



Review

A review of the human–horse relationship

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Abstract

Despite a long history of human–horse relationship, horse-related incidents and accidents do occur amongst professional and non professional horse handlers. Recent studies show that their occurrence depend more on the frequency and amount of interactions with horses than on the level of competency, suggesting a strong need for specific research and training of individuals working with horses. In the present study, we review the current scientific knowledge on human–horse relationships. We distinguish here short occasional interactions with familiar or unfamiliar horses (e.g. veterinary inspection) and long-term bonds (e.g. horse–owner).

An important aspect of the horse–human relationship is to try and improve the development and maintenance of a strong *positive* relationship. Studies show that deficits in the management conditions (housing, feeding, possibilities for social contact, and training methods) may lead to relational problems between horses and humans. Different methods have been used to assess and improve the human–horse relation, especially at the young age. They reveal that the time and type of contact all play a role, while recent studies suggest that the use of familiarized social models might be a great help through social facilitation.

We argue that an important theoretical framework could be Hinde’s [Hinde, R., 1979. *Towards Understanding Relationships*. Academic Press, Londres] definition of a relationship as an emerging bond from a series of interactions: partners have expectations on the next interaction on the basis of the previous ones. Understanding that a relationship is built up on the basis of a succession of interactions is an important step as it suggests that attention is being paid to the “positive” or “negative” valence of each interaction as a step for the next one. A better knowledge of learning rules is certainly necessary in this context not only to train the horse but also to counterbalance the unavoidable negative inputs that exist in routine procedures and reduce their impact on the relationship.

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It appears clearly that research is needed in order to assess how to better and safely approach the horse (e.g. research in position, posture, gaze, etc.), what type of approaches and timing may help in developing a positive bond, what influence human management and care have on the relationship, and how this can be adapted to have a positive influence on the relationship. Also the interaction between rider and horse, the search for the optimal match between two individuals, is an aspect of the horse–human relationship that requires attention in order to decrease the number of horse-riding accidents and reduced states of welfare. On the other hand, adequate knowledge is readily available that may improve the present situation rapidly. Developing awareness and attention to behavioural cues given by horses would certainly help decreasing accidents among professionals when interacting. Scientists therefore should play a major role in transmitting not only elements of the current knowledge of the ethology of the horse but also by helping developing observational skills.

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1. Introduction

Human–horse relationship has a long and varied history. While meat may have been the first motivation in the very early stages for domestication, horses became progressively important “tools” for transportation and, like other domestic animals, they are currently more and more used as companion animals (Digard, 1999). Contrarily to many other domestic ungulates, which

are mostly kept for breeding, meat production, milk production or wool production, horses “rapidly” acquired a mixed status: source of food for some, for leisure and sport for others, or, less frequently, an agricultural working companion in rural areas (Edenburg, 1999). Recently, another use of horses has gained a lot of attention. Horses and horseback riding is getting very popular in therapeutic riding programs (Anderson et al., 1999).

This diversity of uses corresponds to a diversity of people: professional and non professional riders, breeders, lads and caretakers, farriers, veterinarians, therapists, etc. The interaction between horse and human can be observed in a spectrum from the short occasional interactions (for example a veterinarian) to the really long-term bond that appears between an owner and his/her horse. In every case however, problems are possibly encountered, that reveal difficulties in the interspecific communication.

Most available information comes from surveys of accidents that do not give an overview of all problems, but enable us to extract relevant information about the context and types of persons involved. The frequency of biting by horses for example appears low compared to other domestic animals (2%: Moore et al., 2003). Horses were in overall responsible for 15% of accidents in a survey of 995 American veterinarians behind cattle and dogs, who are responsible for respectively 46% and 24% of the accidents (Landercasper et al., 1988). In a similar survey, performed under 216 Swiss veterinarians, it appeared that 75% of them were kicked at least once a year (3% were kicked 5–10 times); these accidents could not reliably be associated with the horse’s breed or emotional state at that time (Jaegglin et al., 2005). An interesting finding is that the tendency to be injured was more related to the degree of exposure to horses than to experience: the practitioners who did not own a horse were less often kicked by horses. The same conclusion was reached in other studies performed in Switzerland (Exadaktylos et al., 2002), Kentucky in the United States (Kriss and Kriss, 1997) or New Zealand (Johns et al., 2004): non riding accidents (especially kicks) are more frequent in professional people and rely more on the frequency and amount of interactions with horses than on the level of competency.

These studies underline the need for a better knowledge and observation of the behaviour of the horse in these professions. While falls during riding are more related to non professional riders as mentioned in the United States (63%: Kriss and Kriss, 1997; McCrory and Turner, 2005), in Australian (66%: Abu-Zidan and Rao, 2003), in British (75%: Chitnavis et al., 1996) and in New Zealand reports (Johns et al., 2004), most accidents involving professional people happen mainly when at foot (grooming, cleaning stables, breeding, etc.) as recorded by the “Mutualité Sociale Agricole” (agricultural social insurance) in France in 1999 (51% out of 2057 cases of accidents followed by sick leave). In overall, people working with horses are exposed to different occupational hazards when at foot compared to professional riding (Holler, 1984; Iba et al., 2001; Turner et al., 2002).

These general observations suggest that different skills may be required in various contexts. Difficulties in riding situations, often due to unexpected movements of the horse (Newton and Nielsen, 2005), may involve both choice of horse–rider combination and choice of training methods (Weeks and Beck, 1996). Statistical data on falls rarely make a difference between occasional horse–rider combinations or combinations in which the rider also is the owner of the horse and hence owner/horses pairs with an established relationship has been created. Difficulties in the daily working situation may involve particularly close attention and good observational skills from people. Most reports on horse accidents state that horses were not necessarily nervous at the time of the accident.

These reports are indicative of a real need in understanding how to behave with horses and develop a better relationship. Differences are to be expected according to whether the person has

to deal with an unfamiliar horse during a short interaction (veterinarians, farriers) or with one or several familiar horses on a daily basis (caretakers, owners). In the first case, close attention and good observational skills have to help positioning and handling at the present moment; in the second case, each interaction will have an influence on the following one and the same skills have to be used in order to establish and maintain a positive bond.

Hinde (1979) defined a “relationship” as the emerging bond from a series of interactions: partners have, on the basis of the past experiences, expectations on the other individual’s responses. In the present report, we will try and review the present scientific knowledge on how to better interact and develop a relationship with horses. The scientific interest on human–horse interactions is becoming increasingly popular (Robinson, 1999) but sound data is still limited, especially on the rider–horse relationship.

2. Interacting with horses: which elements are relevant?

There are a number of important elements to consider when approaching or handling horses.

When approaching, humans display postures, may produce vocal signals and may or may not focus their attention on the animal by gazing at the focal animal. The famous case of Clever Hans has revealed how a horse is able to detect and use subtle visual information displayed by a person (Pfungst cited in Waring, 2003).

Positioning, i.e. the relative angle and distance from one organism to another organism, has been suggested to be important in cattle (Grandin, 1980; Grandin and Deesing, 1998) but up to now, no scientific publication is available on horses. It is highly probable however that an inappropriate position (e.g. approaching closely from behind) may be responsible for some of the accidents recorded (Exadaktylos et al., 2002). We know that horses do show lateralized responses to stimuli (direction of gaze towards novel objects) which suggests that the side of approach may have an influence (Larose et al., 2006).

Seaman et al. (2002) did not find an influence of the direction of the gaze of the human on the reactions of horses. There was no difference between a person approaching with or without visual contact. Again, further research is needed. Especially, as some ponies or horses seem to be sensitive to pointing or touching an object as a directional cue (McKinley and Sambrook, 2000).

Emotional cues may be carried by humans through different channels: voice (prosody), posture, expression and pheromones. The only single study performed on emotional cues shows that when people have negative feelings towards animals, while stroking a horse, they induce an increase of heart rate in the animal in the first few minutes. “Neutral” or “positive” persons do not have such an influence (Hama et al., 1996). Chamove et al. (2002), who performed a study on the effect of human attitude on horse behaviour with one single horse, suggested that human attitude correlates with the behaviour of the horse when led through a predefined course. Similarly, Morgan et al. (2000) suggest that the rider’s personality correlates with behaviour patterns of the ridden horse.

There is no evidence whatsoever that the gender of the human has any impact on the behaviour of the horse: yearlings behaved the same way towards a female and a male experimenter in Henry et al.’s (2005) study.

It is likely that other factors such as type or colour of clothes may have an influence, but probably more as a result of experience (white coat and veterinarian handling for example).

Finally, the way the horse is handled may induce different types of reactions. Restraint in its different facets (twitch, hobble, chute, bit with a chain, etc.) is often used in order to avoid flight or aggression but application of a twitch reveals to be one of the important sources of accidents

for equine veterinarians (Pasquet, 2004). Additionally, a forced contact, early in life, may also induce reluctance for human contact in foals at later stages (Henry et al., 2006b).

This last finding emphasizes how experience through single interactions may shape the relationship between humans and horses. Naturally, the horse's own temperament is a substrate on which these experiences will model the way horses respond to humans (Hausberger and Richard-Yris, 2005). Individual differences are observable in young horses raised in similar environments in their tendency to approach or avoid human contact (McCann et al., 1988a; Visser et al., 2001, 2002, 2003a; Lansade and Bouissou, 2005).

However, reactions of horses to interactions with humans are mostly the result of this interplay between their own temperament, the temperament and skills of the human and the experience acquired with humans. Since so little is known scientifically on the best ways to approach the horses, and because of these individual behavioural differences in horses, no recipe-based method can be given by scientists to improve the way horse-people should interact with these animals. However, there is enough present knowledge on horse behaviour and observation methods to help training professionals and non professionals in terms of observational skills and attention, which are, as mentioned earlier, key elements, at least to prevent accidents. The best we can do at present is certainly train people to ethological observational methods, attract their attention to the horse's body postures and attitudes (see Waring, 2003 on postures in horses) and prevent anthropomorphic interpretations of behaviour. If attention is given and maintained on the horses' signals, based on a better knowledge of behaviour, then the horses' responses to the human approach can best teach to people what is the proper way and how to adapt to different horses.

An up to date transmission of scientific knowledge, such as this review, is the necessary complement to practical training of the observational skills.

Finally, while we have to admit that scientifically very little is known on how to approach an unfamiliar horse by adapting posture, position, direction of gaze, emotional state and that a whole line of research is to be developed here, a large number of studies, mostly in the last decade, have concentrated on the human–horse relationship and its development.

3. Human–horse relationship

Most scientific studies focus on how the animal “considers” humans as a positive, negative or neutral stimulus (Waiblinger et al., 2006) as the result of previous interactions. This requires measurements and evaluations to assess the impact of the experience reflecting the type and length of the interactions.

3.1. Tools for assessing the horses' relation to humans

The development of methods to evaluate the way horses react to humans is rather recent and a variety of approaches have been developed, especially through behavioural tests.

3.1.1. Observer ratings

The aim here is to have an evaluation of the general way horses behave towards humans in their domestic environments. It is thought that familiar caretakers or “users” may have a good appreciation of the personality of the animals they work with regularly, which includes the relation to humans (Gosling, 2001). A large survey where trainers and veterinarians assessed the behaviour of 10 different breeds revealed that Quarter Horses were classified as “patient” or

“obedient” while Arabian horses were classified as “over-reactive” (Hayes, 1998). Other questionnaires have been designed to compare reactions in a behavioural test to the working situation. In these studies correlations were found between reluctance to be led over an unfamiliar obstacle (“bridge test”) and fear reactions while ridden or handled (Le Scolan et al., 1997), between fear reactions during the exposure to a novel object (“novel object test”) and the perception of personality traits by unfamiliar riders (Visser et al., 2003b), and between learning abilities in a test and performance or trainability in a riding situation (Le Scolan et al., 1997; Visser et al., 2003a,b) or at ground work training (Fiske and Potter, 1979).

Finally, some studies focus on evaluations of personality inspired by researchers in the psychometric field (Mills, 1998; Morris et al., 2002; Momozawa et al., 2003, 2005), amongst which horses are being assessed for their tendency to be “affectionate”, “confident” (Mills, 1998) or show “agreeableness, conscientiousness” (Morris et al., 2002) or “friendliness” (Momozawa et al., 2005) in their relations to humans. These methods, however, remain dependent on commonly used terms that may be interpreted differently according to the person (Mills, 1998) and the results may not be suitable for unusual situations or simply for studies on horse behaviour. Although this way of assessment is gaining popularity, the problem of uniformity of the definitions makes it very hard to be useful in training horse people to assess the horses’ behaviour objectively. It should therefore remain complementary to other methods and only be used in scientific studies. Apart from the scientific aspects, it is clear that these approaches can not help training horse people to have an “objective” view of the horse’s behaviour and therefore should be at best kept for the scientific community.

3.1.2. Behavioural tests

Different tests have been designed to test or assess reactions of horses to humans. Tests have been designed in which a human stands still and waits for the horse to approach (e.g. Visser et al., 2001; Seaman et al., 2002; Søndergaard and Halekoh, 2003; Lansade et al., 2004; Henry et al., 2005), tests in which the human moves around (e.g. Jezierski and Gorecka, 2000; Pritchard et al., 2005), tests in which the human approaches the horse suddenly (Hausberger and Muller, 2002) or slowly (e.g. McCann et al., 1988a), and tests in which the human tries to touch the horse (e.g. Søndergaard and Halekoh, 2003; Henry et al., 2005, 2006b).

More “invasive” methods consist in assessing either the acceptance of foals to stroking (e.g. Spier et al., 2004; Henry et al., 2005), equipment fitting (Henry et al., 2005, 2006b; Lansade and Bouissou, 2005) or their response to forced actions such as stroking (e.g. Hama et al., 1996; Williams et al., 2002), grooming (Feh and de Mazières, 1993), catching (e.g. Jezierski et al., 1999), hoof picking (e.g. Spier et al., 2004), and veterinarian inspection (e.g. Houpt and Kusunose, 2000; Simpson, 2002).

Finally, tests have been designed to evaluate the horses’ responses while being led (e.g. Mal and McCall, 1996; Lansade and Bouissou, 2005), possibly over an unfamiliar obstacle (Wolff et al., 1997; Visser et al., 2001) or in a truck (e.g. Shanahan, 2003), and tests in which their behaviour is recorded during breaking (Heird et al., 1986; Rivera et al., 2002; Søndergaard and Ladewig, 2004; Lansade and Bouissou, 2005).

Except for the handling tests which are rather specific (hoof picking, truck loading, vet examination etc.), three categories show up amongst the most commonly used tests (Waiblinger et al., 2006):

- *The motionless person test* which consists of one person entering the test area (e.g. Seaman et al., 2002; Nicol et al., 2005), the stall-box (e.g. Williams et al., 2002; Henry et al., 2005), the

field (Henry et al., 2005) or stands in front of the box (e.g. Lynch et al., 1974; Visser et al., 2001) and who remains still at a distance of a few meters from the animal to be tested. Information concerning visual contact is scarce; the experimenter seeks it (Seaman et al., 2002), avoids it (Seaman et al., 2002; Simpson, 2002) or literature is not informative on the fact. Tests do not exceed 10 min.

- *The approach test* in which a person comes closer to the horse, in the test area, the stall-box or the field. Sometimes it is held by a second person (Jeziński et al., 1999) or tied (Jeziński and Gorecka, 2000; Pritchard et al., 2005). The horse is more often alone but if it's a foal, its mother is present and some authors test an individual in the presence of conspecifics (e.g. Lynch et al., 1974; Søndergaard and Halekoh, 2003; Nicol et al., 2005), thus minimising the effects of social isolation for animals which are not accustomed to be alone. A slow and regular gate towards the horse is mainly described and the person walks in direction of the head (with a 45° angle, Pritchard et al., 2005) or the shoulder (Henry et al., 2005, 2006b), looking at the animal or not (Simpson, 2002). The duration of the procedure is a few minutes.
- *The stroking test* in which the goal of the experimenter is to evaluate either the reactions of the horse to human physical contact or the tolerance or both. The horse remains free (e.g. Henry et al., 2005; Søndergaard and Halekoh, 2003) or is restrained (e.g. Hama et al., 1996; Spier et al., 2004). The contact is made on a defined area such as the neck (e.g. Hama et al., 1996; Henry et al., 2005) or the withers (Feh and de Mazières, 1993). Measures consider the reaction of the animal in terms of immobility or interaction with the experimenter (e.g. Henry et al., 2005), or the variations in the horse's heart rate variables (e.g. Feh and de Mazières, 1993; Hama et al., 1996). The tolerance of the animal is assessed by the ability of the experimenter to stroke it or not (e.g. Henry et al., 2005; Spier et al., 2004) and the duration of acceptance of the stimulus (e.g. the saddle pad on the back: Henry et al., 2005).

3.1.3. Behavioural measures

Measurements include for example latency to approach the person (e.g. Visser et al., 2001) or allowing to be touched (e.g. Henry et al., 2005), scores of reactivity with a predefined scale (McCann et al., 1988a,b; Houpt and Kusunose, 2000; Hausberger and Muller, 2002; Pritchett et al., 2003) or frequencies of target behaviours such as number of interactions with the experimenter (e.g. Søndergaard and Ladewig, 2004; Nicol et al., 2005), or gazes (e.g. Henry et al., 2005; Nicol et al., 2005).

3.1.4. Physiological measures

Heart rate (HR) and other related variables, such as heart rate variability (HRV, rMSSD) have been measured in several studies during handling or in response to the mere presence or appearance of a human (e.g. Feh and de Mazières, 1993; Hama et al., 1996; Williams et al., 2002; Visser et al., 2003b).

Cortisol levels have been measured in several studies (e.g. Rivera et al., 2002; Shanahan, 2003) and one study investigated glucose (Spier et al., 2004). It is assumed that when the horse is exposed to a stressful event, its levels of glucose and cortisol would increase. These measures have proved useful in a variety of studies as complementary ways of assessing the potential emotional reaction of the horse to humans but also give rise to contradictory results (e.g. Mills et al., 1997; Mal et al., 1991). An increase in cortisol level may also for example be induced by the mere act of sampling, especially if the horse had previous negative experience with venipuncture and not as much by the human presence. Therefore these measures must be accompanied by other behavioural measurements.

3.1.5. *Measuring the reactions of horses to humans: a good way to assess the relationship?*

Despite the fact that many studies converge towards similar procedures, the details of these procedures may vary greatly or are not always described precisely. Direction of gaze, posture, positioning, speed of approach, precise type of contact are most often either not mentioned or roughly described. Caution should therefore be taken in comparison of these studies and future work should aim at standardizing variables, especially as their effects on the horses' behaviour is not known.

Yet another important facet of these tests is that the experimenter can be either a familiar or unfamiliar person. The use of such tests for assessing how the horse "categorizes" the humans in terms of positive, negative or neutral stimulus (Waiblinger et al., 2006) implies that horses are considered to be able to generalize from their daily contact with humans to an interaction with an unfamiliar person. That horses are able to generalize has been demonstrated for some cognitive abilities (Hanggi, 2003), but less is known about possible emotional associations. In a study of Henry et al. (2005) however, young horses showed similar reactions to two different experimenters (familiar woman/unfamiliar man), suggesting that this may be the case. Similarly, horses managed by the same caretaker tended to show similar reactions to the appearance of an unfamiliar person (Hausberger and Muller, 2002). On the other hand, a simple test with an unfamiliar person may not totally reflect the potential bond between a horse and its owner or caretaker (Pritchard et al., 2005). Both evaluations would probably be useful.

3.2. *Evaluating the humans' relation to horses*

In a recent review, Mills and Mc Nicholas (2005) surveyed the present knowledge on how humans consider their horse. Early reports mention that the majority of riders consider their horse to be part of the family, but that the relationship with horses also depends on society (e.g. Anglo-American versus French society where horses are more readily eaten). Moreover, unlike other pet animals, horses are often not kept on a life long scale as they may be sold when not "usable" or "suitable" anymore. However, even in high level competition, the relationship is considered as involving an emotional bond (Wipper, 2000). In all cases, grief is observed when a horse is lost through euthanasia (Brackenridge and Shoemaker, 1996a,b,c). Little is still known though on how the reciprocal bond builds and what each partner put into the relationship. It is highly probable that the way owners or caretakers "view" their horses has an important influence on the way they manage and handle them, as has been demonstrated for other domestic animals (Lensink et al., 2001).

3.3. *Human management and horse behaviour towards humans*

Few studies have broached this question and none of them gives real information on what factors precisely are involved in the effects of human management on the behaviour of horses towards humans. When comparing the behavioural reactions of adult breeding stallions in different national facilities, Hausberger et al. (2004b) found large differences between sites in the emotional reactions and learning abilities of horses, but particularly in a test where an unfamiliar experimenter led the horse over an unknown obstacle ("bridge test"). As the different sites did not differ in terms of way of life (box), food, activity (breeding with little work), the authors suggested that the way the humans behaved towards the horses (caretakers) may be responsible for the differences. This hypothesis is reinforced by the finding that, in a study on 224 geldings living in the same conditions, the reactions of the horses to the sudden appearance of an

unfamiliar person could be related to the caretaker. Each caretaker was responsible for 7–8 horses and these horses tended to respond similarly to this human reaction test (Hausberger and Muller, 2002).

Finally, in a survey on 21 breeding farms, Hausberger et al. (2004a) found large differences in the tendency of yearlings to approach a standing motionless person or to be approached or touched, according to the farm, ranging from 0 to 100% of the foals seeking human contact.

These results strongly suggest that the daily human–horse contact has a great influence on the way horses perceive humans and the resulting relation.

The way horses are handled repeatedly can progressively induce reactions: in the Hausberger et al. (2004a) study, the less familiar yearlings had been either very intensively handled or neglected. More contacts could be established with yearlings which had been handled more episodically around weaning or after.

As mentioned before there is a lack of knowledge on the effects of parameters such as ways of handling in adults, attitude of the caretaker (posture, voice, . . .) on the horses reactions to humans while these aspects are certainly crucial in the establishment of the relationship.

The “site” as a multidimensional factor (environmental conditions and human management) appeared as one of the major factors in determining personality in adult horses in a large scale study (Hausberger et al., 2004b).

3.4. *Horse personality and its influence on the relation*

Despite an important increase in studies on horses’ temperament and personality in recent years (review in Hausberger and Richard-Yris, 2005), very few studies focus on this question. Genetic effects may be involved. Differences according to sire have been found in the reactions of 9000 young thoroughbreds to a veterinarian inspection while the offspring of a given stallion tended to react the same way even when living in different training centres (Haupt and Kusunose, 2000). Foals at weaning tend to be more or less “open” to human contact and handling also according to sire (Henry et al., *in press*).

Differences between breeds are mentioned in Hayes’ (1998) survey where Quarter Horses are classified as more obedient and patient than other breeds considered. Thoroughbreds showed more indifference to the appearance of an experimenter while in their box than French saddlebreds or Anglo-Arabs in Hausberger and Muller’s (2002) study.

Although sex differences are often evoked in the professional context, no clear scientific results are available. Sex was not a major factor in determining temperament, and in particular did not influence the responses to the bridge test (Hausberger et al., 2004b; Visser et al., 2001, 2002), no sex differences are evoked either in terms of reactions to humans in Visser et al. (2001, 2002, 2003a) and Henry et al. (2005, *in press*) studies, but Lansade (2005) mentions that female yearlings would be less close to humans. Clearly, more specific research is needed here.

On the other hand, domestic horse personality and the relation between horses and humans might also be affected by the general management. Physical suffering may induce undesirable reactions to humans (Pritchett et al., 2003; Jaegglin et al., 2005), leading sometimes to aggression (Casey, 2002). Confinement (box) has been shown to be one factor involved in the development of stereotypies or change of behaviour when horses are turned out even when they work regularly (Chaya et al., 2006), but also in the reactions at work (Rivera et al., 2002). Also social deprivation at a young age is found to affect the relationship: horses may seek more contact with humans but this is associated with unwanted behaviours such as biting or kicking the trainer (Søndergaard and Ladewig, 2004).

In general, group living horses are found to be easier to handle and train (Rivera et al., 2002; Søndergaard and Ladewig, 2004) which may be due to learning, through social interactions with conspecifics, to be attentive to other's signals, including the trainer's (Søndergaard and Ladewig, 2004).

3.5. *Horse–rider relationship: finding the ultimate match*

Although it is commonly known that the horse–rider relationship is of major importance in both competition as well as recreational horseback riding, there is surprisingly little proper scientific literature on the determinants of this relationship and the consequences of a mismatch between rider and horse. An above average performance is dependent on effective cooperation between the rider and the horse. The rider not only needs to be in control of his own body and mind but equally prepared to deal with the different facets of the horse's character. The ability to remain calm and focused, yet alert and positive at all times throughout riding in order to communicate effectively with his/her horse becomes one of the fundamental skills any rider must master (Meyers et al., 1999). Horse back riding is one of the most dangerous recreational sports (e.g. Uebeck et al., 2004) with more accidents per hour happening than, for example during motor cycling (Chitnavis et al., 1996). In the USA it has been estimated that horseback riding accounts for 2300 hospital admissions each year with an overall injury rate of 0.6 per 100 hours of riding (Christey et al., 1994). Keeling et al. (1999) concluded that the relationship that exists between horse and its rider was also an important factor when determining the risk of injury while riding. Approximately one quarter of all horse-related accidents was due to the horse being frightened and miscommunication between horse and rider (Keeling et al., 1999).

The horse–rider relationship encompasses many facets that at different levels also have an effect on the performance of the combination and on the welfare of both horse and rider. It is likely that the number of different horse characters is as large as the number of rider's personalities and hence there it is very reasonable that only a proportion of possible combinations of personalities result in optimal matches between horse and rider. Not every horse can jump 1.60 fences. The rider for example influences the horse and its performance by its riding style, encompassing seat, position, riding attitude and riding aids. A correct seat makes it possible for the rider to influence the horse in an efficient way and results in minimal interference and disturbance of the natural movements of the horse. The type of work and/or riding style is suggested to effect the general state of welfare of the horse. Normando et al. (2002) for example suggested that horses ridden in the western style developed less stereotypic behaviour compared to horses ridden in the English style. Differences in the occurrence of stereotypies according to the type of work have also been found by Mc Greevy et al. (1995) and Hausberger et al. (1996, submitted). In the study of Hausberger et al. (1996, submitted) more stereotypies were found in horses used for dressage than for showjumping or eventing. . . even when all other factors (breed, food, housing, . . .) were kept identical. An increase of stereotypies in two year old thoroughbreds is also suggested to be related to the onset of training (Mills et al., 2002). In addition, Hausberger et al. (2004a,b) and Lansade (in preparation) found that show horses had higher emotional reactions in experimental tests compared to leisure horses. The type of work, independently of genetic selection, appeared as a major factor in determining the personality of horses in Hausberger et al. (2004a,b) study. Differences were particularly observed in a handling test where horses had to cross a "bridge". Dressage horses showed higher emotional reactions to these tests. The remaining question is thus whether the type of work during riding affects the rest of the human–horse relation. In any case, the question whether riding affects welfare is crucial

(Ödberg and Bouissou, 1999). Christie et al. (2006) report an increase of weaving with the time spent working. Bad welfare or increased emotional state can certainly lead to undesirable reactions of horses when ridden.

For many reasons thus, it seems important and urgent that this specific part of the human–horse relationship is scientifically addressed both for finding out precisely where the horse–rider relationship fails and for identifying better practices to improve better performances and to decrease welfare problems.

4. Developing the relationship: human–foal interactions

The behavioural development of individuals refers to how the behaviours are shaped and modified through maturation and experience (Guyomarc'h, 1995). Different experiential factors are involved in the behavioural development of foals including the physical, social (mother and others) and human environment. In addition, the own temperamental traits of the young will affect the impact that these factors can have.

Many recent studies have considered the importance of the early stages for the later horse–human relation. They deal with questions such as when, how and whether or not to handle the foals, but also with concerns on the effects of management (social environment, weaning methods) on this relation. Despite this recent interest, lots of questions remain.

4.1. Foal's behavioural development

In natural herd conditions, mares actively seek isolation 2–24 h prior to foaling (Waring, 2003) and in the first few days after birth, mares prevent other horses from approaching their young (Estep et al., 1993; Van Dierendonck et al., 2004), which might be a way to avoid interferences at the crucial moment of bonding of the foal to its dam (Crowell-Davis and Weeks, 2005).

Mares form a strong reciprocal and exclusive bond with their foals rapidly after giving birth which is established through the first bouts of licking (in the first 30 min) and nursing (Houpt, 2002; Grogan and McDonnell, 2005). The rupture of the dam-foal bond, even on a short term basis, induces extreme distress (McCall et al., 1985; Moons et al., 2005). Over-handling of the neonate (Grogan and McDonnell, 2005) accompanied with or solely the mare's high level of fear or anxiety related to exposure to humans in particular may induce an impairment of maternal abilities (Rushen et al., 1999; Forde, 2002; Janczak et al., 2003). First suckling occurs mostly between 30 and 180 min post-partum (Rossdale, 1967). During the first week of life, the foal tends to remain within 5 m of its dam (Crowell-Davis, 1986), while this distance progressively increases when the young develops social bonds with other group members, especially the young ones.

Early individual differences can be observed in the distances to the dam, reactions to novelty or humans (Hausberger et al., submitted; Wolff and Hausberger, 1994; Visser et al., 2001) as a result of genetic (sire in particular) and non genomic maternal influences (Crowell-Davis, 1986; Henry et al., 2005) or early experiences (Hausberger et al., 2004b; Hausberger et al., 2007). But as mentioned before, other aspects, such as husbandry practices may be involved.

4.2. A point on husbandry practices and their impact on foals' behaviour

As mentioned before, young horses at different farms appeared to react very differently to humans. In a study performed on 21 breeding farms in Brittany (France) (170 young horses,

aged between 1 and 3 years old) it appeared that in some farms all horses approached spontaneously while in others, none approached or even obviously fled when a human entered the paddock. Experimental tests performed on the 2- and 3-year-old horses on the same farms revealed similarly a gradient between farms. Farms could be described as farms where the animals were not emotionally reactive and learned easily an instrumental task and farms where the animals showed strong emotional reactions in novel situations and learned poorly. Interestingly, the same farms that were found to have calm 2–3-year-old horses, also housed easy and quiet yearlings. When these results are related to management practices, it appeared that the “best” farms (i.e. with easy and calm yearlings and young horses) corresponded to those where handling occurs mainly around weaning and/or in the following year, while the farms showing “bad scores” (i.e. fearful animals) were characterized by either very intensive and permanent handling: from imprinting to daily halter fitting, leading, feet picking etc. or by no handling at all after weaning and the following year. (Henry et al., in preparation; Hausberger et al., 2004a)

Therefore, there is not a simple linear relation between the amount of handling and the quality of the horse–human relation or the emotional state of the animal. Both qualitative and quantitative aspects are probably at stake here as follows... at stake here : “two much constrained” handling may well bring aversive responses (Hausberger et al., 2004a), whereas some periods during the young’s development may be inappropriate for human contacts (or specific kind of human contacts). Furthermore, few studies have investigated the influence of young horses’ housing and management on the relation between horses and humans. One can consider that a variety of environmental factors which are involved in adults (housing in box, social environment, amount of roughage, access to exercise, spacing, etc.) may be as important for the young animals (McGreevy et al., 1995a,b; Zeeb and Schnitzer, 1997; Chaya et al., 2006). Thus, all the already mentioned effects of group versus single housing, social experience and confinement are valid in the context of the development of the human–foal relationship (Rivera et al., 2002; Søndergaard and Halekoh, 2003; Søndergaard and Ladewig, 2004)

Within the husbandry practices, one major event is weaning. While weaning naturally occurs at the birth of the next foal that is around the age of one year, most breeders perform weaning between 4 and 6 months of age, when the foal is still in close relation to its dam. Under domestic conditions, weaning is commonly recognised for the foal as a source of emotional, physical and physiological stress (Haupt et al., 1984; Knight and Tzunik, 1985; McCall et al., 1985; Malinowski et al., 1990; Hoffman et al., 1995). Not only the breaking of the mare-foal bond is often abrupt (McCall et al., 1985, 1987), but feeding practices and housing may be deeply altered. In parallel, the amount of human contact is frequently increased, as foals are usually vaccinated, dewormed and halter broken during the weaning period. Moreover in a four-year prospective study on 225 foals, Waters et al. (2002) revealed that in domestic situations, stereotypic behaviours emerged rapidly after weaning: they found the incidence of crib-biting to be 10.5% from the age of 20 weeks, whereas 30.0% of foals already showed “wood-chewing” from the age of 30 weeks. Also the development of gastric ulcers due to the new diet and/or the intense stress seem to be involved in the development of cribbing in foals (Nicol et al., 2002). Interestingly these abnormal behaviours have never been documented in feral horse populations (Tyler, 1972; Boy and Duncan, 1979) and consequently, particular attention must be paid to weaning and post-weaning breeding practices that may play an important role in the development of stereotypic behaviours or of other behavioural characteristics.

Several studies have investigated methods of weaning that may reduce undesirable effects:

- *Gradual weaning* through repeated short separations from the dam before complete separation does not improve the reactions and even seem to induce a higher sensitivity of foals to the definitive separation (Moons et al., 2005).
- *Weaning in social conditions* seems to be preferable to isolated weaning. Pair-weaned foals vocalize less (Houpt et al., 1984) as do group-weaned foals (Heleski et al., 2002). Individually housed weanlings are at a higher risk to develop stereotypies (Nicol, 1999). However, the composition of the group has to be considered in order to avoid the social situation to become an additional source of stress (Hoffman et al., 1995). Foals living in groups of mare-dam pairs reacted less to the progressive retrieval of mares (including their dam) than single weaned foals (Holland et al., 1996). Even the presence of unfamiliar adult horses may help reduce the stress (Henry et al., 2006a,b, in preparation).
- *Environmental conditions*, such as being in a paddock rather than in a box, high foraging opportunities, are other important elements (Waters et al., 2002). Foals fed prior to weaning with a high fat and fibre diet are not only less distressed immediately after weaning than those fed with a starch and sugar diet, but they are also more tractable during a range of tests, including a handling test (Nicol et al., 2005).

Beyond the importance of increasing animal welfare, this last study adds to earlier reports showing that early weaning experiences may affect learning abilities, training aptitude and emotionality (Mal et al., 1994; Mal and McCall, 1996), several features important for the human–foal bond. Preventing stereotypic behaviour to be developed may also be important for training the young horse: adult horses showing stereotypic behaviour performed less well in comparison to non stereotypic horses in an instrumental task (Hausberger et al., 2007), which may be indicative of lower learning abilities at work (Le Scolan et al., 1997).

4.3. Establishing a human–foal bond

It is well established in dogs and cats, that the previous experience with humans during the first months of life can have a great impact on later behaviour (Appleby et al., 2002; Fox, 1978; McCune, 1995). In farm animals (silver foxes: Belyaev and Trut, 1975; rabbits: Kersten et al., 1989; cattle: Fordyce et al., 1985; Boissy and Bouissou, 1988; Jago et al., 1999; goats: Boivin and Braastad, 1996; pigs: Tanida et al., 1995; sheep: Markowitz et al., 1998), extra human contacts in the early life may also reduce fear responses of animals toward people. Furthermore, these numerous studies have revealed three major factors related to the development of a human–animal bond: (1) the nature, quality and frequency of human contact (Hemsworth et al., 1992; Jones, 1994), (2) the time period when handling occurs (Hediger, 1968), (3) the social environment (Nicol, 1995). It is particularly important in this context to consider that the resulting relation will follow from series of human–foal interactions and that each of these will participate to the construction of the bond.

4.3.1. The timing of interactions

Several studies have concentrated on the *neonatal period*, to a large extent following Miller's (1991) claims that this would correspond to a sensitive period, during which this early handling would lead to long term memories. In his “imprint training” commercial method, he

recommends to perform, immediately after birth, before the first suckling bout, a very thorough handling of the newborn foal on the whole body while restraining it on the ground and to let the foal get in contact with future usually fear-inducing objects (plastic bag, hair clipper, halter, . . .). All scientific studies performed agree on the fact that this procedure does not correspond to natural way of imprinting and that the foals show a high resistance and high level of stress to the procedure (Diehl et al., 2002; Sigurjónsdóttir and Gunnarsson, 2002).

Whether this early stress is justified in terms of later ease of handling, habituation to stimuli or lowered emotional reactions is not quite clear yet, but even when positive effects are mentioned they remain rather limited. Williams et al. (2002, 2003) who handled foals at birth and/or at 12, 24 and 48 h after birth found no beneficial effect on foals' behaviour when tested at 1, 2 and 3 months of age (Williams et al., 2002) or at 6 months of age (Williams et al., 2003). Some other studies point out some positive effects on a short-term basis: for example, the same approach performed between 1 and 5 days by Simpson (2002) showed that handled foals approached a familiar person (but not a stranger) more easily at the age of 4 months, while Spier et al. (2004) mentioned a better acceptance of hind feet handling in handled foals at the age of 3 months. Overall, the handling did not show any positive effect on the fear reactions of foals towards specific stimuli: for instance, the imprinted foals reacted as strongly as the control foals to halter fitting or shearing at 3 or 4 months of age (Simpson, 2002; Williams et al., 2002; Spier et al., 2004). According to Simpson (2002), the slight positive effect on approachability might well be obtained as well with later handling. Furthermore, the beneficial effects reported by some horse breeders or owners could be related to other approaches of animals (relation to the mare, food reward) or might be the result of reinforcements through frequent subsequent training sessions (Williams et al., 2002). Sigurjónsdóttir and Gunnarsson (2002) also concluded that imprinted foals, that were not regularly handled afterwards, were as difficult to approach as controls.

Handling *at later stages*, in the days or weeks following birth does not seem to have long lasting effects either, even if they facilitate haltering, leading and reduce emotional reactivity in the human presence on a short-term basis (Mal and McCall, 1996; Jezierski et al., 1999; Lansade et al., 2005). In the study of Mal et al. (1994), foals handled (stroking, haltering, picking up feet) twice daily during 7 days after birth with or without a session per week until weaning were not easier to handle 4 months after weaning than non-handled foals. Conversely, the same handling performed during the first 14 days following birth gave also short-term effects that decreased rapidly with time: handled foals were more tractable 3 months later than non-handled foals in haltering, leading and picking up feet tasks, but six months later only few differences were found and at one year of age, there was no more differences between handled and not handled foals (Lansade et al., 2004). To maintain the beneficial effects of early handling, it seems necessary to repeat handling on a regular basis. The study of Jezierski et al. (1999) showed that foals, which are handled 5 days a week from the age of 2 weeks or 10 months to the age of 24 months scored better on manageability tests (catching, leading, picking up feet, being approached by an unfamiliar person) at 12, 18 and 24 months than non-handled foals.

Handling *at weaning* seems to be more efficient, especially if it is repeated in a longer term. Heird et al. (1986) reported that horses handled regularly from weaning until 18 months of age had a higher trainability than the other foals. Lansade et al. (2004) compared two groups of foals handled (haltering, leading, picking up feet) daily for 12 days: the first group was handled immediately after weaning (early handled), whereas handling of the second group began 3 weeks after weaning (late handled). A third group consisted of non-handled foals. Results showed that early and late handled foals were easier to handle and less reactive than controls. However, 18

months after the end of the handling period, the late handled foals did not differ from controls, whereas the early handled still showed few differences. At this particular period when foals are socially deprived, they may be more open to human contact. In the above mentioned study on French breeding farms, some breeders appeared indeed to choose this time period for handling especially because they were bringing the foals in the stables for weaning. However, it appears that some effects diminished with time (Lansade et al., 2004). Weaning and the following year may well be privileged time for establishing the bond. However, there is no clear evidence in foals for the existence of sensitive periods through development, which may facilitate the establishment of a foal-human bond. According to the results of Søndergaard and Halekoh (2003), 2-year-old non-handled animals become as familiar as handled animals, probably as a result of the mere daily exposure to the caretakers bringing food. One has to consider the influence of additional handling as compared to daily contacts with the young through routine procedures. The simple association of humans with events such as food distribution is a clear positive association and appears to be sufficient to reduce the level of fear (Søndergaard and Halekoh, 2003). As in adults, the daily relation to the caretaker and its attitude towards animals must be taken into account. Therefore, the most promising research line may well be in the way the relation is established rather than the moment.

4.3.2. *Active actions on the foal or indirect approaches: what is best?*

The type of handling and how it is perceived by the animal could strongly influence its impact on the later human–animal relationship. In domestic horses, a small amount of investigation has been done on how the handling of various human contacts was perceived. It was nevertheless assumed that non-aggressive forms of tactile contact (gentling, stroking or brushing) were rewarding or positive. However in farm animals, mixed results were observed (see above). Some studies have therefore investigated whether gentling or brushing had a rewarding value for animals. The results suggest that gentling is not necessarily rewarding for animals (Boivin et al., 1998; Jago et al., 1999; Pajor et al., 2003) and Pajor et al. (2000) found even some evidence that cows find brushing to be aversive. Furthermore, in many of the studies in which human contact has been shown to reduce the animals' fear of humans and improve handling ability, the human presence was associated with the provision of food (de Pasillé et al., 1996; Munksgaard et al., 1997). On the other hand, some studies (Jago et al., 1999; Hemsworth et al., 1996) report that handling without feeding mediation does not improve animals' responses to humans. The association of the human presence or handling with a positive reinforcer (food) is a clear positive association for animals, which may lead to lower the negative impact of handling. For instance, scientists working with laboratory primates have achieved considerable success in using food rewards to train animals to extend an arm or a leg for blood sampling (Reinhardt, 1991). It could be of much interest to use such approaches with young horses, as soon as they orient their feeding behaviours toward solid food. In addition, it has been demonstrated that the mere exposure to a motionless human may lead to beneficial effects (cattle: Le Neindre et al., 1994; red deers: Pollard et al., 1994; pigs: Hemsworth et al., 1986; goats: Lyons et al., 1988) and that the mother's reactions to humans may be transmitted to its young through social facilitation (goats: Lyons et al., 1988; Ruiz-Miranda and Callard, 1992; quails: Bertin and Richard-Yris, 2004). Moreover, Sigurjónsdóttir and Gunnarsson (2002) found a correlation between the dam's nervousness and the imprinted foal's resistance to capture, haltering and leading at the age of 4 months. Thus, when mares were calm, foals were easier to handle.

In order to identify which approach of the foal is the best, Henry et al. (2005, 2006b) have performed a set of experiments, including different approaches at birth or in the following days.

Four approaches were thus tested in the postpartum period and compared to a controlled situation (no additional handling):

- (1) Two of them consisted of actively handling the foals: (a) bringing the foal to the dam's teat (a common practice in breeding farms), (b) a forced handling (stroking) of foals during 15 min in the five days after birth.
- (2) The other two treatments involved undirect approaches in the postpartum period: (a) *a mere daily exposure during 15 min to a passive human in the five days post-partum*, (b) *a gentle handling of the mare (soft brushing and food reward) in front of the foal, without any direct attention from the experimenter to the foal during the same period* (testing a possible social facilitation).

When the effects of the four types of handling were compared at later ages, it appeared that foals, which have been brought to the teat or forcedly handled, tended to refuse a direct contact afterwards. It can also be noticed that during the handling procedures, foals attempted to escape from restraint. A passive human presence, induced lower flight reactions than in controls at the age of 2 weeks, but the effects were not long lasting. Finally, foals whose dams had been brushed and hand-fed, approached very readily the experimenter at the age of 2 weeks and accepted easily a direct human contact, as well as for most of them a saddle pad on the back at the age of 1 month. They were even easily approached in the paddock and stroked by a familiar or non familiar experimenter one year later, without any further handling, which was totally impossible with the control yearlings (Henry et al., 2005). The use of this natural tendency of the foal to learn from the dam seems therefore promising, especially as it does not induce any stress. It is however likely that the effects may be very negative if the human–dam relationship is poor or if the mare is particularly nervous or aggressive. Establishing a positive human–dam relationship may therefore be one key to enhance durably the manageability of foals.

In conclusion, in accordance to [Hinde \(1979\)](#)'s theory, it is likely that each invasive human interference, if it induces stress, may alter the development of the human–foal bond. It appears difficult to evaluate what is really positive from the animal's point of view, but it is similarly probable that the accumulation of positive interactions may reinforce the development of a positive relationship. Thus, handling may be assessed as positive only when the animal's behavioural responses during the ongoing treatment are positive, which implies approach/seeking contact, but no avoidance, aggression or at least no flight. During the presence of a motionless person and above all during the mare's soft handling treatment, foals clearly enhanced their proximity to the person involved and initiated physical interactions ([Henry et al., 2005, 2006a,b, in press](#)), while forced handling of foals (imprinting, stroking, haltering) induced a strong resistance of animals, as seen previously, and has to be considered with caution.

5. From interactions to relationships: the importance of learning processes

The daily human–horse interactions are very varied and include both positive (for example, feeding) and negative (for example, veterinary inspections and treatments) events, leading to a more or less balanced relationship. Many of the tasks associated with the management of animals, such as vaccination, foot care, administration of medication and transport, may constitute aversive contacts with humans, which as a result, may increase fear reactions of animals and induce long lasting undesirable reactions to humans.

In laboratory primates, considerable success has been achieved in using food rewards (see above, Reinhardt, 1991), while, as mentioned before, food provisioning may enhance the effects of handling in domestic animals (Jago et al., 1999; Hemsworth et al., 1996). These findings are in accordance with general learning rules that, if they were applied, would certainly prove very useful in improving the human–horse relationship, whether while handling or riding it. According to Hinde (1979), each interaction is influenced by the previous one(s) in the process of developing a relationship: therefore, according to the possible “positive or negative memory” related to it, each partner has expectations on the other’s behaviour at the following one, which can also be modulated by all the other previous experiences.

Learning rules are rarely mentioned in the training of professional or non-professional riders and caretakers, and empirical observations show a tendency for trainers to use more negative reinforcements (learning to perform a behaviour in order to avoid a disliked stimulus, Nicol, 2005) and punishments (use of an aversive stimulus to inhibit a behaviour) while paying little attention to potential positive reinforcement (Waran and Casey, 2005).

Amongst the problems mentioned, are the over-use of punishment to reduce an ongoing behaviour which can place the horse in a situation where it has no control, leading to motivational conflict; the involvement of ineffective rewards such as patting that is unlikely to be an innately pleasurable experience for a horse; a poorly timed reward which makes rewards becoming meaningless or even encourage inappropriate behaviours (McGreevy and McLean, 2005; Waran and Casey, 2005). This poorly timed rewarding has often led to the abandon of primary reinforcers such as food which, while powerful if associated with a task, may induce begging or even biting if given out of context. Additionally, the lack of clarity of orders induces confusions and may lead to neurotic behaviours (Richard-Yris et al., 2004).

An excessive conflict between horse and rider (unjustified punishment, a too harsh negative reinforcement) leads to stress and creates risks of increased levels of agonistic behaviour such as biting, kicking, bucking or rearing (McGreevy and McLean, 2005). The study of Pinchbeck et al. (2004) even shows that whip use during hurdle and steeplechase racing is associated with horse falls.

Inappropriate “tools” and inappropriate use of “riding aids” such as hard bits, badly adjusted or unfitted saddles, lead to undesirable reactions (Newton and Nielsen, 2005) and the repetition of the association between riding and pain can certainly contribute to an altered human–horse relationship.

The above mentioned example of primates’ training shows that even negative events can be counterbalanced by using appropriate learning rules. This clearly remains a line for future research, observation but also training of humans working with horses. The key for developing and maintaining a positive human–horse relationship relies certainly upon it, both when dealing with adult or young animals. Precisely in the latter, it may be especially important to be aware of these rules in order to avoid having “bad memories” of interactions interfering with the development of the relationship.

6. Conclusion and perspectives

This review elucidates the strong need for specific research and training of humans working with horses in order to improve the human–horse relationship that, as shown by the high incidence of accidents and increasing number of horses with a decreased welfare is far from optimal.

Further research is needed in order to assess how to better and safely approach the horse (e.g. research in position, posture, gaze etc), what type of approaches and timing may help in

developing a positive bond, what influence human management and care has on the relationship, and how this can be adapted to have a positive influence on the relationship. Also, both the welfare of horses and rider can be improved when tools or methods could be developed to initiate and assess the optimal match between horse and rider.

On the other hand, adequate knowledge is readily available that may improve the present situation rapidly. Developing awareness and attention to behavioural cues given by horses would certainly help decreasing accidents among professionals when interacting. The higher level of accidents with veterinarians owning horses has been attributed to a lowered attention (Jaegglin et al., 2005), while the accidents (kicks, crushes, jostles) implying professionals caretakers and leisure riders underline the need for a better knowledge and observation of the horse (e.g. Kriss and Kriss, 1997). It is interesting that these accidents do not decrease with experience or level of competency, showing that new training for this group is required.

Finally, professional and non professional persons handling horses should be stimulated and informed in order to try and improve the development and maintenance of a really positive relationship. They have to be aware that deficits in the management conditions (housing, food, social context, and training) may lead to disturbances in the horse' behaviour and ultimately to relational problems.

Moreover, understanding that a relationship is built upon the basis of a succession of interactions, may make them aware of the importance of a good knowledge of basic learning rules in order to be able not only to train the horse but also to counterbalance the unavoidable negative inputs that exist in routine procedures and reduce their impact on the relationship.

While learning to be able to interact with any horse is crucial in some professions (farriers, veterinarians); learning to develop a relationship is especially crucial for breeders, caretakers, horse owners, trainers. No recipe-based method can offer the required capacity to adapt to horses and/or to situations (Waran and Casey, 2005). Only well trained observational skills allied with advanced knowledge of horse behaviour can realize horses being handled safely.

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References

- Abu-Zidan, F.M., Rao, S., 2003. Factors affecting the severity of horse-related injuries. *Injury* 34, 897–900.
- Anderson, M.K., Friend, T.H., Evans, J.W., Bushong, D.M., 1999. Behavioural assessment of horses in therapeutic riding programs. *Appl. Anim. Behav. Sci.* 63 (1), 11–24.
- Appleby, D.L., Bradshaw, J.W.S., Casey, R., 2002. Relationship between aggressive and avoidance behaviour by dogs and their experience in the first six months of life. *Vet. Rec.* 150, 434–438.
- Belyaev, D.K., Trut, L.N., 1975. Some genetic and endocrine effects of selection for domestication in silver foxes. In: Fox, M.W. (Ed.), *The Wild Canids*. Van Nostrand Reinhold, New York, pp. 416–426.
- Bertin, A., Richard-Yris, M.-A., 2004. Mothers' fear of human affects the emotional reactivity of young in domestic Japanese quail. *Appl. Anim. Behav. Sci.* 89, 215–231.
- Boissy, A., Bouissou, M.F., 1988. Effects of early handling on heifers' subsequent reactivity to humans and to unfamiliar situations. *Appl. Anim. Behav. Sci.* 22, 259–273.
- Boivin, X., Braastad, B.O., 1996. Effects of handling during temporary isolation after early weaning on goat kids' later response to humans. *Appl. Anim. Behav. Sci.* 48, 61–71.

- Boivin, X., Garel, J.P., Durier, C., Le Neindre, P., 1998. Is gentling by people rewarding for beef calves? *Appl. Anim. Behav. Sci.* 61, 1–12.
- Boy, V., Duncan, P., 1979. Time budgets of Camargue horses. I. Developmental changes in the time budgets of foals. *Behaviour* 71, 187–202.
- Brackenridge, S., Shoemaker, S., 1996a. The human/horse bond and client bereavement in equine practice, part 1. *Vet. Clin. North Am. Equine Pract.* 18 (1), 19–22.
- Brackenridge, S., Shoemaker, S., 1996b. The human/horse bond and client bereavement in equine practice, part 2. *Vet. Clin. North Am. Equine Pract.* 18 (2), 23–25.
- Brackenridge, S., Shoemaker, S., 1996c. The human/horse bond and client bereavement in equine practice, part 3. *Vet. Clin. North Am. Equine Pract.* 18 (4), 20–23.
- Casey, R., 2002. Clinical problems associated with intensive management of performance horses. In: *The Welfare of Horses*, Kluwer Academic Publishers, Dordrecht, Boston, London, pp. 19–44.
- Chamove, A.S., Crawley-Hartrick, O.J.E., Stafford, K.J., 2002. Horse reactions to human attitudes and behaviour. *Anthrozoos* 15, 323–331.
- Chaya, L., Cowan, E., McGuire, B., 2006. A note on the relationship between time spent in turnout and behaviour during turnout in horses (*Equus caballus*). *Appl. Anim. Behav. Sci.* 98, 155–160.
- Chitnavis, J.P., Gibbons, C.L.M.H., Hirigoyen, M., Lloyd Parry, J., Simpson, A.H.R.W., 1996. Accidents with horses: what has changed in 20 years? *Injury* 27, 103–105.
- Christey, G.L., Nelson, G.L., Rivara, F.P., Smith, S.M., Condie, C., 1994. Horseback riding injuries among children and young-adults. *J. Fam. Pract.* 39 (2), 148–152.
- Christie, J., Hewson, C., Riley, C., McNiven, M., Dohoo, I., Bate, L., 2006. Management factors affecting stereotypies and body condition score in nonracing horses in Prince Edward Island. *Can. Vet. J.* 47, 136–143.
- Crowell-Davis, S.L., 1986. Spatial relations between mares and foals of the Welsh pony (*Equus caballus*). *Anim. Behav.* 34, 1007–1015.
- Crowell-Davis, S., Weeks, J., 2005. Maternal behaviour and mare–foal interaction. In: Mills, D.S., Mc Donnell, S.M. (Eds.), *The Domestic Horse: The Origins, Development and Management of its behaviour*. Cambridge University Press, Cambridge, pp. 126–138.
- Diehl, K.D., Egan, B., Tozer, P., 2002. Intensive, Early Handling of Neonatal Foals: Mare–Foal Interactions. In: *Proceedings of the Havermeyer Foundation Horse Behavior and Welfare Workshop*, Hólar, Iceland, June, pp. 23–26.
- Digard, J.-P., 1999. Un animal intermédiaire: le cheval. In: *Les français et leurs animaux*, Fayard, Paris, pp. 51–70.
- Edenburg, N., 1999. Perceptions and attitudes towards horses in European societies. *Equine Vet. J. (Suppl.)* 28, 38–41.
- Estep, D.Q., Crowell-Davis, S.L., Earlcostello, S.A., Beatey, S.A., 1993. Changes in the social behaviour of drafthorse (*Equus caballus*) mares coincident with foaling. *Appl. Anim. Behav. Sci.* 35, 199–213.
- Exadaktylos, A., Egli, S., Inden, P., Zimmermann, H., 2002. Hoof kick injuries in unmounted equestrians. Improving accident analysis and prevention by introducing an accident and emergency based relational database. *Emerg. Med. J.* 19, 573–575.
- Feh, C., de Mazières, J., 1993. Grooming at a preferred site reduces heart rate in horses. *Anim. Behav.* 46, 1191–1194.
- Fiske, J.C., Potter, G.D., 1979. Discrimination reversal learning in yearling horses. *J. Anim. Sci.* 49, 583–588.
- Forde, J.N.M., 2002. Piglet- and stockperson-directed sow aggression after farrowing and the relationship with a pre-farrowing, human approach test. *Appl. Anim. Behav. Sci.* 75, 115–132.
- Fordyce, G., Goddard, M., Tyler, R., Williams, G., Toleman, M., 1985. Temperament and bruising of *Bos indicus* cross cattle. *Aust. J. Agric. Res.* 25, 283–285.
- Fox, M.W., 1978. The dog: its domestication and behaviour. In: *Effects of Domestication on Prey-catching and Killing in Domestic and Wild Canids and F₂ Hybrids*, Garland STPM Press, New York and London (Chapter VI).
- Gosling, S.D., 2001. From mice to men: what can we learn about personality from animal research? *Psychol. Bull.* 127, 45–86.
- Grandin, T., 1980. Observation of cattle behaviour applied to the design of handling facilities. *Appl. Anim. Ethol.* 6, 19–31.
- Grandin, T., Deesing, M.J., 1998. Genetics and behaviour during handling, restraint, and herding. In: Grandin, T. (Ed.), *Genetics and the Behavior of Domestic Animals*. Academic Press, London, UK, pp. 113–144.
- Grogan, E.H., McDonnell, S.M., 2005. Mare and foal bonding problems. *Clin. Tech. Equine Pract.* 4, 228–237.
- Guyomarç'h, J.C., 1995. *Abrégés d'éthologie*. Masson (Ed.), Paris, p. 175.
- Hama, H., Yogo, M., Matsuyama, Y., 1996. Effects of stroking horses on both humans' and horses' heart rate responses. *Jpn. Psychol. Res.* 38, 66–73.
- Hanggi, E.B., 2003. Discrimination learning based on relative size concepts in horses (*Equus caballus*). *Appl. Anim. Behav. Sci.* 83, 201–213.

- Hausberger, M., Muller, C., 2002. A brief note on some possible factors involved in the reactions of horses to humans. *Appl. Anim. Behav. Sci.* 76, 339–344.
- Hausberger, M., Richard-Yris, M.-A., 2005. Individual differences in the domestic horse, origins, development and stability. In: Mills, D.S., Mc Donnell, S.M. (Eds.), *The Domestic Horse: The Origins, Development and Management of its Behaviour*. Cambridge University Press, Cambridge, pp. 33–52.
- Hausberger, M., Henry, S., Richard, M.-A., 2004a. Expériences précoces et développement du comportement chez le poulain. In: *Compte-rendu de la 30^{ème} Journée de la Recherche Equine*, 3 mars 2004, Paris, pp. 155–164.
- Hausberger, M., Bruderer, C., Le Scolan, N., Pierre, J.-S., 2004b. Interplay between environmental and genetic factors in temperament/personality traits in horses (*Equus caballus*). *J. Comp. Psychol.* 118, 434–446.
- Hausberger, M., Henry, S., Larose, C., Richard-Yris, M.-A., 2007. First suckling: a crucial event for mother-young attachment? *J. Comp. Psychol.* 121, 109–112.
- Hausberger, M., Le Scolan, N., Muller, C., Gautier, E., Wolff, A., 1996. Caractéristiques individuelles dans le comportement du cheval: prédictibilité, facteurs endogènes et environnementaux. In: *Compte-rendu de la 22^{ème} Journée d'Etude, C.E.R.E.O.P.A.* 28 février 1996.
- Hausberger, M., Muller, C., Gautier, E., Jégo, P., 2007a. Lower learning abilities in stereotypic horses. *Appl. Anim. Behav. Sci.* 107, 299–306.
- Hayes, K., 1998. Temperament tip-offs. *Horse and Rider*, November, pp. 47–84.
- Hediger, H., 1968. *The Psychology and Behaviour of Animals in Zoos and Circuses*. Dover Publications, Inc., USA.
- Heird, J.C., Whitaker, D.D., Bell, R.W., Ramsey, C.B., Lokey, C.E., 1986. The effects of handling at different ages on the subsequent learning ability of 2-year-old horses. *Appl. Anim. Behav. Sci.* 15, 15–25.
- Heleski, C., Shelle, A., Nielsen, B., Zanella, A., 2002. Influence of housing on weanling horse behaviour and subsequent welfare. *Appl. Anim. Behav. Sci.* 78, 291–302.
- Hemsworth, P.H., Barnett, J.L., Hansen, C., 1986. The influence of handling by humans on the behaviour, reproduction and corticosteroids of male and female pigs. *Appl. Anim. Behav. Sci.* 15, 303–314.
- Hemsworth, P.H., Barnett, J.L., Coleman, G.J., 1992. Fear of humans and its consequences for the domestic pig. In: Davis, H., Balfour, D. (Eds.), *The Inevitable Bond: Examining Scientist–Animal Interactions*. Cambridge University Press, Cambridge, UK, pp. 264–284.
- Hemsworth, P.H., Price, E.O., Borgwardt, R., 1996. Behavioural responses of domestic pigs and cattle to humans and novel stimuli. *Appl. Anim. Behav. Sci.* 50, 43–56.
- Henry, S., Hemery, D., Richard, M.-A., Hausberger, M., 2005. Human–mare relationships and behaviour of foals toward humans. *Appl. Anim. Behav. Sci.* 93, 341–362.
- Henry, S., Briefer, S., Richard-Yris, M.-A., Hausberger, M., 2006a. Utilisation des influences sociales autour du sevrage. In: *Compte-rendu de la 32^{ème} Journée de la Recherche Equine*, 1 mars 2006, Paris, pp. 71–81.
- Henry, S., Richard-Yris, M.-A., Hausberger, M., 2006b. Influence of various early human–foal interferences on subsequent human–foal relationship. *Dev. Psychobiol.* 48, 712–718.
- Henry, S., Briefer, S., Richard-Yris, M.-A., Hausberger, M. Are six-month old foals sensitive to dam's influence? *Dev. Psychobiol.*, in press.
- Hinde, R., 1979. *Towards Understanding Relationships*. Academic Press, Londres.
- Hoffman, R.M., Kronfeld, D.S., Holland, J.L., Greiwe-Crandell, K.M., 1995. Preweaning diet and stall weaning method influences on stress response in foals. *J. Anim. Sci.* 73, 2922–2930.
- Holland, J.L., Kronfeld, D.S., Meacham, T.N., 1996. Behaviour of horses is affected by soy lecithin and corn oil in the diet. *J. Anim. Sci.* 74, 1252–1255.
- Holler, A., 1984. Occupational hazards of farriers. *Am. Ind. Hyg. Assoc. J.* 45, 34–38.
- Haupt, K., 2002. Formation and dissolution of the mare–foal bond. *Appl. Anim. Behav. Sci.* 78, 319–328.
- Haupt, K., Kusunose, R., 2000. Genetics of behaviour. In: Bowling, A.T., Ruvinsky, A. (Eds.), *The Genetics of the Horse*. CABI Publishing, New York, pp. 281–306.
- Haupt, K.A., Hintz, H.F., Butler, W.R., 1984. A preliminary study of two methods of weaning foals. *Appl. Anim. Behav. Sci.* 12, 177–181.
- Iba, K., Wada, T., Kawaguchi, S., Fujisaki, T., Yamashita, T., Ishii, S., 2001. Horse-related injuries in a thoroughbred stabling area in Japan. *Arch. Orthop. Trauma Surg.* 121, 501–504.
- Jaegglin, S., Furst, A., Auer, J., 2005. Kick injuries of veterinarians during examination and treatment of horses: a retrospective study in Switzerland. *Schweiz. Arch. Tierheilkd.* 147, 289–295.
- Jago, J.G., Krohn, C.C., Matthews, L.R., 1999. The influence of feeding and handling on the development of the human–animal interactions in young cattle. *Appl. Anim. Behav. Sci.* 62, 137–151.
- Janczak, A.M., Pedersen, L.J., Rydhmer, L., Bakken, M., 2003. Relation between early fear- and anxiety-related behaviour and maternal ability in sows. *Appl. Anim. Behav. Sci.* 82, 121–135.

- Jeziński, T., Gorecka, A., 2000. Changes in the horses heart rate during different levels of social isolation. *Anim. Sci. Pap. Rep.* 18, 33–41.
- Jeziński, T., Jaworski, Z., Gorecka, A., 1999. Effects of handling on behaviour and heart rate in Konik horses: comparison of stable and forest reared youngstock. *Appl. Anim. Behav. Sci.* 62, 1–11.
- Johns, E., Farrant, G., Civil, I., 2004. Animal-related injury in an urban New Zealand population. *Injury* 35, 1234–1238.
- Jones, R.B., 1994. Regular handling and the domestic chick's fear of human beings: generalisation of response. *Appl. Anim. Behav. Sci.* 42, 129–143.
- Keeling, L.J., Blomberg, A., Ladewig, J., 1999. Horse-riding accidents: when the human–animal relationship goes wrong! In: 33rd International Congress of the International Society for Applied Ethology, Agricultural University of Norway, Lillehammer.
- Kersten, A.M.P., Meijsser, F.M., Metz, J.H.M., 1989. Effects of early handling on later open-field behaviour in rabbits. *Appl. Anim. Behav. Sci.* 24, 157–167.
- Knight, D.A., Tyznik, W.J., 1985. The effect of artificial rearing on the growth of foals. *J. Anim. Sci.* 60, 1–5.
- Kriss, T., Kriss, V., 1997. Equine related neurosurgical trauma: a prospective series of 30 patients. *J. Trauma* 43, 97–99.
- Landercasper, J., Coghill, T., Strutt, P., Landercasper, B., 1988. Trauma and the veterinarian. *J. Trauma* 28, 1255–1259.
- Lansade, L., 2005. Le tempérament du cheval. Etude théorique. Application à la sélection des chevaux destinés à l'équitation. Thèse universitaire en Sciences de la Vie, Tours.
- Lansade, L., Bouissou, M.-F., 2005. Recherche d'un lien entre le tempérament du cheval et son aptitude à être utilisé. In: *Compte-rendu de la 31^{ème} Journée de la Recherche Equine*, 2 mars 2005, Paris, pp. 119–130.
- Lansade, L., Bertrand, M., Boivin, X., Bouissou, M.-F., 2004. Effects of handling at weaning on manageability and reactivity of foals. *Appl. Anim. Behav. Sci.* 87, 131–149.
- Lansade, L., Bertrand, M., Bouissou, M.-F., 2005. Effects of neonatal handling on subsequent manageability, reactivity and learning ability of foals. *Appl. Anim. Behav. Sci.* 92, 143–158.
- Larose, C., Rogers, L.J., Richard, M.-A., Hausberger, M., 2006. Laterality of horses associated with emotionality in novel situations. *Laterality* 11, 355–367.
- Le Neindre, P., Trillat, G., Chupin, J.M., Poindron, P., Boissy, A., Orgeur, P., Boivin, X., Bonnet, J.N., Bouix, J., Bibe, B., 1994. Les ruminants et l'homme, un vieux lien qu'il faut entretenir. In: *Un point sur ... comportement et bien-être animal*. INRA (Ed.), Paris.
- Lensink, B.J., Fernandez, X., Cozzi, G., Florand, L., Veissier, I., 2001. The influence of farmers' behavior on calves' reactions to transport and quality of veal meat. *J. Anim. Sci.* 79, 642–652.
- Le Scolan, N., Hausberger, M., Wolff, A., 1997. Stability over situations in temperamental traits of horses as revealed by experimental and scoring approaches. *Behav. Processes* 41, 257–266.
- Lynch, J., Fregin, F., Mackie, J., Monroe, R., 1974. Heart rate changes in the horse to human contact. *Psychophysiology* 11, 472–478.
- Lyons, D.M., Price, E.O., Moberg, G.P., 1988. Social modulation of pituitary–adrenal responsiveness and individual differences in behavior of young domestic goats. *Physiol. Behav.* 43, 451–458.
- Mal, M.E., McCall, C.A., 1996. The influence of handling during different ages on a halter training test in foals. *Appl. Anim. Behav. Sci.* 50, 115–120.
- Mal, M.E., Friend, T., Lay, D., Vogelsang, S., Jenkins, O., 1991. Behavioral responses of mares to short-term confinement and social isolation. *Appl. Anim. Behav. Sci.* 31, 13–24.
- Mal, M.E., McCall, C.A., Cummins, K.A., Newland, M.C., 1994. Influence of preweaning handling methods on post-weaning learning ability and manageability of foals. *Appl. Anim. Behav. Sci.* 40, 187–195.
- Malinowski, K., Hallquist, N.A., Helyar, L., Sherman, A.R., Scanes, C.G., 1990. Effect of different separation protocols between mares and foals on plasma cortisol in cell-mediated immune response. *Equine Vet. J.* 10, 363–368.
- Markowitz, T.M., Dally, M.R., Gursky, K., Price, E.O., 1998. Early handling increases lamb affinity for humans. *Anim. Behav.* 55, 573–587.
- McCall, C.A., Potter, G.D., Kreider, J.L., 1985. Locomotor, vocal and other behavioral responses to varying methods of weaning foals. *Appl. Anim. Behav. Sci.* 14, 27–35.
- McCall, C.A., Potter, G.D., Kreider, J.L., Jenkins, W.L., 1987. Physiological responses in foals weaned by abrupt or gradual methods. *Equine Vet. J.* 7, 368–374.
- McCann, J., Heird, J., Bell, W., Lutherer, L., 1988a. Normal and more highly reactive horses. I. Heart rate, respiration rate and behavioral observations. *Appl. Anim. Behav. Sci.* 19, 201–214.
- McCann, J., Heird, J., Bell, W., Lutherer, L., 1988b. Normal and more highly reactive horses. II. The effect of handling and reserpine on the cardiac response to stimuli. *Appl. Anim. Behav. Sci.* 19, 215–226.
- McCrory, P., Turner, M., 2005. Equestrian injuries. *Med. Sport Sci.* 48, 8–17.

- McCune, S., 1995. The impact of paternity and early socialization on the development of cats' behaviour to people and novel objects. *Appl. Anim. Behav. Sci.* 45, 109–124.
- McGreevy, P., French, N., Nicol, C., 1995a. The prevalence of abnormal behaviours in dressage, eventing and endurance horses in relation to stabling. *Vet. Rec.* 137, 36–37.
- McGreevy, P., Cripps, P., French, N., Green, L., Nicol, C., 1995b. Management factors associated with stereotypic and redirected behaviour in the Thoroughbred horse. *Equine Vet. J.* 27, 87–91.
- McKinley, J., Sambrook, T., 2000. Use of human-given cues by domestic dogs (*Canis familiaris*) and horses (*Equus caballus*). *Anim. Cogn.* 3, 13–22.
- Meyers, M.C., Bourgeois, A.E., LeUnes, A., Murray, N.G., 1999. Mood and psychological skills of elite and sub-elite equestrian athletes. *J. Sport Behav.* 22 (3), 399–409.
- Miller, R.M., 1991. Imprint Training of the Newborn Foal. Western Horseman Inc., Colorado Springs, CO.
- Mills, D.S., 1998. Personality and individual differences in the horse, their significance, use and measurement. *Equine Vet. J.* 27 (Suppl.), 10–13.
- Mills, D.S., Alston, R.D., Rogers, V., Longford, N.T., 2002. Factors associated with the prevalence of stereotypic behaviour amongst thoroughbred horses passing through auctioneer sales. *Appl. Anim. Behav. Sci.* 78, 115–124.
- Mills, D., Mc Nicholas, J., 2005. The rider–horse relationship. In: Mills, D.S., Mc Donnell, S.M. (Eds.), *The Domestic Horse: The Origins, Development and Management of its Behaviour*. Cambridge University Press, Cambridge, pp. 161–168.
- Mills, P.C., Ng, J.C., Kramer, H., Auer, D.E., 1997. Stress response to chronic inflammation in the horse. *Equine Vet. J.* 29, 483–486.
- Momozawa, Y., Ono, T., Sato, F., Kikusui, T., Takeuchi, Y., Mori, Y., Kusunose, R., 2003. Assessment of equine temperament by a questionnaire survey to caretakers and evaluation of its reliability by simultaneous behaviour test. *Appl. Anim. Behav. Sci.* 84, 127–138.
- Momozawa, Y., Kusunose, R., Kikusui, T., Takeuchi, Y., Mori, Y., 2005. Assessment of equine temperament questionnaire by comparing factor structure between two separate surveys. *Appl. Anim. Behav. Sci.* 92, 77–84.
- Moons, C.P.H., Laughlin, K., Zanella, A.J., 2005. Effects of short-term maternal separations on weaning stress in foals. *Appl. Anim. Behav. Sci.* 91, 321–335.
- Moore, J., Millar, C., Matsuda, M., Buckley, T., 2003. Human infections associated with horse bites. *Equine Vet. J.* 23, 52–54.
- Morgan, K., Zetterqvist, M., Hassmen, P., Visser, E.K., Rundgren, M., Blokhuis, H.J., 2000. Rider's personality and the perception of the co-operation between rider and horse. In: 51th Annual Meeting of the European Association for Animal Production (abstract).
- Morris, P., Gale, A., Duffy, K., 2002. Can judges agree on the personality of horses? *Pers. Individ. Dif.* 33, 67–81.
- Munksgaard, L., DePassille, A.M., Rushen, J., Thodberg, K., Jensen, M.B., 1997. Discrimination of people by dairy cows based on handling. *J. Dairy Sci.* 80, 1106–1112.
- Newton, A., Nielsen, A.M., 2005. A review of horse-related injuries in a rural Colorado hospital: implications for outreach education. *J. Emerg. Nurs.* 31, 442–446.
- Nicol, C.J., 1995. The social transmission of information and behaviour. *Appl. Anim. Behav. Sci.* 44, 79–98.
- Nicol, C.J., 1999. Stereotypies and their relation to management. In: Harris, P.A., Gomarsall, G., Davidson, H.P.B., Green, R. (Eds.), *Proceedings of the BEVA Specialists Days on Behaviour and Nutrition*. Equine Vet. J., Newmarket, UK, pp. 11–14.
- Nicol, C.J., 2005. Learning abilities in the horse. In: Mills, D.S., Mc Donnell, S.M. (Eds.), *The Domestic Horse: The Origins, Development and Management of its Behaviour*. Cambridge University Press, Cambridge, pp. 169–183.
- Nicol, C.J., Davidson, H.P.B., Harris, P.A., Waters, A.J., Wilson, A.D., 2002. Study of crib-biting and ulceration in young horses. *Vet. Rec.* 151, 658–682.
- Nicol, C., Badnell-Waters, A., Bice, R., Kelland, A., Wilson, A., Harris, P., 2005. The effects of diet and weaning method on the behaviour of young horses. *Appl. Anim. Behav. Sci.* 95, 205–221.
- Normando, S., Canali, E., Verga, M., 2002. Behavioral problems in Italian saddle horses. *J. Eq. Vet. Sci.* 22, 117–120.
- Ödberg, F.O., Bouissou, M.F., 1999. Development of equestrianism from the baroque period to the present day and its consequences for the welfare of horses. The role of the horse in Europe. *Equine Vet. J.* 28 (suppl), 26–30.
- Pajor, E.A., Rushen, J., de Passillé, A.M.B., 2000. Aversion learning techniques to evaluate dairy cattle handling practices. *Appl. Anim. Behav. Sci.* 69, 89–102.
- Pajor, E.A., Rushen, J., de Passillé, A.M.B., 2003. Dairy cattle's choice of handling treatments in a Y-maze. *Appl. Anim. Behav. Sci.* 80, 93–107.
- Pasquet, H., 2004. Les accidents et dommages corporels des vétérinaires équins dans l'exercice de leur profession. Thèse de Doctorat Vétérinaire, Créteil.

- de Passillé, A.M.B., Rushen, J., Ladewig, J., Petherick, C., 1996. Dairy calves' discrimination of people based on previous handling. *J. Anim. Sci.* 74, 969–974.
- Pinchbeck, G.L., Clegg, P., Proudman, C., Morgan, K., French, N., 2004. Whip use and race progress are associated with horse falls in hurdle and steeplechase racing in the UK. *Equine Vet. J.* 36, 384–389.
- Pollard, J.C., Littlejohn, R.P., Webster, J.R., 1994. Quantification of temperament in weaned deer calves of two genotypes (*Cervus elaphus* and *C. elaphus* × *Elaphus davidianus* hybrids). *Appl. Anim. Behav. Sci.* 45, 301–308.
- Pritchard, J., Lindberg, A., Main, D., Whay, H., 2005. Assessment of the welfare of working horses, mules and donkeys, using health and behaviour parameters. *Prev. Vet. Med.* 69, 265–283.
- Pritchett, L., Ulibarri, C., Roberts, M., Schneider, R., Sellon, D., 2003. Identification of potential and behavioural indicators of postoperative pain in horses after exploratory celiotomy for colic. *Appl. Anim. Behav. Sci.* 80, 31–43.
- Reinhardt, V., 1991. Training adult male rhesus monkeys to actively cooperate during in-homecage venipuncture. *Anim. Technol.* 42, 11–17.
- Richard-Yris, M.-A., Hausberger, M., Henry, S., 2004. Bases éthologiques de l'apprentissage. In: *Compte-rendu de la 30^{ème} Journée de la Recherche Equine*, 3 mars 2004, Paris, pp. 179–187.
- Rivera, E., Benjamin, S., Nielsen, B., Shelle, J., Zanella, A.J., 2002. Behavioral and physiological responses of horses to initial training: the comparison between pastured versus stalled horses. *Appl. Anim. Behav. Sci.* 78, 235–252.
- Robinson, I.H., 1999. The human–horse relationship: how much do we know? *Equine Vet. J. Suppl.* 28, 42–45.
- Ruiz-Miranda, C.R., Callard, M., 1992. Effects of the presence of the mother on responses of domestic goat kids (*Capra hircus*) to novel inanimate objects and humans. *Appl. Anim. Behav. Sci.* 33, 277–285.
- Rossdale, P.D., 1967. Clinical studies on the newborn thoroughbred foal. I. Perinatal behaviour. *Br. Vet. J.* 123, 470–481.
- Rushen, J., Taylor, A.A., de Passillé, A.M., 1999. Domestic animals' fear of humans and its effect on their welfare. *Appl. Anim. Behav. Sci.* 65, 285–303.
- Seaman, S., Davidson, H., Waran, N., 2002. How reliable is temperament assessment in the domestic horse (*Equus caballus*)? *Appl. Anim. Behav. Sci.* 78, 175–191.
- Shanahan, S., 2003. Trailer loading stress in horses: behavioural and physiological effects on nonaversive training (TTEAM). *J. Appl. Anim. Welf. Sci.* 6, 263–274.
- Sigurjónsdóttir, H., Gunnarsson, V., 2002. Controlled study of early handling and training of Icelandic foals. Dorothy Russell Havemeyer Workshop Horse Behavior and Welfare, Iceland, 13–16 June 2002. [http://www3.vet.upenn.edu/labs/equinebehavior/hvnmkshp/hv02/sigurjon\(1\).htm](http://www3.vet.upenn.edu/labs/equinebehavior/hvnmkshp/hv02/sigurjon(1).htm).
- Simpson, B., 2002. Neonatal foal handling. *Appl. Anim. Behav. Sci.* 78, 303–317.
- Søndergaard, E., Ladewig, J., 2004. Group housing exerts a positive effect on the behaviour of young horses during training. *Appl. Anim. Behav. Sci.* 87, 105–118.
- Søndergaard, E., Halekoh, U., 2003. Young horses' reactions to humans in relation to handling and social environment. *Appl. Anim. Behav. Sci.* 84, 265–280.
- Spier, S., Berger Pusterla, J., Villarroel, A., Pusterla, N., 2004. Outcome of tactile conditioning of neonates, or “imprint training” on selected handling measures in foals. *Vet. J.* 168, 252–258.
- Tanida, H., Miura, A., Tanaka, T., Yoshimito, T., 1995. Behavioral response to humans in individually handled weanling pigs. *Appl. Anim. Behav. Sci.* 42, 249–259.
- Turner, M., McCrory, Halley, W., 2002. Injuries in professional horse racing in Great Britain and the Republic of Ireland during 1992–2000. *Br. J. Sports Med.* 36, 403–409.
- Tyler, S.J., 1972. The behaviour and social organization of the New Forest ponies. *Anim. Behav. Monogr.* 5, 85–196.
- Ueack, B.A., Dierks, E.J., Homer, L.D., Potter, B., 2004. Patterns of maxillofacial injuries related to interaction with horses. *J. Oral Maxillof. Surg.* 62 (6), 693–696.
- Visser, E., Van Reenen, C., Hopster, H., Schilder, M., Knaap, J., Barneveld, A., Blokhuis, H., 2001. Quantifying aspects of young horses' temperament: consistency of behavioural variables. *Appl. Anim. Behav. Sci.* 74, 241–258.
- Visser, E., Van Reenen, C., Van der Werf, J., Schilder, M., Knaap, J., Barneveld, A., Blokhuis, H., 2002. Heart rate and heart rate variability during a novel object test and a handling test in young horses. *Physiol. Behav.* 76, 289–296.
- Visser, E., Van Reenen, C., Engel, B., Schilder, M., Barneveld, A., Blokhuis, H., 2003a. The association between performance in show-jumping and personality traits earlier in life. *Appl. Anim. Behav. Sci.* 82, 279–295.
- Visser, E., Van Reenen, C., Rundgreen, M., Zetterqvist, M., Morgan, K., Blokhuis, H., 2003b. Responses of horses in behavioural tests correlate with temperament assessed by riders. *Equine Vet. J.* 35, 176–183.
- Wäiblinger, S., Boivin, X., Pedersen, V., Tosi, M.-V., Janczak, A., Visser, K., Jones, R.B., 2006. Assessing the human–animal relationship in farm species: a critical review. *Appl. Anim. Behav. Sci.* 101, 185–242.
- Waran, N., Casey, R., 2005. Horse training. In: Mills, D.S., Mc Donnell, S.M. (Eds.), *The Domestic Horse: The Origins, Development and Management of its Behaviour*. Cambridge University Press, Cambridge, pp. 184–195.
- Waring, G.H., 2003. *Horse Behavior*. Noyes Publications, New York.

- Waters, A., Nicol, C., French, N., 2002. Factors influencing the development of stereotypic and redirected behaviours in young horses: findings of a four year prospective epidemiological study. *Equine Vet. J.* 34, 572–579.
- Weeks, J., Beck, A., 1996. Equine agitation behaviors. *Vet. Clin. North Am. Equine Pract.* 18, 23–24.
- Williams, J.L., Friend, T.H., Collins, M.N., Toscano, M.J., Sisto-Burt, A., Nevill, C.H., 2003. Effects of imprint training procedure at birth on the reactions of foals at age six months. *Equine Vet. J.* 35, 127–132.
- Williams, J.L., Friend, T.H., Collins, M.N., Toscano, M.J., Sisto-Burt, A., Nevill, C.H., 2002. The effects of early training sessions on the reactions of foals at 1, 2 and 3 month of age. *Appl. Anim. Behav. Sci.* 77, 105–114.
- Wipper, A., 2000. The partnership: the horse–rider relationship in eventing. *Symbolic Interact.* 23 (1), 47–70.
- Wolff, A., Hausberger, M., 1994. Behaviour of foals before weaning may have some genetic basis. *Ethology* 96, 1–10.
- Wolff, A., Hausberger, M., Le Scolan, N., 1997. Experimental tests to assess emotionality in horses. *Behav. Processes* 40, 209–221.
- Zeeb, K., Schnitzer, U., 1997. Housing and training of horses according to their species-specific behaviour. *Livestock Prod. Sci.* 49, 181–189.