Influence of Training Techniques and Housing Environments on Horse Success in an Object Choice Test

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Abstract

This study examined the influence of training techniques and housing environments on the success of horses in following distal sustained human pointing and sustained body orientation. Understanding how external factors affect horses’ interpretation of human non-verbal communication is central for enhancing training practices, improving welfare, and ensuring safety in human-horse interactions.

We employed the Object Choice Test (OCT), a commonly used method for assessing an animal's response to human cues. The success of 34 adult horses was recorded in two separate test times and then analysed. A comparison was made between subjects trained solely and partly with positive reinforcement or solely with negative reinforcement. Regarding housing environments, the comparison was between horses in open stable group housing and traditional social isolation stall-paddock housing. We hypothesised that horses trained with positive reinforcement and those housen in open stables would perform better due to previously reported favourable effects on cognition.

Only three horses passed the pointing condition and five passed the body orientation, with a statistically significant difference. This indicates that the OCT is a challenging task for horses overall being especially the case with pointing. Our results align with most previous publications in terms of general success. However, they greatly differ from an earlier study using the same study protocol, where the overall success was high and better with pointing in comparison to body orientation.

As expected, the training technique affected the performance. All the successful horses in our study were in the positive reinforcement group. Being subject to negative reinforcement significantly correlated with being unsuccessful with both of the cues. Our study is the first to assess the impact of positive reinforcement training on horses' performance in the OCT, offering new insights into the role of the technique in enhancing cognitive responsiveness. No correlation was found for housing environment despite being hypothesised after a previous study on horses and OCT. This and other aspects of our study are discussed in depth.

These results underscore the importance of training in shaping horses' cognitive abilities, with implications for developing more effective and humane training methods. Further research is needed to explore the underlying mechanisms and the potential influence of environmental factors.

Keywords: horse, object choice test, human-animal relationship, social cognition, positive reinforcement, housing, horse welfare, cognitive performance

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1. Introduction

Misconceptions about animal cognition can lead to unrealistic expectations and even maltreatment (Mclean & Christensen 2017). To prevent misunderstandings and to reduce conflict behaviour in both the human and horse, it is essential to advance our understanding of equine cognitive abilities and factors affecting it (Ladewig et al. 2022, Fenner et al. 2024). Such insights can enhance the way we manage and interact with horses, ensuring their - and our - well-being and harmonising human-animal relationships (Hausberger et al. 2019).

With the rise of alternative horse management practices comparison with traditional methods through objective research is increasingly important. One such alternative is positive reinforcement training, where the animal is hinted of the wanted behaviour with a simultaneously timed sound mark. The sound is promptly followed by food, which acts as a reinforcer for the behaviour. This technique uses the deductive skills of the animal building welfare supporting agency and proactivity, as well as a stronger human-animal bond (Sankey et al. 2010b, Lefebvre et al. 2019, Merkies & Franzin 2021).

Positive reinforcement has been shown to offer significant benefits in horse training, leading to faster learning and better retention of learned behaviors indicating enhanced cognitive performance (Innes & McBride 2008, Sankey et al. 2010b, Hendriksen et al. 2011). Horses trained with this method are more human-oriented, motivated and have lower cortisol levels as well as fewer signs of distress (Innes & McBride 2008, Hendriksen et al. 2011, Lesimple et al. 2020). They also exhibit fewer unwanted behaviors, such as avoidance or aggression (Sankey et al. 2010a, Lundberg et al. 2020, Merkies & Franzin 2021).

In contrast, traditional training methods heavily rely on negative reinforcement, where physical pressure is applied to provoke the wanted behaviour and then released to reinforce it (Mclean & Christensen 2017). Whenever the release of pressure fails, it becomes a punishment. Punishing horses intentionally is also a common practice (Mclean & Christensen 2017). These typically lead to increased passivity, distress, and a reactive response style (Innes & McBride 2008, McGreevy & McLean 2009, Hendriksen et al. 2011), potentially impairing cognitive function and reducing problem-solving abilities in horses. The techniques are often associated with heightened anxiety and stress-related behaviours (Yarnell et al. 2020).

In addition to training methods, housing conditions significantly impact equine behavior and welfare (Hausberger et al. 2019). After all, horses spend the vast majority of their lives entrapped in some type of housing system. Horses are an obligatory social species, and thus fully depend on interactions with conspecifics for proper cognitive development and functioning (Krueger et al. 2021). Research shows that horses housed in groups especially in open stable systems exhibit lower overall stress levels, quicker recovery from stress, and improved cognitive performance (Hartmann et al. 2012, Hausberger et al. 2019, Lürzel et al. 2020a). This stems from opportunities for socialising and the vast array of other natural behaviours made available.

These environments also promote enhanced social learning and adaptability, reduce stereotypic behaviours, and increase engagement in training (Søndergaard & Ladewig 2004, Hartmann et al. 2012, Hausberger et al. 2019, Lürzel et al. 2020a). In contrast, horses kept in restrictive housing conditions, such as individual stalling and paddocks, often experience higher stress levels, a greater risk of stress-induced behaviors and cognitive impairments (Søndergaard & Ladewig 2004, Hartmann et al. 2012, Hausberger et al. 2019, Henry et al. 2021). This study will use the Object Choice Test to examine how different training techniques and housing conditions influence horses' understanding of human non-verbal communication, providing insights into the role of environmental factors in shaping equine cognition.

1.1 The Object Choice Test (OCT)

The Object Choice Test (OCT) is a widely used method to assess whether different species can understand and act on intentional meanings behind human social cues, such as pointing or body orientation (Krause & Mitchell 2018). In the test, a human indicates the 'correct' option of several possible choices, and the animal's task is to act accordingly to receive a food reward (McCreary et al. 2023).

Pointing, a key behaviour to human animals emerging early in development, has received particular attention in OCT studies (McCreary et al. 2023). The success of dogs in the OCT, particularly with pointing (Miklósi et al. 1998, Hare & Tomasello 2005, Kaminski & Nitzschner 2013) has led to the domestication hypothesis, suggesting a genetic basis for their ability to interpret human signals (Krause & Mitchell 2018, McCreary et al. 2023). As dogs and humans have a shared evolution of 30 000 years, the result may not be surprising (Chambers et al. 2020, Bergström et al. 2022). They have also been selectively bred for distally synchronised tasks with humans, such as hunting (Srinivasan & Würzig 2023). Other domesticated species, like cats, have also demonstrated the ability to follow human pointing and gaze direction (Miklósi et al. 2005, Pongrácz et al. 2019, Mäses et al. 2023).

As these species often live with humans in the same space, the success could be due to extensive exposure of human interaction and thus, learning. However, even zoo-housed domestic goats have shown some success in the OCT (Nawroth et al.

2020), indicating that extensive human interaction may not be the sole factor for succeeding in these tests.

1.2 Previous studies on horses

Horses' success in riding and other uses is highly dependent on their cognitive abilites to decipher different pressures applied by humans (Mclean & Christensen 2017). Over the course of their short domestication of 4200 years (Librado et al. 2024), horses have likely been very little subject to human visual signals from distance i.e. non-verbal communication. This has potentially affected how horses have evolved - or not evolved - to respond to human body language.

The performance of horses in the OCT has been mixed, leading to questions about their cognitive capabilities and the relevance of human referential signals like pointing to them. In general horses seem to base their decision on the external appearance of one of the choices offered using stimulus or local enhancement. Signals which are less apparent and short in duration, such as gaze alternation and momentary distal pointing, have not yielded success (Maros et al., 2008, Proops et al., 2010). Horses have performed better with more obvious or salient signals, such as proximal sustained pointing with the finger directly above or touching the correct choice until the horse has chosen (Maros et al. 2008, Proops et al. 2010, Liehrmann et al. 2023). Similarly, horses have performed well with physical markers such as an object placed in front or a human standing behind the correct option (Proops et al. 2010, Krueger et al. 2011, Proops et al. 2013).

Pointing signals short in duration as well as most signals from a distance have been particularly challenging for horses (Maros et al., 2008, Proops et al., 2010, Proops et al. 2013). As an outlier the results of Proops et al. (2010) indicated that horses could successfully follow a sustained distal point present during the decision-making process but performed less well when presented with a body orientation cue. Given that orienting their bodies towards meaningful stimuli is a natural behaviour for horses (McGreevy, 2012), we aimed to retest this signal alongside sustained distal pointing to further explore these cues.

Liehrmann et al. (2023) investigated the impacts of intraspecies social conditions on the OCT performance. Their results showed that horses living in groups, instead of alone or in dyads, had better success. Pasture conditions were also favourable in comparison to small paddocks. We aimed to assess these factors further by comparing the housing conditions of group housed open stable and traditional housing in individual stalls. We included in the statistical model the duration of the relationship with the owner, as well as the number of owners which both have been shown to be significant in regards to horse behaviour (Liehrmann et al. 2022).

One earlier study has assessed the effect of training on the OCT performance in horses. Dorey et al. (2014) found that horses trained with Parelli natural horsemanship versus traditional training were able to learn the object choice task much faster and succeeded better. As body language is extensively used in the Parelli method, the result suggests that training can significantly influence a horse's ability to interpret and respond to human cues in cognitive tests like the OCT. The effect of positive reinforcement on the object choice task performance has not previously been studied.

2. Aim and Hypotheses

Understanding horses' cognitive abilities in relation to human communication is essential not only for advancing theoretical knowledge in animal cognition but for increasing horse welfare in human-horse interactions. As there has been inconsistencies in previous Object Choice Test results with horses, this research aims to provide more insight into how external factors, such as training method and housing conditions, influence horses' ability to interpret human non-verbal cues.

The study set to answer the following research questions:

i) *Do horses consistently pass a two-way Object Choice Test?*
ii) *Does the training technique affect the performance of horses in the Object Choice Test?*
iii) *Does the housing environment affect the performance of horses in the Object Choice Test?*

Existing literature suggests that positive reinforcement enhances motivation and cognitive performance, potentially improving horses' responsiveness to human signals (Innes & McBride 2008, Hendriksen et al. 2011, Lesimple et al. 2020, Larssen & Roth 2022). Additionally, social housing conditions in open stables are associated with reduced stress and improved cognitive functioning, which may further influence their ability to read human cues (Hausberger et al. 2019, Hartmann et al. 2021, Liehrmann et al. 2023).

We hypothesised that:

i) Horses can understand both human distal sustained pointing and sustained body orientation.
ii) *Horses trained solely or partly with positive reinforcement are more successful than horses trained solely with negative reinforcement.*
iii) *Horses in group housing are more successful than horses in social isolation.*

3. Methods

3.1 Ethical Statement

An ethical permit was obtained from the Board of Ethical Evaluation of the University of Helsinki (decision number 5/2020) before the commencement of the study. All the horse owners read and signed informed consent forms regarding their horses before the study. The data from the horse background interviews with identification details was stored confidentially and was only handled by people directly involved in the research.

Special attention was paid to the *refinement* of the whole test experience for the horses during, but also before and after testing as recommended by The International Society for Applied Ethology (2023). As the study only included non-invasive behavioural tests using food rewards, no *replacement* or *reduction* of animals was necessary in accordance with the 3Rs of animal testing (ISAE 2023).

Thorough measures were implemented

i) to ensure the safety and well-being of both horses and humans
ii) ii) to provide a fair chance for all the horses to perform and
iii) iii) to ensure the horses' voluntary participation in the study. Each horse's behaviour was closely monitored for signs of stress or reluctance. If a horse showed signs of discomfort or unwillingness, the test was paused or terminated to prioritize their well-being.

There were no conflicts of interest in the conduct of this study. The research was conducted independently, and all findings were reported transparently, without external influence.

3.2 Background Information

Before the tests, comprehensive background information on the horses was gathered through interviews with the owners. The information included the horse's sex, age, breed, health status, ownership turnover, duration of ownership, time in the stable and training methods used. It was ensured that all the horses were allowed to graze grass and that none of them were allergic to carrots.

3.3 Stables

The data collection occurred at five stables situated in Southern Finland between June and August of the years 2019, 2020, and 2021. The stables were acquired using an advertisement in a Finnish horse-related Facebook group and by contacting both previously known and unknown stable owners. The stables were selected based on the type of housing (open stable group housing/social isolation in traditional stalls), suitable facilities (riding arena with fences or indoor arena), as well as geographic location and the number of suitable horses for logistical reasons.

There were two open stables (A and B), and three traditional stables with individual housing (C, D and E). Stables D and E were located next to each other but were entirely separate establishments.

3.4 Sample Size and Subjects

Before the tests, comprehensive background information on the horses was gathered through interviews with the owners. The information included the horse's sex, age, breed, health status, ownership turnover, duration of ownership, time in the stable and training methods used. It was ensured that all the horses were allowed to graze grass and that none of them were allergic to carrots.

The 34 test subjects were adult riding horses (5 years or older), without known health ailments or with veterinary permission to be exercised in all gaits (walk, trot and canter) and being used regularly by a small number of people. These criteria were in place to assess OCT in adults as opposed to foals, and to reduce the negative effect of pain and changing handlers on cognition. None of the subjects had participated in a cognitive test before.

The age of the subjects varied from 5 to 21 years old (mean=9.9 years, median=8 years). The majority of the horses were geldings (n=22) and the rest were mares (n=12). The horses were ridden warmbloods and warmblood mixes (n=25, including three Andalucians), and coldblooded native type breeds (n=9, Finnhorse, Estonian, Norwegian Fjord).

Most of the horses were privately owned and primarily ridden by one or two designated individuals. Two horses were used in small-scale riding lessons with dedicated riders and three of the horses were owned by a horse dealer undergoing training for eventual sale. The test subjects were utilised for various equestrian activities including hobby riding (n=11), competitive show jumping or eventing (n=10) and competitive dressage (n=3).

3.5 Training

Roughly half of the horses were subject to positive reinforcement using food as a reinforcer on a regular basis (R+ total n=16). Systematic positive reinforcement was either the main method of training and handling (R+ solely n=9) or used in specific situations e.g. when mounting or training something new (R+ partly n=7). The horses trained with positive reinforcement lived mainly in the open stable housing (R+ in open stable n=12, in social isolation n=4).

Negative reinforcement was the only systematic training method with the rest of the horses (R- total n=18). A couple of owners reported using positive reinforcement with only scratching as a reward. However, scratching often fails as a reinforcer with adult horses. Studies have shown that scratching is less preferred than food (Kieson et al. 2020) and it is unlikely to increase the occurrence of wanted behaviour (Lürzel et al. 2020b). These horses were thus included in the negative reinforcement only group. Most of the horses subjected to negative reinforcement lived in social isolation (R- in social isolation n=16, R- in open stable n=2).

3.6 Housing

In the open stables horses (n=16) were kept in pairs or larger social groups in expansive enclosures allowing for all gaits accessible 24/7. Seven horses had partial access to summer fields for the night from their usual enclosures. During the testing period, six horses had just started residing full-time in large summer fields in their usual social groups with very little shelter.

The rest of the horses (n=18) were housed in individual stalls. Fourteen were taken to individual, small paddocks enabling either only walking or a couple of steps of trot, and four were let outside in paddocks with enough space for all gaits. The duration of outdoor access ranged from 4 to 10 hours per day.

Horses other than in the summer fields received roughage 3 to 4 times daily, except for two horses in the open stable A, which ate 6 times a day from a hay machine.

3.7 Test Location

A subset of the open stable horses (n=7) underwent testing in an outdoor arena whilst the stable yard was closed for other activities. From this arena, there was a visual contact with horses in surrounding large enclosures not included in the study. All the remaining subjects (n=27) were tested in indoor arenas, without visual contact with other horses. Only people participating in testing were permitted into the arena. There was only one horse at a time in the arena.

In some previous OCT studies on horses (e.g. Maros et al. 2008, Ringhofer et al. 2021), the tests were run in small paddocks. We however tested in large arenas to avoid the psychological distress of a small space for a prey animal, especially in a novel situation with unknown humans. The other end of the arenas could be cut off with fencing at times, but the area available to the horses remained large and open.

3.8 Assistants, Assessor and Handling

The research staff were all female. All the assistants (n=7) had several years' experience with horses. Whenever possible, a nominated handler was used for each horse to ensure a better performance of both horses and handlers through predictability. The assessor had expert-level knowledge in both horses and animal training. All the assistants were thoroughly pretrained in regard to the protocol and in the expected ways of handling.

The horses wore their own ordinary halters with wide nylon straps and a safe fit leaving the airways unobstructed. The assistants wore riding helmets, gloves, sturdy boots and large treat pouches on the waist always whilst handling. The equipment of the assessor was the same except for the gloves.

Handling in and outside of testing was done using 10 m lunge lines. Calm, predictive handling using as little pressure as possible was emphasised to protect the mental state of the horses. The assistants were encouraged to use positive reinforcement with food rewards when leading the horses to and from the tests to create a smooth workflow with highly compliant animals within the tight schedule.

3.9 Test setting

The test was set roughly in the middle of the arena in a part without mirrors to avoid safety hazards and distractions. In the indoor arenas, the lights were always switched on despite the time of day to prevent strong differences in light levels in the space. The exact point of the setting depended on the size and proportions of the arena, and the size of the horse. Larger horses were allowed more space to be led around to avoid a) discomfort due to sharp turns and b) the need to use pressure on the head in the steering.

The test setting had the same basic layout as Proops et al. (2010) including the release line and the point of the assessor (see figure 1). The release line was drawn in the sand parallel to the long side of the arena and marked with two small, identical objects found at the location (e.g. rocks). The visual aids of the release line were used to increase the accuracy of the handling.

The assessor faced the release line four meters away from it around the centreline of the arena. There was a small note in front of them on the ground with the test pattern. Next to the assessor were two identical plastic bowls (⌀ 35 cm, sides 15 cm high). The bowls were placed atop each other in front of the assessor during reinforcement rounds and separately 40 cm away on each side during test rounds.

Object choice tests were recorded in high definition (HD) using one video camera at a time, employing two distinct cameras in total (Sony AXR53 and Canon HFR800). The camera was positioned on a stand outside the riding arena whenever feasible or maintained at a safe distance from the test setting within the arena. The camera angle depended on the space available.

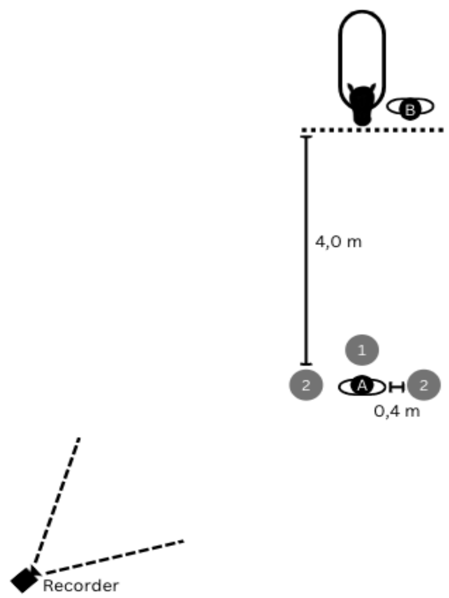

Figure 1. The test setting after Proops et al. (2010). The horse is led to the release line by the assistant (B). The plastic bowls by the assessor (A) are at the 1st position during the habituation rounds and at the 2nd position during the test rounds.

3.10 Test Protocol

The tests were performed twice with a minimum of 7 days in between. This allowed us to get more repetitions in the assessment without tiring the animals excessively and to get a more reliable understanding of the performance of the individuals.

Testing took place between 8 am and 6 pm, one to three hours after the horses had been given roughage, where applicable. We wanted to give the horses time to eat peacefully and to avoid them being hungry during the tests. If two hours or over had passed since the horse had finished eating, it was allowed to graze grass in hand before the test to mitigate food-related frustration during testing. If the horse had to wait for their turn before entering, they were allowed to graze to keep them calm. The horses at the open stable A were taken into the test directly from a field without any waiting as there was only one assistant at a time at the location. At no point were they able to see another horse being tested on the outside arena.

3.10.1 Habituation

All the horses were familiar with the arena at their stable. As horses are often not encouraged to explore their surroundings when handled, we allowed them ample time to check the space whilst being led around in a loose lunge to make sure they felt safe and calm. This also allowed the horses and assistants to get used to one another. The horses would not, however, be allowed to approach the test setting.

If a horse exhibited nervousness within the arena in general or at a specific location near the testing, the assistants desensitised and counter-conditioned the horses according to the assessor's verbal instructions until a state of relaxation was attained. This ensured everyone's safety as well as laid a relaxed mental state for the horses to perform cognitively.

3.10.2 General Structure

A pilot study to practice the protocol was conducted with a horse not included in the test cohort to ensure the quality of the study. The Object Choice Test was carefully replicated according to the protocol outlined by Proops et al. (2010).

Every round commenced with the assistant walking the horse from the long side of the arena straight to the release line. When the horse's head was above the line, the assistant stopped the horse gently.

Then the horse was released, and the assistant calmly stepped away from them whilst turning their gaze towards the ground. From this moment onwards the assistant remained immobile and unresponsive to the horse until it had either approached the assessor, refrained from moving in any direction for a long period or left the test setting.

When the horse had performed any of the aforementioned, the assistant captured the horse and led it around to start the next reinforcement or test round. If the horse did not move at all or approach the assessor after two trials, the test was discontinued, and the horse was taken away.

3.10.3 Reinforcement Rounds

First, six reinforcement rounds were carried out to teach the horses the basic idea of the test and to build their motivation. Given that many horses are specifically trained not to move beyond a nearby handler, this previous learning was reversed with careful training. Proops et al. (2010) only tried to initiate the movement of the horses towards the food bowls by dropping food into the top bowl. To our knowledge, no attention was paid to the timing of the act and no other measures were in place if it failed.

In this study, the assessor used both shaping and luring of behaviour to get the horses to approach the bowls. The horse's behaviour was shaped by dropping pieces of carrot into the top bowl the second the horse's ear or muzzle oriented in the direction of the bowls to any degree. This was repeated until the horse started approaching them. The dropping movement was done using both hands simultaneously to avoid only one hand being associated with the food.

If the horse did not quickly respond to shaping by walking to the bowls, luring was used. Pieces of carrot were strategically thrown in front of the horse until it had reached the bowls. Then they also received some carrots in the top bowl. After some repetitions carrots were disposed into the top bowl without shaping and the horse would walk to the bowls to eat.

The quantity of food utilised was increased according to the size of the horse to balance cost-benefit and to ensure high motivation to participate (*optimal foraging theory* e.g. Devenport et al. 2005). One horse was not familiar with carrots and refused to eat them. Scrunched, fresh dandelion leaves were used instead as rewards.

A reinforcement round also took place each time two test rounds had passed to maintain the horse's motivation to participate in the test. In these intermittent reinforcement rounds, carrots were dropped into the top bowl for the horse. If this was not efficient enough to initiate the horse's approach, shaping and possible luring would be used as described above.

3.10.4 Test Rounds

Unlike in some previous studies (e.g. Maros et al. 2008) the assessor avoided contact with the horses during the tests to avoid unconscious nonverbal communication and the Clever Hans effect (Samhita & Gross 2013, Chijiiwa et al. 2021). Contact was also avoided outside of the tests to reduce familiarisation.

In the tests, the assessor concealed their gaze behind the visor of the riding hat and stayed as motionless as possible. To minimise movement neither the assistant nor the assessor checked the time during testing. The maximum time for latency to act (120s) was measured from the recordings.

The assessor performed the pointing signal by lifting their arm with a stretched index finger directed at the bowls. In the body orientation, the assessor rotated their whole body to face towards the bowl. The direction of the signals was randomised so that the pattern could not start with the same side twice and the same side was signalled never more than twice in a row. One pattern was used for the first test time and its opposite for the second time. A minimum of 7 days was kept between the test times.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
R	R	R	R	R	R	Po	Po	R	Po	Po	R	Po	Or	R	Or	Or	R	Or	Or
						Ri	Le		Ri	Le		Le	Ri		Le	Le		Ri	Le

Figure 2. The test pattern with 20 rounds in total (R=reinforcement round, Po=pointing signal, Or=body orientation signal, Ri=right, Le=Left). The sides for the signals were mirrored for the second test time.

Figure 3. The pointing signal to the left side.

Figure 4. The body orientation signal to the left side.

After the signal initiation, the assistant released the horse and stepped away from them with the gaze fixed on the ground. If the horse left the test setting and did not approach the assessor, it was captured by the assistant and returned to the release point for subsequent rounds. If the horse did not initiate any movement after release despite being given several minutes to act, it was led around to start over. If no action of any kind ensued after two trials, the horse was removed from testing.

After making their choice, the assessor gently captured the horse from the halter. This was the only direct contact between the assessor and the horses during the tests. The assistant then approached the horse in a half-circle making sure to stay in the horse’s field of vision and attached the line. Then the assistant guided the horse around a large curve to the release point. The direction of the curves was also randomised.

4. Statistical Analysis

4.1 Data Scoring

The binomial success of the horses (0/1) was scored into Google Sheets. Then descriptive statistics and the percentages of correct choices for each horse for each condition (pointing, body orientation and combined) were attained. The data was analysed further using IBM SPSS version number 29 for Mac. A result was considered significant with a confidence interval of 95% and a p-value of 0.05 or lower.

4.2 Data Editing

Out of the 34 test subjects, 31 were included in the statistical analyses for success. Three horses were discarded: one horse refused to perform in both test rounds despite passing the reinforcement rounds. Another was abruptly sold before the second test time and the third had one of its recordings lost due to a technical problem. All the discarded test subjects were trained with negative reinforcement and lived in social isolation. The reduction made the sample size for the housing conditions almost even, but the negative reinforcement group became considerably smaller than the positive reinforcement group (R+ n=18, R- n=13).

Each horse was tested 10 times for the pointing signal and 10 times for the body orientation signal in total. Due to leaving the start line but not arriving at the assessment point, 3 horses had 1 binomial value missing and 2 horses had 2 values missing. These horses were still included in the analyses. In total, the data sample thus had 613 data points.

4.3 Success

The choice was considered correct when the horse's head was approximately 20 centimetres away from the bowl. The correctness of choice was determined by the assessor during the tests and logged from the recordings. If in a body orientation test the horse had first chosen the bowl behind the assessor's back and was accidentally rewarded for approaching the correct one after, the horse's choice was logged as false from the recording. This happened on two occasions.

If the horse had 9 out of 10 choices correct (90%), the result was significant according to the binomial test. For the results combined, the required level was 16 out of 20 (80%).

4.4 The Effects of Training and Housing

A generalized linear mixed model (GLMM) with a binomial distribution and logit link function was used to assess the effects of training and housing on performance. Horse ID was included as a random factor to account for repeated measures, while test type, training technique, housing type, number of owners, years owned, age, sex, and trial were fixed factors.

Success ~ Test Type + Training Used + Housing Type + Number of Owners + Number of Years owned + Age + Sex + Trial + (1 | Horse ID)

The GLMM was chosen for its ability to handle the binary success/failure outcomes and repeated measures. A logit link function modelled the probability of success, and the inclusion of horse ID addressed within-subject correlation. The model assumptions were checked and met. Scatter plots with Pearson residuals versus predicted values were used to assess linearity of the logit and homoscedasticity.

Multicollinearity was assessed using the Variance Inflation Factor (VIF), obtained through linear regression in SPSS. All the VIF values were well below 5, not revealing any issues with multicollinearity. Model selection was based on Akaike and Bayesian Information Criterions to balance both the fit and complexity for the model. The -2 Log Likelihood supported the model's fit as no significant deviations from the data structure were indicated.

5. Results

5.1 Success

We found a lower performance in the pointing test compared to the body orientation test, suggesting that horses had greater difficulty with the pointing task. Only 3 horses out of the 31 (10%) included in analyses passed the pointing, while 5 horses (16%) passed the body orientation. This differs drastically from the results by Proops et al. (2010) using the same protocol where 26 out 28 horses (82%) passed pointing and 16 out of 27 (60%) passed the body orientation.

Criteria (pointing, orientation or combined) were passed 13 times in total by 8 different individuals. Only 1 individual passed both tests and had also the highest combined score in the sample overall. One horse passed all trials on the first test day, but only six on the second and thus reached a 'pass' grade only when looked at both of the tests and both days combined.

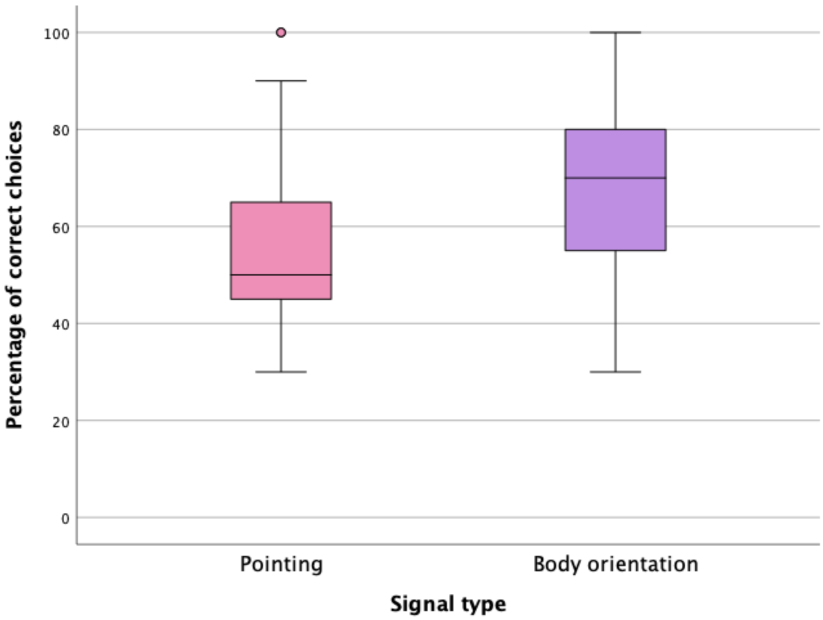

Figure 5. The percentage of correct choices with pointing signal vs. body orientation signal.

Table 1. The performance of open stable group housed horses. The individual performances marked in bold are above chance level (binomial test, two sided, 9 or more trials correct out of 10, p < 0.05, and 16 or more out of 20, p < 0.05).

Open Stable ID	Horse ID	Training Used	SUM Pointing	SUM Body	%CORR. Pointing	%CORR. Body	%CORR. Total
A	MA	R+	8	7	80	70	75
A	MS	R+	7	5	70	50	60
A	SF	R-	5	7	50	70	60
A	PP	R+	4	4	40	40	40
A	GR	R+	4	3	40	30	35
A	AA	R+	6	7	60	70	65
A	AU	R+	6	6	60	60	60
B	KR	R+	3	**9**	30	**90**	60
B	HU	R+	3	6	30	60	45
B	LA	R+	**10**	7	**100**	70	**85**
B	ER	R+	5	5	50	50	50
B	IN	R+	7	**9**	**70**	**90**	**80**
B	NA	R+	8	8	80	80	**80**
B	AN	R-	3	7	30	70	50
B	DN	R+	**9**	8	**90**	80	**85**
B	PL	R+	5	6	50	60	55
				M	*58*	*65*	*62*
				Mdn	*55*	*70*	*60*
				SD	*22*	*17*	*16*

Table 2. The performance of horses in traditional stable housing in social isolation. The following individuals were not included in the statistical analyses for success: MO refused to participate fully or partly after the reinforcement rounds. TA** was abruptly sold before the second test time. IR's *** second test time recording was lost due to technical issues.*

Sos. Isol. Stable ID	Horse ID	Training Used	SUM Pointing	SUM Body	%CORR. Pointing	%CORR. Body	%CORR. Total
C	RI	R-	5	8	50	80	65
C	FU	R-	5	5	50	50	50
C	AI	R-	5	6	50	60	55
C	PU	R-	6	8	60	80	70
C	JT	R-	5	3	50	30	40
C	SA	R-	4	5	40	50	45
C	MO*	R-	1*	0*	10*	0*	5 *
C	JS	R+	3	**9**	30	**90**	60
C	HE	R-	6	8	60	80	70
D	TA**	R-	2**	5**	20**	50**	35 **

D	KA	R-	5	7	50	70	60
D	IR***	R-	3***	5***	30***	50***	40 ***
D	VP	R-	6	7	60	70	65
E	CA	R-	6	7	60	70	65
E	FI	R-	5	4	50	40	45
E	YO	R+	4	**10**	40	**100**	70
E	PN	R+	7	6	70	60	65
E	AL	R+	**10**	**9**	**100**	**90**	**95**
				M	*49*	*62*	*56*
				Mdn	*50*	*65*	*60*
				SD	*20*	*24*	*19*

5.2 The Effects of Training and Housing

All the horses which passed criteria were trained either solely or partly using positive reinforcement. The General Linear Mixed Model showed that being subject to the traditional R- training without R+ significantly reduced the success of the horses (p=0.018, Coeff.=-0.63, SE=0.26, CI lower=-1.14 upper=-0.11) as did the test type finger pointing (p=0.01, Coeff.=-0.45, SE=0.17, CI lower=-0.80 upper=-0.10).

From the individuals in open stable housing 5 passed a criterion 8 times in total. They were all from the same stable B (horses in the stable total n=9). None of the horses from the other open stable A passed any criteria (total n=7).

In total, 3 individuals in the social isolation housing passed criteria 5 times. From the stable with most participants in this category (stable C, n=9) only 1 horse passed 1 criterion. From the stable D none passed (total n=2) and from the stable E (total n=5), 1 horse passed 1 criterion and 1 passed all the 3 criteria. No effect of social isolation housing on success was found (p=0.06, Coeff.=-0.55, SE=0.28, CI lower=-1.11 upper=-0.01).

None of the other factors included in the model affected the success (*nr. of owners* p=0.14, Coeff.=0.13, SE=0.09, CI lower=-0.04 upper=0.30, *years owned* p=0.15, Coeff.=0.07, SE=0.05, CI lower=-0.03 upper=0.18, *sex* p=0.06, Coeff.=0.44, SE=0.23, CI lower=-0.01 upper=0.90, *age* p=0.40, Coeff.=-0.03, SE=0.04, CI lower=-0.11 upper=0.05).

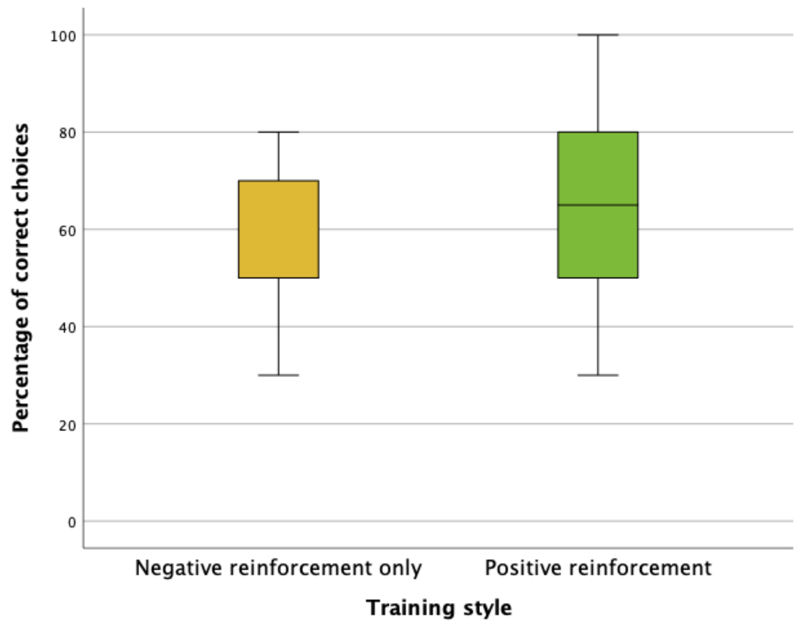

Figure 6. The percentage of correct choices for both signals comparing horses trained with negative reinforcement only vs. positive reinforcement only or combined style.

6. Discussion

6.1 General Success

Overall, the horses' success - or the lack of it - in our study aligns with findings from most previous studies. Our test subjects were not consistently very successful with the used signals weak in stimulus and local enhancement. However, our results significantly differ from those of Proops et el. (2010) conducted using the same protocol. The difference could be due to undescribed practices in the study protocol from their side, or differences in the qualities of the sample. The horses in their study may also simply have been more hungry and thus more motivated to gain access to food. This highlights the importance of considering potential variations in experimental designs and conditions when interpreting and comparing study outcomes.

Horses may understand a task but choose not to adhere due to absence of significance. When the rules of a food acquisition game were altered to have both high stakes as well as high risks, horses changed their strategy and exhibited understanding of the rules despite being indifferent to them just moments before (Evans et al. 2024).

Many horses first investigated the assessor's raised hand (in pointing test) or the front side of the assessor (in the body orientation test) before lowering their heads towards the bucket. This and other similar behaviours demonstrating reliance on local and stimulus enhancement for decision making have been reported by several authors before (McKinley & Sambrook 2000, Maros et al. 2008, Proops et al. 2010). In our study, the horses familiar with positive reinforcement may also have associated the hand with attaining food rewards or the hand being a muzzle touch target and could have offered a learnt behaviour.

Further analysis of the videos could determine whether horses approached the bucket intentionally or merely stumbled upon it after investigating the hand or the instruction sheet. To assess whether the horse's choice was deliberate, a minimum time within the 20 cm proximity criterion could have been applied - although a delay in delivering the reinforcer could easily decrease the horses' motivation and jeopardise finishing the tests.

6.2 Training Techniques

Our study supports the previous findings that negative reinforcement training decreases the success of horses in behavioural tests (Innes & McBride 2008, Krueger et al. 2011, Larssen & Roth 2022). As anticipated, horses trained with positive reinforcement succeeded better. This outcome likely stems from a higher initial motivation for human contact, as suggested before (Larssen & Roth 2022), coupled with a sustained high level of attention (Ringhofer et al. 2021). Given that only horses exposed to this training succeeded in the task - albeit a small proportion of them - the second hypothesis is accepted, and the null hypothesis is rejected.

Given that the R+ horses were accustomed to food acquisition games in the form of their everyday training and handling, they may have developed a clearer conceptual understanding of the task and a higher motivation to perform. Horses may indeed perceive the OCT as a food puzzle, requiring extra information or a high motivation to exhibit their skills.

Interestingly, even though horses were not specifically selected for the study based on the training they were subject to, approximately half of the participating horses were trained with positive reinforcement. This may reflect a changing trend in the horse industry. Notably, the distribution of training styles across stables revealed a pattern: most horses trained with positive reinforcement were housed in open stables in groups, while those trained with negative reinforcement were primarily found in social isolation stables. This implies, that both the traditional and alternative approaches are carried out in a consistent manner across all sections of management.

According to interviews with horse owners, those who employed positive reinforcement were knowledgeable in learning theory principles, including the four quadrants of operant conditioning (Staddon & Cerutti 2003) and described their methodology often in great detail. In contrast, almost none of the owners who relied exclusively on negative reinforcement were familiar with general training terminology and the majority were not able to describe their methodology in technical terms. The possible lack of deeper understanding from the human side could influence the quality of the interaction with the horses and be reflected on their motivation and - subsequently - on our results (DeAraugo et al. 2014, Lundberg et al. 2020).

Interestingly, all but one of the horses who had missing data points due to refusing to cooperate altogether or did not arrive at the point of assessment belonged in the negative reinforcement condition group. The higher level of unresponsiveness and lack of cooperation in horses trained using negative reinforcement only has been previously reported by several authors (Innes & McBride 2008, Sankey et al. 2010, Hendriksen et al. 2011). The one exception was a horse currently under rehabilitation with positive reinforcement and open stable housing (more below) after facing abuse at a previous owner.

Several owners using R- only shared that their horses had become much more cooperative with them and calmer in the riding arenas after the R+ handling and thorough desensitisation during the testing period. This supports previous findings on the effects of R+ on the human-horse relationship (Larssen & Roth 2022). It also highlights the long-term effects of animal behaviour research on the test animals and their owners and the responsibility which lands upon researchers.

All the horses in the negative reinforcement group (n=15 included in the analyses) had most likely been subject to this traditional style from the beginning of their training. As a contrast, only 3 horses out of 16 had been trained solely or partly with positive reinforcement since foals. Half of the R+ horses (n=8) had been or were currently being *retrained* using positive reinforcement without any specific justification provided by the owners.

Positive reinforcement was specifically described as a *rehabilitative strategy* for 4 horses with traumatic pasts. Three of these horses exhibited clear signs of learned helplessness (immobility, unresponsiveness, stiff lateral neck, and a frozen face and head) during their first test day, as described by Fureix et al. (2012). The assessor was able to help these horses "unfreeze" by taking a slow, patient approach and using a training protocol that involved both luring and shaping. Although these horses did not have high success in the tests, they were able to complete all the rounds on both test times except for one individual missing one data point. They fell asleep at the last test signal after being in the test for almost half an hour due to a strong freeze behaviour at the beginning of the testing.

To fully understand the impact of positive reinforcement on equine cognition, future studies should aim to include only horses that have been consistently trained with the technique from a young age. Otherwise, we may still be measuring effects of the traditional training methodology despite other intentions. As positive reinforcement gains popularity, this may become more feasible in the future.

6.3 Housing Conditions

No significant correlation was found between housing type and performance on the OCT tests, contrary to the findings of Liehrmann et al. (2023). They compared the group housed, dyad housed and isolated horses in OCT performance and found that the former had a higher success rate than the two latter. In general, the individuals housed in social isolation required more time with habituation before tests and spooked more often, but it is hard to determine whether this was due to the socially isolated housing conditions, or the R- training type as they largely overlapped.

In our study, several conditions at the open stable A may have influenced the study outcomes, both in terms of training and housing. None of these horses (n=7) were in their usual housing or social groups during testing. Two horses unable to be turned out to pasture due to risk of laminitis, remained in their usual open stable environments with a gravel floor.

One resided with a pair from their usual group and the other was housed with a horse it had been with for a summer some years earlier. Typically residing in large social groups, these horses not allowed to the summer fields with the others may have experienced stress from the restricted social interactions and the inability to graze, potentially impairing their cognitive function.

Six horses had recently been moved to summer pastures with unlimited access to grass, likely leading to increased foraging activity and reduced rest, which could have a negative impact on their cognitive performance (Ruet et al. 2021). In general, sudden changes in management have been shown to decrease horse welfare - and thus performance - as a whole (Ruet et al. 2021, Christensen et al. 2022).

The summer 2021 in the stable A geographical area had a high level of insects which was reflected as irritability and lethargic behaviour in the horses. The summer pastures had very small, open shelters not providing much protection against insects nor the sun. They were not big enough to house all the horses simultaneously. The enclosures did not have tree coverage or any other natural shelter either.

One of the study subjects had a strong allergy (sweet itch) towards biting insects and was fully covered with a thick fly rug except for the muzzle and lower legs. The horse was soaking in sweat every time the rug was removed for the testing. The constant exposure to hot weather and especially the insects has been shown to be a strong stressor to horses affecting rest and overall welfare (Christensen et al. 2022).

Furthermore, only the horses from stable A were tested in an outdoor arena, exposing them to hot weather and insects during testing. All in all, the poor performance of these horses may support previous findings that sudden changes and pasture turnout without adequate shelter are significant stressors for horses (Ruet et al. 2021, Christensen et al. 2022).

For future studies, we recommend that horses being assessed for the effects of housing type remain in their usual housing environment, with any changes occurring several months or at least weeks prior to testing. Additionally, cognitive tests should ideally take place indoors or outside of the summer season.

One horse at open stable B was tested early in the morning and had to be woken from fully recumbent REM sleep to be taken to the tests. Most likely due to this they only got 60% correct on the second test time despite having all choices correct when assessed for the first time. We would thus strongly recommend also considering the animal’s sleep-wake cycle when carrying out cognitive testing.

Given these limitations in our sample, we cannot entirely rule out the potential impact of housing on the cognitive performance of horses and fail to reject the null hypothesis.

6.4 Other Notions

Our reinforcement protocol which included unrushed habituation, shaping and luring with food amounts proportional to horse size, was highly successful. All 34 test subjects progressed from reinforcement rounds to test rounds. In contrast, previous OCT studies on horses have reported dropout rates ranging from 18% to 60% during the habituation/reinforcement phase (McKinley & Sambrook 2000, Maros et al. 2008, Proops et al. 2010, Proops et al. 2013, Krueger et al. 2011, Ringhofer et al. 2021, Liehrmann et al. 2023).

Of the 292 horses tested with OCT so far to our knowledge, 68 (23%) have been excluded. Ensuring that the testing process considers the animals' affective states, learning theory, and behavioural ecology is crucial not only for animal welfare but also for cost-effectiveness of research projects and the robustness of statistical analyses.

6.5 Practical Implications

As the overall performance of horses with the Object Choice Test in our study was low, we find it unlikely that horses understand human gestures aiming to guide their decision making. The strong possibility that horses may indeed lack the capabilities to read human behaviour as some dogs do, must be taken seriously.

We hope that this study contributes to reducing conflict behaviour from humans to horses and increases empathy and patience instead. When the horse does not behave as the humans want, the reason is everything else than the traditional framing of them 'acting out' or being 'stubborn'. One very likely reason for their behaviour (or the lack of behaviour) is their inability to understand us.

Our study adds to the growing pile of evidence on positive reinforcement being beneficial for the human-horse interaction. The mechanisms through which this takes place may lie in increased human orientation and motivation. With the recent research interest also on open stables, future studies will hopefully shed more light on their possible effects on horse cognition and welfare and consequently, on the shared human-horse activities.

As a lot of thought and effort was put into ensuring the horses' wellbeing throughout the testing, we hope that that this work can give some guidance on how to consider horse welfare in a holistic way in the future behavioural research.

7. Conclusion

In this study, we wanted to assess the effects of traditional and alternative training techniques and housing environments on the object choice performance of adult horses. We hypothesised, that horses systematically trained with rewards and the ones housed in groups would have better performance.

Our results imply that horses overall might not understand human body language intending to guide their decision making, and that they are likely to rely on stimulus and local enhancement in OCT. However, as repeatedly found in previous studies, horses trained with positive reinforcement seem to be more motivated for social contact with humans.

Due to limitations in our study design and sample no direct conclusions of the effect of housing in regard to social isolation could be made. In general, the sample sizes were limited with different conditions and practices, and thus the results are suggestive requiring more attention.

In future studies should be included as many horses as possible which have been trained using positive reinforcement systematically from a young age. This would ensure that the technique's effects on horse cognitive performance are truly assessed, instead of the remnants of the traditional methods. The horses in different housing conditions should be in the management system contemporarily with no acute changes in the last months. We also recommend the cognitive assessments to take place outside of the summer season to avoid the detrimental effects of insects and warm temperatures on horse cognition.

In conclusion, this research further highlights the favourable impact of positive reinforcement training on the human-horse interaction. It also underlines the importance of considering the overall welfare status of the animal before, during and after cognitive testing.

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Popular science summary

Horses are used for a wide range of purposes and the success depends on their ability to understand us. The question is, however: how much do they truly understand? And is their understanding based on innate, evolved capabilities acquired through domestication, or on individual learning of trial and error - or both?

Recent studies have revealed that horses have been domesticated only for some 4000 years, which is a very short time in the evolution of behaviour. Traditionally the communication from humans to horses is through using pressure or threat of it to provoke a wanted behaviour. This would not have given substance for horses to evolve a refined understanding of human communication using distant signalling - unlike in the domestication of dogs. Still, humans frame and punish horses for behaving in unwanted ways as if they were doing so deliberately.

It is thus important to clarify through research the qualities of brain processing (cognition) of horses. We wanted to redo a previous study which implied – against other studies – that horses could understand human referential pointing from a distance towards a meaningful choice. We also wanted to retest whether horses would be better able to read us orienting our body towards a preferred choice.

As there have emerged new ways of keeping and handling horses in the equine industry, we also wanted to see if these had a favourable effect on the horses' performance. So, we compared traditional stable housing, where horses are kept separate in boxes and paddocks, to open stable housing where horses are together and can move freely between the stable and the large enclosure.

Only 10% of horses in our study reached a statistically significant level of success with the pointing and 16% with the body orientation signal. These were much lower than in the study using the same design before. We do not believe that horses have an innate understanding of the non-vocal communication typical to our human species.

All of the horses which passed the tests were trained using a non-traditional way: systematical rewarding of wanted behaviour with food. Due to positive experiences with humans, these horses were likely more motivated to try and succeed at this new food acquisition game presented to them. We could not conclude whether the housing type affected the success of the horses due to limitations in our sample. We hope that the subject gains interest in the future and that people would treat their horses with patience and kindness instead of inventing oppressive narratives. We also hope that our study could serve as an example on how to create a good behavioural test experience to horses as this was very important to us.

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