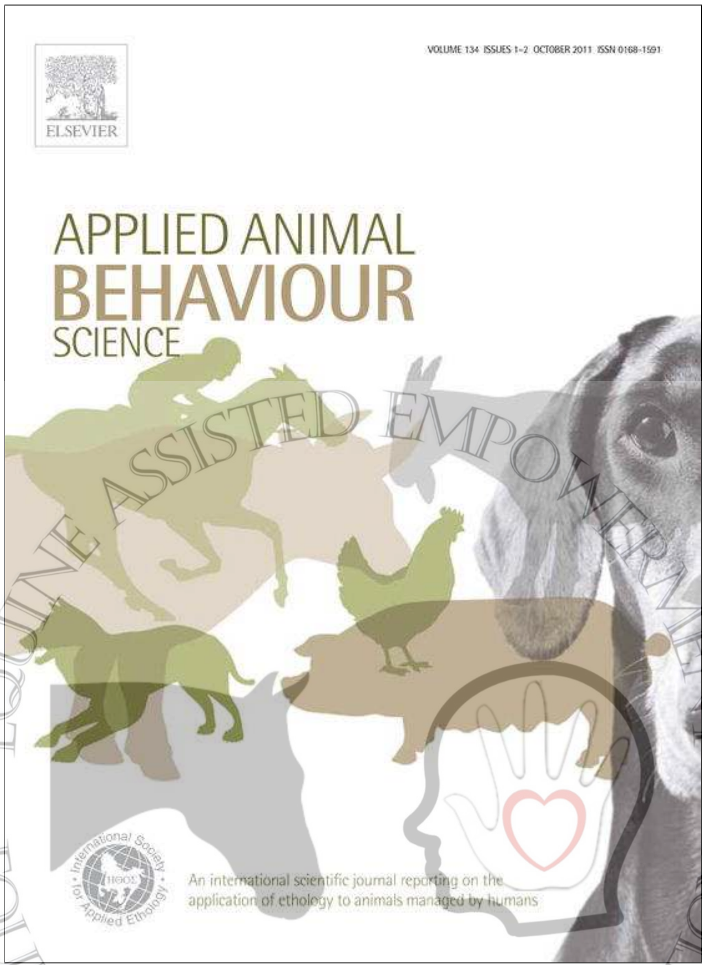
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Horses' responses to variation in human approach

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ABSTRACT

The behaviour of humans around horses is thought to have a substantial impact on how people are perceived in subsequent interactions and many horse trainers give detailed advice on how handlers should behave when initially approaching a loose horse. Here we report on three studies designed to explore the effect of different human approach styles on the behaviour of naïve and experienced horses.

In the first study, the change in flight distance (distance at which horses started to avoid an approaching human) of twelve semi-feral Dartmoor ponies, undergoing training to allow handling, was assessed. Over the 10 handling sessions median flight distance decreased significantly ($p < 0.001$) from 2.38 m to 0.00 m and there was a significant positive shift in the ponies' behaviour following the appearance of the researcher ($p = 0.002$).

In a second study the effect of a direct (vigorous, swinging a lead rope and with eye contact) versus indirect (relaxed, no rope swinging and without eye contact) approach style was assessed on six adult experienced riding horses. The mean flight distance during a direct approach style (6.87 m) was significantly greater than that which occurred during an indirect approach style (2.32 m). Direction of approach was not found to significantly affect flight distance.

In a third study, the effect of the rope was removed and a similar method to the second study applied to a group of naïve, feral ponies. The effect of different components of approach style, speed of approach, handler body posture and direction of gaze, which might contribute to observed differences in behavioural responses, were then examined systematically in this population. This revealed no significant difference in mean flight distance between the two approach styles (2.28 m indirect versus 2.37 m direct approach), but ponies were significantly more likely to move off in trot ($p = 0.025$) and to travel further ($p = 0.001$) when a direct approach was used. Speed of approach was the most salient factor, with a fast approach increasing both the tendency to move off in trot ($p < 0.001$) and distance travelled ($p < 0.001$). Body posture (relaxed or tense) had no effect, while flight distance was significantly greater when the person was looking away ($p = 0.045$).

These results suggest horses may have an important egocentric spatial barrier, which perhaps relates to personal space and triggering of the flight response. Contrary to popular belief, body posture did not appear to be very important in the contexts examined unless accompanied by extraneous aids, while the speed of approach is particularly significant. These results are of important practical relevance in reducing the risk of injury, and the effective management of horses with minimal stress.

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1. Introduction

Domestic horses spend their lives in relatively close contact with people, and human behaviour has considerable potential to affect their welfare. Recent work has looked at the effects of handler behaviour on the welfare of a range of captive species in different contexts, e.g. in agriculture, where livestock productivity may be adversely affected (reviewed in Hemsworth, 2003); or in zoos, where the activities of visitors can provoke aversive reactions (Hosey, 2005), while in laboratory animals, differences in physiological reactions to painful stimuli have been demonstrated resulting from different handlers (Chesler et al., 2002).

Despite the importance of human-horse interaction to the utility of horses, there is relatively little research on human interactive behaviour towards them, such as effects of posture and direction of gaze (Hausberger et al., 2008). Also, with increasing numbers of leisure horses in recent years, comes considerable variation in conditions of husbandry and expertise of handlers (British Horse Industry Confederation, 2005), with implications for both equine welfare and human safety. The review by Hausberger et al. (2008) identified research on horses' reactions to a motionless human, to human approach and touch. They note that direction of gaze, posture, positioning and speed of approach of the human are often poorly specified in these studies, and call for further research detailing how these specific variables affect horses' reactions. Such research has important applications in handler education to minimise the risk of injury, and in horse welfare where handler confidence may promote greater cooperation from the horse (Chamove et al., 2002).

The body posture adopted by a handler towards a horse is an explicit consideration in what has been called "natural horsemanship", which is becoming increasingly popular (Birke, 2007); natural horsemanship trainers frequently suggest approaching horses in a "soft", relaxed manner. For example Roberts (1996) claims that approaching naïve horses face-on with direct eye contact encourages them to flee, whereas a person approaching obliquely, at 45°, and not looking directly at the horse invites contact. Some trainers suggest that looking directly at the horse allows the human handler to maintain control, while others argue that direct gaze should be avoided (Verrill and McDonnell, 2008).

The degree to which horses respond to specific human body postures, movement or direction of gaze by an approaching person has been little studied, in either naïve animals or those habituated to frequent handling. This paper reports three small studies, done in separate locations, each of which investigated horses' responses to different human approach style, particularly differences between direct and indirect approach. Study 1 used semi-feral native Dartmoor ponies to examine flight responses before and after human handling. This study tested the hypothesis that the flight distance (that is, the distance from an approaching human at which the ponies would take flight) would decrease after handling. An "indirect" approach was used, which involved moving towards the ponies with the person's body angled, and no direct eye contact. Studies 2 and 3a, by contrast, compared effects of a similar indirect approach to a direct one, in which the person approaching faced the animals, with an upright stance and looking at them. These studies tested the hypothesis that a direct approach would lead to stronger flight responses, using adult, well-handled horses (Study 2), or naive semi-feral Welsh Mountain ponies (Study 3a). However, approach style, whether direct or indirect, is in effect a compound stimulus comprised of three different components of handler behaviour: body posture, direction of eye gaze and speed of approach. Study 3b aimed to dissociate these three parts of the compound stimulus and examined the effect of each component on the flight response and behaviour of naive semi-feral Welsh Mountain ponies.

2. Methods and results

2.1. Study 1

2.1.1. Materials and methods

2.1.1.1. Subjects and housing. Twelve feral Dartmoor ponies were used (7 fillies; 5 geldings). They were taken from the moor in the autumn, and housed at a lairage on the edge of Dartmoor prior to testing and preparation for sale. Prior handling varied between subjects and included gelding or identification procedures such as branding and ear tagging on a previous occasion, but this was a considerable time earlier and at other sites, so they were naïve about the test site per se. The ponies received no other scheduled handling, and had not previously encountered the researcher. They were between 12 and 24 months at the time of testing.

2.1.1.2. Procedure and design. On arrival at the lairage, ponies were released into a pen as a group. For testing, individual ponies were separated and moved by an experienced researcher using just their body language and positioning to direct the selected animal through a gate into an empty adjacent high-sided pen (3.5 m × 8 m) for measuring and handling. This restricted visual but not auditory contact between subjects. After 2 h acclimatisation, during which animals were left without human contact, and appeared to become more relaxed, the controlled handling procedure began: on entering the pen, the researcher stood motionless for 30 s, with a relaxed, indirect stance (body slightly angled, no direct eye contact). The orientation of the horse's head relative to the researcher, and the direction of any movement in response to the entry of the researcher, was noted at this time. Head and feet movements were scored as no response (neutral), turned away from the human (avoidance), or towards (investigatory). The horse was thus given the opportunity to move to whatever distance from the researcher it preferred during this initial 30-s period. The next stage was not commenced until after the 30 s of exposure to the researcher, and the horse was stationary. Then the researcher began to approach in a line towards the horse's right shoulder, using an indirect stance. Approach stopped once the pony moved its feet to take a step, and flight distance in response to researcher approach was then measured at this time, using a Trimble HD360 handheld laser as the distance from researcher hip to horse shoulder at the time when the pony first moved off. The researcher continued to approach and pause until she was

Table 1
Study 1: changes in flight distance of naive young ponies over handling sessions ($N = 12$).

Session	Mean flight distance ± S.D. (in m)
1	2.40 ± 0.54
2	2.10 ± 0.54
3[a]	1.66 ± 0.66
4	1.19 ± 0.62
5[a]	0.97 ± 0.77
6	0.77 ± 0.48
7[a]	0.54 ± 0.68
8	0.43 ± 0.37
9[a]	0.15 ± 0.31
10	0.07 ± 0.17

Flight distance = the distance from an approaching human at which the ponies took flight.
[a] Sessions following handling procedures.

able to make contact with the horse and undertake a predefined handling procedure. The handling procedure was undertaken by the same experimenter throughout (LP) and comprised: touching with a rope to familiarise the pony with pressure, introduction to the halter and haltering; leading from the halter. The ponies were then taught basic skills (picking up feet, tying up, loading into trailer) and introduced to novel objects (e.g. umbrella, football). This procedure conformed to a handling method called Positive Horsemanship (www.positivehorsemanship.com). Measurements of the orientation and movement of the head and feet in response to the appearance of the researcher in the pen and flight distance were recorded over 10 sessions over 6 days, as follows: initial measurements (day 1), before and after handling procedures (i.e. twice on days 2–5), and prior to ponies being moved for sale (day 6).

2.1.1.3. Data analysis. Data were analysed using Minitab 15 and were not normally distributed so a Kruskal–Wallis test was used to evaluate the effect of session number and individual horse identity on flight distance separately. A Chi-square test was used to compare frequencies of head and foot position (avoidance, neutral or investigatory) in response to the appearance of the researcher, before versus after the handling sessions (i.e. sessions 2–9 inclusive). To assess the overall change in the horse's behaviour, the head and foot responses of the horses in the first and last session were compared using a Wilcoxon sign test, with an improvement (i.e. avoidance to neutral or investigatory), scoring positively, no change scoring zero and a deterioration scoring negatively.

2.1.2. Results

2.1.2.1. Flight distance. Ponies showed a significant decrease in their flight distance over the 10 sessions (K–W = 79.97, 9 d.f., $p < 0.001$), with average flight distance falling by 97% over the 10 sessions (Table 1). The effect of individual horse was also significant (K–W = 22.78, 11 d.f., $p = 0.019$).

2.1.2.2. Behavioural response: head and foot position. In the first session 8 horses turned their head away and 7 of these also moved away in response to the appearance of the researcher, all other responses were neutral. In the final session, only 1 horse turned its head away, 3 were neutral and the remaining 8 turned their head towards the researcher; 1 moved away, 5 were stationary and 6 moved towards the researcher. Changes in orientation from away to either no movement or towards the researcher, or from no movement to towards the researcher, were considered positive. The recorded changes in head and foot movement were significant (head movement: 11 positive and 1 no change: $p = 0.002$: foot movement: 11 positive and 1 no change: $p = 0.002$).

Concerning the sessions immediately preceding and following handling, there was a significant change in head orientation, with greater investigatory and reduced neutral or avoidance movement occurring in the sessions following handling ($\chi^2 = 7.6$, 2 d.f., $p = 0.022$).

The effect on leg movement was not significant, with the majority of sessions evoking a neutral response ($\chi^2 = 4.025$, 2 d.f., $p = 0.13$). This is consistent with handling having a specific effect on the ponies' perception of people, rather than a simple time dependent effect.

2.2. Study 2

Study 1 demonstrated that repeated exposure to humans using indirect approaches and careful handling over a period of 6 days, led to a reduced flight distance and more orientation towards the human, by ponies that had previously had little handling. Study 2 examined the responses to two different approach styles in adult subjects with considerable experience of handling.

2.2.1. Materials and methods

2.2.1.1. Subjects and housing. Six domesticated horses were used, housed at the Equestrian Centre, University of Lincoln, who were normally stabled for part of the day. They were three mares and three geldings, of mixed breeding, aged between 15 and 20 years old (mean age = 17) and between 15.1 hands (155 cm) and 17.2 hands (178 cm) in height.

2.2.1.2. Procedure and design. Subjects were turned loose individually into an outdoor arena, 60 m × 20 m, with an artificial substrate. Once the horse was stationary, one researcher (JM) began to approach, from a distance of approximately 10 m, at a practiced speed (0.8 m/s). Once the horse moved away, approach stopped. Approaches followed 8 different paths, counterbalanced between subjects: one each direct to the front or back of the horse, and one towards each of the following: the shoulder, middle or quarter, from the left or right. This controlled for effects of approach direction: an examination of results post hoc indicated that direction of approach was not significant.

Each horse was tested with the eight approaches three times for a given approach style to obtain means for each individual. Two approach styles were used, in counterbalanced order: these were:

Direct – with direct eye contact, and gently swinging a lead rope in the right hand.

Table 2
Study 2: mean flight distance for individual adult horses, direct versus indirect approach ($N = 6$).

Horse	Mean flight distance ± S.D. (in m)	
	Direct	Indirect
A	9.49 ± 3.4	3.46 ± 3.97
B	2.70 ± 1.6	4.30 ± 1.99
C	8.11 ± 3.63	1.01 ± 1.44
D	7.08 ± 2.52	0.18 ± 0.34
E	8.04 ± 2.08	1.86 ± 2.8
F	5.81 ± 2.03	3.13 ± 3.1

Flight distance = the distance from an approaching human at which the horses took flight.

Indirect – no direct eye contact, and the lead rope held still in the right hand.

Flight distance was calculated from recordings made using a Trimble HD360 hand-held laser by a second researcher who remained stationary, in line with, but behind, the path taken by the first researcher towards the horse.

The horse's responses after each approach were observed using focal behaviour sampling and continuous recording, to measure movements of head or ears, or other behaviour, such as bucking. Bucking was defined as a lowering of the head and neck and shifting of the weight to the forelegs with both hind legs lifted off the ground in simultaneous backward extension (McDonnell, 2003).

2.2.1.3. Data analysis. Data were analysed using Minitab 15 and were not normally distributed. They were analysed using non-parametric tests to examine the effects of individual horse, approach style and direction of approach on flight distance. Chi squared tests were used to assess the association between specific behaviours and approach style.

2.2.2. Results

2.2.2.1. Flight distance. Style of approach had a significant effect on flight distance (Wilcoxon signed rank test = 9910, $p < 0.001$). The mean flight distance of horses approached directly was 6.87 m, and 2.32 m when approached indirectly (Table 2). There was significant individual variation in both circumstances (K–W Direct = 68.38, 5 d.f., $p < 0.001$, K–W Indirect = 12.55, 5 d.f., $p = 0.028$). There was no effect of direction ($p > 0.9$ in both instances), which is consistent with horses having a wide field of view.

2.2.2.2. Behavioural response. Head movement ($\chi^2 = 4.74$, $p = 0.029$), movement of one ear ($\chi^2 = 16.72$, $p \leq 0.001$) and both ears ($\chi^2 = 16.72$, $p \leq 0.001$) occurred significantly more often in association with indirect approaches (head movement was observed 12/144 direct approaches, 32/144 indirect; movement of one ear 10/144 direct, 36/144 indirect; movement of both ears 6/144 direct approaches, 32/144 indirect). Bucking was found to be significantly associated with the direct approaches ($\chi^2 = 13.62$, $p < 0.001$) being observed 12/144 direct approaches but not seen at all in response to indirect approaches.

2.3. Study 3

The first two studies indicated similar flight distances in response to indirect approaches in quite different captive populations (2.43 m in session one of Study 1 – naïve ponies; 2.3 m overall in Study 2 – horses accustomed to frequent handling). Study 2 also showed that direct approach accompanied by a swinging rope led to a threefold increase in mean flight distance (mean = 6.9 m) by well handled horses. The rope's movement could not, however, be dissociated from the researcher's approach style. Study 3 used naïve, feral ponies to compare responses to approaches differing only in the person's style (direct/indirect: Study 3a). A second experiment on the same group of ponies (Study 3b), examined separately the different components of approach style, speed of approach, handler body posture and direction of gaze, which might contribute to observed differences in behavioural responses.

2.3.1. Materials and methods

2.3.1.1. Subjects and housing. Thirty-six semi-feral Welsh mountain ponies (26 colts and 10 fillies) were used in two experiments. The ponies were 6–8 months old for Study 3a and 9–11 months old for Study 3b. The ponies were semi-feral until rounded up and transported to the study site (lairage in Buckinghamshire) 2 months prior to Study 3a. The ponies were housed in two mixed groups: 16 were housed in a 25 m × 8 m barn (A), and 20 in a 32 m × 8 m barn (B), separated from each other by a central walkway. Each group had access to an outside concrete yard of approximately 200 m^2. Apart from a brief veterinary examination in a crush shortly after arrival, they had little individual attention from caretakers.

2.3.1.2. General testing procedure. A temporary corral (9 m × 8 m) inside the home barn of the horses was used for testing. To avoid additional stress due to social separation, the ponies were tested in groups of three (Study 3a) or two (Study 3b). Allocation to groups was by convenience sampling, with ponies in close proximity in the barn tending to be grouped together. After each test procedure, the group was moved to the outside yard. To ensure that ponies were not left alone, not all animals were used at any one time. Study 3a used a total of 10 groups each consisting of three ponies.

In Study 3b, convenience sampling was again used, and pairs of ponies allowed to move into the corral naturally before the corral was closed off for testing. This was done over 2 days: 18 pairs of ponies were tested on one experimental day, and 17 pairs the following day, with allocation to testing conditions done in a balanced design. No individual was run in the same pair on the 2 days of testing, so that each pairing was unique. Thus, this study used groups or pairs rather than individuals as subjects, although data were recorded only from the first pony to move.

Inside the test corral a few pony nuts and/or carrots were pooled on the straw 4 m from the researcher waiting at the end of the corral. This attracted the ponies to one area to allow standardised start conditions for each trial. Each trial began when the group had been quietly eating for 1 minute and all were orientated towards the experimenter (which they did naturally). The researcher approached the group according to the test condition until reaching the ponies' start point. The experimenter returned to the start position and the ponies were permitted to settle back before the second trial began. All trials were recorded on video, using a camera placed alongside the corral, opposite the feeding point.

The same researcher (JH) was used throughout and was trained until able to adopt a standard body posture, pace length and speed for each test condition. As in the previous studies, the researcher was a person unfamiliar to the ponies, though in this case wore dark red overalls identical to the ones worn by the animals' daily caretakers.

2.3.2. Study 3a

2.3.2.1. Study specific procedure and design. The aim of this experiment was to investigate effects of direct versus indirect approaches on the flight behaviour of the pony groups. It was a within subjects design, with a researcher approaching each of 10 test groups of three ponies directly and indirectly counterbalanced for order effects between groups. Once the ponies had moved away from the first approach, the researcher allowed them to settle, and return to the feeding site, before the second approach began.

In the *direct* condition the researcher walked assertively towards the ponies, adopting a tense, upright stance, with head and shoulders facing square onto the pony group, and eye gaze focused onto the group. In the *indirect* condition the researcher adopted a more relaxed posture, with relaxed upper body turned 45° away from the direction of movement, and eye gaze averted from the ponies. The researcher approached the middle of the pony group in each test, taking care to avoid directing their approach on an individual pony. Due to the way the ponies orientated themselves around the food on the ground while keeping the researcher in their field of view this was easily done.

Flight responses were coded from the video recordings as follows:

- distance of the researcher from the pony group when the first pony lifted its head (alert response (m));
- distance of the researcher from the pony group, when the first pony moved off (flight distance (m));
- distance of flight around the corral after first movement (the distance the first pony fled (m));
- pace of flight of lead pony (pace = walk or trot).

Distances were measured using a perspex perspective grid placed over the monitor screen to record the number of grid squares travelled (lines on grid = 1 m).

2.3.2.2. Study 3a: data analysis. Measures of distance in this study were found to be normally distributed, and distance data from experiment one were analysed using *t*-tests (SPSS v.14), to compare effects of the two types of approach. Data for pace of flight were analysed using a chi-squared test.

2.3.2.3. Study 3a: results. Flight distances in this experiment were similar to those observed in the previous two studies. However, there were no significant differences between direct and indirect approaches in flight distance or distance at first alert response (Table 3). There was a significant difference in distance travelled by the ponies ($t_9 = 5.23$, $p = 0.001$), and they were significantly more likely to move off in trot than in walk in response to direct approach (χ^2 325 = 8.6; $p < 0.025$).

Table 3
Study 3a: responses of naive young ponies, direct versus indirect approach (*N* = 10 groups of three).

Variable	Mean ± S.D. (distances in m)	
	Direct	Indirect
Alert response	2.78 ± 0.47	2.58 ± 0.83
Flight distance	2.37 ± 0.73	2.28 ± 0.85
Distance travelled	11.2 ± 1.58	7.10 ± 2.24

Flight distance = the distance from an approaching human at which the ponies took flight.

2.3.3. Study 3b

2.3.3.1. Study specific procedure and design. The general test procedure was the same as for Study 3a (see Section 2.3.1.2). However, as the ponies were slightly older for Study 3b, they were tested in pairs rather than in groups of three. Pony pairs were tested with body posture (relaxed or tense), eye gaze ("on" the horse or "off"), and speed (fast or slow). The effects of body posture and eye gaze were tested between subjects (pairs of ponies). This was done in a counterbalanced design, so that each temporary pairing was allocated to one of four test conditions: relaxed/gaze on, relaxed/gaze off, tense/gaze on and tense/gaze off). However, speed of approach was tested within subjects, as a repeated measure, with pony pairs tested twice (as was done in Study 3a): the slow speed trial (approach at 0.6 $\mathrm{m\,s^{-1}}$) always preceded the fast trial (1.2 $\mathrm{m\,s^{-1}}$) to minimise any sensitisation effects arising from the fast approach, although data from Study 3a had not indicated any sensitisation effects on responses on the second trial. As in the previous experiment, the following were measured from the video recording: alert response (distance from researcher at first head-up); flight distance (distance from researcher when group moved off); pace of flight; and distance fled around the corral.

2.3.3.2. Study 3b: data analysis. The data from this experiment were normally distributed. The design combined between subject measures (posture, and direction of gaze) and within-subjects measures (speed of approach), requiring a mixed between-within subjects Analysis of Variance (Pallant, 2007), using SPSS v.14.

Chi-squared and Wilcoxon tests were used to analyse pace of flight (walk away versus trot away).

2.3.3.3. Study 3b: results. Table 4 shows distances from researcher at first alert, flight distance (FD), and the distance travelled after first moving away, in response to experimental variables (speed, approach style, direction of gaze).

Alert response: The multivariate analysis showed a significant effect of eye gaze; that is, alert responses

Table 4
Study 3b: responses of ponies to different approach speed (slow/fast), approach style (relaxed/tense) and gaze direction (on/off): total $N = 35$ pairs.

Response to approach	Mean ± S.D. (distances in m)			
	Relaxed		Tense	
	Gaze on	Gaze off	Gaze on	Gaze off
Alert				
Fast approach	2.5 ± 0.8	2.3 ± 0.9	2.2 ± 1.0	3.0 ± 0.5
Slow approach	2.1 ± 1.2	3.2 ± 0.7	1.9 ± 0.9	2.4 ± 1.3
Flight distance				
Fast approach	2.0 ± 1.0	2.2 ± 0.9	1.7 ± 0.9	2.4 ± 0.8
Slow approach	1.7 ± 1.1	2.6 ± 0.9	1.4 ± 1.1	1.8 ± 1.2
Distance travelled				
Fast approach	5.3 ± 1.9	5.9 ± 2.0	7.4 ± 2.0	4.9 ± 1.8
Slow approach	3.5 ± 1.8	2.8 ± 1.8	2.7 ± 1.7	3.2 ± 1.9

Flight distance = the distance from an approaching human at which the ponies took flight.

occurred at a greater distance from the researcher with eye gaze off ($F1,31 = 4.17$; partial eta squared = 0.12; $p = 0.05$). There was no significant effect of approach style. There was a significant speed × body posture × eye gaze interaction for within-subject contrasts (Wilk's lambda = 0.85; $F1,31 = 5.35$; partial eta squared = 0.15; $p = 0.028$), suggesting that the effect of eye gaze was affected by approach speed (slow approach with eyes off led to alert responses at a greater distance than other approaches).

Flight distance: There was one significant between-subjects effect, for eye gaze (on versus off): flight distance was greater (that is, flight was initiated sooner) when eye contact was off the horse ($F1,31 = 4.38$; partial eta squared = 0.12; $p = 0.045$). There were no other significant effects.

Distance of flight: There was a significant effect due to speed, with ponies travelling further in response to a fast approach (Wilk's lambda = 0.24; $F = 96.2$; partial eta squared = 0.76; $p < 0.0001$), and a significant interaction between speed × body posture × eye gaze (Wilk's lambda = 0.69; $F1,31 = 14.0$; partial eta squared = 0.311; $p = 0.001$); the greatest distance travelled was in response to fast speed, with tense posture and eyes on.

Pace of flight: The chi-square test showed a significant effect of treatment group ($\chi^2 = 26.2$; d.f., = 7; $p < 0.001$). Separate examination of groups indicated that trot occurred significantly more often after fast approach (Wilcoxon $Z = 4.36$; $p < 0.0001$).

3. Discussion

Taken together, these separate studies indicate that both naïve and experienced horses, whether alone or in a group, show similar reactions to an initial approach by an unknown individual, with a flight response being triggered initially at around 2.5 m. Austin and Rogers (2007), examining the symmetry of flight responses and turning in horses, also reported an overall mean around 2.5 m, although they also report this may vary with side of approach and direction of turn, which we did not find. The consistency of this initial flight distance across the different populations studied is quite remarkable, but consistent with Heideger's proposal (Heideger, 1950) that the natural flight distance of an animal may be relatively hard-wired, which has been supported by more recent neurophysiological work on egocentric spatial thresholds (e.g. Graziano and Cooke, 2006). Egocentric space refers to the definition of space by reference to the observer's own position within it and includes concepts such as personal space. This might be considered to be the distance at which an important psychological boundary is crossed, which has the potential to result in some form of avoidance response, similar to initial touch. Naturally there may be many other important boundaries and the significance of this boundary might be altered by learning as well as other factors which might trigger an avoidance response more readily (i.e. result in a greater flight distance). This is particularly likely to be the case in feral animals in an open environment.

Horses in these studies generally responded to approach by moving away, but "hard" approaches by a person led to stronger responses than "softer" ones. This is consistent with the suggestion made by natural horsemanship practitioners that a direct approach, facing the animal with a tense body posture and making eye contact is more likely to elicit flight. In Study 1, daily routines were designed to familiarise naïve ponies to the initial presence of a human, to human handling and to stable management practices (grooming, picking out feet, for example). This study demonstrated that the ponies' initial flight responses could be reduced as they became habituated to the presence of people and such procedures; over just 5 days with 2 exposures a day flight distance decreased and they displayed greater orientation towards the researcher and accepted their approach more readily. At the beginning of the training, these naïve ponies had little experience, and so little potential to predict human actions and body positioning on the basis of any learning. Indeed the main experience of people was likely to have been aversive as it was associated with branding or tagging and possibly castration. It is therefore somewhat surprising that even older, experienced, horses, such as those used in Study 2, reacted to similar human approach at a similar distance. The horses used here were accustomed to the routines of the riding school; such experienced horses would be expected to react positively to confident people when being handled, as Chamove et al. (2002) suggest. However, horses' perceptions of humans can be affected by prior experience of interacting with people (Fureix et al., 2009), and riding school horses might learn to associate human approach with negative outcomes (work, being ridden by inexperienced novice riders). The greater flight distance and incidence of bucking observed after "hard" approaches in this study may, moreover, have been partly a reaction to the swinging rope, which could increase the arousal elicited by the approaching human.

Approach styles are compound stimuli. "Soft" or "hard" approaches may differ, for example, in body posture, speed or approach, how humans look at the horse, or whether they carry things in their hands. Study 3a confirmed that direct approaches lead to greater arousal and stronger reactions, particularly in the speed of movement (trot versus walk) and distance moved from the human. The study also demonstrated that there was little effect of varying approaches on flight distance when a rope was not used. The distance from the human at which animals became alert (head up) or moved off remained fairly constant, and was consistent with findings from the previous two studies. There were, however, notable differences in response *intensity* – pace of movement, and distance moved.

The purpose of Study 3b was to tease out some of the stimulus components involved, particularly in relation to the behaviour of the human. Contrary to claims made by many practitioners, body posture per se does not seem to be important: ponies reacted similarly to humans with "hard"/tense or "soft"/relaxed body tone. There was a small effect of eye gaze direction – but, surprisingly, eye gaze *away* led to the ponies reacting sooner. Direct eye gaze (staring) can be perceived as a threat in some vertebrate species, such as dogs (Bradshaw and Nott, 1995), macaques (Coss et al., 2002) and iguanas (Burger et al., 1992). Staring similarly elicited more locomotor movement and vigilance behaviour by sheep than indirect gaze (Beausoleil et al., 2006). In horses, by contrast, Verrill and McDonnell (2008) found no difference between the effects of direct eye contact versus looking away on the ease with which a researcher could catch a horse in a pasture. Horses, like many other species such as dogs (Soproni et al., 2001) and jackdaws (von Bayern & Emery, 2009) are clearly sensitive to human gaze patterns, since Proops and McComb (2010) have shown that individuals with long experience of handling choose humans whose visual gaze is directed at them in food-related discrimination tasks.

The ponies in Study 3 were little handled, but the encounters they had previously had with humans were likely to involve humans looking directly at them before or during a direct approach. These ponies would be expected to make an assessment, similar to the vigilance responses shown by sheep (Beausoleil et al., 2006) and perhaps humans approaching with averted gaze might be a less familiar and unpredictable stimulus, so eliciting quicker reactions.

By far the strongest effect on flight behaviour was due to approach speed. Fast approaches led to more intense responses (faster pace, further distance travelled). This finding corroborates claims made by many horse trainers that approaching horses "softly" has less effect on their flight, but dissects out a key feature of this style of approach. Thus, in practice people need to modulate speed, rather than body posture to avoid arousing the horse excessively. Personal observations by the authors, suggest that many individuals involved in "natural horsemanship" approach much faster when using their direct "hard" form of approach. This is consistent with the suggestion that the distribution of ganglion cells and retinal structure of horses, like many prey species, is such that it allows particular sensitivity to movement and acceleration (Saslow, 2002).

Taken together, these three separate studies indicate that horses react more strongly if approached in certain ways. Of particular importance is their response to faster or more direct human movement – not only do they react more quickly but also they are more likely to move off at a faster pace, indicating a startle response. There are clearly implications for human safety in how quickly such large animals respond, particularly if startled.

4. Conclusion

These studies support the general claim made by many trainers that how people approach horses affects the animals' responses. Speed is a particularly salient factor, but body posture, contrary to trainers' claims, does not appear to be important. How horses are approached prior to handling is important not only for the animals' welfare, but also in terms of human safety; moving slowly is clearly preferable.

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References

Austin, N.P., Rogers, L.J., 2007. Asymmetry of flight and escape turning responses in horses. Laterality 12, 464–474.
Beausoleil, N.J., Stafford, K.J., Mellor, D.J., 2006. Does direct human eye contact function as a warning cue for domestic sheep (*Ovis aries*)? J. Comp. Psychol. 120, 269–279.
Birke, L., 2007. "Learning to speak horse": the culture of "natural horsemanship". Soc. Anim. 15, 217–240.
Bradshaw, J.W.S., Nott, H.M.R., 1995. Social and communication behaviour of companion dogs. In: Serpell, J. (Ed.), The Domestic Dog: Its Evolution, Behaviour and Interactions with People. Cambridge University Press, Cambridge, pp. 115–130.
British Horse Industry Confederation, 2005. Strategy for the Horse Industry in England and Wales. Department for Environment, Food and Rural Affairs, London (www.defra.gov.uk: last accessed July, 2010).
Burger, J., Gochfeld, M., Murray, B.G., 1992. Risk discrimination of eye contact and directness of approach in black Iguanas (*Ctenosaura similis*). J. Comp. Psychol. 106, 97–101.
Chamove, A.S., Crawley-Hartrick, O.J.E., Stafford, K.J., 2002. Horse reactions to human attitudes and behaviour. Anthrozoos 15, 323–331.
Chesler, E.J., Wilson, S.G., Lariviere, W.R., Rodriguez-Zas, S., Mogil, J.S., 2002. Influences of laboratory environment on behavior. Nat. Neurosci. 5, 1101–1102.
Coss, R.G., Marks, S., Ramakrishnan, U., 2002. Early environment shapes the development of gaze aversion by wild bonnet macaques (*Macaca radiata*). Primates 43, 217–222.
Fureix, C., Jego, P., Sankey, C., Hausberger, M., 2009. How horses (*Equus caballus*) see the world: humans as significant "objects". Anim. Cogn. 12, 643–654.
Graziano, M.F.A., Cooke, D.F., 2006. Parieto-frontal interactions, personal space and defensive behaviour. Neuropsychologia 44, 845–859.
Hausberger, M., Roche, H., Henry, S., Visser, E.K., 2008. A review of the human–horse relationship. Appl. Anim. Behav. Sci. 109, 1–24.

Heideger, H., 1950. Wild Animals in Captivity. Butterworth Scientific Publications, London.
Hemsworth, P.H., 2003. Human–animal interactions in livestock production. Appl. Anim. Behav. Sci. 81, 185–198.
Hosey, R.G., 2005. How does the zoo environment affect the behaviour of captive primates? Appl. Anim. Behav. Sci. 90, 107–129.
McDonnell, S.M., 2003. A Practical Field Guide to Horse Behavior: The Equid Ethogram. The Blood Horse Inc., Lexington, 279 pp.
Pallant, J., 2007. SPSS: Survival Manual. Open University Press, Maidenhead, Berkshire.
Proops, L., McComb, K., 2010. Attributing attention: the use of human-given cues by domestic horses (*Equus caballus*). Anim. Cogn. 13, 197–205.
Roberts, M., 1996. Join-Up. Training Video. Flag Is Up Farms, Solvang, CA.
Soproni, K., Miklosi, A., Topal, J., Csanyi, V., 2001. Comprehension of human communicative signs in pet dogs (*Canis familiaris*). J. Comp. Psychol. 115, 122–126.
Saslow, C.A., 2002. Understanding the perceptual world of horses. Appl. Anim. Behav. Sci. 78, 209–224.
Verrill, S., McDonnell, S., 2008. Equal outcomes with and without human-to-horse eye contact when catching horses and ponies in an open pasture. J. Equine Vet. Sci. 28, 309–312.
von Bayern, A.M.P., Emery, N.J., 2009. Jackdaws respond to human attentional states and communicative cues in different contexts. Curr. Biol. 19, 602–606.