manipulation, but only the three play behaviour patterns were included when analysing object play.

8.8.2 Object Manipulation

Kruskal-Wallis analysis detected no significant difference in the time spent manipulating objects between the individual horses (X^2=8.26, *df*=10, NS) (Figure 8.6).

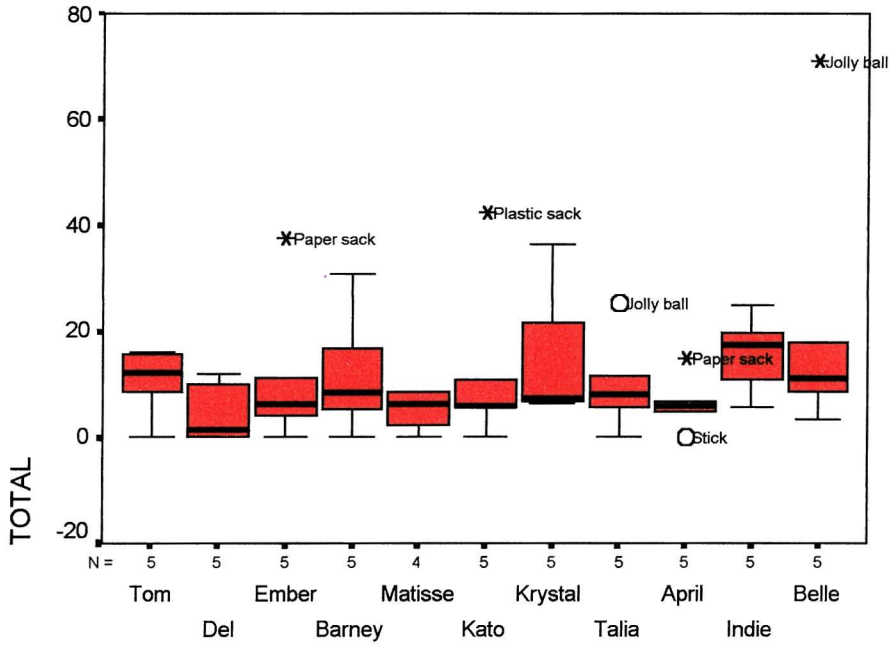


Figure 8.6 Box-plot illustrating the total duration, in seconds, of object manipulation (TOTAL) for each horse. Outlying values are labelled with the names of the objects

Friedman analysis detected a significant difference between objects in the total amount of time spent manipulating (X^2=1.12, *df*=4, P<0.05). A box-plot (Figure 8.7) shows that the paper sack and the Jolly Ball were manipulated for the longest and the stick and the towel were the least manipulated objects.

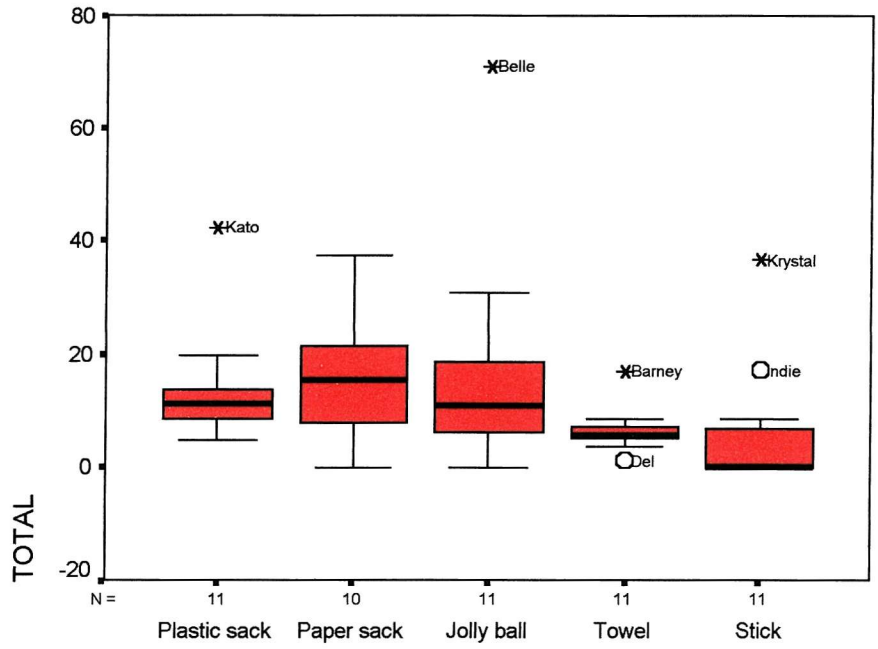


Figure 8.7 Box-plot illustrating the total duration, in seconds, of object manipulation (TOTAL) for each object. Outlying values are labelled with the names of the horses

8.8.3 Object Play

Object play was only displayed by five of the 11 horses studied (see Figure 8.8). Kruskal-Wallis analysis detected a significant difference in the amount of play displayed by individual horses (X^2=20.12, *df*=10, P<0.05).

There was no significant difference in the duration of object play displayed for each object (X^2=13.88, *df*=4, NS), but there appeared to be a trend for the paper sack to elicit more object play than the other objects (see Figure 8.9).

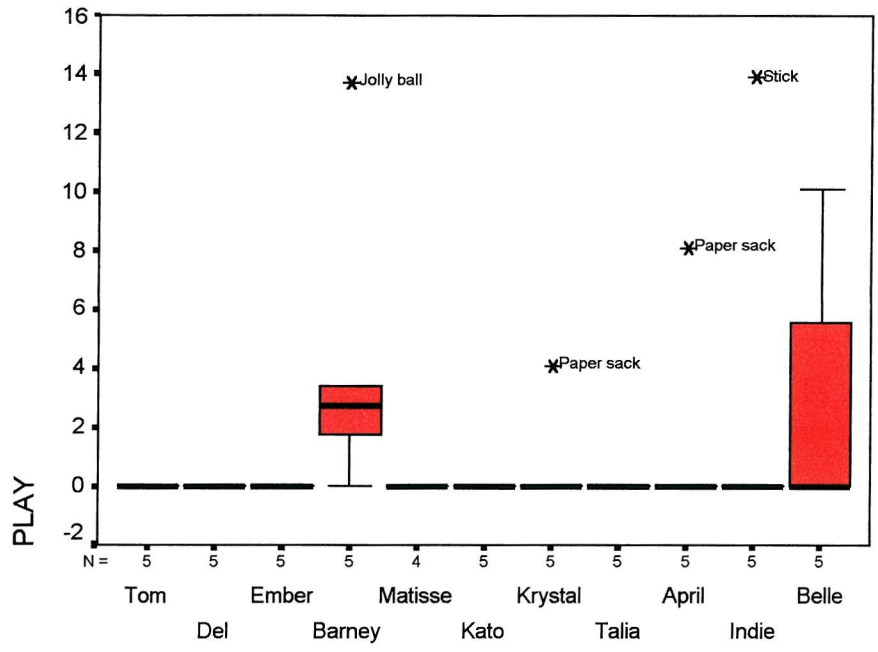


Figure 8.8 Box-plot illustrating the duration, in seconds, of object play for each horse. Outlying values are labelled with the names of the objects

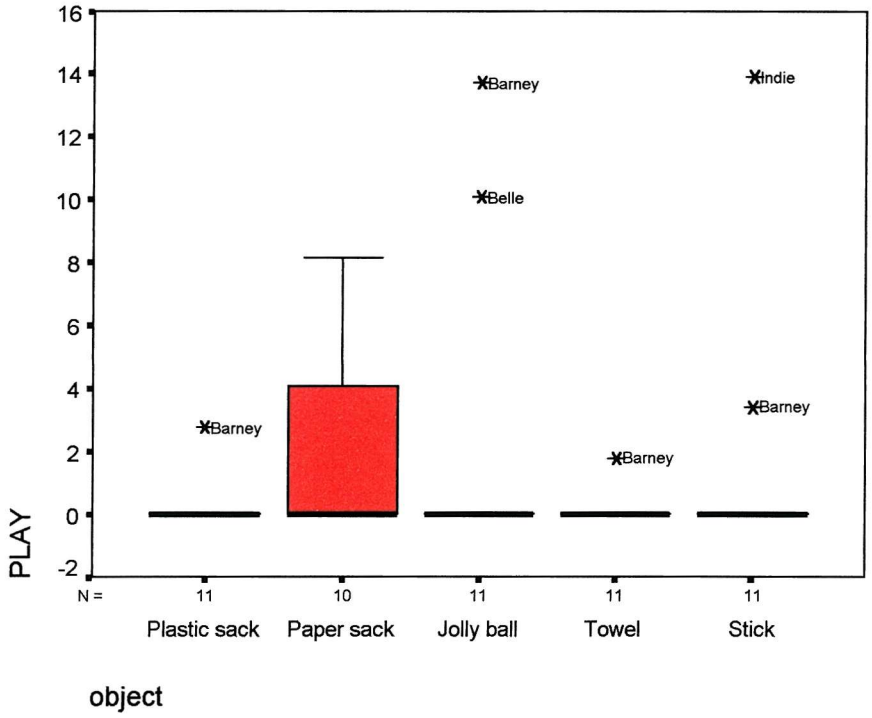


Figure 8.9 Box-plot illustrating the duration, in seconds, of object play for each object. Outlying values are labelled with the names of the horses

8.8.4 Sex Differences

Barney (male) and Belle (female) appeared to display more play than the other horses. The three remaining horses that displayed object play were female. However, Mann-Whitney analysis detected no significant sex difference in the level of object manipulation or play (Z=-1.33, NS; Z=-0.76, NS).

8.9 Discussion

8.9.1 Trial Conditions

This trial suggests that manipulation of objects reported by horse owners to elicit object play does occur at low durations under the trial conditions, but that perhaps not all horses will show a tendency to play with objects under these conditions. As discussed in Trial One the trial environment in which the objects were presented to the horses may provide sub-optimal welfare conditions as it contained no bedding or food and prevented social contact. Play is reported not to occur when welfare conditions are not optimal (Sommer and Mendoza-Granados 1995; Suomi 1982). Furthermore, although object play was displayed during this study, the durations of play were still low. The highest duration of object play displayed by Indie (13.9s), accounted for only 1.5% of the 15 minute observation.

Since all the horses approached the stable door when the experimenter entered to place the object in the stable, it was not possible to compare the latency of each horse to approach each object.

8.9.2 Sex Differences

No sex differences were detected, although this may have been confounded by the greatly differing management conditions between the males and females. The small sample size also makes it difficult to make any definite conclusions from these results. It is interesting that apart from Barney the only horses to perform object play behaviour were female. All the horses observed, however, displayed object manipulation. Colts are reported to play more than fillies (Tyler 1972). So, this finding may indicate that the short-term, prolonged stabling of the females increased their propensity to manipulate and play with objects. This is in agreement with the findings of Mal, Friend, Lay, Vogelsang and Jenkins (1991) who reported that mares

subjected to short term confinement and social isolation had a greater motivation for movement and performance of a greater number of activities than mares maintained at pasture with conspecifics. However, the females only displayed object play towards the paper sack and Barney (the only male to exhibit object play), played with all the objects, with the exception of the paper sack. Therefore, there may also be sex differences in preferences for play objects, but with the small sample of this trial it is difficult to draw any overall conclusions.

8.9.3 Effectiveness of Objects at Eliciting Object Manipulation and Play

The paper sack and the Jolly Ball appeared to elicit the most object manipulation and play. It is possible that an unrelated trial that was running alongside this trial affected the results for the Jolly Ball. The other trial involved the horses learning to roll a ball that dropped food pellets as it rolled. Some of the horses showed very similar behaviour to this during the current trial with the Jolly Ball.

The paper sack proved to be an object that generated a great deal of noise. When the horses nuzzled it, it rustled and this may have prompted further investigation and play. It has been suggested that auditory feedback is more potent than visual feedback in eliciting and maintaining play responses in children (Burn 1967). The smell of the paper sack may also have affected the amount of manipulation and play that it elicited. It may have absorbed odours from the surroundings, stimulating investigation, or, the paper may itself emit an agreeable odour. When grazing, horses have been reported to browse on a variety of trees and shrubs (Gill 1988) and strip bark from trees (Fraser 1992). The paper sack may carry a similar odour to wood and this may explain the horses' interest in it. It is also possible that prior experience of feed sacks may have prompted increased manipulation of this object.

The low levels of object manipulation and play elicited toward these objects may also be a reflection of the fact that in some cases they are alternatives to the actual objects reported by horse owners to elicit object manipulation and play. The plastic and paper feed sacks were substituted with sacks possessing no odour of feed. However, this may be the reason why the horses reported on in the questionnaire manipulated and played with these objects. The towel substituted for clothing, but it may have been the odour of the owner or another horse that stimulated object manipulation and play. These odours would be difficult to control for experimentally

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because, for example, in the case of the odour of the owner, they would be specific to each horse. Another explanation for the low response to the towel could be that the odour of the washing powder used was unpleasant to the horses.

8.9.4 Comparison of Trials

The objects presented to the horses in this trial were more effective at eliciting object manipulation and play than those presented in the same test environment in Trial 1. This could have been because they were larger than the dog toys, so the horses were more likely to notice them. It is possible that there is an optimal size for objects that are successful in eliciting object play in horses. As discussed in Trial 1, Hall (1995) found that cats played more with small objects, similar to the size of their natural prey. She also found that as the cats became hungrier they would begin to manipulate larger objects (Hall and Bradshaw 1998). This suggests that the motivation for object play in the domestic cat is associated with predation. In the domestic horse the motivation for object manipulation play may be associated with the exploration of biologically significant changes in their environment, such as food, social opportunities and possible predators. Therefore, the smaller objects presented to the horses in Trial 1 may have been too small to elicit a response.

Alternatively, these objects may have elicited more play than those in Trial 1 because they were objects that horses had actually been reported to play with and so were probably more suitable for study.

8.10 Conclusions

Not all of the objects reported by horse owners to induce object manipulation and play were effective when presented to the horses at the Equine Behaviour Centre. This could be due to the observation environment, or because the substituted objects did not possess the same sensory attributes as those reported to elicit object manipulation and play by horse owners. It is also possible that the owners were reporting behaviour that may not truly be considered object play.

Although no significant sex differences were detected in the levels of object play, there did appear to be a trend for females to exhibit more object play. It is possible that this was due to their different management regimen. Thus it would be interesting

to test how long term stabling affects the propensity of domestic horses to play with objects.

Very low durations of object play were observed during this study. This may have been due to the short testing time of 15 minutes. Leaving the objects for longer periods of time would indicate whether object play continues over a longer period of time and how long it takes for the novelty of each object to fall to a level where it no longer elicits object play. However, it will first be necessary to identify an object(s) that elicits a significant initial interest.

As mentioned previously the observation environment could also be exerting an effect on the levels of object play observed. Testing the horses in their normal stable environment (i.e. the stable that the horse is regularly stabled in, containing the bedding material that the horse is accustomed to) would provide a better indication of how effective an object may be in a more realistic situation. For example, some objects may not be suitable if they become lost in the bedding in the stable.

More object manipulation and play was observed in this trial, than in Trial 1, suggesting that it was more likely that the objects presented in Trial 1 were simply not successful at eliciting object manipulation and play.

The paper sack appeared to elicit the most object play. Further experiments would be necessary to determine which of the sensory attributes, i.e. the type of material, including the audibility and the shape, makes this object attractive to the horses.

9. Do Domestic Horses Show Preferences to Materials in the Exhibition of Object Play?

Two trials were conducted to determine whether domestic horses show preferences for the materials from which objects are constructed. The first of these (Trial 3) studied a group of adult horses and consisted of one replicate. Object play was only observed twice during this trial and the levels of object manipulation observed were low. Therefore, a second trial was conducted (Trial 4) that consisted of two replicates and studied a group of mainly juvenile horses.

Do Adult Horses Show Material Preferences in the Exhibition of Object Play?

Trial 3

9.1 Introduction and Aim

The paper sack appeared to be the most effective object at eliciting object play in Trial 2 (Section 8). Therefore, this study attempted to determine which sensory characteristics of this object made it effective.

The aim of this trial was:

1. To test sacks constructed of various materials in order to determine whether the texture and the audibility of an object affected the exhibition of object play by adult domestic horses.

9.2 Methods

9.2.1 Subjects

The trial group contained twelve adult horses at Sparsholt College. Some information about the subjects is given in Table 9.1. The weekly management programme was that on weekdays the horses were stabled for 22 hours and exercised for the other two hours. While stabled the horses were fed hay or haylage and a concentrate feed twice daily. At the weekend the horses were turned out to pasture for 24 hours each day.

Table 9.1 Age, sex and breed of the subjects in Trial 3

Horse No.	Horse Name	Sex	Age	Breed
1	**Charm**	Gelding	13	Cob
2	**Archie**	Gelding	13	Trakhener
3	**Kleeb**	Gelding	18	Anglo-Arab
4	**Limmie**	Gelding	16	Irish Cob
5	**Bovver**	Gelding	10	Thoroughbred
6	**Clyde**	Gelding	6	Clydesdale
7	**Mindy**	Mare	19	Thoroughbred x Warmblood
8	**Tilly**	Mare	19	Cleveland Bay
9	**Bess**	Mare	12	Cob
10	**Megan**	Mare	6	Thoroughbred
11	**Whorley**	Mare	11	Irish Thoroughbred
12	**Flossie**	Mare	11	Dutch Warmblood

9.2.2 Objects

The sacks were constructed in the same way as the paper sack in the previous study (Section 8) and presented as a three-dimensional object.

Table 9.2 The sensory characteristics of the sacks

Material	Texture	Audibility
Brown parcel paper	Smooth	Noisy
Anaglypta (textured)	Bumpy	Quiet
Anaglypta (smooth)	Smooth	Quiet
Cotton	Smooth	Quiet
Bubble wrap (textured)	Bumpy	Noisy
Bubble wrap (smooth)	Smooth	Noisy

As this group of horses was different from that in the previous study (Section 8) the paper sack (brown parcel paper) was also included so that the levels of object manipulation could be compared between the two groups.

The dimensions of the paper, anaglypta and bubble wrap sacks were 100cm×70cm when flat. The dimensions of the pillowcase were 70cmx50cm. Figures 9.1 and 9.2 show the textured surface of the sacks constructed from anaglypta and bubble wrap.

Figure 9.1 The texture of the anaglypta

Figure 9.2 The texture of the bubble wrap.

9.2.3 Observations

Observations took place in a large demonstration stable (see Figure 9.3), which contained bedding (rubber matting and wood shavings) and one water bucket. All food was removed. All the observations took place on weekdays, beginning at 14.00hours and ending at 17.00 hours. The horses were given their evening feed after all the observations were completed.

During observations each horse was led into the stable and left for two minutes to allow time for exploration of the stable. The object was placed in the centre of the stable and the horses' responses filmed for five minutes using a hand held Hi8 format video camera. The length of the observations was reduced from 15 minutes in Trial 1 (Section

7), to five minutes in this study because in Trial 1 most interactions with the objects occurred in the first five minutes of the observation period.

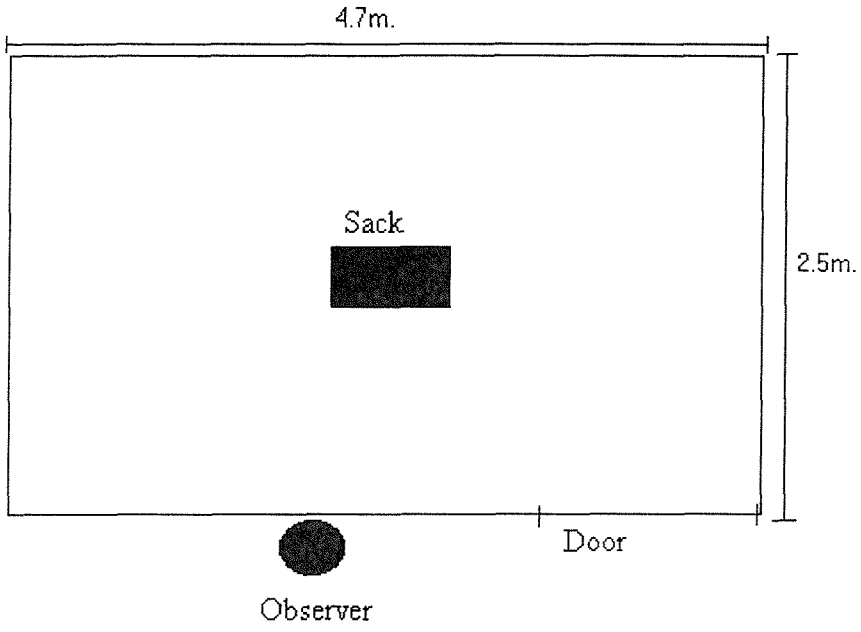

Figure 9.3 The observation stable

Each horse was observed once on each study day with at least one rest day between test days. The horses were observed in a random order on each study day (see Table 9.3) and the order in which each object was presented was also random (see Table 9.4).

Table 9.3 The order in which the horses were observed on each study day

Day 1.	1	2	3	4	5	6	7	8	9	10	11	12
Day 2.	6	10	12	9	2	8	1	4	3	7	5	11
Day 3.	8	6	11	7	3	1	5	12	2	4	10	9
Day 4.	11	5	4	2	1	9	6	10	7	12	8	3
Day 5.	9	7	2	10	6	4	11	5	12	8	3	1
Day 6.	4	1	10	5	9	11	2	7	6	3	12	8

Table 9.4 The order in which the objects were presented to each horse

Horse	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6
Charm	Paper	BWB	BWS	ANB	ANS	Cotton
Archie	Cotton	BWS	BWB	ANS	Paper	ANB
Kleeb	ANS	Cotton	Paper	BWB	ANB	BWS
Limmie	ANB	Cotton	BWB	Paper	ANS	BWS
Bovver	Cotton	ANB	Paper	BWS	BWB	ANS
Clyde	ANB	Paper	ANS	BWB	BWS	Cotton
Mindy	BWB	Paper	ANB	ANS	Cotton	BWS
Tilly	ANS	BWB	Cotton	ANB	BWS	Paper
Bess	Paper	ANB	BWS	Cotton	ANS	BWB
Megan	BWS	ANS	Cotton	Paper	BWB	ANB
Whorley	BWB	ANS	ANB	Cotton	BWS	Paper
Flossie	BWS	ANB	BWB	ANS	Cotton	Paper

Abbreviations: Paper = brown paper Cotton = cotton pillowcase
ANS = smooth anaglypta ANB = bumpy anaglypta
BWS = smooth bubble wrap BWB = bumpy bubble wrap

9.2.4 Data Recording

The Hi8 tapes were transferred to VHS format for viewing. The videotapes were observed using scan sampling and the duration of the object manipulation behaviours in the ethogram described in Table 4.3 were timed using a stopwatch and recorded on check sheets.

9.2.5 Statistical Analysis

All analyses were performed using SPSS v.9. As the data did not follow a normal distribution non-parametric statistical tests were used. The tests used were Kruskal-Wallis, Friedman, Mann-Whitney and Spearman Rank correlation. Details of these analyses are given in Section 4.2.5.

In all the box-plots presented in this section outlying values (those cases with values between 1.5 and three box lengths from the upper or lower edge of the box, where the box length is the interquartile range) are labelled with a circle (O) and extreme values (those cases with values more than three box lengths from the upper or lower edge of the box, where the box length is the interquartile range) are labelled with an asterisk (*).The interquartile range contains 50% of the recorded values. The whisker lines that extend from each box are drawn between the highest and lowest values, excluding outliers. The thick black line across the box indicates the median. The "N" value on the x-axis indicates the number of cases in each plot.

9.3 Results

9.3.1 Object Play

Object play was only observed twice during this study (see Section 8.8.1 for the behaviour patterns included as object play). Charm licked the textured anaglypta sack once in one observation period for a total of 10.44 seconds. Kleeb pawed at the textured bubble wrap sack once in one observation period for a total of 1 second. Due to the low durations of object play observed it was not statistically analysed.

9.3.2 Object Manipulation

On average, object manipulation accounted for 1.06(SD1.93)% of each observation (see Section 8.8.1 for the behaviour patterns included as object manipulation).
Friedman analysis detected no significant difference (X^2=7.18, *df*=5, NS) in the duration of object manipulation between the six sacks (see Figure 9.4).

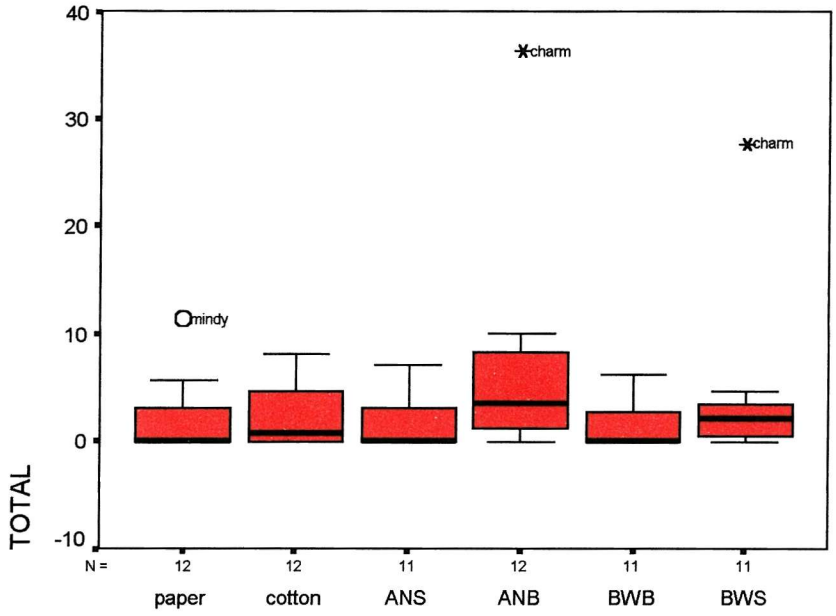

Figure 9.4 Box-plot illustrating the duration of object manipulation (TOTAL), in seconds, displayed toward each sack (see Table 9.4 for abbreviations) Outlying values are labelled with the identity of the horse

Kruskal–Wallis analysis detected a significant difference in the duration of object manipulation displayed between individual horses (X^2=21.43, *df*=11, 0.01<P>0.05) (see Figure 9.5).

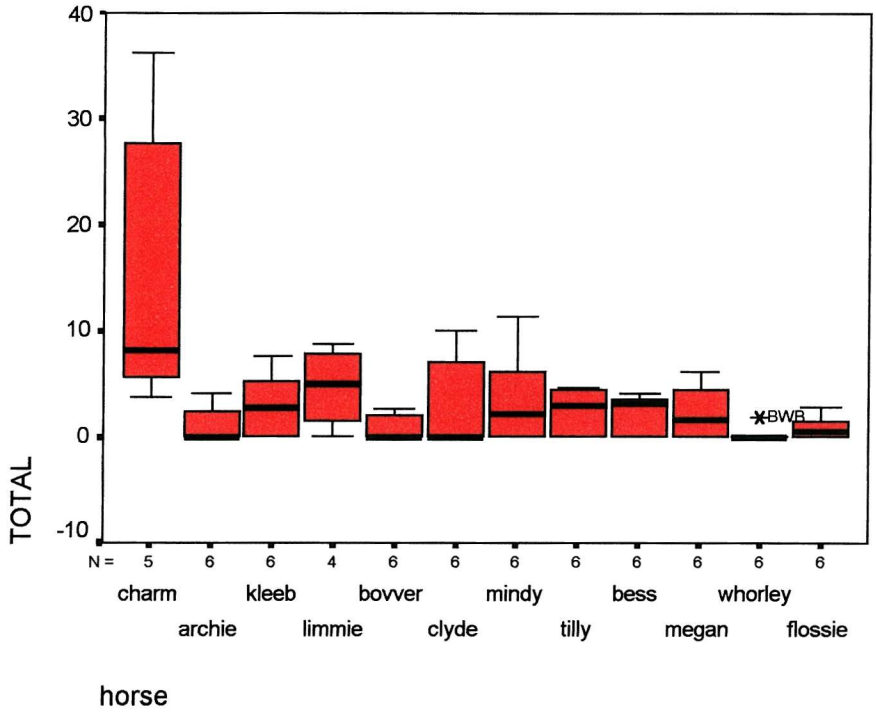

Figure 9.5 Box-plot illustrating the duration of object manipulation (TOTAL), in seconds, displayed by each horse. Outlying values are labelled with the identity of the sack

Mann–Whitney analysis did not detect any significant difference in the duration of object manipulation between males and females (Z=-0.84, NS), and there was no significant correlation between the amount of object manipulation exhibited and the age of the horse (Spearmans rho=0.24, NS).

A study by Lindberg A.C. *et al* (1999) of observational learning found that non-warmblood type horses investigated the task object more than warmblood type horses. To test whether this effect occurred in this population of horses the horses were categorised as either warmblood type (Archie, Kleeb, Bovver, Mindy, Tilly, Megan, Whorley and Flossie) or non-warmblood type (Charm, Limmie, Clyde and Bess). Mann-Whitney analysis showed that the non-warmblood type horses exhibited significantly more object manipulation than the warmblood type horses (Z=-2.214, P<0.05), as shown in Figure 9.6.

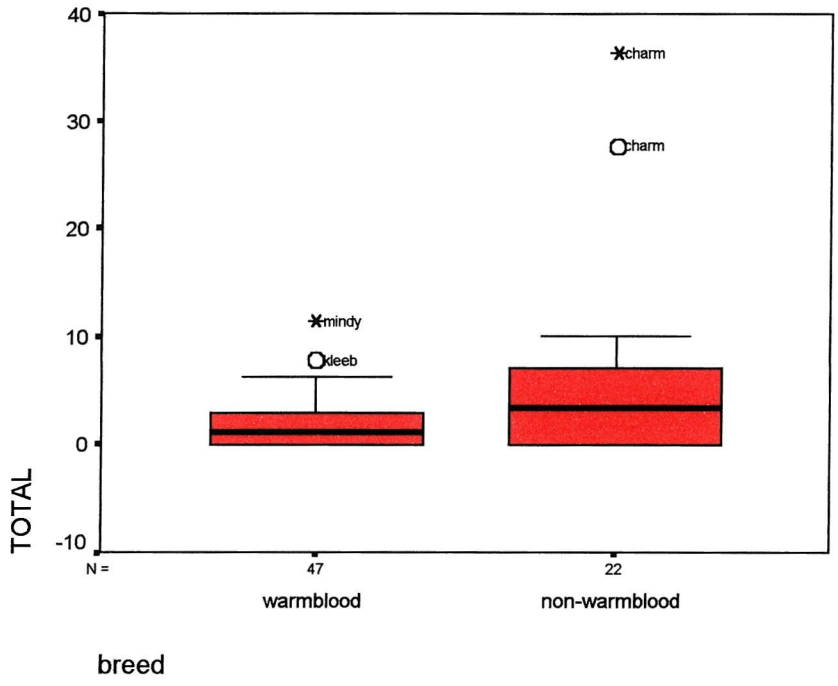

Figure 9.6 Box-plot illustrating the total duration of object manipulation (TOTAL), in seconds, exhibited by warmblood type horses and non-warmblood type horses. Outlying values are labelled with the identity of the horse

9.3.3 Comparison of Trials

The sack constructed of brown paper was used in this trial because the horses in Trial 2 (Section 8) displayed a considerable amount of object play toward it, compared with the other objects. In this trial no object play was displayed toward the paper sack and levels of object manipulation towards it were not significantly different from those for the other objects. The duration of all object manipulation displayed toward the paper sack during each trial were compared using Mann–Whitney analysis. This analysis detected a significant difference between the two trials ($Z=-3.28$, $P<0.01$) (see Figure 9.7). The observations in Trial 2 were 15 minutes in length, compared to the five minute observations in Trial 3. However, as has been mentioned previously interactions with the objects in Trial 2 were recorded only in the first five minutes of the observations.

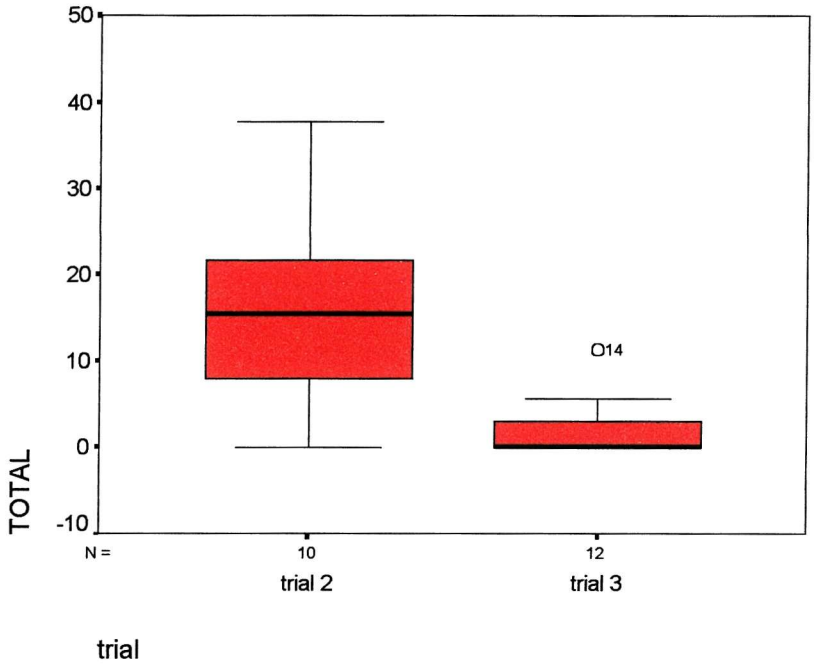

Figure 9.7 Box-plot illustrating the total duration of object manipulation (TOTAL), in seconds, displayed toward the paper sack in Trial 2 and Trial 3

9.4 Discussion

9.4.1 Object Manipulation

The duration of object manipulation did not differ between the different materials used to construct the sacks. This may suggest that the texture and/or audibility of the materials used to construct the objects did not affect the propensity of adult horses to manipulate these objects. The duration of object manipulation was different between individuals. This was not due to the sex or the age of the horses. However, all the horses studied were adults and were of similar ages. The individual differences detected may have been due to the type or breed of the horses, as non-warmblood type horses appeared to exhibit more object manipulation than warmblood type horses. This finding concurs with that of Lindberg A.C. *et al* (1999). Individual differences may also have occurred due to the tendency of different individuals to manipulate objects.

9.4.2 Comparison with the Previous Trial – Age Effects

The horses used in this trial displayed a significantly lower response to the paper sack, compared with those in Trial 2. This may be an effect of maturity as all the horses used in this trial were adults, whereas the majority of the horses in Trial 2 were juvenile. Play is considered to be primarily a juvenile behaviour (Fagen 1976), which may explain the higher levels of object manipulation and play toward the paper sack by the juvenile horses in Trial 2. The older horses are also likely to have more experience of novel objects and environments and so may not be motivated to explore as much as the less experienced juvenile horses. They may also habituate more quickly to novel surroundings and objects.

9.4.3 Comparison with the Previous Trial – Management Effects

The female horses observed in Trial 2 (Section 8) were stabled for 22 hours per day for four weeks prior to the study and during the study they displayed more object manipulation than the male horses at the same establishment that were at pasture before and during the trial. It was suggested in Section 8 that the increase in the levels of object manipulation seen in the females could have been due to short term prolonged stabling. The horses used in these trials were stabled for 22 hours per day during the college term time. However, these horses displayed less object manipulation toward the paper sack than those in Trial 2. This suggests that long term prolonged stabling does not increase the propensity of horses to manipulate or play with objects. The lower duration of object manipulation and play in the current trial may have been because these horses have already established ways of coping with any frustration or "boredom" associated with long term prolonged stabling and these are often difficult to break (Owen 1982). None of the horses studied in this trial exhibited stereotypies such as weaving, crib-biting or box walking (McGreevy 1997). However, if environmental exploration is prevented by a monotonous environment, animals may also display apathy and inactivity (Wood-Gush and Vestergaard 1989), referred to as "star gazing" in horses (Luescher *et al* 1991). This may partly explain the lack of investigatory behaviours displayed by the horses observed in this trial. Another explanation for the lower levels of object manipulation and play could be that the busy yard in which the horses were observed during this trial provided distractions for the horses. This may have led to less object manipulation and play being exhibited.

9.4.4 Comparison with Previous Trial – Empty Stable vs. Stable with Bedding

In Trials 1 and 2 the horses were observed in a stable with no bedding or food. In this trial the stable was larger and contained wood shavings for bedding. The horses in this trial could also look out of the stable over the stable door, which the horses in Trials 1 and 2 could not. Therefore, the horses in the current trial had a more diverse environment than those in Trials 1 and 2. It was suggested in Section 8 that the welfare of the horses in the barren environment might have been sufficiently sub-optimal to reduce play, but they showed more play than those observed in the more enriched stable. It may be that the horses in this trial were more interested in their surroundings than in the objects. However, this environment is a better simulation of a normal stable environment in which owners would use toys and a successful object would need to elicit and sustain object manipulation and play in these conditions.

9.5 Conclusions

The results of this trial show that in this group of adult domestic horses none of the materials tested consistently stimulated object manipulation or play. This may have been due to the more diverse environment in which the trial took place, or that the objects used in the trials were not effective at eliciting object manipulation and play.

Several explanations have been suggested for the reduced interest in the paper sack in this study, when compared with Trial 2. It is likely that this difference is because this trial observed adult horses, whereas Trial 2 observed juvenile horses. Juveniles are reported to investigate their surroundings and objects more (Lindberg A.C. *et al* 1999) and play more (Fagen 1976) than adults. Therefore, it would be necessary to repeat this study with a group of juvenile horses.

Do Juvenile Horses Show Preferences to Materials in the Exhibition of Object Play?

Trial 4

9.6 Introduction and Aims

As the adult horses at Sparsholt College displayed a significantly lower response to the paper sack than the juvenile horses at the Equine Behaviour Centre (see Trial 2, Section 8), Trial 3 was repeated using the mainly juvenile group at the Equine Behaviour Centre. The Sparsholt horses were all over six years old and the majority of the Equine Behaviour Centre horses were under four years old. Therefore, the differences in response may have been due to the age differences of the horses.

The aims of this study were

1. To compare the response of the Sparsholt horses and those of the Equine Behaviour Centre horses to the sacks constructed of different materials, in an attempt to determine whether age could be a factor in the level of object play displayed by domestic horses.
2. To determine whether the horses' responses to the objects were affected by the material from which the objects were constructed

9.7 Methods

9.7.1 Subjects

The horses observed were April, Indie, Talia, Belle, Krystal and Kato. The details of the subjects can be found in Table 8.1. April (20 years old) and Belle (five years old) were adults. The remaining horses were juveniles (under four years old).

9.7.2 Observation Environment

It is possible that the barren stable, used as the observation environment in Trial 1 and Trial 2, may have been sub-optimal for play to occur, therefore, a different observation environment was used. Part of the barn in which the horses were stabled was fenced off to create a "liberty area" which was 4m x 7m in size (see Figure 9.8). This was larger than the stable and so the horses had more opportunity to move about. During observations no other work was conducted in the barn, limiting additional distractions to the horses.

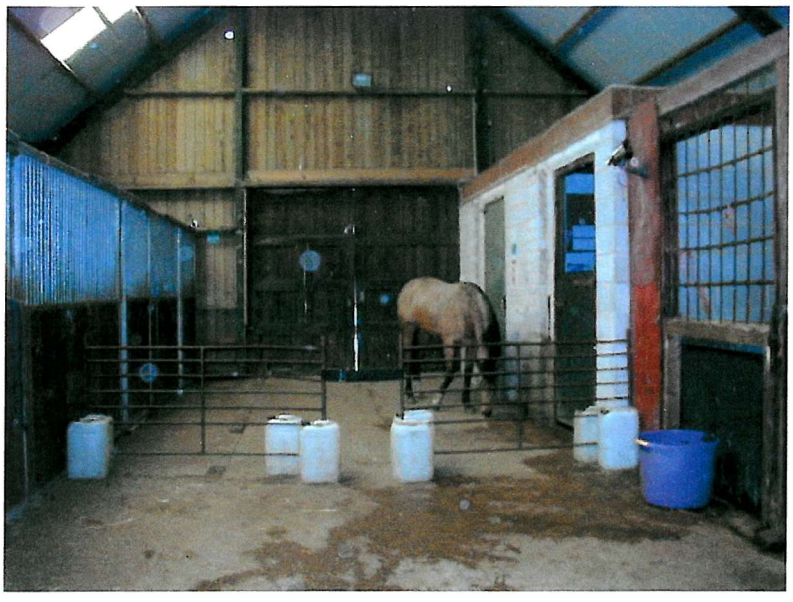

Figure 9.8 The "Liberty area"

9.7.3 Observations

The observations were conducted as described in Section 9.2.3, with each observation lasting for five minutes. Two replicates were completed in order to investigate replicate effects, reliability, learning and habituation effects. The order in which the horses were observed and the order in which the objects were presented in Replicate 1 and Replicate 2 was randomized and are described in Tables 9.5, 9.6, 9.7 and 9.8.

Table 9.5 Horse order for each day of Replicate 1

Day 1	April	Talia	Belle	Indie	Krystal	Kato
Day 2	Belle	Krystal	Indie	Talia	Kato	April
Day 3	Indie	Kato	Talia	Belle	April	Krystal
Day 4	Krystal	April	Kato	Indie	Belle	Talia
Day 5	Talia	Indie	Krystal	Kato	April	Belle
Day 6	Kato	Talia	April	Krystal	Belle	Indie

Table 9.6 Horse order for each day of Replicate 2

Day 1	Krystal	Kato	Belle	Indie	April	Talia
Day 2	April	Indie	Talia	Belle	Krystal	Kato
Day 3	Kato	Talia	Krystal	April	Belle	Indie
Day 4	Belle	Krystal	Indie	Kato	Talia	April
Day 5	Indie	Belle	April	Talia	Kato	Krystal
Day 6	Talia	April	Kato	Krystal	Indie	Belle

Table 9.7 Order of object presentation for each horse in Replicate 1 (see Table 9.4 for abbreviations)

	Day 1	**Day 2**	**Day 3**	**Day 4**	**Day 5**	**Day 6**
April	Paper	Pillow	BWB	BWS	ANB	ANS
Talia	Pillow	Paper	ANB	ANS	BWS	BWB
Belle	BWB	ANS	BWS	Paper	ANB	Pillow
Indie	BWS	BWB	Pillow	ANS	Paper	ANB
Krystal	ANB	BWS	ANS	Pillow	BWB	Paper
Kato	ANS	ANB	Paper	BWB	BWS	Pillow

Table 9.8 Order of object presentation for each horse in Replicate 2 (see Table 9.4 for abbreviations)

	Day 1	**Day 2**	**Day 3**	**Day 4**	**Day 5**	**Day 6**
April	ANB	ANS	BWB	BWS	Paper	Pillow
Talia	Paper	BWS	Pillow	BWB	ANB	ANS
Belle	ANS	Pillow	ANB	Paper	BWB	BWS
Indie	BWB	ANB	BWS	ANS	Pillow	Paper
Krystal	BWS	BWB	Paper	Pillow	ANS	ANB
Kato	Pillow	Paper	ANS	ANB	BWS	BWB

9.7.4 Data Recording

The Hi8 tapes were transferred to VHS format for viewing. The videotapes were observed using continuous sampling and the duration of the object manipulation

behaviours in the ethogram described in Table 4.3 were timed using a stopwatch and recorded on check sheets.

9.7.5 Statistical Analysis

All statistical analyses were conducted using SPSS v.9. The non-parametric tests used were: Kruskal-Wallis, Friedman, Wilcoxon signed ranks, Mann-Whitney and Spearman Rank correlation. Details of these tests can be found in Section 4.2.5.

In all the box-plots presented in this section outlying values (those cases with values between 1.5 and three box lengths from the upper or lower edge of the box, where the box length is the interquartile range) are labelled with a circle (O) and extreme values (those cases with values more than three box lengths from the upper or lower edge of the box, where the box length is the interquartile range) are labelled with an asterisk (*).The interquartile range contains 50% of the recorded values. The whisker lines that extend from each box are drawn between the highest and lowest values, excluding outliers. The thick black line across the box indicates the median. The "N" value on the x-axis indicates the number of cases in each plot.

9.8 Results

9.8.1 Object Play

All of the horses except April exhibited object play. Object play accounted for 3.85(SD8.31)% of observation time in Replicate 1 and 0.97(SD2.17)% in Replicate 2. Wilcoxon analysis detected significantly greater durations of object play in Replicate 1 than Replicate 2 ($Z=-2.43$, $P<0.05$) (see Figure 9.9).

Friedman analysis detected no significant difference in the durations of object play directed towards each object (Replicate 1: $X^2=2.26$, $df=5$, NS. Replicate 2: $X^2=4.35$, $df=5$, NS) (see Figures 9.10 and 9.11).

Kruskal-Wallis detected significant individual differences between horses in the durations of object play they exhibited toward the objects (Replicate 1: X^2=20.98, *df*=5, P<0.01. Replicate 2: X^2=21.84, *df*=5, P<0.01) (see Figures 9.12 and 9.13).

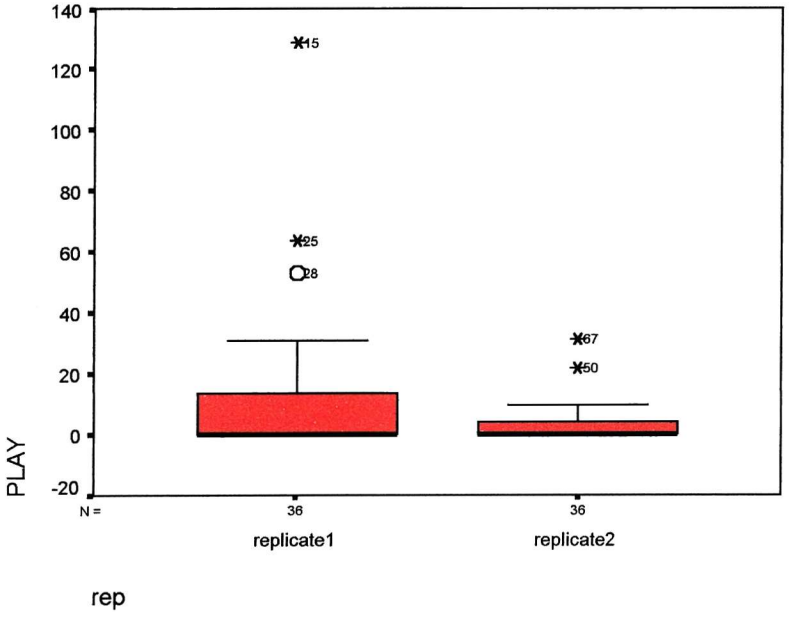

Figure 9.9 Box-plot illustrating the difference in the duration, in seconds, of object play (PLAY) displayed in Replicate 1 and Replicate 2

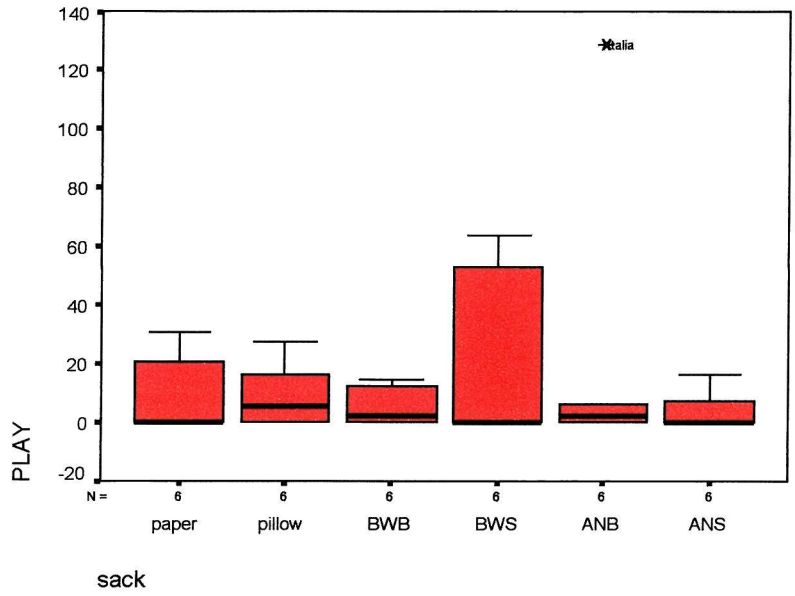

Figure 9.10 Box-plot illustrating the duration, in seconds, of object play (PLAY) directed toward each sack in Replicate 1. Outlying values are labelled with the identity of the horse (see Table 9.4 for abbreviations)

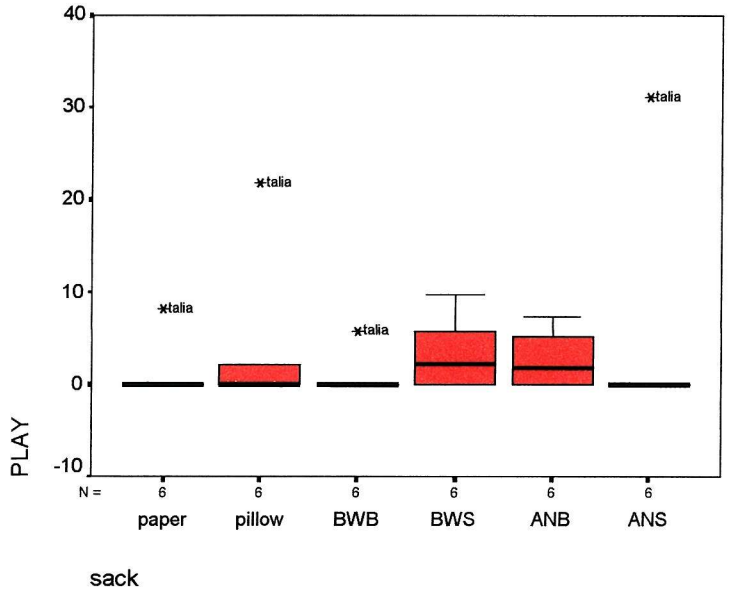

Figure 9.11 Box-plot illustrating the duration, in seconds, of object play (PLAY) directed toward each sack in Replicate 2. Outlying values are labelled with the identity of the horse (see Table 9.4 for abbreviations)

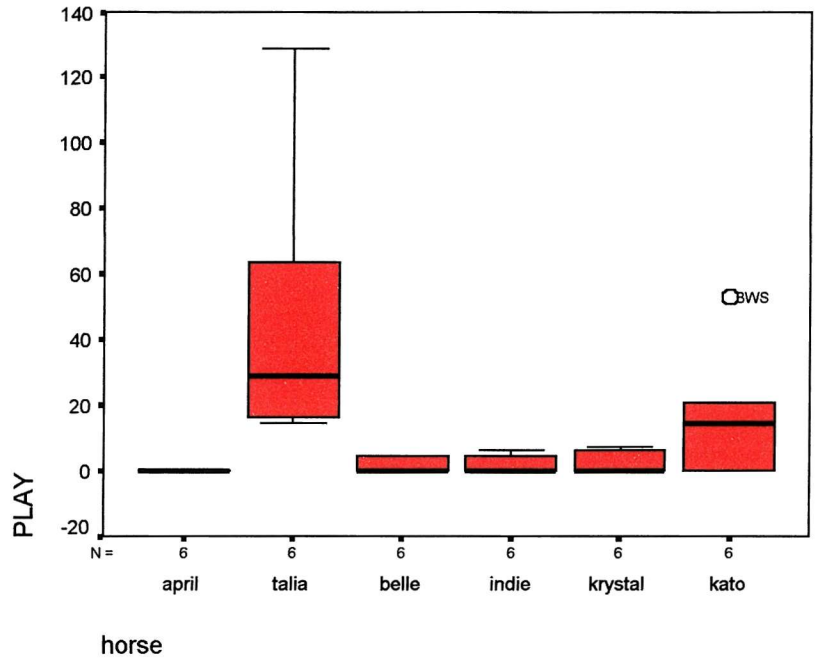

Figure 9.12 Box-plot illustrating the duration, in seconds, of object play (PLAY) exhibited by each horse in Replicate 1. Outlying values are labelled with the identity of the object (see Table 9.4 for abbreviations)

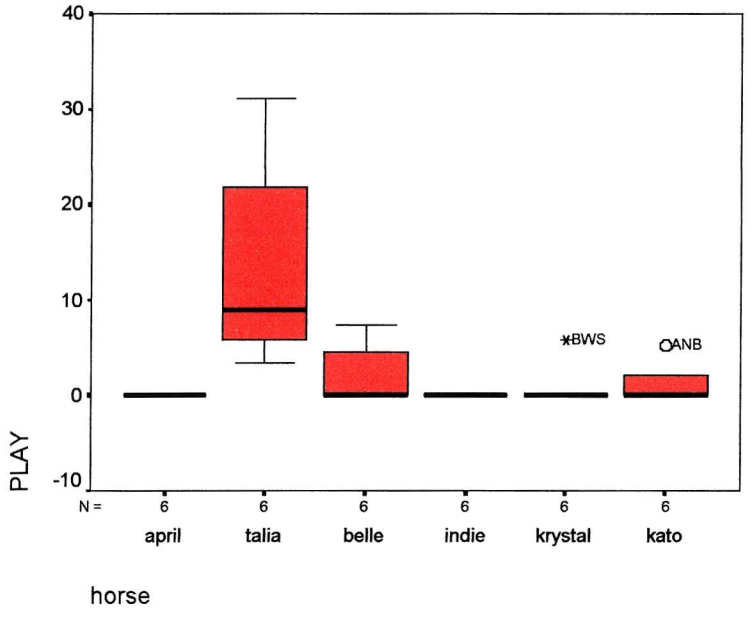

Figure 9.13 Box-plot illustrating the duration, in seconds, of object play (PLAY) exhibited by each horse in Replicate 2. Outlying values are labelled with the identity of the object (see Table 9.4 for abbreviations)

9.8.2 Object Manipulation

Object manipulation accounted for an average of 7.23(SD10.02)% of observation time in Replicate 1 and 3.49(SD3.66)% in Replicate 2. Wilcoxon analysis detected significantly greater durations of object manipulation in Replicate 1 than Replicate 2 ($Z=-2.79$, $P<0.01$) (see Figure 9.14).

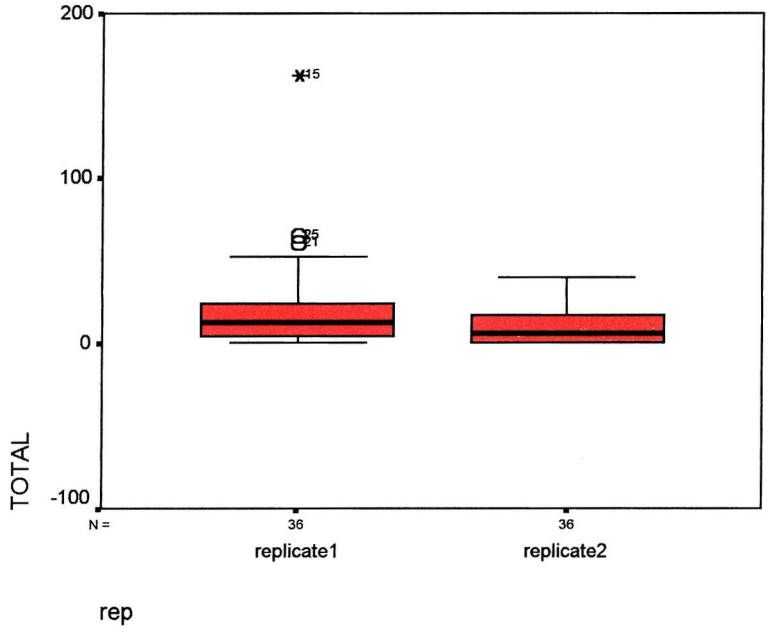

Figure 9.14 Box-plot illustrating the duration, in seconds, of object manipulation (TOTAL) displayed in Replicate 1 and Replicate 2

Friedman analysis detected no significant difference in the durations of object manipulation exhibited toward each object in Replicate 1 ($X^2=1.88$, *df*=5, NS) or Replicate 2 ($X^2=8.26$, *df*=5, NS) (see Figures 9.15 and 9.16).

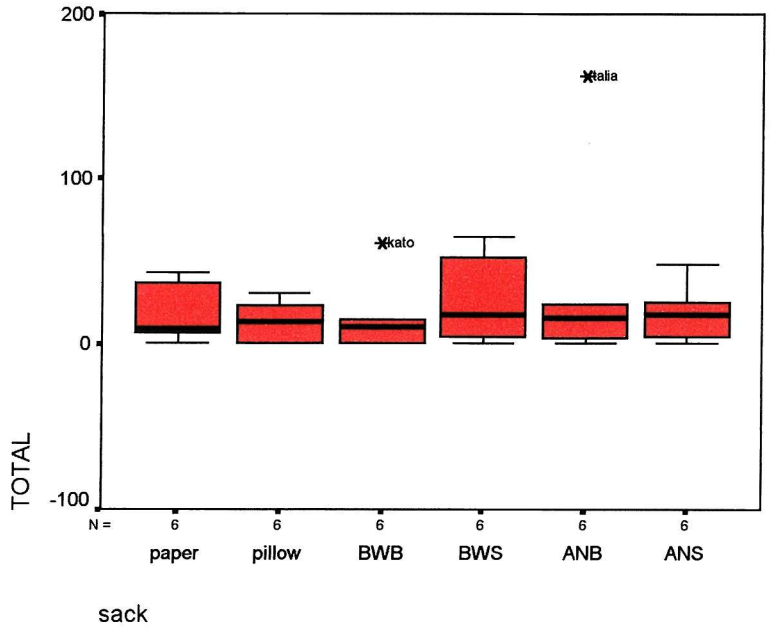

Figure 9.15 Box-plot illustrating the duration, in seconds, of object manipulation (TOTAL) exhibited toward each sack in Replicate 1. Outlying values are labelled with the identity of the horse (see Table 9.4 for abbreviations)

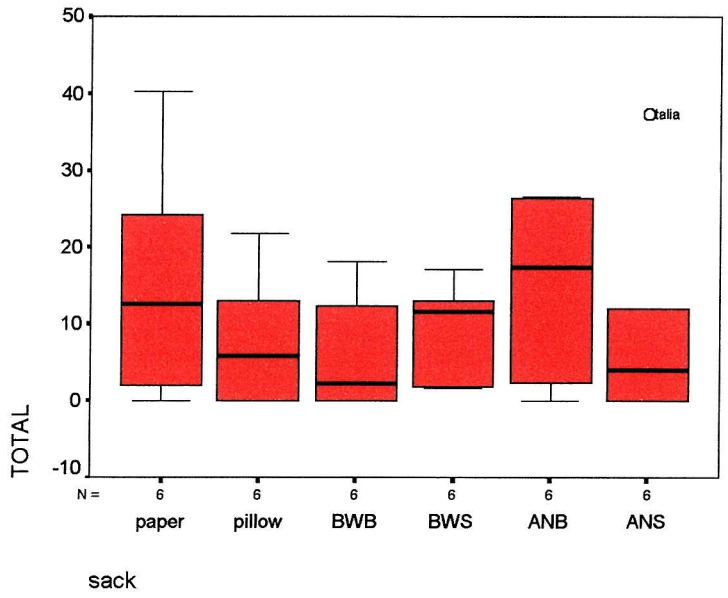

Figure 9.16 Box-plot illustrating the duration, in seconds, of object manipulation (TOTAL) exhibited toward each sack in Replicate 2. Outlying values are labelled with the identity of the horse (see Table 9.4 for abbreviations)

Kruskal-Wallis analysis detected significant individual differences in the durations of object manipulation exhibited by each horse in Replicate 1 (X^2=21.19, *df*=5, P<0.01) and Replicate 2 (X^2=18.98, *df*=5, P<0.01) (see Figures 9.17 and 9.18).

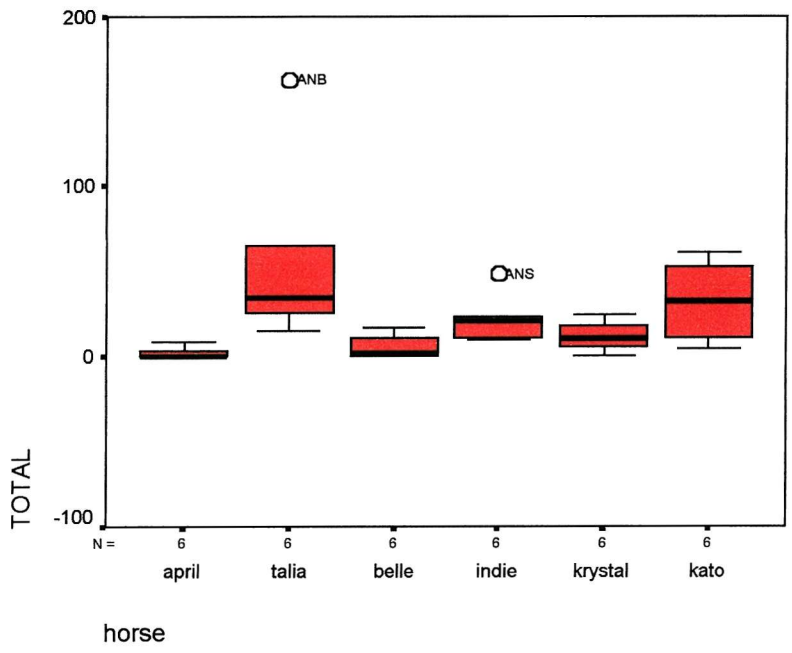

Figure 9.17 Box-plot illustrating the duration, in seconds, of total object manipulation (TOTAL) exhibited by each horse in Replicate 1. Outlying values are labelled with the identity of the object (see Table 9.4 for abbreviations)

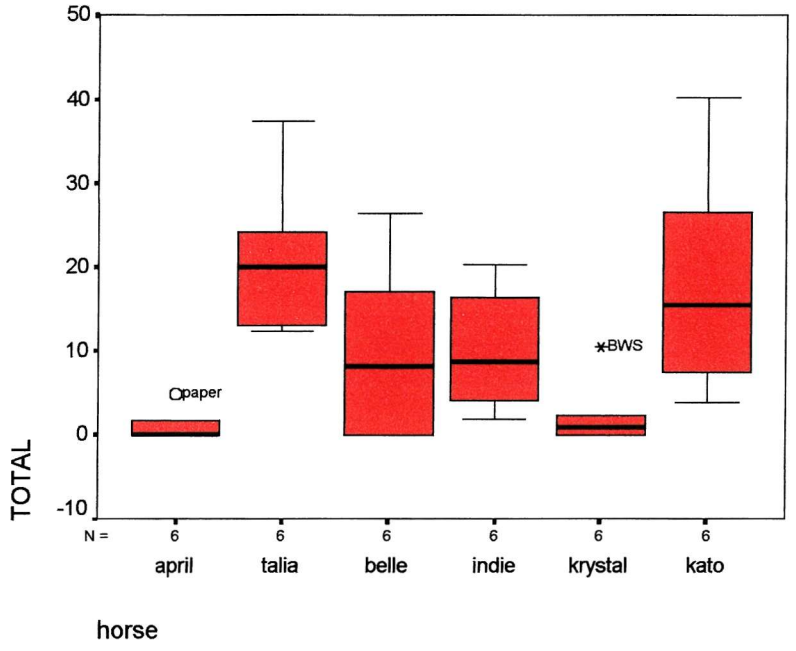

Figure 9.18 Box-plot illustrating the duration, in seconds, of total object manipulation (TOTAL) exhibited by each horse in Replicate 2. Outlying values are labelled with the identity of the object (see Table 9.4 for abbreviations)

9.8.3 Age Effects

Non-parametric correlations showed that the younger horses exhibited longer durations of object manipulation and object play than the older horses (Object manipulation: Spearman's rho = -0.519, $P<0.01$; Object play: Spearman's rho = -0.555, $P<0.01$).

9.8.4 Effects of Material and Texture

Wilcoxon signed rank tests detected no significant differences between the durations of object manipulation and object play displayed toward anaglypta and bubble wrap (Object manipulation: $Z=-1.42$, $P>0.05$, Object play: $Z=-0.30$, NS), or toward smooth material and bumpy material (Object manipulation: $Z=-0.24$, NS, Object play: $Z=-0.42$, NS).

9.8.5 Comparison of Trials

Mann-Whitney analysis detected a significant difference in the duration of object play ($Z=-5.41$, $P<0.001$) and manipulation ($Z=-4.9$, $P<0.001$) between this trial (Trial 4) and Trial 3. This is illustrated in Figures 9.19 and 9.20.

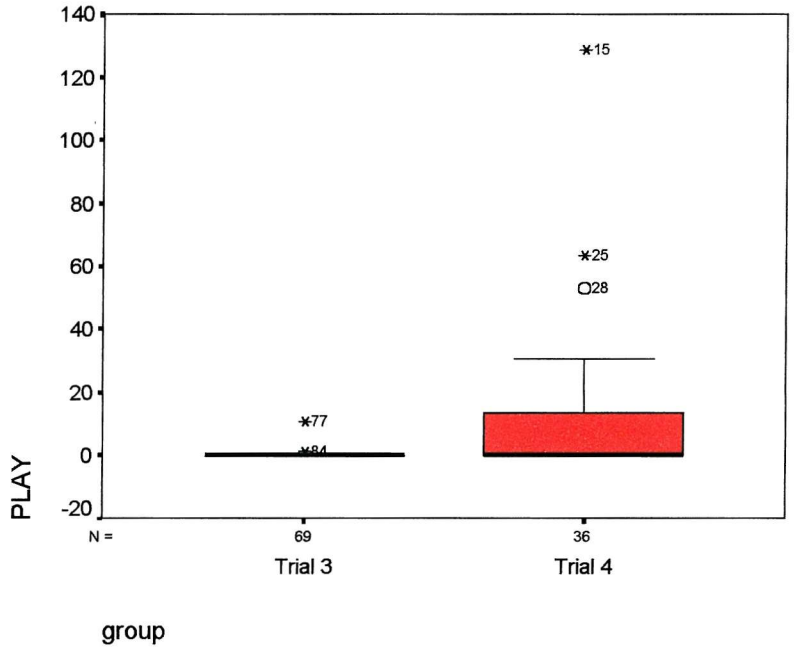

Figure 9.19 Box-plot illustrating the difference in the duration, in seconds, of object play (PLAY) exhibited during Trial 3 and Trial 4

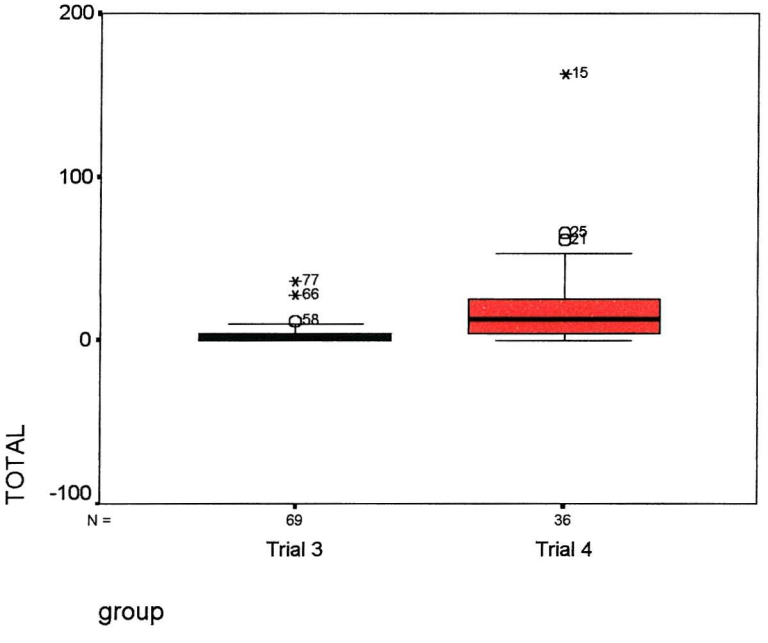

Figure 9.20 Box-plot illustrating the difference in the duration, in seconds, of total object manipulation (TOTAL) exhibited during Trial 3 and Trial 4

9.9 Discussion

9.9.1 Effectiveness of the Objects

All the materials and textures were manipulated at some time during the trial. Although none of the materials or textures elicited more object play or manipulation than the others, there were significant individual differences between the duration of object play and manipulation exhibited by the horses. This may be due to individual preferences and differences in their tendency to investigate objects.

9.9.2 Comparison of Trials

The level of object play and manipulation was significantly greater in Trial 4, in which four of the subjects were juveniles, than in Trial 3, in which the subjects were all adults. This may, therefore, be due in part to the difference in the age of the horses studied. Lindberg A.C. *et al* (1999) observed that juvenile horses investigated objects more than adults and this agrees with the results of this trial. However, the test conditions were slightly different. In Trial 3 the horses were introduced to the sacks in a stable and in Trial 4 the horses were introduced to the sacks in the liberty area. The liberty area may have been a less aversive environment for the horses because it was larger than the stables, giving the horses more opportunity to move. This may be why more object manipulation and object play were observed. Conclusions drawn from the results of Trial 3 may prove unreliable as it consisted of only one replicate, but this trial was discontinued because so little play was recorded. However, the results for the replicates in Trial 4 were consistent.

9.9.3 Habituation Effects

Significantly greater levels of object manipulation and object play were observed in the first replicate than the second replicate of this trial. This suggests that habituation to these objects has occurred. Habituation to an object occurs when the stimulus value of the object is no longer great enough to elicit a response. Although habituation to the objects may seem to have occurred quickly, it is in accordance with the findings of Hall (1995) who reported that domestic cats habituated to an object within three, three minute sessions of exposure. Therefore, novelty may be an important characteristic for an object that is successful in eliciting object manipulation and play in the domestic horse.

An object could be made novel by changing one of the sensory characteristics. However, it would first be necessary to determine which sensory characteristics are important in eliciting object play in domestic horses. It is likely that such sensory characteristics would be those with biological relevance to domestic horses. If these stimuli have a large enough biological relevance they may even prevent habituation to an object. Rapid habituation to an object could also suggest that the object does not have a high stimulus value.

9.10 Conclusion

None of the textures or materials elicited more object manipulation or play than the others. So a further range of objects varying in shape and audibility need to be presented to horses, using the same methods.

As horses mature they appear to manipulate and play with objects less frequently. Therefore, in further studies it would seem to be more appropriate to study juvenile horses in order to investigate sensory characteristics stimulating object play behaviour.

Habituation to the objects appeared to occur in the second replicate of this trial, suggesting that the objects tested in this trial do not possess a high stimulus value to this group of domestic horses.

10. The Effect of the Presentation of Objects on Object Manipulation and Play

The aim of these two trials was to establish how the presentation of objects affected the duration of object manipulation displayed towards them. Objects were therefore presented either on the ground, as in the previous trials (Sections 7, 8 and 9), or suspended from the wall of the liberty area.

During the first trial in this section (Trial 5) it was observed that the majority of the horses did not interact with the objects that were presented suspended from the wall of the liberty area. Therefore, the second trial of this section (Trial 6) investigated the effects of re-positioning these objects to a location in the liberty area in which the horses spent more time.

Trial 5

10.1 Introduction and Aims

As it was not possible to establish that any of the individual materials or textures were more successful than the others at eliciting object play in the previous studies (Sections 7, 8 and 9), a further series of objects that represented a different variety of sensory stimuli was presented to the horses at the Equine Behaviour Centre, in order to observe their effectiveness in eliciting object play in domestic horses.

It had been observed that horses at the Equine Behaviour Centre, at a private livery yard and during the foal studies, manipulated lead-ropes and other objects that were hanging inside and outside their stables (personal observations). It may be, therefore, that the position in which the object is presented is important in eliciting object manipulation and play in domestic horses.

The aims of this trial were:

1. To determine which sensory stimuli caused the horses to manipulate lead-ropes hanging in their stables.
2. To determine whether the horses manipulated the lead-ropes because they were hanging up and not placed on the ground, which is where the objects had been presented in the previous trials.

10.2 Methods

10.2.1 Objects

In order to test whether horses would be interested in manipulating objects that were hanging and constructed from rope, they were presented with red, braided cotton lead-ropes and white plastic chains. These two materials varied in the complexity of their structures, i.e. audibility, colour and odour. It has been demonstrated that braided cotton cord and rubber strips presented hanging vertically with loose ends elicited more object

manipulation than the same materials presented as a loop in pigs (Frazer 1993). Therefore the lead-ropes and chains were presented hanging vertically (with a loose end) or suspended horizontally (with no loose ends).

To test whether horses would be more interested in objects that were suspended above the ground, rather than placed on the ground, rope handles were attached to two objects that were presented on the floor of the liberty area. For safety reasons it was decided not to present lead-ropes and chains on the floor. The decision not to present objects with chain handles was taken in order to limit the number of objects used in the trial, due to time constraints and because the primary aim of the trial was to determine whether horses preferred objects presented on the ground or suspended and not the type of material. Any preference for rope or plastic chain could be detected in differences in the duration of object manipulation and play displayed toward the suspended objects.

Therefore, the objects presented were:

- Two lead-ropes hanging vertically
- Two lead-ropes suspended horizontally
- Two plastic chains hanging vertically
- Two plastic chains suspended horizontally
- A plastic box with two rope handles
- A Jolly Ball with two rope handles

These are shown in Figures 10.1-10.6. The suspended objects were attached to the stable walls using baler twine as a safety precaution. If a horse became tangled in the ropes or the chains the baler twine would break easily, allowing the horse to be freed. The rope handles were also attached to the plastic box and Jolly Ball using baler twine. The Jolly Ball was chosen for use in this trial because it appeared to elicit more object manipulation than the other objects presented in Trial 2 (Section 8). The plastic box was chosen because the horses appeared to show an interest in a plastic box in an unrelated study carried out at the Equine Research Centre.

Figure 10.1 Jolly Ball with rope handles

Figure 10.2 Plastic box with rope handles

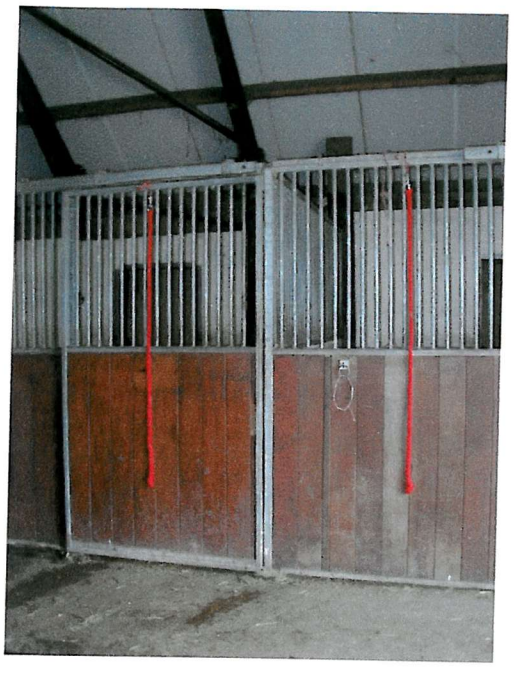

Figure 10.3 Lead-ropes hanging vertically

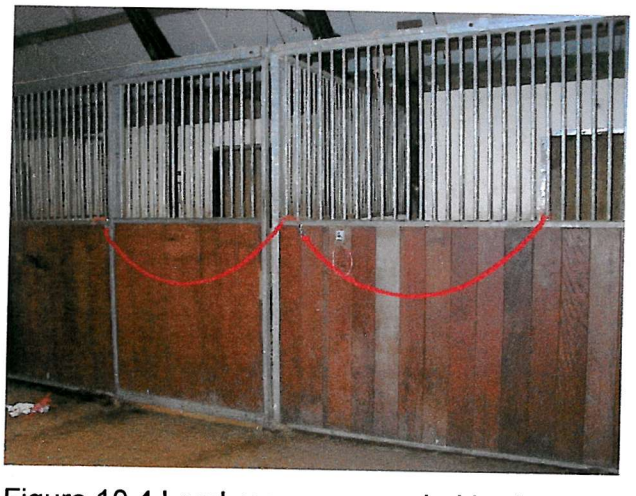

Figure 10.4 Lead-ropes suspended horizontally

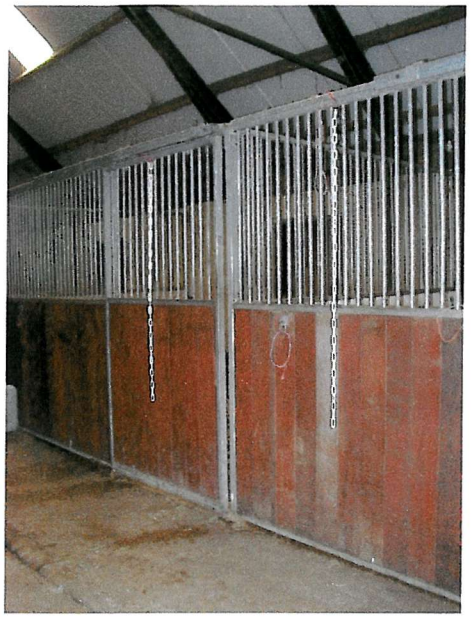

Figure 10.5 Plastic chain hanging vertically

Figure 10.6 Plastic chain suspended horizontally

10.2.2 Subjects

The horses used in this trial were: April, Talia, Belle, Indie, Krystal, Kato, Tom and Hagar. The details of the first seven horses on this list are shown in Table 8.1. The additional horse, Hagar, was an Arabian mare aged six years. This mare was not being ridden and was maintained in the same conditions as the other horses.

10.2.3 Observations

The objects were presented to the horses in the liberty area used in Trial 4 (see Figure 9.1). The hanging objects were tied to the Lodden stables as shown in Figures 10.1-10.4. An object was placed in the liberty area and the horse was led in, turned toward the object and released. The horses' responses were filmed for six minutes using a remote video camera. The additional minute, compared with the observation periods in Section 9, was included to allow for any time spent investigating the liberty area, as no acclimatisation period was used in this trial.

Two replicates of the observations were completed. The order in which the horses were tested in each replicate was according to the randomised latin squares shown in Tables 10.1 and 10.2. The order in which the objects were presented to the horses in each replicate was according to the randomised latin square designs shown in Tables 10.3 and 10.4.

Table 10.1 The order in which the horses were tested on each trial day in Replicate 1

Day 1.	Hagar	Tom	Talia	Indie	Belle	Krystal	April	Kato
Day 2.	Tom	Kato	April	Belle	Talia	Indie	Hagar	Krystal
Day 3.	Talia	April	Indie	Kato	Krystal	Tom	Belle	Hagar
Day 4.	Indie	Belle	Kato	Hagar	Tom	April	Krystal	Talia
Day 5.	April	Hagar	Belle	Krystal	Indie	Kato	Talia	Tom
Day 6.	Belle	Talia	Krystal	Tom	Kato	Hagar	Indie	April

Table 10.2 The order in which the horses were tested in Replicate 2

Day 1.	Belle	Indie	Kato	Hagar	Talia	Tom	Krystal	April
Day 2.	Hagar	April	Belle	Krystal	Tom	Indie	Talia	Kato
Day 3.	Krystal	Kato	Hagar	Talia	Indie	April	Tom	Belle
Day 4.	April	Talia	Indie	Kato	Hagar	Krystal	Belle	Tom
Day 5.	Indie	Krystal	Tom	April	Belle	Hagar	Kato	Talia
Day 6.	Talia	Belle	Krystal	Tom	April	Kato	Indie	Hagar

Table 10.3 The order in which the objects were presented to each horse in Replicate 1

	Day 1.	Day 2.	Day 3.	Day 4.	Day 5.	Day 6.
April	CV	CH	RV	RH	Ball	Box
Talia	RV	RH	Box	Ball	CH	CV
Belle	CH	RV	RH	Box	CV	Ball
Indie	CH	RV	RH	Box	CV	Ball
Krystal	CV	CH	RV	RH	Ball	Box
Kato	Ball	CV	CH	RV	Box	RH
Tom	Box	Ball	CV	CH	RH	RV
Hagar	RH	Box	Ball	CV	RV	CH

Ball = Jolly Ball with rope handles Box = Plastic box with rope handles

CH = Plastic chain suspended horizontally CV = Plastic chain hanging vertically

RH = Lead-ropes suspended horizontally RV = Lead-ropes hanging vertically

Table 10.4 The order in which the objects were presented to each horse in Replicate 2 (see Table 10.3 for abbreviations)

	Day 1.	Day 2.	Day 3.	Day 4.	Day 5.	Day 6.
April	RH	CV	CH	RV	Box	Ball
Talia	RH	CV	CH	RV	Box	Ball
Belle	CH	Box	Ball	CV	RV	RH
Indie	RV	RH	CV	Ball	CH	Box
Krystal	RV	RH	CV	Ball	CH	Box
Kato	Box	Ball	RV	CH	RH	CV
Tom	CV	CH	Box	RH	Ball	RV
Hagar	Ball	RV	RH	Box	CV	CH

10.2.4 Data Recording

The horses' responses to the objects were filmed using a remote Hi8 format video camera. These tapes were converted to VHS format for data recording. The duration of the object manipulation behaviour patterns described in the ethogram in Table 4.3 were timed using a stopwatch and recorded on check-sheets. Object manipulation consisted of all interaction with the objects. Object play consisted of bite, paw and pick up object.

10.2.5 Statistical Analysis

All statistical analyses were performed using SPSS v.10. All the statistical tests used were non-parametric as initial exploration of the data showed that it did not follow a

normal distribution. The tests used were Kruskal-Wallis, Friedman, Wilcoxon signed ranks and Spearman Rank correlations.

In all the box-plots presented in this section outlying values (those cases with values with values between 1.5 and three box lengths from the upper or lower edge of the box, where the box length is the interquartile range) are labelled with a circle (O) and extreme values (those cases with values more than three box lengths from the upper or lower edge of the box, where the box length is the interquartile range) are labelled with an asterisk (*). The interquartile range contains 50% of the recorded values. The whisker lines that extend from each box are drawn between the highest and lowest values, excluding outliers. The thick black line across the box indicates the median. The "N" value on the x-axis indicates the number of cases in each plot.

10.3 Results

10.3.1 Object Manipulation

Total object manipulation accounted for 4.5(SD11.46)% of observation time in Replicate 1 and 1.19(SD2.31)% in Replicate 2. Wilcoxon signed rank analysis detected no significant difference between the durations of object manipulation displayed during Replicate 1 and Replicate 2 ($Z=-2.66$, $P<0.01$) (see Figure 10.7).

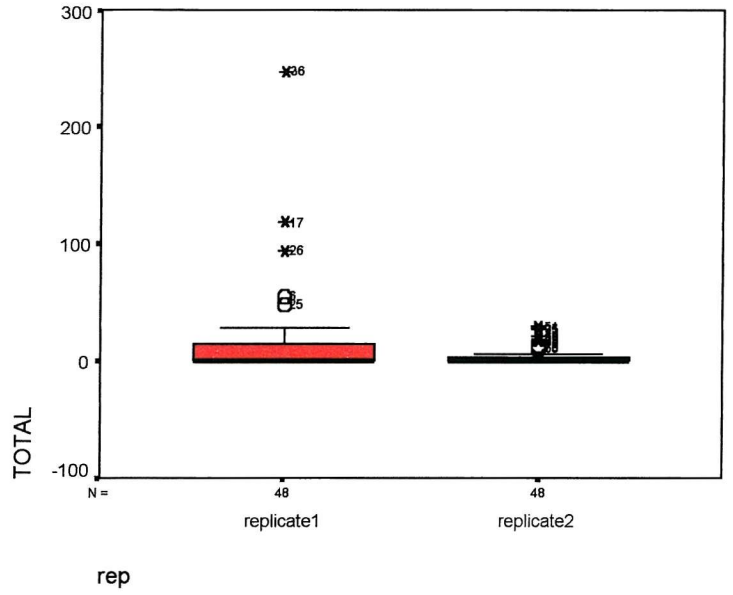

Figure 10.7 Box-plot to illustrate the difference in the duration, in seconds, of object manipulation (TOTAL) displayed between Replicate 1 and Replicate 2

Kruskal-Wallis analysis detected no significant individual differences in the durations of object manipulation exhibited by each horse in Replicate 1 (X^2 =9.54, *df*=6, NS) and Replicate 2 (X^2= 9.83, *df*=6, NS) (see Figures 10.8 and 10.9).

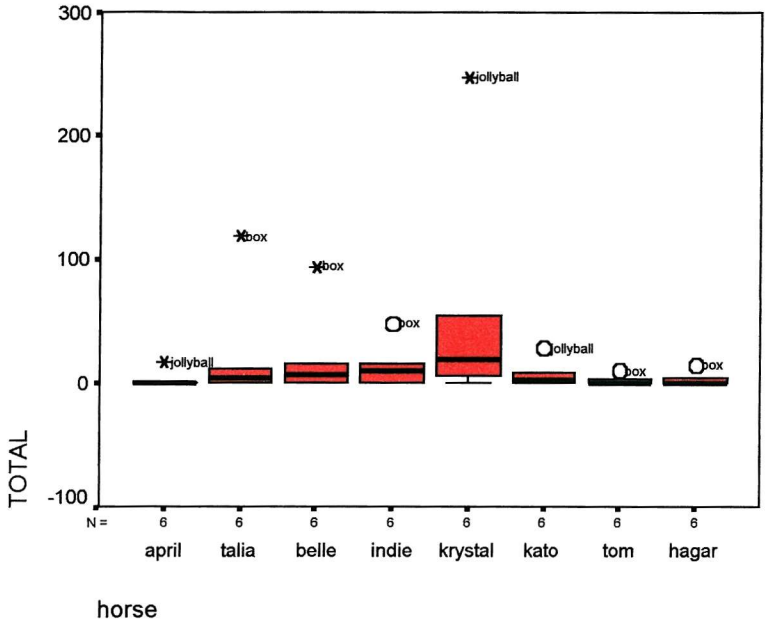

Figure 10.8 Box-plot to illustrate the duration, in seconds, of object manipulation (TOTAL) exhibited during the study by each horse in Replicate 1. Outlying values are labelled with the identity of the object (see Table 10.3 for abbreviations)

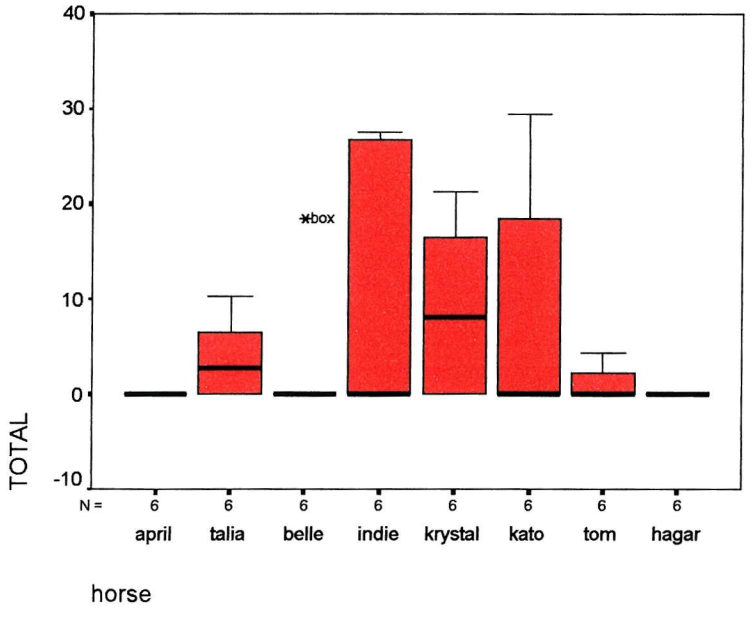

Figure 10.9 Box-plot to illustrate the duration, in seconds, of object manipulation (TOTAL) exhibited during the study by each horse in Replicate 2. Outlying values are labelled with the identity of the object (see Table 10.3 for abbreviations)

Friedman analysis detected significant differences in the durations of object manipulation exhibited toward each object in Replicate 1 (X^2 =19.49, *df*=5, P<0.01) and in Replicate 2 (X^2 =13.57, *df*=5, P<0.05) (see Figures 10.10 and 10.11).

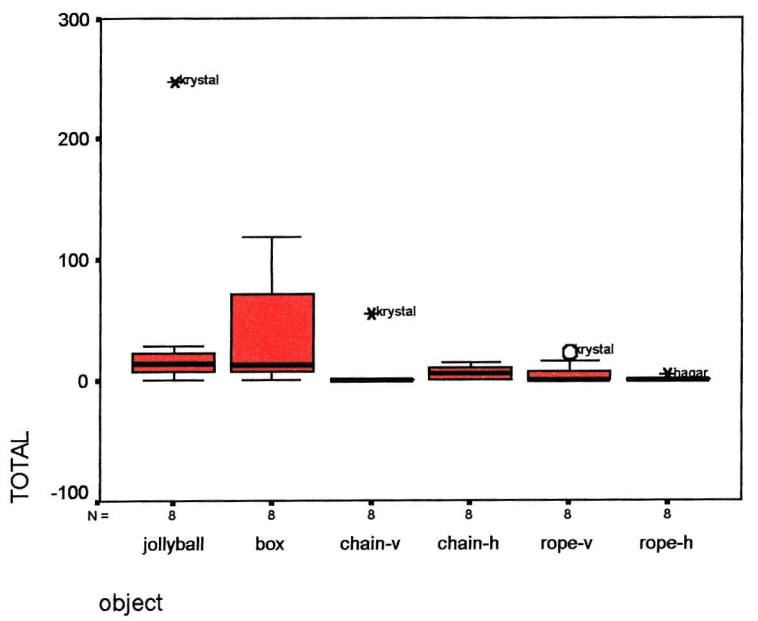

Figure 10.10 Box-plot to illustrate the duration, in seconds, of object manipulation (TOTAL) exhibited toward each object during Replicate 1. Outlying values are labelled with the identity of the horse

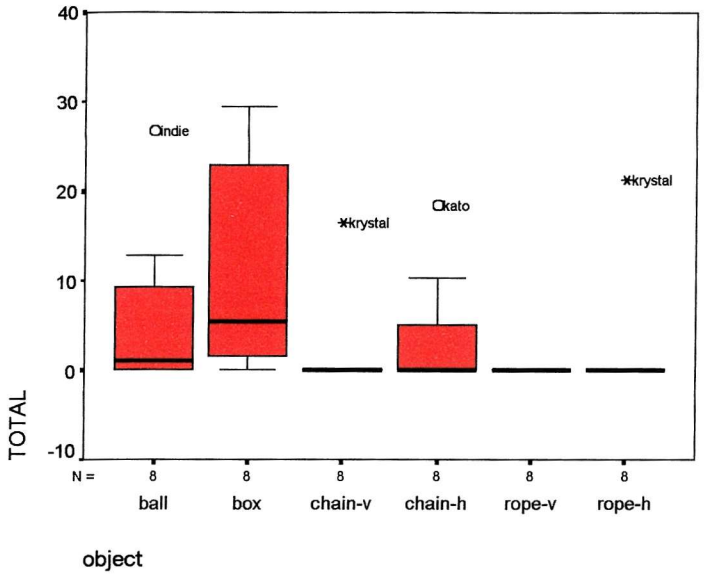

Figure 10.11 Box-plot to illustrate the duration, in seconds, of object manipulation (TOTAL) exhibited toward each object during Replicate 2. Outlying values are labelled with the identity of the horse

10.3.2 Object Play

Object play accounted for an average of 2.64 (SD10.86)% of observation time in Replicate 1 and 0.54 (SD1.45)% in Replicate 2.

Wilcoxon signed rank analysis detected no significant difference in the durations of object play displayed between Replicate 1 and Replicate 2 (Z=-1.08, NS) (see Figure 10.12).

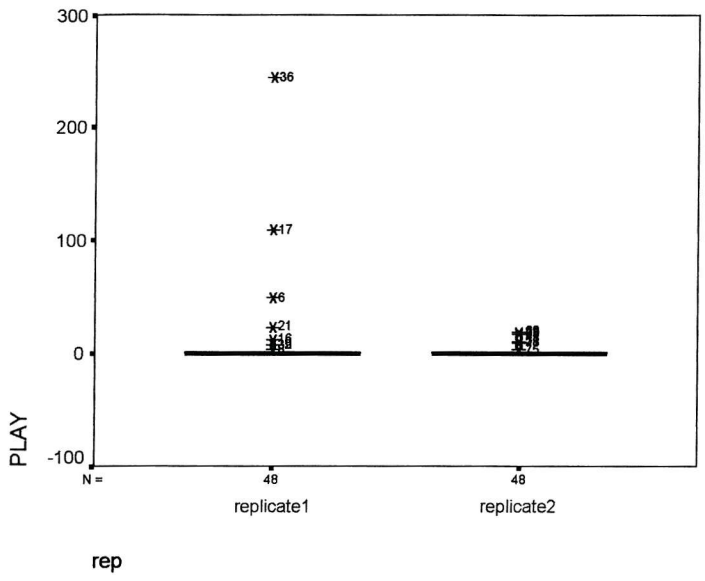

Figure 10.12 Box-plot to illustrate the difference in the duration, in seconds, of object play (PLAY) displayed between Replicate 1 and Replicate 2.

Kruskal–Wallis analysis detected significant individual differences in the duration of object play exhibited by each horse in Replicate 1 (X^2 =22.16, *df*=7, P<0.01) and Replicate 2 (X^2 =14.25, *df*=6, P<0.05) (see Figures 10.13 and 10.14).

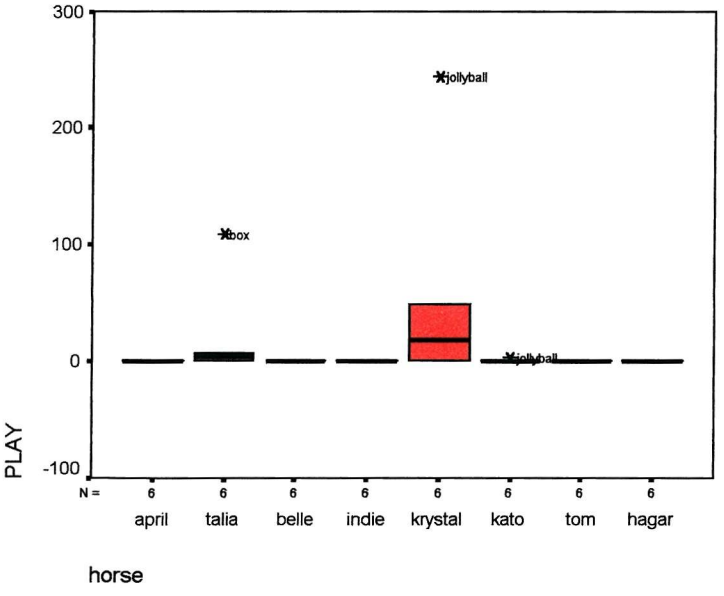

Figure 10.13 Box-plot to illustrate the duration, in seconds, of object play (PLAY) exhibited by each horse during the Replicate 1. Outlying values are labelled with the identity of the object (see Table 10.3 for abbreviations)

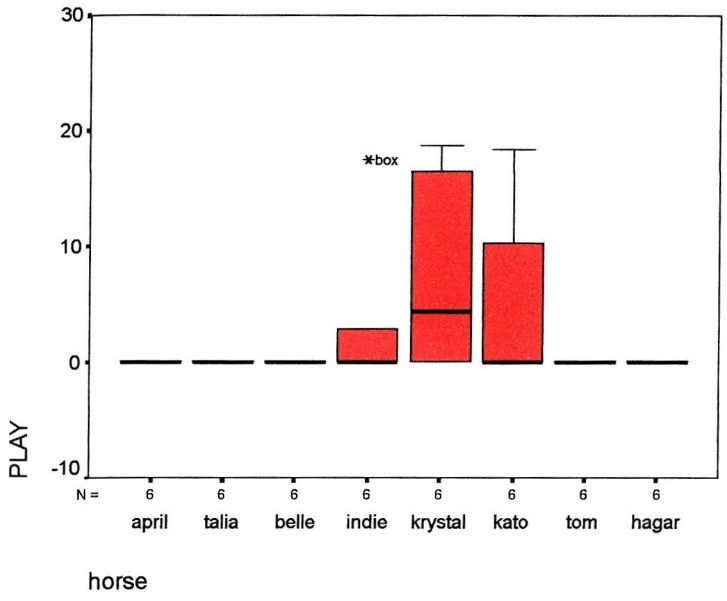

Figure 10.14 Box-plot to illustrate the duration, in seconds, of object play (PLAY) exhibited toward each object during the Replicate 2. Outlying values are labelled with the identity of the horse

Friedman analysis detected no significant difference in the duration of object play exhibited toward each object in Replicate 1 (X^2 =7.63, *df*=5, NS) and Replicate 2 (X^2 =3.33, *df*=5, NS) (see Figures 10.15 and 10.16).

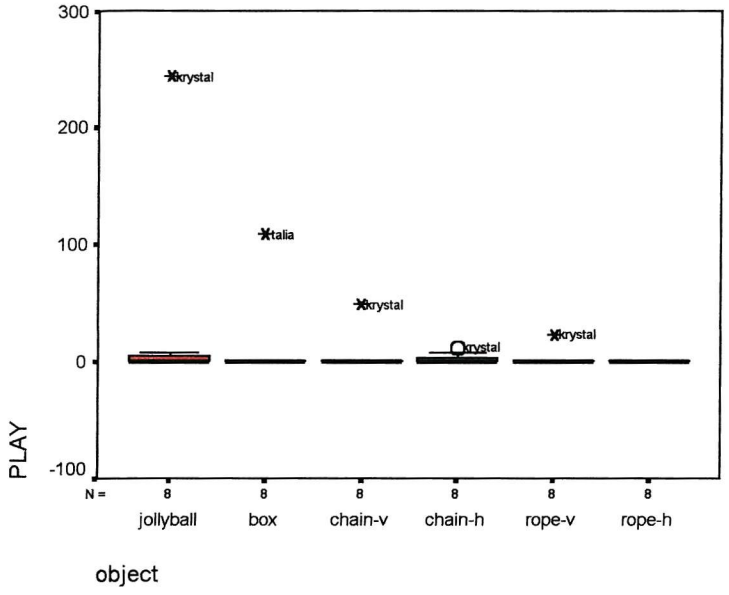

Figure 10.15 Box-plot to illustrate the duration, in seconds, of object play (PLAY) exhibited toward each object during the Replicate 1. Outlying values are labelled with the identity of the horse

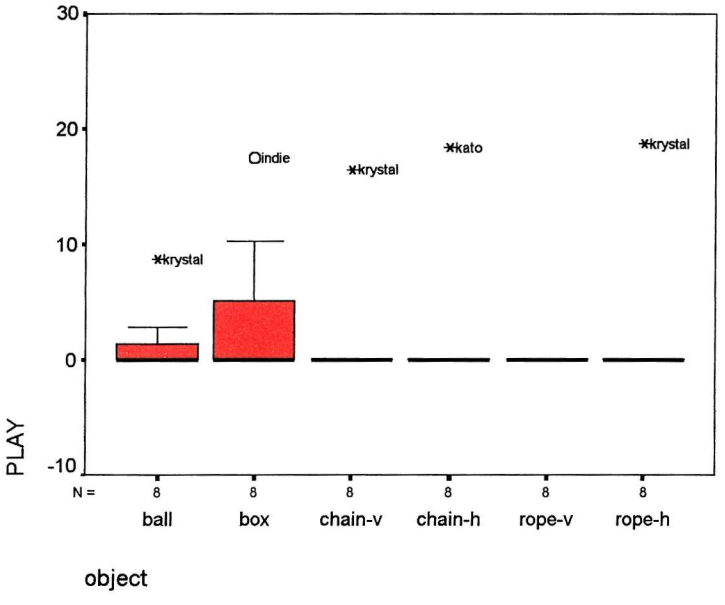

Figure 10.16 Box-plot to illustrate the duration, in seconds, of object play (PLAY) exhibited toward each object during the Replicate 2. Outlying values are labelled with the identity of the horse

10.3.3 Chain vs. Rope

Wilcoxon analysis detected no significant difference between the duration of object manipulation displayed toward the hanging objects constructed of rope and the hanging objects constructed from plastic chain (Z=-0.57, NS).

10.3.4 Horizontal vs. Vertical

Wilcoxon analysis detected no significant difference between the duration of object manipulation displayed toward the objects suspended horizontally and the objects suspended vertically (Z=-0.52, NS).

10.3.5 Hanging Objects vs. Objects Presented on the Ground

Wilcoxon analysis detected a significant difference between the duration of object manipulation displayed toward the objects hanging up and the objects presented on the ground (Z=-2.98, P<0.01). A box-plot demonstrated that more object manipulation was displayed towards the objects presenting on the ground (see Figure 10.17).

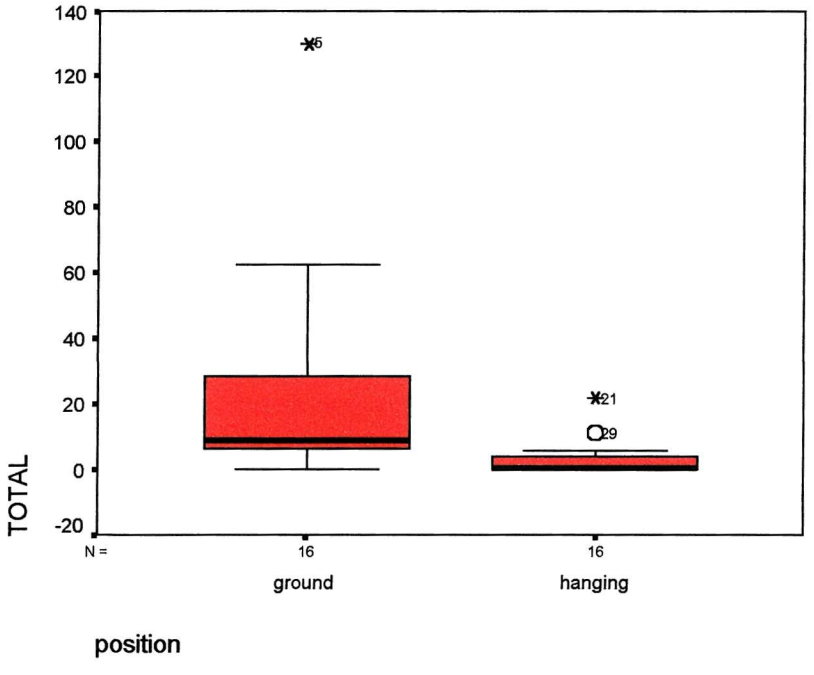

Figure 10.17 Box-plot illustrating the difference in the duration of object manipulation (TOTAL) displayed toward the objects presented on the ground (ground) and those presented hanging up (hanging)

10.3.6 The Effect of Age on Object Manipulation and Play

Significant negative correlations were detected between age and object manipulation in both replicates (Replicate 1: Spearman's rho = -0.391, P<0.01. Replicate 2: Spearman's rho: -0.400, P<0.01) and age and object play in both replicates (Replicate 1: Spearman's rho = -0.547, P<0.01. Replicate 2: Spearman's rho: -0.340, P<0.01).

10.4 Discussion

10.4.1 Effectiveness of the Objects at Eliciting Object Manipulation and Play

The Jolly Ball and the plastic box with rope handles elicited more object manipulation than any of the hanging objects. It appeared that the majority of the horses were not aware of the lead-ropes and plastic chains hanging from the stable walls. However, it is more likely that they were not of sufficient interest to elicit a response. Only Krystal exhibited object play toward the hanging objects, but she spent the majority of the observations stood in the front left hand corner of the liberty area facing the hanging objects, whereas the other horses spent the majority of the observations stood at the front of the liberty area facing away from the objects. Another explanation could be that the visual stimuli of the barn were more complex than that of the liberty area (see Figures 10.18 and 10.19) and, therefore, the horses ignored the objects hanging on the wall of the liberty area. It is possible, therefore, that the positioning of the objects is important in eliciting object manipulation and play. This may have been why object manipulation and play was displayed toward the lead-ropes hanging outside stable doors, as the horses spent a great deal of time looking over their stable doors. The lead-ropes were not, therefore, sought out by movement toward them, but were possibly manipulated because they were in a location frequently occupied by the horses. A greater response to the hanging objects may be observed if they are suspended in an area of the liberty area where the horses spend more time in, i.e. the front of the liberty area.

10.4.2 Effect of Presentation of the Object

The objects presented on the ground elicited more object manipulation than the objects presented hanging up, suggesting a preference for objects presented on the ground.

However, as mentioned above, it is possible that the hanging objects were not in a location in the liberty area where most of the horses stood during observations, and even though the horses were released facing the objects at the beginning of each observation, the view of the barn outside the liberty area may have been more interesting than these objects.

The objects with added handles presented on the floor may have elicited more interest because they were a more complex stimulus than the hanging objects. They may also have been easier to manipulate. The hanging objects may have been difficult to bite because they moved and the horses could not manipulate them using their hooves.

Interestingly, the commercially available horse toys, designed for use in the stable, are hanging toys, but these are not normally suspended so that they hang against the wall. In a questionnaire to horse owners (see Section 8) concerns were raised about horses injuring themselves on objects in the stable and the possibility that they wouldn't lie down if there were an object on the stable floor. Objects would also become soiled more readily if they were placed on the floor.

10.4.3 Effect of Age on Object Manipulation and Play

Age was negatively correlated with object manipulation and play. This agrees with the results of the previous trials and again suggests that object manipulation and play are exhibited more frequently by juvenile horses than by adults.

10.5 Conclusion

Although the hanging objects appeared to elicit less object manipulation than the objects presented on the ground it is possible that the hanging objects were simply poorly positioned in the liberty area. Therefore, in the next trial (Trial 6) the hanging objects were re-positioned in order to observe the horses' responses to these objects when they are located in an area of the liberty area where the horses spend more time.

The older horses played less with the objects, which is in agreement with the results of the previous trials.

The Effect of the Location of Objects on Object Manipulation and Play

Trial 6

10.6 Introduction and Aim

During Trial 5 it was observed that the durations of object manipulation and play directed toward the objects presented hanging above the ground was low, with one horse (Krystal) exhibiting most of the manipulation and play toward these objects. This horse spent the majority of the observation time standing in the front left hand corner of the liberty area, facing the objects, and so was more likely to see them. The remaining horses spent the majority of the observation time facing the front of the liberty area and so were less likely to encounter the objects. It may be that the location of the hanging objects was affecting the likelihood of the horses exhibiting object manipulation and play toward them.

It has been anecdotally suggested (Williams 1976) that changing the location of an object can increase its novelty. This may lead to an increase in the response to the hanging objects.

The aim of this study was:

1. To determine whether changing the position of the hanging objects, to the area where the horses spent most of their time, would affect the levels of object manipulation and play exhibited toward them.

10.7 Methods

10.7.1 Subjects

Eight horses were observed in this study. These were the same eight horses that were observed in Trial 4 (Trial 4 study group: April, Talia, Belle, Indie, Krystal, Kato, Tom and

Hagar). The details of these horses can be found in Table 8.1, except for Hagar whose details are in Section 9.2.

10.7.2 Objects

The objects presented to the horses were:

- Two lead-ropes hanging vertically
- Two lead-ropes suspended horizontally
- Two plastic chains hanging vertically
- Two plastic chains suspended horizontally

These are illustrated in Figures 10.3, 10.4, 10.5 and 10.6. However, in this trial the objects were hanging at front of the liberty area (see Figures 10.18 and 10.19). During observations there were no horses in the gangway. These photographs were taken from within the liberty area.

Figure 10.18 An example of how the vertically hung objects were presented (view from the liberty area to show the rest of the barn

Figure 10.19 An example of how the horizontally suspended objects were presented (view from the liberty area to show the rest of the barn)

10.7.3 Observations

Each horse was led into the liberty area, turned to face the front of the liberty area, where the objects were hung up, and then released. The horse's reactions to the objects were filmed for six minutes using a remote video camera. The horse was then led out of the liberty area. The order in which the horses were observed on each trial day of Replicate 1 and Replicate 2 was according to a randomised Latin square design. These are detailed in Tables 10.5 and 10.6. The order in which each object was presented to each horse in Replicate 1 and Replicate 2 was also according to a randomised Latin square design. These are detailed in Tables 10.7 and 10.8.

Table 10.5 The order in which each horse was observed on each trial day of Replicate one

Day 1	April	Tom	Belle	Kato	Krystal	Talia	Hagar	Indie
Day 2	Krystal	Belle	Tom	Talia	April	Kato	Indie	Hagar
Day 3	Tom	Krystal	April	Indie	Belle	Hagar	Kato	Talia
Day 4	Belle	April	Krystal	Hagar	Tom	Indie	Talia	Kato

Table 10.6 The order in which each horse was observed on each trial day of Replicate two

Day 1	Kato	Indie	Talia	Hagar	Krystal	Tom	April	Belle
Day 2	Talia	Hagar	Kato	Indie	April	Belle	Krystal	Tom
Day 3	Hagar	Kato	Indie	Talia	Tom	April	Belle	Krystal
Day 4	Indie	Talia	Hagar	Kato	Belle	Krystal	Tom	April

Table 10.7 The order in which each object was presented to each horse in Replicate one (see Table 10.3 for abbreviations)

Horse	Day 1	Day 2	Day 3	Day 4
April	RH	CV	CH	RV
Talia	CV	CH	RV	RH
Belle	CH	RV	RH	CV
Indie	CH	RV	RH	CV
Krystal	CV	CH	RV	RH
Kato	RH	CV	CH	RV
Tom	RV	RH	CV	CH
Hagar	RV	RH	CV	CH

Table 10.8 The order in which each object was presented to each horse in Replicate two (see Table 10.3 for abbreviations)

Horse	Day 1	Day 2	Day 3	Day 4
April	CH	CV	RV	RH
Talia	RH	RV	CV	CH
Belle	RV	CH	RH	CV
Indie	RH	RV	CV	CH
Krystal	CH	CV	RV	RH
Kato	CV	RH	CH	RV
Tom	RV	CH	RH	CV
Hagar	CV	RH	CH	RV

10.7.4 Data Recording

The horses' responses to the objects were filmed using a remote, Hi8 format video camera. These tapes were converted to VHS format for data recording. The duration of object manipulation and play behaviours, as described in Section 4.2.4, were timed using a stopwatch and recorded on check sheets.

10.7.5 Statistical Analysis

All statistical analyses were performed using SPSS v.10. Non-parametric analysis was used to analysis the data, as they did not follow a normal distribution. The statistical tests used were: Friedman, Kruskal-Wallis, Wilcoxon Signed Ranks and Spearman Rank correlation.

In all the box-plots presented in this section outlying values (those cases with values between 1.5 and three box lengths from the upper or lower edge of the box, where the box length is the interquartile range) are labelled with a circle (O) and extreme values (those cases with values more than three box lengths from the upper or lower edge of the box, where the box length is the interquartile range) are labelled with an asterisk (*). The interquartile range contains 50% of the recorded values. The whisker lines that extend from each box are drawn between the highest and lowest values, excluding outliers. The thick black line across the box indicates the median. The "N" value on the x-axis indicates the number of cases in each plot.

10.8 Results

10.8.1 Object Manipulation

Object manipulation accounted for an average of 3.01 (SD6.1)% of observation time in Replicate one and 0.95 (SD2.35)% in Replicate two. Wilcoxon analysis detected significantly greater durations of object manipulation displayed in Replicate one than Replicate two ($Z=-2.52$, $P<0.05$).

Kruskal-Wallis analysis detected no significant individual differences in the durations of object manipulation displayed by each horse in Replicate one ($X^2=12.82$, $df=7$, NS) and Replicate two ($X^2=8.47$, $df=7$, NS).

Age was significantly negatively correlated with object manipulation in Replicate one (Spearman's rho=-0.518, $P<0.01$), but not in Replicate two (Spearman's rho=-0.148, NS).

10.8.2 Object Play

Object play accounted for an average of 1.56 (SD5.43)% of observation time in Replicate one and 0.31 (SD0.77)% of observation time in Replicate two. Wilcoxon analysis detected no significant differences in the levels of object manipulation displayed between the two replicates ($Z=-1.51$, NS).

Kruskal-Wallis detected no significant individual differences in the durations of object play displayed by each horse during the observations in Replicate one and Replicate two (Replicate one: X^2=13.30, *df*=7, NS; Replicate two: X^2=8.76, *df*=7, NS).

Age was significantly negatively correlated with object play in Replicate one (Spearman's rho=-0.588, P<0.01) and in Replicate two (Spearman's rho=-0.393, P<0.05).

10.8.3 Rope vs. Chain

Wilcoxon analysis detected no significant difference between the durations of object manipulation displayed toward the objects constructed of rope and those constructed of plastic chain (Z=0, NS).

10.8.4 Horizontal vs. Vertical

Wilcoxon analysis detected significantly greater durations of object manipulation displayed toward the objects hanging vertically than the objects suspended horizontally (Z=-3.35, P<0.01) (see Figure 10.20).

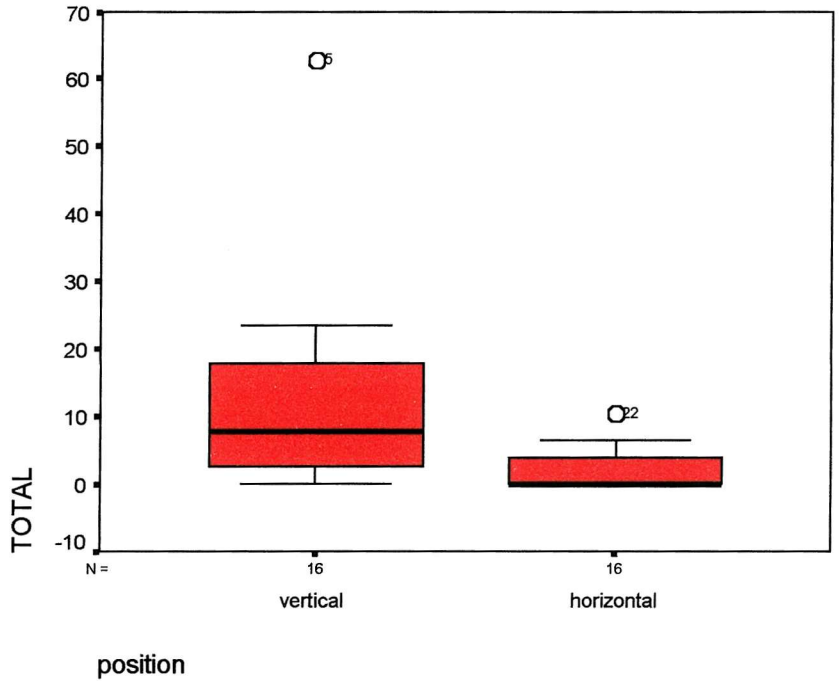

Figure 10.20 Box-plot to illustrate the difference between the durations, in seconds, of object manipulation (TOTAL) displayed toward the objects hanging vertically and the objects suspended horizontally

10.8.5 Effect of Location on Object Manipulation and Play

Wilcoxon analysis was used to compare the responses to each of the four hanging objects in Trial 5 (objects presented at the side of the liberty area) and Trial 6 (objects presented at the front of the liberty area). The results are detailed in Table 10.9. Significantly more object manipulation was displayed toward the chain hanging vertically and the rope hanging vertically when they were hung at the front of the liberty area.

Table 10.9 Result of Wilcoxon Signed Ranks analysis comparing the objects when hanging at the front and the side of the liberty area

Object	Wilcoxon Z	Significance
Chain hanging vertically	-2.366	P<0.05
Chain suspended horizontally	-1.782	NS
Rope hanging vertically	-2.100	P<0.05
Rope suspended horizontally	-0.405	NS

10.9 Discussion

10.9.1 Effect of the Materials from which the Objects are Constructed

There was no difference in the amount of object manipulation elicited by the rope or the plastic chain. This further agrees with the results of Trial 5 and suggests that the material from which the hanging objects were constructed was not important in eliciting object manipulation and play. This finding is in contrast to the results of Apple and Craig (1992), who presented a pliable, rubber, hourglass shaped dog toy; two lengths of rope; a length of brass-plated chain and a length of rubber hose suspended from the ceiling to groups of pigs. They reported that the pigs directed more object play toward the rubber dog toy than the other objects. There was also evidence that the rope elicited more play than the chain and rubber hose later in the observation period. In this case the shape, as well as the material, may have affected the duration of object manipulation displayed toward it. Frazer (1993) suggests that pigs prefer to manipulate easily damaged materials than indestructible items. This could explain why the rope elicited more object play than the other materials in Apple and Craig's (1992) study. It may be that the lead-ropes outside the horses' stables elicit object manipulation and play because they have absorbed odours from the environment and so were more interesting. The lead-ropes and chain used in this trial were clean and so may have elicited less interest than the lead-ropes that the horses were observed to manipulate when stabled.

10.9.2 Effect of the Position of the Objects

The objects hanging vertically appeared to be more successful at eliciting object manipulation than those suspended horizontally. This is in agreement with the results of Trial 5. In this trial it is possible that the horses spent more time manipulating the vertically hanging objects because they were hung higher up than the horizontally suspended objects. They could, therefore, have been more obvious to the horses. lashing of the tail from side to side is reported to be a signal that a horse is agitated (Odberg 1987, Weeks and Beck 1996). The vertically hanging objects that move in this manner may therefore be more biologically relevant to horses as they would recognise the tail lashing as an important social signal. The horses were observed to manipulate the gates on which the horizontal objects were attached, the barrels holding the gates in place, which were lower than the hanging objects, and the elastic surcingle used to

access the liberty area. It is possible that the horses manipulated these objects in order to explore methods of escaping from the liberty area.

The vertically hanging objects could have been more successful at eliciting object manipulation because they moved more freely and in a more unpredictable manner than the horizontally suspended objects. This may have made them more visible and/or more interesting to the horses. Carlstead (1996) suggested that a swinging boxing ball elicited a high response from rhinoceroses because it moved unpredictably when it was manipulated. Hall (1995) also found in domestic cats that moving toys, and particularly a toy suspended on a length of string elicited more play than a stationary object on the ground. It was suggested that this was associated with predation, as prey are initially located by movement. However, in Hall's study the object was swung, whereas the objects in this trial would only move if the horse manipulated them. So, it is likely that if the movement of an object is important in eliciting object manipulation and play in horses, it would be the random movement caused by the horse's actions that is attractive. This characteristic of an object may be important because it allows the horse to exert a degree of control over its surroundings. This factor has been suggested to be important for the welfare of captive animals because it enables them to predict the outcome of behavioural responses to the environment (Carlstead 1996). It would be of interest to investigate horses' responses to objects that move spontaneously as the element of control would be eliminated.

Another explanation for the success of the vertically suspended objects over the horizontally suspended objects could be that the loose ends of the vertically suspended objects were attractive to the horses. A study by Frazer (1993) reported that pigs played more with ropes presented hanging with loose ends than with ropes presented in a loop. It was suggested that the pigs preferred the ropes with loose ends because they are easily damaged. Although no damage was caused to the vertically suspended objects during these trials the horses were observed to manipulate both the ends and the length of the ropes. It has also been anecdotally suggested that horses may have a preference for manipulating destructible objects. Indeed, in Trials 2, 3 and 4 several of the horses destroyed the paper and anaglypta sacks.

10.9.3 The Effect of the Location of the Objects

The horses spent more time manipulating the objects hanging vertically when they were located at the front of the liberty area. This was probably because the horses spent the majority of the observation time at the front of the liberty area. Therefore, the location of any hanging objects used for environmental enrichment is important. They are likely to be most effective if hung in an area of the stable where the horse spends a lot of time. The results of this study, therefore, concur with the suggestion of Williams (1976) that changing the location of an object may disinhibit object manipulation and play behaviour in the domestic horse.

10.9.4 The Effect of Age on Object Play

The older horses spent less time playing with objects than younger horses in both replicates of this study. This further supports the results of Trial 5 and Trial 4 (Section 9).

10.10 Conclusions

Neither of the materials from which the hanging objects were constructed appears to have an effect on the level of object manipulation displayed toward them.

Objects hanging vertically are more effective at eliciting object manipulation than objects suspended horizontally. This may be because the vertically suspended objects displayed more movement than those suspended horizontally.

For hanging objects to be effective at eliciting object manipulation it is likely that they would need to be located in a part of the stable in which the horse spends the majority of its time.

As in the previous trials the older horses displayed less object play than the younger horses.

11. The Effect of Sound on the Display of Object Manipulation and Play

Trial 7

11.1 Introduction and Aims

In Trial 2 (Section 8) the brown paper sack appeared to elicit more object manipulation than the other objects. However, the sack constructed of brown paper in Trials 3 and 4 did not elicit more manipulation than the other materials. It is possible that the noises produced by the paper and bubble wrap sacks when they were manipulated were the reason that they elicited manipulation. In children, objects that provided auditory feedback were found to elicit and maintain more object play than those that provided only visual feedback (Burns 1967). However, Hall (1995) found no effect of sound on the levels of object play displayed by domestic cats toward objects. In Hall's trials a buzzer designed for use as a doorbell produced the sound. In the horse domestic sound is likely to be important in the detection of predators, keeping in contact with members of the social group and in the domestic horse the sound of feed being prepared in plastic buckets.

The aim of this study is:

1. To determine whether the sound that an object makes when it is manipulated affects the amount of object manipulation it elicits.

11.2 Method

11.2.1 Subjects

Six horses were recruited from a private yard. Information regarding the horses' age, sex, breed, management conditions and exercise, are given in Table 11.1. They included four juveniles and two adults. As the object presented to the horses in this trial was similar to foraging devices designed for horses it was necessary that the horses had no experience of foraging from a foraging device.

Table 11.1 Details of the subjects in Trial 7

Horse	Sex	Age	Breed	Management Conditions	Exercise (hours/week)
Lola	Female	7	Cob x	Stabled during day Pasture at night	4
Jade	Female	2	New Forest	Pasture 24 hours	1
Sammy	Male	3	Connemara x	Pasture during day Stabled at night	2
Rio	Male	7	Quarter Horse	Pasture 24 hours	2
Bramble	Female	4	New Forest	Stabled 24 hours	0
Solo	Male	3	New Forest	Pasture 24 hours	0

11.2.2 Objects

The object used in this trial was a plastic dog training ball originally designed to release food pellets as it is rolled (Figure 11.1). A feed ball designed for horses was not used because it was too large to use in the stables.

Figure 11.1 The training ball presented to the horses in this study

Items could be placed inside the ball, so that when the ball was rolled a noise was emitted. The opening was closed completely so that items inserted into the ball would not be released as it was rolled.

The noises chosen were:

Control – no objects placed in the ball, so that it made no noise

Bells – seven small bells placed in the ball

Rattle – gravel placed in the ball

The rattle produced by the gravel was chosen because it sounded similar to horse food pellets rattling in a plastic bucket, which all the horses tested were accustomed to. However, there was no associated smell of feed, or a food reward. The bells were chosen as a sound that the horses were unlikely to have experienced.

11.2.3 Observations

All observations took place between 1500 hours and 1700 hours commencing on 13/08/01 and finishing on 2/10/01 and in the horses' own stables, so that they were in a familiar environment. Two replicates were included in the study.

At the start of each observation the object was shaken twice, so that the horse was introduced to the sound in a controlled manner, placed on the floor at the front of the stable and the behaviour of the horse filmed for five minutes by the observer from outside the stable with a hand held Hi8 format video camera.

The order in which the sounds were tested with each horse was according to a randomised Latin Square design and is detailed in Table 11.2 and Table 11.3.

Table 11.2 Order in which each sound was presented to each horse during Replicate one

Lola	Control	Bells	Gravel
Jade	Gravel	Control	Bells
Sammy	Bells	Gravel	Control
Rio	Gravel	Control	Bells
Bramble	Control	Bells	Gravel
Solo	Bells	Gravel	Control

Table 11.3 Order in which each sound was presented to each horse during Replicate two

Lola	Control	Bells	Gravel
Jade	Bells	Gravel	Control
Sammy	Control	Bells	Gravel
Rio	Bells	Gravel	Control
Bramble	Gravel	Control	Bells
Solo	Gravel	Control	Bells

11.2.4 Data Recording

The observations were filmed using a Hi8 format video camera. These tapes were transferred to VHS format for data recording. The duration of object manipulation and object play behaviours, as described in Table 4.3, were timed using a stopwatch and recorded on check sheets.

11.2.5 Statistical Analysis

Non-parametric analyses were used to analyse this data, as exploratory analysis indicated it did not follow a normal distribution. The tests used were Kruskal-Wallis, Friedman, Mann-Whitney, Wilcoxon Signed Ranks and Spearman Rank Correlation. Details of these tests are given in Section 4.2.5.

In all the box-plots presented in this section outlying values (those cases with values between 1.5 and three box lengths from the upper or lower edge of the box, where the box length is the interquartile range) are labelled with a circle (O) and extreme values (those cases with values more than three box lengths from the upper or lower edge of the box, where the box length is the interquartile range) are labelled with an asterisk (*). The interquartile range contains 50% of the recorded values. The whisker lines that extend from each box are drawn between the highest and lowest values, excluding outliers. The thick black line across the box indicates the median. The "N" value on the x-axis indicates the number of cases in each plot.

11.3 Results

11.3.1 Object Manipulation

Object manipulation accounted for an average of 3.6(SD4.57)% of each observation in Replicate 1 and 3.43(SD6.43)% in Replicate 2. There was no significant difference in the duration of object manipulation displayed between Replicate 1 and Replicate 2 (Wilcoxon Z=-0.41, NS).

Kruskal-Wallis analysis detected no significant individual differences in the duration of object manipulation displayed by each horse during Replicate 1 (X^2=9.16, *df* 5, NS) (see Figures 11.2 and 11.3) or Replicate 2 (X^2=9.40, *df* 5, NS).

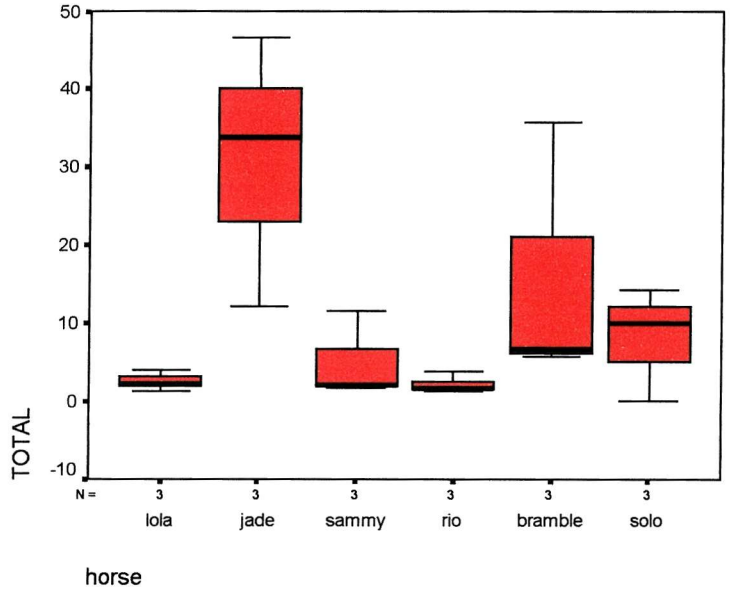

Figure 11.2 Box-plot illustrating the duration, in seconds, of object manipulation (TOTAL) displayed in Replicate 1

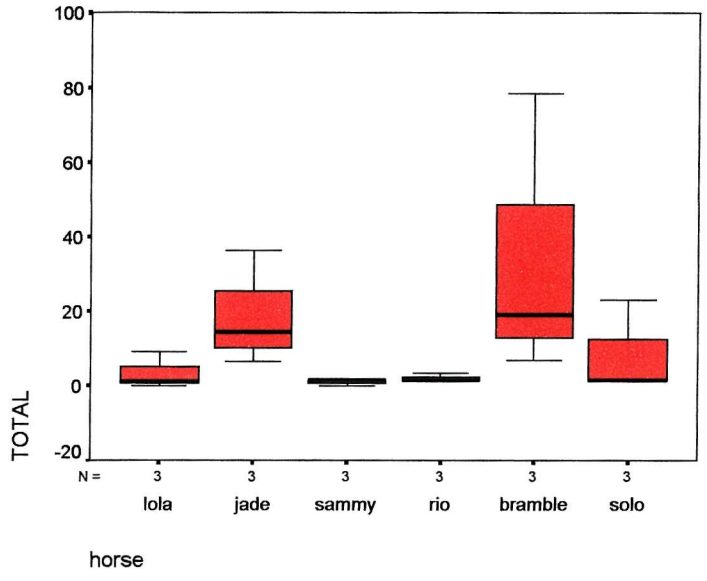

Figure 11.3 Box-plot illustrating the duration, in seconds, of object manipulation (TOTAL) displayed in Replicate 2

Friedman analysis detected no significant difference in the duration of object manipulation displayed toward each sound in either Replicate 1 (X^2=0.33, *df* 2, NS) (see Figures 11.4 and 11.5) or Replicate 2 (X^2=2.33, *df* 2, NS).

Mann-Whitney analysis detected no significant sex difference in the duration of object manipulation displayed in Replicate 1 (Z=-1.63, NS) and Replicate 2 (Z-=1.68, NS). Object manipulation and age were negatively correlated (Spearman's rho=-0.562, P<0.05) in Replicate 1. They were not significantly correlated in Replicate 2 (Spearman's rho=-0.291, NS).

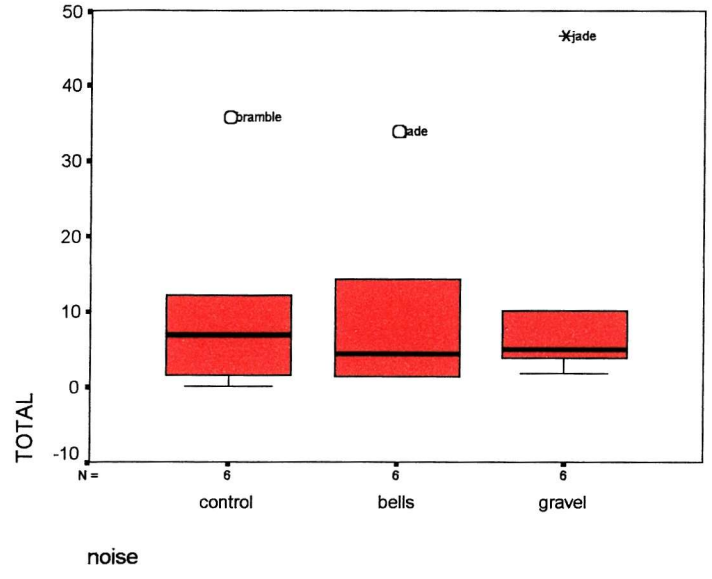

Figure 11.4 Box-plot illustrating the duration, in seconds, of object manipulation (TOTAL) displayed toward each sound in Replicate 1. Outlying values are labelled with the identity of the horse

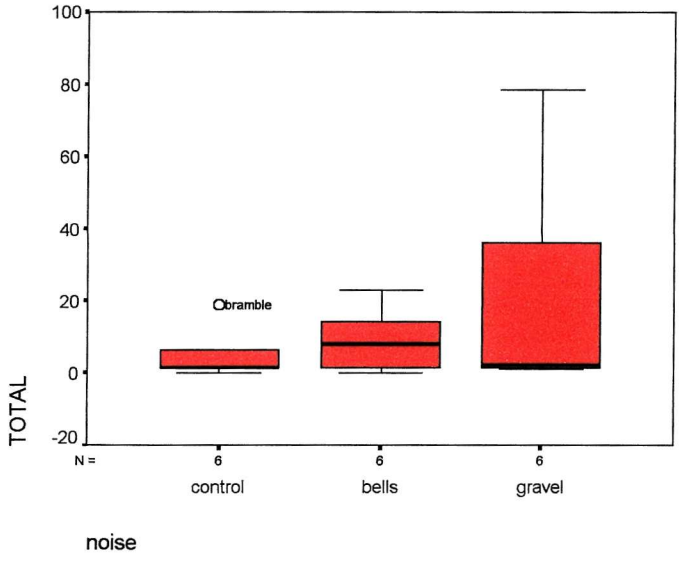

Figure 11.5 Box-plot illustrating the duration, in seconds, of object manipulation (TOTAL) displayed toward each sound in Replicate 2. Outlying values are labelled with the identity of the horse

11.3.2 Object Play

Object play accounted for an average of 1.58(SD2.51)% of each observation during Replicate 1 and 0.99(SD2.36)% in Replicate 2. There was no significant difference in the duration of object play displayed between Replicate 1 and Replicate 2 (Wilcoxon Z=-0.89, NS).

Kruskal-Wallis analysis detected no significant individual differences in the duration of object play displayed by each horse in Replicate 1 (X^2=10.75, *df* 5, NS) (see Figures 11.6 and 11.7) and Replicate 2 (X^2=5.96, *df* 5, NS).

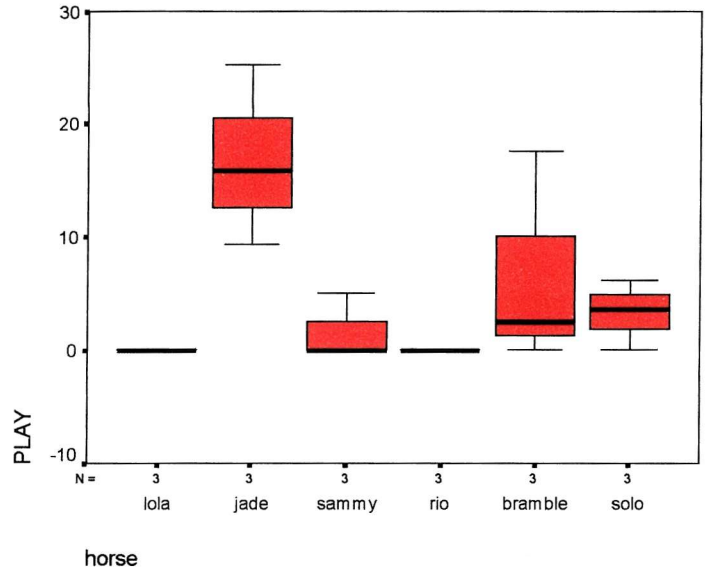

Figure 11.6 Box-plot to illustrate the duration, in seconds, of object play (PLAY) displayed by each horse during Replicate 1

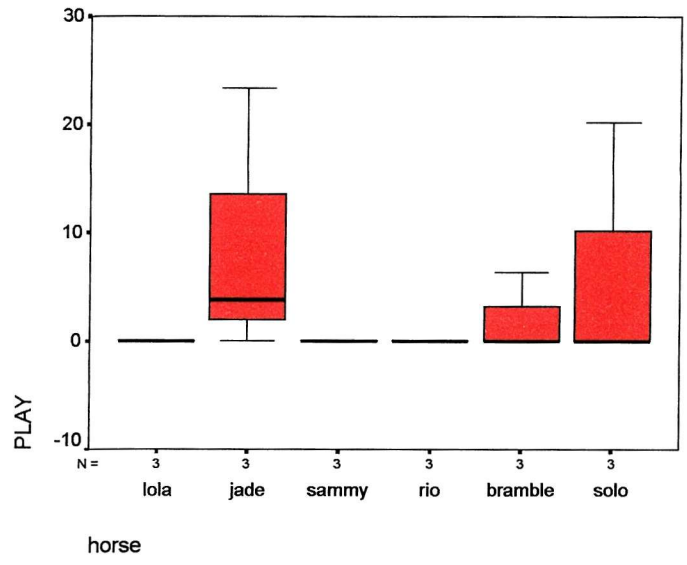

Figure 11.7 Box-plot to illustrate the duration, in seconds, of object play (PLAY) displayed by each horse during Replicate 2

Friedman analysis detected no significant difference in the duration of object play displayed toward each sound in Replicate 1 (X^2=0.13, *df* 5, NS) (see Figures 11.8 and 11.9) and Replicate 2 (X^2=1.4, *df* 5, NS).

Mann-Whitney analysis detected no significant sex difference in the duration of object play displayed during Replicate 1 (X^2=-1.31, *df* 5, NS) and Replicate 2 (X^2=-1.03, *df* 5, NS).

Object play and age were negatively correlated (Spearman's rho=-0.675, P<0.01) in Replicate 1. They were not significantly correlated in Replicate 2 (Spearman's rho=-0.446, NS).

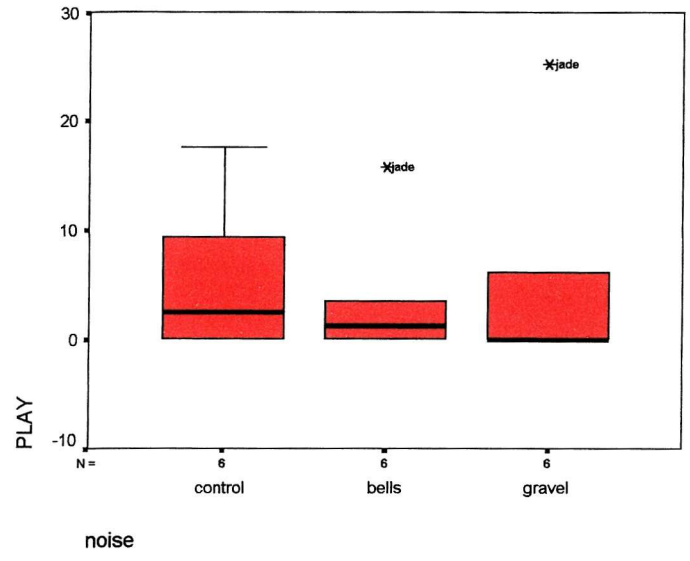

Figure 11.8 Box-plot to illustrate the duration, in seconds, of object play (PLAY) displayed toward each sound during Replicate 1. Outlying values are labelled with the identity of the horse

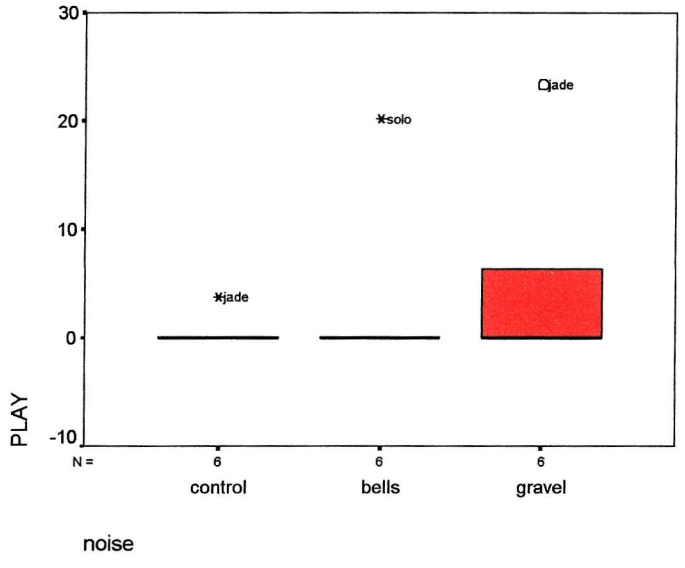

Figure 11.9 Box-plot to illustrate the duration, in seconds, of object play (PLAY) displayed toward each sound during Replicate 2. Outlying values are labelled with the identity of the horse

11.4 Discussion

11.4.1 Effect of Sound on Object Manipulation and Play

The audibility of the object did not, in this trial, have a significant effect on the duration of object manipulation and play that it elicits. So, it is possible that auditory feedback may not be an important factor in eliciting object manipulation and play in domestic horses. This concurs with the results of Hall (1995) who found that sound had no effect on the levels of object play displayed by domestic cats toward objects. She explains her findings as a result of excessive neophobia, as the sounds she used were artificial. No avoidance behaviour was observed toward any of the sounds in this study, including the bells, which produce an artificial sound. It is possible that the sounds and/or the object presented to the horses were not optimal to induce greater levels of object manipulation and play. There was a trend in Replicate 2 for more object play displayed toward the training ball when it contained gravel (see Figure 11.9). It is possible that the sample size was not large enough to produce a statistically significant result. If auditory feedback is not important in eliciting object play it may be that the use of foodballs by horses relies on the food reward.

The results suggest that horses have individual preferences for either objects that produce a sound, or objects that are quiet. Jade appeared to spend more time manipulating and playing with the objects that produced a noise, whereas Bramble appeared to spend more time manipulating and playing with the control object which was quiet. In this small sample size this individual preference may have obscured any differences leading to the overall result suggesting that auditory feedback had no significant effects on the duration of object manipulation and play observed.

The sample size was very small and the management regimens of the horses were very different. To confirm the results and determine whether individual preferences for audible objects exist, it would be necessary to repeat the study using a larger sample size of horses of a similar age, engaged in similar levels of work and with similar stabling and feeding routines.

11.4.2 Effects of Management Regimen

It is perhaps surprising that no significant differences were detected in the duration of object manipulation and play displayed by the individuals observed, as their management regimens were so different. This could be due to the small sample size. It is also possible that management regimen has little effect on the duration of object manipulation and play displayed by domestic horses. However, in Trial 2 the management regimen did appear to affect the duration of object manipulation and play exhibited by the females. Prolonged stabling in Trial 2 appeared to cause an increase in the levels of object manipulation displayed. In this trial Bramble was stabled for 24 hours each day. She did not, however, display more object manipulation and play than the other horses. Therefore, factors other than simply the management regimen were responsible for the individual differences observed.

11.4.3 Effects of Age

The older horses manipulated and played with the objects less than the younger horses in Replicate 1. However, these correlations were not significant in Replicate 2. This could be because habituation effects obscured any effects due to age. Overall no significant difference in the levels of object manipulation and play were detected between the two replicates. It might have been expected that as the older horses displayed little object manipulation and no object play and the younger horses would be expected to have habituated to the objects in the second replicate that the correlation between age and object manipulation may weaken. However, more object manipulation was displayed in Replicate 2 than in Replicate 1, whereas in the previous trials more object manipulation was displayed in Replicate 1 than in Replicate 2. Exhibition of object play was reduced in Replicate 2, but not significantly. So, this hypothesis may explain the weakening of the negative correlation between age and object play. It is also possible that rather than an effect of age being observed that an effect of level of training or work was observed. During the trial Jade was long-reined, but had not started training to be ridden; Solo had not started training and Bramble was on box rest (receiving topical treatment for sarcoids). These horses engaged in longer durations of object manipulation and play than those that were being ridden (Sammy, Lola and Rio). It may be that the riding horses had greater opportunity to express evolutionary adaptive behaviour, e.g. locomotion and exploration, than those that were not in ridden work and

that these highly motivated behaviour patterns were re-directed toward the training ball by the younger horses that were not in ridden work.

11.5 Conclusion

Auditory feedback did not appear to be an important factor in eliciting object manipulation and play in the domestic horse in this trial, although individual preferences for noisy and quiet objects may exist within the general population.

Older horses again appeared to manipulate and play with objects less. This confirms the results of the previous trials. However, in this trial the level of work and training may have also contributed to this result.

As the sample size of this study was small and the management regimens of the horses varied, further studies would be necessary to confirm these results.

Summary of Chapter 3

Seven trials were conducted in order to determine which sensory characteristics of play objects are important in eliciting object manipulation and play in juvenile and adult domestic horses.

- A survey determined that horse-owners have observed their horses exhibiting object manipulation and play and that horse owners believe play is an important part of horses' behavioural repertoire.
- It was not possible to identify any sensory characteristics of play objects that were significantly more successful than the others at eliciting object manipulation and play. The horses that displayed object play toward the objects (Trials 2, 4, 5 and 6) that were tested at the Equine Behaviour Centre are detailed in Table 11.4. The paper and textured anaglypta sacks elicited object play in the five out of six of the horses. Although these objects were not manipulated for significantly longer than the other sacks it appears that paper and a complex paper texture were appealing these horses.
- Age appears to affect the duration of object manipulation and play displayed. Younger horses display more object manipulation and play than older horses.
- The horses manipulated objects presented on the ground for longer than objects that were hung in the same observation area.
- The horses manipulated objects that were hung vertically more than objects that were suspended horizontally.

Table 11.4 A summary of the object play displayed by each horse toward the test objects

Object	April	Talia	Belle	Indie	Krystal	Kato
Brown paper sack	**X**	**X**	**X**		**X**	**X**
Plastic sack						
Jolly Ball			X			
Towel						
Stick				X		
Cotton sack		X		X		X
ANB		**X**	**X**	**X**	**X**	**X**
ANS		X			X	
BWB		X	X			X
BWS		X	X		X	X
Jolly Ball with handles		X		X	X	X
Box with handles		X		X		X
Chain-h5					X	X
Chain-v5					X	
Rope-h5					X	
Rope-v5					X	
Chain-h6		X				X
Chain-v6		X		X	X	
Rope-h6				X		X
Rope-v6		X			X	

Abbreviations:
ANB Textured anaglypta sack ANS Smooth anaglypta sack
BWB Textured bubble wrap sack BWS Smooth bubble wrap sack
Chain-h5 Chain suspended horizontally (Trial 5)
Chain-v5 Chain hung vertically (Trial 5)
Rope-h5 Lead-rope suspended horizontally (Trial 5)
Rope-v5 Lead-rope hung vertically (Trial 5)
Chain-h6 Chain suspended horizontally (Trial 6)
Chain-v6 Chain hung vertically (Trial 6)
Rope-h6 Lead-rope suspended horizontally (Trial 6)
Rope-v6 Lead-rope hung vertically (Trial 6)

CHAPTER 4

Discussion and Conclusions

12. Discussion

12.1 Object Manipulation and Play in Foals

12.1.1 Aim 1: To determine the ontogeny of object manipulation and play and its relation to the ontogeny of social play and solitary-locomotor play

Object manipulation and play was observed throughout the first three months of life, suggesting that it is an important part of the behavioural repertoire of domestic horse foals for acquiring information about their environment and acquiring and improving their feed handling skills.

On analysing the three foal studies it was not possible to detect a pattern in the development of object manipulation and play by investigating the duration of these behaviours, as they appear to be constant over the first three months of life. These results suggest that object manipulation and play does not develop in a similar way to that of solitary-locomotor play, which has been reported to decrease rapidly at two months of age, or social play, which has been reported to increase during two months of age in horses (Fraser 1992, Gunjima 1997). However, it was also not possible to detect these patterns in the development of solitary-locomotor or social play in the 1999 foal study group (Section 4). A possible explanation is that the observations in the studies presented in this thesis only provide a "snapshot" of the play behaviour displayed by domestic horse foals. This is more likely in the studies of the 2000 and 2001 foal study groups (Sections 5 and 6), in which observations took place only once a week, whereas in the 1999 foal study the foals were observed every other day.

Play is a relatively rare behaviour and the duration of play bouts is short. For example, the mean duration of play fighting is reported to be in the range of five to 20 seconds for a variety of species (Thompson 1998). Therefore, longer and more frequent observations may be required in order to detect any changes. It may also be that the pattern of object manipulation and play development is different for each foal, due to effects such as dam behaviour and other experiences that could not be controlled for in these studies. It was observed that foals with foal proud dams manipulated objects less

than foals with less foal-proud dams. The sample sizes in these studies were small, and so large individual differences could be obscuring developmental changes that would have been evident in larger sample sizes.

Social play did not increase over the first three months of life, in contrast to the suggestion of Fraser (1992). However, the positive correlation observed between social interactions and object manipulation and play suggests that play bouts consist of both these types of play behaviour, in agreement with other reports (e.g. Thompson 1998).

Object manipulation and play appeared to increase after weaning in the 1999 foal study. This could have been due to relative novelty, as the foals were only exposed to the Jolly Ball once a month during this period. It could also signify a developmental change and/or be associated with the stressful weaning process.

The increase in object manipulation and play observed between the first three month period of life and one year of age in the 2000 foal study group could be due to a developmental change and/or be associated with the weaning process. It is also possible that there is more than one "sensitive period" during which foals are receptive to novel stimuli, as shown in dogs (Serpell *et al* 1995), and that one such period occurs at around one year of age. It has been anecdotally suggested that a second sensitive period occurs in horses at six months of age, but the breed in which this was observed and the length of time it persisted was not reported (Simpson 2001). This is an aspect of development that warrants further investigation.

12.1.2 Aim 2: To determine whether "boldness" could be identified as a personality trait in domestic horse foals, and how the "boldness", or "inquisitiveness", of the foals affects the ontogeny of object play

Boldness was defined as the willingness of the foals to take risks. The foals that interacted with the observer, and so were considered bold, also manipulated objects more in the presence of an observer. Individual differences in the boldness scores were detected, suggesting that boldness may be an identifiable personality trait in domestic horse foals as in other species (Wilson *et al* 1994; domestic cats: Lowe and Bradshaw 2001). Further studies with larger numbers of subjects would be needed to support the results of those reported in this thesis. It would also be necessary to determine whether

this personality trait is an inherited effect or is affected by experience. It has been suggested that experience of close proximity contact in play fighting is important in giving an animal courage in social interactions (squirrel monkeys: Biben 1998). This implies that animals have become bolder through experience. It has been shown that boldness is context specific in pumpkinseed sunfish (*Leponis gibbosus*) (Coleman and Wilson 1998). Therefore, it may be more adaptive to be bolder, or seek risks, in some situations than in others. The positive correlation between the observer score and object score suggests that foals are equally bold when interacting with a person or an object in the presence of an observer, further suggesting that boldness may represent a personality trait in the domestic horse.

Temperament tests have been used in several studies in an attempt to categorize the temperament of animals. The methods used have included novel object and handling tests (domestic horse: Wolff, Hausberger and Le Scolan 1997; Visser, van Reenen, Hopster, Schilder, Knaap, Barneveld and Blokhuis 2001), exposing animals to a threatening and a non-threatening stimulus (pumpkinseed sunfish: Coleman and Wilson 1998) and scoring perceived personality traits using a coded scale (domestic dog: Serpell and Hsu 2001; domestic donkey: French 1993; domestic horse: Andersson, Friend, Evans and Bushong 1999). The advantage of using observational methods such as novel object and handling tests, or exposing animals to stimuli and recording their reactions, is that they are less subjective than reported scoring methods. However, the results of novel object and handling trials could be dependent on the animals' previous experience of the particular object used and their handling. This method may therefore be more appropriate for assessing young or naïve horses. The use of reported scoring methods has the advantage of being easy to use and does not necessarily involve having to place the animal in a controlled environment. However, scoring methods are subjective and will involve some inter-observer variability, which would need to be quantified.

The boldness score used in the 2000 and 2001 foal studies (Sections 5 and 6) was a crude scale used to estimate the foals' willingness to take risks by assessing their willingness to approach an observer and to manipulate objects in the presence of an observer. It would, perhaps, have been more useful to apply a series of tests carried out at different ages to assess the foals' temperaments at different stages of development.

The form of the test could be similar to that used by Visser *et al* (2001) to assess the temperaments of domestic horses. This included a handling test and a true novel object test, i.e. a different novel object would be used each time the foal was tested. This is in contrast to these trials where the same object was used throughout to control for the complexity of the stimuli presented by the play object. Temperament testing using different objects would, therefore, have to take place alongside the observational studies of object play. These tests would, however, be confounded by the complexity of the stimuli of the objects and the prior experience of the foals to novel objects. Temperament tests based on open field tests and handling tests could also be used. However, these too would have been confounded in these studies due to the effects of the amount of human handling the foals experience, environmental, maternal and dietary effects. Under the conditions of these studies, where the management of the foals could not be controlled, the use of a single object was considered to be the best way of eliminating other confounding effects in study groups with so many other uncontrollable independent variables.

12.1.3 Aim 3: To determine how the social environment of the foal affects the ontogeny of object play, and whether object play could have a role as a substitute for social play in socially isolated foals

The socially isolated foals did appear to manipulate and play with objects for longer periods than socially kept foals in the observation periods during the first three months of life. This result suggests that object play may have a role as a substitute for social play in socially isolated foals. The sample size was very small, however, so further investigation would be required to confirm these results. It would also be of interest to study the solitary kept foals as they matured to see how their play behaviour developed when compared with the socially kept foals.

Object play may be used as a means of redirecting frustrated social behaviour for domestic horse foals. Providing objects may, therefore, be useful for foals that are kept isolated from other conspecifics and when it is necessary to stable foals with their dam. In such situations the provision of objects may create a less restrictive environment. It has also been suggested that object manipulation and play could be used to redirect unwanted behaviours exhibited by foals during weaning and prevent the development of stereotypies (Mills and Nankervis 1999).

The composition of the social group in which a foal is raised may also affect the development of object manipulation and play. Colts are reported to play more than fillies (Tyler 1972) and so may stimulate a higher level of play behaviour in fillies than would normally be expected. Therefore, if foals are engaged in higher levels of social play they may interact less with objects. The relatedness of the foals within a group may also affect the play and social interactions displayed by individuals. Several species have been reported to play with kin more than unrelated individuals, including Japanese macaques (Glick *et al* 1986; Koyama 1985), Siberian ibex (Byers 1980) and big horn sheep (Berger 1979). Stallions have also been reported to play more with their sons; six times more than with unrelated, similarly aged colts (Berger 1986).

12.2 Sensory Characteristics

12.2.1 Aim 4: To determine which sensory characteristics of objects are important in eliciting object play in adult and juvenile domestic horses

The objects that appeared to be the most effective in the trials conducted were the Jolly Ball (the three foal studies), the paper sack (Trial 2), the textured anaglypta sack (Trial 4), the rope hanging vertically at the front of the liberty area (Trial 6) and the training ball, with and without auditory feedback (Trial 7). It was not possible to isolate any particular sensory characteristics that could be important in determining why these objects were successful in eliciting object play in domestic horses. However, it has been suggested that the most important features of play objects are novelty and the ability to stimulate multiple senses (Thompson 1996). Sensory characteristics may also supplement each other, and deficiencies in one characteristic may be compensated for by increasing one of the others (Hinde 1970). It is also possible that horses express individual preferences for certain stimuli. Therefore, the process of developing an object or objects that are successful at eliciting object play in horses is likely to be more complicated than simply isolating sensory characteristics of objects that appeal to horses. For an object to be successful as a "toy", exploration should decrease as familiarity increases and should be replaced by increased levels of play (Hinde 1970). For this to occur the toy would need to possess a high stimulus value. Also, responses to the same intensity of stimuli may change according to the animal's current state and competing motivations (Hinde 1970).

Future research to elucidate the sensory characteristics that are important in eliciting object manipulation and play in the domestic horse could investigate auditory feedback more thoroughly, as well as odour and objects that move without prior actions of the horse, i.e. spontaneously. It would then be prudent to combine the most successful stimuli from all the previous trials and investigate how their effects interact.

12.2.2 Aim 5: To determine how age affects the levels of object manipulation and play exhibited by domestic horses

During the trials reported in this thesis juvenile horses displayed more object manipulation and play than adults. This result was unsurprising as it is widely reported that in many species juveniles play more than adults (Fagen 1976). Explanations for this phenomenon include the possibility that juvenile animals have surplus energy that is dissipated through play (Bekoff 1976). It could be suggested that the adult domestic horses in these trials may also have had excess energy to dissipate. As domestication of the horse has led to a reduction in survival pressures on adults, in this respect it could be suggested that they could have similar excess energy to juveniles. However, the adult horses in these trials displayed virtually no object play. It is interesting that other domestic species, such as the dog and cat, continue to exhibit object play throughout adulthood. It may be that this represents a difference in the function of play between carnivores and herbivores, or that the behaviour of cats and dogs has become more paedomorphic than that of horses. Goodwin *et al* (1997) report that highly domesticated "immature" breeds of dog display a high frequency of play signalling. This supports the idea that the exhibition of juvenile social play behaviour in the adult animals has been encouraged by domestication.

It has been suggested that play occurs in sensitive periods of juvenile behavioural development (Byers 1998). This theory would best fit the observed differences between the levels of object manipulation and play during these trials, as it would be expected that adult horses would have more experience of different objects and may have habituated to certain sensory characteristics. Therefore, they may not have the same motivation to investigate objects as inexperienced juveniles. It is also possible that the exhibition of object manipulation and play is lower in adults than juveniles due to effects of training. During training horses may experience less freedom as they are taught

acceptable behaviour and may be punished for displaying play behaviours toward objects that their trainers may not wish them to damage. The results of these trials suggest that in future research investigating object manipulation and play in the domestic horse more object play data would be collected if juveniles were observed.

Other internal factors affecting object play, such as hunger, are also worthy of further investigation in the domestic horse. Hall and Bradshaw (1998) reported that domestic cats engaged in more object play when they were hungry. As the feeding behaviour of many stabled horses is restricted it is likely that they experience hunger. If the exhibition of object play behaviour increases when domestic horses are hungry then providing objects for play could be a potential means of environmental enrichment for stabled horses.

12.3 General Discussion

12.3.1 Individual Differences

Individual differences between the levels of object manipulation and play displayed by each horse were detected in the majority of the trials reported here. These differences would be expected, as individual variation ensures survival of the species through natural selection and adaptive evolution. Individual horses are likely to have different learning abilities, speed of acquisition and learning styles. Previous experience will also play a part in individual differences in behaviour. Favourable or unpleasant experiences associated with external stimuli are likely to have affected the responses of the juvenile horses in the trials reported here. It may be possible to reduce the effect of these individual differences in trials by increasing the sample sizes.

12.3.2 Sex Differences

Although there is evidence to suggest that colts play more than fillies (Tyler 1972), surprisingly, these differences were not detected during this research. The only difference detected between colt and filly foals was that colts appeared to be more cautious when investigating objects, seeming to prefer to spend longer pawing at objects and not lowering the head, which would then be vulnerable, towards them. This could be associated with the behaviour of stallions toward suspicious objects. The dominant

stallion of feral bands are reported to lead investigations of novel objects (Feist 1971). Therefore, colts may display more initial investigation toward objects than fillies. Low sample sizes also increase the effects of individual variation and may therefore have masked any effects due to sex. In the 2001 foal study it was not possible to test for sex effects because only one colt was recruited.

12.3.3 Effects of Stabling

The foals in the 1999 foal study displayed greater durations of object manipulation and play when they were stabled. This could be a re-direction of frustrated social and solitary-locomotor play behaviour, or simply because the foals encounter the objects more frequently in the confines of the stable. The objects in the stable may have created a more diverse environment for the foals. Further investigation would be necessary to determine whether or not foals that manipulate objects in their stable continue to do so when they are juveniles and adult horses. This may affect how successful object manipulation could be as a form of long-term environmental enrichment for stabled domestic horses.

The stabling regimen of the adult and juvenile horses observed in the sensory characteristics trials also appeared to affect the levels of object manipulation and play displayed. Stabling for 22 hours a day for a short period of time appeared to increase the duration of object manipulation displayed by the females in Trial 2. This concurred with the results of Mal *et al* (1991). In the long term this stabling regimen appeared to cause a reduction in the display of object manipulation in Trial 3. This could have occurred because the area around the stables was very busy and so the horses may have been distracted from manipulating the objects by activities outside the stable. Also, as the horses in Trial 3 were all adults, and older horses were observed to manipulate objects less than younger horses in later trials, it is possible that this result could also be explained by age effects rather than the effect of the stabling regimen. If long term stabling was shown to cause a reduction in the display of object manipulation and play, it is possible that it would also be linked to an observed increase in apathy and inactivity which is reported to be a coping strategy in monotonous environments (Wood-Gush and Vestergaard 1989). This is referred to as "star-gazing" in horses (Luescher *et al* 1991). Further investigation of the provision of objects at the beginning of a period of long term stabling would indicate whether the effect of increased object manipulation produced in

Trial 2 persisted. This could be useful in determining whether object manipulation and play could be effective as a means of environmental enrichment for horses that require long-term, prolonged stabling.

12.3.4 Effect of the Observer

Crowell-Davis (1992) reports that the behaviour of domestic horses observed at pasture was affected by the presence of an observer. The presence of an observer has also been shown to influence the behaviour of other species. Domestic cats displayed more defensive behaviours when observed directly by an observer rather than from remote video recordings (Nott and Bradshaw 1994). Captive red-bellied tamarins (*Sanguinas labiatus*) were observed to enter their nest boxes significantly later in the presence of both familiar and unfamiliar observers (Caine 1992). This was the predicted result, as tamarins prefer to keep their nest sites concealed from predators. Therefore, in the three foal studies the presence of the observer could have affected the behaviour of the foals and the other horses kept with them. If the foals were made apprehensive by the presence of the observer, play may have been inhibited, as it occurs when animals are in a relaxed state (Carlstead 1996). Also, the observer may have distracted the foals and so the time the foals spent investigating the observer could have been spent in other ways, possibly in social, solitary-locomotor or object play. Although the observer attempted to remain neutral throughout the observations it was also sometimes necessary to move away from the foals, for example, if they were becoming too boisterous or aggressive. The foals may also have been able to detect inadvertent behavioural cues. For example, the direction of gaze of the observer may affect the foals' behaviour. It has been reported that eye contact made during cat/human interactions can have significant effects on the cat's behaviour (Goodwin and Bradshaw 1997). In all species, apart from primates and humans, gaze functions as a threat/aggression signal (Argyle and Cook 1976). The eyes of predator species tend to be located on the front of the head so that when a predator is looking at another animal both eyes are visible to the other animal. Black iguanas (*Ctenosaura similis*) can use gaze direction to assess the threat of an approaching predator (Burger, Gochfeld and Murray 1992) and sparrows (*Passer domesticus*) can detect three levels of looking: direct, averted and looking directed away from the sparrow (Hampton 1994). Therefore, in future research it may be more appropriate to conceal the observer to reduce any observer effects.

A remote camera was used for all the trials investigating the sensory characteristics of objects (Sections 7-11), except in Trial 3 (Section 9), when a hand held camera was used to film observations from outside the stable. This may also have affected the horses' responses during observations as discussed previously.

12.3.5 Potential of Object Play for Environmental Enrichment

For juvenile and adult domestic horses the provision of objects could be useful as part of an environmental enrichment programme when stabled. A point worthy of further investigation would be whether prior experience of objects as a foal or a juvenile affects the exhibition of object play in adults. The individual differences detected in this thesis suggest that different horses are likely to play with different objects. Also, as novelty decreases the horses will habituate to objects and show less object manipulation and play toward them. Therefore, as suggested by Brent and Stone (1996), several objects may need to be used in rotation to maintain levels of object manipulation and play. Further research would be necessary to determine the length of exposure necessary for horses to habituate to objects and what factors would then induce dishabituation. For example, Hall (1995) habituated domestic cats to a toy during three, three minute sessions. In the fourth session if the colour of the toy was changed it had a post-inhibitory rebound effect and the duration of object play increased. This suggests that in the domestic cat changing the colour of the toy increased the stimulus value of the toy sufficiently to make the toy novel again and elicit object play.

The long term effect on the time budget of stabled domestic horses of providing objects would need to be studied in order to determine whether it could be used to improve welfare. For object manipulation and play to be useful in reducing the incidence of stereotypic behaviour the stimulation derived from it would need to be more rewarding than that derived from the stereotypic behaviour. This in itself could be difficult to achieve. Mills and Nankervis (1999) suggest that horses may need to be trained, or encouraged to play with toys. However, even when object manipulation was reinforced in adult humans with developmental disabilities it could not compete with the stimulation produced by stereotypic self-injurious behaviour (Lindberg J.S. *et al* 1999). Preference tests may be useful in determining the effects of the provision of play objects on welfare, by giving horses a choice between a standard stable and one containing play objects.

Two-choice preference tests have been used successfully in previous studies of the domestic horse to compare the preference of stabled horses and free-ranging horses for visual contact with other horse and preference for bedding (Houpt 1991). This type of test could also be implemented to test for preferences to different sensory characteristics, which could be useful to identify which stimuli are most important in eliciting object play in the domestic horse.

12.4 Conclusions

1. Object manipulation and play is an important part of the behavioural repertoire of domestic horse foals for acquiring information about the environment and handling skills.
2. The development of object manipulation and play in domestic horse foals appears to be different in each individual and affected by many factors, e.g., breed, management factors, personality (i.e. boldness), social environment and experience
3. The individual personality of foals, measured as boldness in this thesis, affects the amount of play behaviour displayed. Bolder foals, those that readily engage in interactions with the observer, also play with objects more in the presence of an observer. Whether this personality trait is inherited or due to previous experience is worthy of further investigation.
4. The social environment of foals appears to affect the amount of object manipulation and play displayed. Foals that are kept with no other foals appear to manipulate and play with objects more than those kept with at least one other foal. This suggests that object manipulation and play may have a role as a substitute for social play in domestic horse foals.
5. It has not been possible to identify which sensory characteristics are important to make an object successful at eliciting object manipulation and play in all juvenile and adult horses. It is likely that this is due to horses exhibiting individual preferences for certain combinations of sensory characteristics. Using larger sample sizes in future trials may reduce this effect.
6. As reported in other species age does affect the amount of play behaviour displayed (Fagen 1976). Juvenile horses appear to play with objects more than

adults. However, it is not clear why and when this occurs in the domestic horse. It may be an effect of the start of training for riding, as they are then rapidly introduced to new experiences. Alternatively, increased experience alone may lead to a decline in the horse's response to novel objects. The observed increase in object play at one year of age compared with the first three months of life could be an effect of weaning or another developmental change. It may also indicate a sensitive period for object play. Developmental changes also appear to affect the composition of object manipulation in foals, leading to a decrease in the duration of investigative behaviour over the first three months of life.

12.5 Future Research

The studies of foals presented in this thesis have demonstrated the importance of object manipulation and play in the development of domestic horse foals. They have also shown that object play could have a role as a substitute for social play in domestic horse foals. It would be of interest to thoroughly investigate the effect of the dam's behaviour, and the sex ratio and relatedness of the foals' social group, on the development of object manipulation and play.

The seven trials investigating what sensory characteristics of objects elicit object manipulation and play showed that mature horses exhibit less object play than juveniles. The effect of the interaction of these sensory characteristics on the exhibition of object play warrants further investigation. When successful play objects have been identified, it would then be of interest to investigate the potential of object play as a form of environmental enrichment for stabled domestic horses using preference tests.

Appendix

Domestic Horse Play Questionnaire

The coding framework used for this questionnaire is included beneath each question in brackets

Carys Hughes (BScHons)
Anthrozoology Institute
School of Biological Sciences
University of Southampton
Southampton SO16 7PX
Phone: 01703 594254

Horse Play Questionnaire

I am a postgraduate student at the Anthrozoology Institute (AzI), University of Southampton. Research at the AzI includes behavioural studies of companion animals and the bond between animals and humans. I am conducting a research project studying play in horses. The first step of my project is to find out about horse owners' attitudes to play in horses and how their horses play.

I would be very grateful if you could spare me some time to fill out the following questionnaire and help me with my project. There are no right or wrong answers and all information you give me will remain confidential.

To begin with it would be useful for me to know a little about you and your horse.

Are you: **Male** □ **Female** □ (please tick a box)

(0) (1)

Which age category are you in? (please tick a box)

Under 18yrs □ **18-35yrs** □ **36-50yrs** □ **Over 50yrs** □

(0) (1) (2) (3)

How many horses do you own?.....

How long (in total) have you owned horses?.....

PTO

Please choose one of the horses that you own to tell me about

Age..... **Breed**..... **Sex**.....

(0=warmblood, 1=non-warmblood) (0=female, 1=gelding)

How long have you owned your horse?.....

Do you stable your horse, and if so, when and for how long each day?.....

.....

(0=stabled during the day in summer or over night in winter, 1=always stabled over night, 2=stabled all the time in the winter or during the day in summer and at night in winter, 3=stabled all the time)

What type of work do you do with your horse (ie hacking, endurance, jumping, dressage etc.)?.....

1. a) Do *you* think that horses play? (please tick a box)

Yes □ **No** □ **Don't know** □

(0) (1) (2)

b) Do *you* think that horses play with objects? (please tick a box)

Yes □ **No** □ **Don't know** □

(0) (1) (2)

2. Do *you* think that it is important for horses to play? (please tick a box)

Yes □ **No** □ **Don't know** □

(0) (1) (2)

3. **How** do you think horses benefit from;

a) playing with other horses?.....

b) playing with objects?.....

4. Do you discourage your horse from;

a) playing with other horses? (please tick a box)

Yes □ **No** □

(0) (1)

If yes, why?.....

b) playing with objects? (please tick a box)

Yes □ **No** □

(0) (1)

If yes, why?.....

5. a) Approximately how often do you see your horse play with other horses?

Every day □ **Once a week** □ **Once a month** □

(0) (1) (2)

Less than once a month □ **Never** □ (please tick a box)

(3) (4)

b) Approximately how often do you see your horse play with objects?

Every day □ **Once a week** □ **Once a month** □

(0) (1) (2)

Less than once a month □ **Never** □ (please tick a box)

(3) (4)

c) If your horse plays with objects where have you seen it play? (please tick a box)

In the field □ **In the stable** □ **both** □

(0) (1) (2)

d) What objects have you seen your horse play with?.....

.....

6. a) Do you give your horse objects to play with in the stable? (please tick a box)

Yes □ **No** □

(0) (1)

b) If yes, what?.....

.....

c) If no, why not?.....

.....

d) Has your horse lost interest in any of the objects you've put in the stable? (please tick a box)

Yes □ **No** □

(0) (1)

e) If your horse has lost interest in an object;

i) Which object(s) did your horse lose interest in?.....

.....

ii) After how long did your horse lose interest?.....

.....

iii) If your horse lost interest what did you do about it?.....

.....

7. a) Have you ever given your horse a stable toy (a commercial toy, or a home-made one) to reduce or prevent unwanted behaviour? (please tick a box) **Yes** □ **No** □

(0) (1)

What behaviour(s) were you trying to reduce/prevent?.....

.....

c) How long was it reduced/prevented for?.....

.....

8. a) Have you ever used any other methods to reduce or prevent unwanted behaviour?

Yes □ **No** □ (please tick a box)

(0) (1)

b) If yes, which?.....

.....

c) What behaviour were you trying to reduce/prevent?.....

.....

d) How long was it reduced/prevented for?.....

.....

9. Would you use a stable toy if you felt that it would reduce problem behaviour?

Yes □ **No** □ **Don't know** □ (please tick a box)

(0) (1) (2)

10. Would you use a stable toy if your horse had no problem behaviour?

Yes □ **No** □ **Don't know** □ (please tick a box)

(0) (1) (2)

Thank you very much for your time.

I am interested in filming horses playing with objects, or not playing with objects, as the case may be. If you would be willing for you and your horse to take part in one of my studies please fill in the contact information below.

All information in this questionnaire and any data acquired from observing your horse will remain confidential, although I would let you know your own horse's results.

Your name:.....

Your horse's name:.....

Address:.....

.....

Glossary

Colt

An uncastrated, juvenile male horse aged three years or younger

Dam

The mother of a foal

Filly

A female, juvenile horse aged three years or younger

Gelding

A castrated male horse

Mare

A female, adult horse aged over three years

Non-Warmblood

This type of horses includes cold-blooded horses, for example Shires and Clydesdales, with phlegmatic temperaments and ponies, for example New Forest Ponies and Shetlands, with variable temperaments (Fraser 1992).

Stallion

An uncastrated, adult male horse aged over three years

Warmblood

For example: Thoroughbred and Arabian breeds.

This type of horses have more reactive temperaments (Fraser 1992).

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