Assessing equine preference for food versus human contact: A replication

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CHARLOTTE MOSS

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Abstract

Horses have been trained through negative reinforcement for centuries. However, as studies show that positive reinforcement is an effective training technique for horses, it is important to discover what a horse finds rewarding. Food is the most-used positive reinforcer, but food is difficult to administer while riding a horse. I undertook a modified replication of Kieson et al. (2020) to investigate how rewarding horses find human contact compared to food. Eight horses were taught to touch a symbol (X for food and O for scratches) to access the reinforcer associated with the symbol. The number of touches on each symbol were counted and recorded. In the final preference assessment, the number of touches on each symbol were compared. All horses preferred a food reinforcer. A progressive ratio task was also performed by seven horses, where the schedule of reinforcement for the horses' preferred reinforcer was thinned and the non-preferred reinforcer was offered on a FR1. Most of the horses continued to touch the preferred reinforcer at increasing response requirements, with one horse switching to their less-preferred option at FR3. Overall, the replication supported the original results in that the horses showed a preference for food over human contact. For most horses, this remained the case even when the reinforcer was thinned.

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Horses and humans have been interacting for thousands of years. Cave painting dating back over 15,000 years show horse and human interaction. Initially, horses were a food source for humans. Since horses were domesticated, they have helped humans in a variety of roles. Horses were one of the last mammals to become domesticated, but they have had the most impact on humans (Goodwin, 1999). Once a human was able to ride a horse, the human's ability to explore increased significantly, allowing humans to cover a greater distance. Horses were also used for hauling meat, firewood, ploughs, and produce. Horses have helped humans in wars, from the Roman years right through to the end of World War 2. The role of the horse has changed dramatically during the 20th century; horses are no longer used as working animals, instead they are used for recreational, sporting, and competing purposes (McGreevy, 2012). Reports suggest horses are one of the less intellectual large domestic animals. However, horses have been selected to assist humans over the years because of their muscle mass, and their trainability (Murphy & Arkins, 2007).

Horse owners experience positive feelings when they are around their horses. Owners feel that their horses teach them to communicate better with other humans and teach them life lessons. Horse owners feel a sense of partnership in their relationship with their horse, in the same way a ballroom dancer would feel towards their dancing partner (Keaveney, 2008). While horse owners consider horses to be a part of their families, horses are sold when considered unsuitable, whereas other companion animals are usually kept for their lifetime (Hausberger et al., 2008).

Humans often consider horses to be a part of their family (Hausberger et al., 2008). Horses are often described as companion animals. However, as horses do not share living space

with humans like dogs and cats do, horses do not really meet the criteria to be considered a companion animal (Hartmann et al.,2021; McGreevy, 2012). Human and horse contact is usually restricted to grooming, being fed, and being ridden (McGreevy, 2012).

Many horse owners aim to create a bond with their horse, just as a dog owner would with their dog or a mother would with a child. Horses are social animals, and therefore have the same requirement to form a bond as humans do. Payne et al. (2016) studied the horse and human attachment bond and noted that horses that have one regular handler are more inquisitive towards humans than horses that have multiple handlers. Horses tend to approach a new object more readily when with a handler than they would alone, suggesting humans may reduce the stress and flight response of horses.

Both food and human touch can contribute to forming an attachment with horses. Food increases the horse's attention towards humans, making the human more relevant to the horse. Food is likely to be a crucial part of the formation of attachment bonds between humans and horses. However, horses do not provide food for other horses (with the exception of a mare and her foal), so food alone cannot explain the horse-to-human attachment bond. Human touch has been shown to lower the heart rate of horses and reduce signs of fear, suggesting that physical contact does have some value to horses (Payne et al., 2016).

Table 1 shows an ethogram of behaviours which horses display when being handled by their owner and a stranger (Lundberg et al., 2020). The behaviours listed in Table 1 are common behaviours that horses are likely to show during my study.

Table 1

Ethogram of Behaviours and Positions

	Functional term	Description
Behaviour		
	Walking	Moving in any forward direction in a four-beat gait with a diagonal sequential movement.
	Trotting	Moving in any forward direction in a two-beat gait where the legs are synchronised diagonally.
	Canter	Moving in any forward direction in a three-beat asymmetrical gait.
	Physical contact	Any part of the horse's head is touching the owner/stranger.
	Human attention	Horse's head is directed towards owner/stranger with both ears directed forward for at least 1 s.
	Ear forward	Both ears of the horse are positioned forward for at least 1 s or more.
	Ear flicker*	Either of the horse's ears changes from one position to another.
	Head high	Horse's poll is positioned above the withers.
	Head low	Horse's poll is positioned below the withers, but the muzzle is not in close proximity nor in contact with ground.
	Exploring	Horse's muzzle is positioned close to the ground, can also be in contact with the ground.
	Pawing	Front leg is lifted, then extended quickly in a forward direction, followed by a movement backward dragging the toe against the ground in a digging motion.
	Head roll #	The horse tosses its head in a circular upward movement. Usually starting at chest or low and then tossing the head upwards as the head twists around the poll.
	Excretion #	The horse defecates or urinates.
Vocalisation		
	Neighing	The horse generates a medium pitched sound.
	Snorting #	The horse generates a vibrating low pulsing exhalation sound.
	Snoring #	The horse generates a short raspy inhalation sound.
Horse's position		
	Door proximity	Within 1.5 m of the door.
	Human proximity	Within one horse's body length of the owner/ stranger.

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Note. From "Does training style affect the horse-human relationship? Asking the horse in a separation-reunion experiment with the owner and a stranger," by P. Lundberg, E. Hartmann, and L. S. V. Roth, 2020, *Applied Animal Behaviour Sci*ence, *233*

McGreevy et al. (2009) completed an equid ethogram showing horse-human interaction. They felt horse-human interactions were informed by a conspecific model rather than a predator model. That is, horses express behaviours towards humans, such as mutual grooming, vocalizations, and head lowering, that they would not show towards predators, suggesting that a horse views a human as a companion rather than a threat. When a horse is relaxed, their body is still, and their head is lowered (Table 2). An anxious horse will have a high head carriage and abrupt movements (Hall et al., 2014). Horses' often show relaxed behaviour around humans.

The way a horse interprets the environment and human activities is influenced by past experiences (Fureix, et al., 2009). Domestic horses can recognize familiar and unfamiliar faces. Horses can also recognize their owner's voice. When hearing a familiar voice, horses look faster, for longer, and more often than they would for an unfamiliar voice (Proops & McComb, 2012). Humans are complex stimuli, and horses can discriminate familiar people using individual elements (voices, smell, and sight) of that compound stimulus. Horses can recognize familiar people from their voice even if they cannot see or smell them (Lampe & Andre, 2012). When horses are regularly handled by the same person, they are more likely to cooperate with that familiar person. Horses show fewer signs of fear when approaching novel objects with a familiar person than they do when approaching with an unfamiliar person (Hartmann et al., 2021). Horse-human interactions will influence the horse's emotional experience and their behavioral expressions. The influence could be due to the handling, focused training, and intensive management required for training, as well as the physical and emotional requirement placed on the horse (Hall et al., 2018). If a training or handling approach provokes a negative emotion such as fear, or where the horse experiences pain, the success of the training approach is likely to be short term and lead to a more fearful horse. Horse trainers need to understand how to avoid

causing negative emotions when handling and training horses. This will not only reduce fear and stress for the horse but also improve trainers' safety (Hall et al., 2018). This shows horses have the ability to form attachment and trust bonds to humans.

When horses are taught a new task, operant conditioning is used. This form of conditioning is also known as trial-and-error learning (McLean, 2003). Cooper et al. (2014) define operant conditioning as the process and selective effects of consequences on behaviour. A functional consequence is a stimulus change that follows a given behaviour in an immediate temporal sequence and alters the frequency of that type of behaviour. Reinforcement increases the frequency of a behavior and can either be positive or negative. Positive reinforcement occurs when a behaviour is followed by the presentation of a stimulus, and, as a result, the behaviour is more likely to occur in the future. For a horse, a positive reinforcer could be food. Negative reinforcement occurs when a stimulus is removed following a behaviour, and the frequency of the behaviour increases as a result of the removal. For a horse, a negative reinforcer could be the removal of pressure from the handler.

When using operant conditioning to decrease the frequency of a behaviour, punishment is used. Punishment as defined by Cooper et al. (2014) as the situation where a behaviour is followed by a stimulus change that decreases the future frequency of that type of behaviour in similar conditions. Positive punishment refers to the addition of a stimulus following the behaviour which leads to a decrease in frequency of the behaviour. For a horse, positive punishment could be the use of a whip or pressure from the trainer's legs or hands. Negative punishment refers to the removal of a stimulus following the behaviour which leads to a decrease in the frequency of the behaviour. For a horse, negative punishment could be social isolation. The use of positive punishment with horses can cause side effects such as the horse being less

willing to try new behaviours and habituation to the punishing stimuli, which can then lead to learnt helplessness. In some cases, the horse can response with fear to the punishing stimuli, the fear response can then become difficult to erase (McLean & Christensen, 2017). Negative punishment is not commonly used by horse trainers, largely due to there being no performance benefits found from the removal of food or water, or the social isolation of the horse, as well as the negative effects these actions would have on the horse (McLean & Christensen, 2017).

Classical, or respondent, conditioning is a stimulus-stimulus pairing, where a neutral stimulus is presented with an unconditioned stimulus until the neutral stimulus becomes a conditioned stimulus that elects a conditioned response (Cooper et al., 2014). Classical conditioning helps the horse interact with their environment. A rustling sound in the bush, for example, prior to the appearance of a predator will quickly become the cue for a flight response (McLean, 2003).

For horses to learn new behaviours, there must be a clear association between the behaviour and the reinforcer. A continuous schedule of reinforcement will produce the desired behaviour more quickly than an intermittent schedule (Mills, 1998), however, behaviours that are acquired under intermittent reinforcement schedules are more resistant to extinction. The most effective approach to teaching a horse a new behaviour is to begin with a continuous reinforcement schedule to teach the behaviour, followed by a fixed ratio schedule to maintain the behaviour once it is established (Mills, 1998).

The techniques for training horses have historically been handed down through word of mouth over generations (McGreevy & McLean, 2007). For centuries, horses have been trained using pressure and release (negative reinforcement) with pressure coming from the trainer's hands or legs. Through classical conditioning, the horse learns to respond to the pressure more

quickly so the pressure is released (McLean & Christensen, 2017). For the past 50 years, more information has been published on safe, efficient, and ethical training techniques for all animals. The development of learning theory for animals provided a practical framework for changing or shaping animals' behaviour. Zoos were quick to become educated about, and utilize, learning theory to train their animals, but many horse trainers have been slower to accept these changes (McLean, 2013).

The use of negative reinforcement is the most common approach to train horses. For many trainers, this is the default approach, and often little thought is given to other training processes or approaches (Jones, 2020). While negative reinforcement refers to the removal of an aversive stimulus, the stimulus is not always painful or frightening. When training horses, the removal of a stimulus refers to the removal of pressure from the rider's legs or hands. Prey animals, and particularly horses, respond quickly and efficiently to negative reinforcement as it reflects how they learn in their natural environment, for example, moving away from another horse who kicks or bites (McLean & Christensen, 2017).

For negative reinforcement to be an effective training tool, the timing of the reinforcement is critical. If the pressure is removed at the wrong time, it will likely reinforce an unwanted behavior. For example, if a handler releases the pressure when the horse rears up, rearing up will become reinforced and will re-occur more often in the future. Inexperienced handlers can find the timing for reinforcement particularly challenging (Jones, 2020). Horses can also become habituated to the pressure if the trainer does not release the pressure at the right moment, resulting in trainers using more pressure or a more aversive stimulus (McGreevy, 2012). In extreme cases of habituation, where the horse has been unable to find relief from the pressure, the horse can enter a state of learned helplessness, where the horse no longer responds

to pressure of any kind (McLean, 2003). When trainers are riding horses, it can be difficult to identify the correct moment to release pressure (McLean & Christensen, 2017). Often when the trainer is riding the horse it can be difficult to see what is happening. A trainer on the ground will have a better view of the horse's behaviour and body language.

Both positive and negative reinforcement can be used when training horses. Warren-Smith and McGreevy (2007) used a blend of positive and negative reinforcement to shape the halt (stop) in horses. A remotely operated pump was used to deliver a reinforcer of molasses water. The horses were asked to halt by applying pressure to the reins. The horses in the positive reinforcement group received molasses as a reinforcer. The use of positive reinforcement did not help the horses achieve the halt any quicker than the horses in the negative reinforcement group. However, the horses in the positive reinforcement group did show less head-shaking behaviour and were more likely to lick their lips. In horse training, the horse licking their lips is considered a sign that the horse is relaxed, and head shaking is an unwanted behaviour as a steady head carriage is desired (Warren-Smith & McGreevy, 2007).

Many horse trainers consider positive reinforcement to be an unconventional training approach and due to the traditions of horse trainers, the majority of horse trainers continue to use negative reinforcement to train horses. However, there is an increase in the number of horse trainers using positive reinforcement (Hendriksen et al., 2011). Warren-Smith and McGreevy (2008) reported that horse trainers considered positive reinforcement to be a useful training technique and punishment to be an unhelpful technique. However, there is a common misunderstanding among horse trainers around the term "negative". Many trainers understand this to mean the use of an aversive stimulus, which suggests a need for more education about training techniques for horse trainers and owners (McLean & Christensen, 2017).

Innes and McBride (2008) compared the behavioural and physiological effects of training naive horses using positive versus negative reinforcement. They found that the horses in the positive reinforcement group were more willing to approach unfamiliar objects than the horses in the negative reinforcement group. This suggests that when using positive reinforcement, horses are quicker to habituate to unfamiliar items. The horses in the negative reinforcement group explored less, suggesting that they may be more fearful of situations and/or humans. During their study, Innes and McBride also noted that the horses in the negative reinforcement group expressed more negative behaviours during training, such as pawing.

Hendriksen et al. (2011) studied the effectiveness of positive reinforcement compared to negative reinforcement. The positive reinforcer was food offered when the horse touched the target, and the negative reinforcer was the removal of pressure from a long whip applied to encourage the horse to move forward. They found that, when using positive reinforcement, the horses displayed fewer discomfort behaviours such as widening of the eyes and nostrils, tail whipping, and avoidance. They also found that horses in the positive reinforcement group required shorter training sessions. The results from these two studies show that positive reinforcement training can be a quicker way to train horses and may be less stressful for horses then the use of negative reinforcement. Positive reinforcement in training can also lower levels of emotional arousal as well as improve learning when compared with the use of negative reinforcement (Hall et al., 2018).

Using positive reinforcement in a training schedule is likely to result in lower levels of emotional arousal. When the horse has a lower level of emotional arousal, they will have an increased ability to complete the task, and will show more exploratory behaviour than they would if negative reinforcement had been used (Hall et al., 2018).

Given that positive reinforcement infers benefits in training, it is necessary for horse trainers to know what horses find reinforcing. Food is a commonly used positive reinforcer. However, offering edible rewards can cause a horse to display negative and, at times, dangerous behaviour. This can include pawing and biting, especially if there is a delay to the reinforcer. This negative behaviour can turn into aggression and become dangerous to the handler (McLean & Christensen, 2017). Rewards might also be rest, scratches, or strokes on the body, muscle massages, social interaction with other horses, and a chance to play (Jones, 2020).

As any reinforcer needs to be delivered quickly to strengthen the association between the reward and the reinforcer. McCarthy and Davidson (1986) found, generally, that when reinforcement is delayed, fewer correct choices and more errors are made. Therefore, accuracy decreases as the delay in reinforcement increases. For humans to give horses the best possible chance to produce the correct response and learn a new behavior, reinforcement should be delivered as close as possible in time to the target behaviour. However, when a trainer is on the horse's back, providing immediate food reinforcers can be difficult, and at times impossible, to achieve.

Although food is commonly used to reinforce positive behaviour, when a trainer is riding a horse, it is not always possible to deliver the food (Warren-Smith & McGreevy, 2007). Finding another way to reinforce behaviour would help trainers use more positive reinforcement when training horses. When training horses, it is easy to apply pressure on the horse and release the pressure when the horse performs the correct behaviour. Offering a positive reinforcer for correct behaviour is often not as straightforward due to the placement of the trainer at the time (often on the horse's back).

When handling horses from the ground, it is usually easier to offer a food reward. When teaching horses to load into a trailer, for example, a food reward is often used. Teaching a horse to load into a trailer can be a stressful situation for the horse due to the unknown situation and the confined space the trainer is asking the horse to step into. The use of positive reinforcement helps to keep the horse both calm and motivated. While positive reinforcement in the form of food is an effective training tool, if a horse's behaviour does not increase following the delivery of a reward, the reward is not effective as a reinforcer (Hendriksen et al., 2011).

Table 2 shows levels of relaxtion or anxiety which the horse may show when exposed to new stimuli or when learning a new behaviour (Hall et al., 2014). These behaviours help horse trainers understand and manage their horses' anxiety levels to ensure learning new behaviours is a positive experience for their horses.

Table 2

Ethogram to Show Levels of Relaxation

Score	Type of response	Associated behaviors
1	Very relaxed	No movement apart from mouth; minimal ear movement. No attempt to avoid procedure.
2	Quite relaxed	Slow movements of head/ears. No attempt to avoid procedure.
3	Alert/interested	Ears forward. Head raised. Looking toward handler/ procedure. Interest but no attempt to avoid.
4	Anxious	Head and neck moving away. Ears back/moving rapidly. No body movement. Initial attempt to avoid procedure.
5	Frightened/ avoidance	Movement of head, neck, and body. Abrupt movement away. Repeated attempts to avoid procedure.

Note. From "Assessing ridden horse behaviour: Professional judgement and physiological measures" by C. Hall, R. Kay, K. Yarnell, 2014, *Journal of Veterinary Behaviour, 9.*

Horses cannot verbally communicate with humans. However, humans can interpret a horse's body language, particularly, the horse's ear positioning (Table 1). When the horse's ears

are pinned back, it is a sign that they feel threatened and when a horse's ears are forward, they are alert and expressing curiosity towards their surroundings. During mutual grooming, the horse's ears are pointed out to each side and the horse often has a tilted head position (Figure 1). The horse's lip extends and moves from side to side during grooming (Figure 2), which is thought to be a sign of enjoyment and relaxation (McGreevy, 2012).

Figure 1

Horse Grooming a Handler in Response to Shoulder Scratches – Ears Pointed Out to Each Side

Horses groom each other to reach areas they cannot reach themselves. During mutual grooming, the horse's heart rate is lowered, suggesting that the horse is more relaxed. When a human grooms the horse's withers, a similar calming effect and lowered heart rate is also seen. When horses groom each other, they begin in the neck area and move towards the withers followed by the shoulders and top of the tail area. This process takes place on both sides of the horse's body (McGreevy, 2012).

Figure 2

Horse Showing Signs of Enjoyment During Grooming From Human – Lip Extended

Thorbergson et al. (2016) compared horses' behaviours and heart rates when being rewarded via patting or wither scratching following work under saddle. In their study, 18 horses were assigned to one of three groups; control (no reward), neck patting, and wither scratching. After a short exercise session, the horses were rewarded by their riders for a period of 1 minute. During the reward period, the horses' heart rates were monitored and their behaviour observed and recorded. From the behaviour observations, the horses showed fewer agitated behaviours, such as an open mouth, stepping forward, tail swishing, and head above the wither area in the wither-scratching group compared to the control and patting groups. The horses in the wither

scratching group also showed more relaxed behaviours, including head below the withers and a neutral ear position. Their results suggest that wither scratching for 1 minute may increase relaxation when under saddle. Their results also suggested that neck patting is an ineffective form of relaxation for horses. McGreevy (2012) also considered neck patting to be an ineffective reward for horses. Patting often becomes the focus of a reward system for trainers, as many horse trainers assume patting is reinforcing for horses (McLean & Christensen, 2017). Patting could be considered a secondary reinforcer, however, for patting to become a reinforcer, it would have to be consistently paired with a primary reinforcer such as food. Hancock et al. (2014) studied the effect of patting and scratching the withers of a horse when being handled. They found that when being scratched at the withers, horses showed more positive behavioural responses such as mutual grooming and upper lip movement. These findings suggest that wither scratching could increase human/horse bonding and be used as a reward for horses.

Preference assessments can be used to identify a horse's preferred reward. During a preference assessment, the horse is given a choice of outcome, with their choice interpreted as the outcome they prefer the most. For example, by offering the horse a choice of environments, such as two different types of bedding in two side-by-side stables which the horse has free access to, the horse's choice is indicative of their preference. By observing where the horse spends more time, their preference can be inferred (Mills & Nankervis, 1999). Determining a horse's preferred grooming site could involve observing the horse's body language to assess what area they prefer to be groomed in.

While a preference assessment gives horses the option to choose between different items or contexts presented, Mejdell et al. (2016) found that horses can differentiate between symbols

and can learn to associate symbols with outcomes. Once horses have learnt to associate symbols with an outcome, they can use symbols to communicate their preferred options.

Kieson et al. (2020) conducted a study to see if human interaction via patting or scratching had any value for the horse and whether human interaction can be a useful reward for a horse. The authors compared the human interaction as a reward with edible rewards. They trained their horses to touch a target to access a reinforcer. Three different targets were used; X (food), O (scratches), and a solid square (patting). In their study, none of the horses touched the scratching or patting symbols. When the patting and scratching symbols were presented side-by-side, the horse chose to touch neither. The horses completed the task with both familiar and unfamiliar handlers. The results showed that the familiarity of the handler to the horse did not affect the outcome. There was no difference noted in the horses' behaviours when in the presence of a familiar and an unfamiliar handler. The results of their study showed that horses prefer food over human contact from both familiar and unfamiliar handlers.

My study was a modified replication of Kieson et al.'s (2020) study. In my study, eight horses (rather than 11) were trained to touch an O symbol for scratches and an X symbol for food. I made a few changes to the original study. Only two reward options were presented to the horse; scratches and food. The patting reward was removed because studies suggested that horses do not find being patted rewarding (Hancock et al., 2014; Thorbergson et al., 2016). Kieson et al. assigned the horses to one of three groups; patting, scratching, and treats, attempting to shape the symbol-touch response of the horses in each group using their assigned outcome from the beginning of training. Horses assigned to the patting and scratching group did not learn to touch the symbol during the behavioural shaping and all were subsequently moved to the treat group, where the symbol-touch response was shaped using treats as a reinforcer. I started training all

horses with the O symbol for scratches to maximise the opportunity to observe whether it was possible to shape symbol-touching using a non-food outcome. I also extended Kieson et al.'s study by adding a progressive ratio task. The progressive ratio task was to determine whether the horses would switch to their less preferred reward if the frequency of delivery of their preferred reward was decreased.

The progressive ratio schedule is a ratio schedule of reinforcement whereby the frequency of reinforcement is decreased after each successive reinforcement delivery (Cooper et al., 2014). A progressive reinforcement schedule is used to see how strong a reinforcer is (Roane, 2008). Thinning the reinforcement schedule will determine how hard an animal is willing to work to obtain the reinforcer. When trainers are aware of the value the animal places on the reinforcer, trainers can rank reinforcers to understand what an animal needs (Sumpter et al., 1999). With more knowledge as to what a horse finds reinforcing, trainers can use higher-ranked reinforcers to improve training outcomes. This is especially useful if the task is new or in the early stages of learning.

In the current study, I examined what consequences horses value more, scratching via a human's hands and nails or a food reward. Based on previous studies, I predicted that the horses would demonstrate a preference for an edible reward (Ellis & Greening, 2016; Kieson et al., 2020). When horses learn new behaviors, they are often willing to work for food (positive reinforcement) (McLean, 2003), suggesting the food reward will be more desirable to the horse. However, as horses are social animals, and research has shown horses can form attachment bonds with humans, some horses may show a preference for human touch over food.

Method

Subjects

Eight horses were used in the study. The horses' backgrounds were known (Table 3), and all horses were accustomed to daily human contact. I owned all horses, they were accustomed to being handled by me, and five horses lived at my home property. Three horses lived on a different property and had another person as their main handler. All horses were accustomed to receiving food from humans via a bucket at feeding time and treats, apples, or carrots as a reward from the handler's hand. All horses in the study were broken to be ridden. None of the horses had participated in a research project before. Ethical approval was received for this study from the University of Waikato Animal Ethics Committee, Approval Number 1121.

Table 3

Horse Information and Background

Horse	Age	Sex	Breed	Main Handler researcher
1	10	Mare	Warmblood	Y
2	7	Mare	Warmblood	Y
3	10	Mare	Warmblood	Y
4	12	Mare	Warmblood	Y
5	22	Mare	Warmblood	Y
6	5	Gelding	Welsh	N
7	4	Mare	Welsh	N
8	4	Gelding	Welsh	N

During the study, the horses' daily routines and exercise remained unchanged. The horses were fed hay, grass, and grain according to their normal requirements. During the study, the horses received daily grooming. At no point during the study were horses deprived of either food or grooming.

The horses (six mares and two geldings) were aged between 4 years and 22 years (M = 9). Horses 1, 2, 3, and 4 were ridden 4-6 times per week, Horse 5 was retired, and Horses 6, 7, and 8 were broken to be ridden but unridden at the time of the study.

The horses were kept in their usual living conditions. Horses 5 and 8 were grazed in pairs. Horses 1, 2, 3, 4, 5, and 7 grazed in individual paddocks with Horses 2, 3, and 5 stabled overnight.

Materials

Symbols were printed on 20-x-30cm (A4 sized) paper (Figure 3), which was laminated and attached to corflute polypropylene material (a recycled real estate agent's sign).

The experiment took place in a horse-handling area. All horses were familiar with, and handled regularly, in the area. The boards with symbols attached were mounted to a gate. The top of the sign was mounted 132cm off the ground for the warmblood horses and 122cm for the welsh ponies.

The food reward was timothy grass pellet feed (True Fiber) supplied by Hekeoa Feeds NZ and delivered in a Stallion Meal Trough Pen Feeder (10-litre size) attached to the gate to avoid human contact. The food was kept in a bag attached to my waist and placed out of sight to avoid the horses mugging me.

All sessions were recorded using a Panasonic HC-160 video camera. The video camera was attached to a tripod and placed 4 meters away from the horses.

Training

Two different symbols were created, a X and a 0. The X signified a food reward and the 0 signified a reward of human touch that imitated mutual grooming. The horses were first taught to associate the rewards with the symbols, starting with the 0 Symbol for scratches.

Figure 3

Single Symbol Set Up

Before each session with the 0 symbol (reward via scratches), I conducted a short preference assessment to locate the horses' preferred scratching spots. The preference assessment involved scratching the horse in different areas and observing the horse's body language to locate their preferred area. Areas included the upper neck, base of neck/withers, between the front legs, and the rump. Once a preference area was located, this area was used as the scratching reward within that session.

I planned to train the horses to touch the symbol using successive approximation of the behaviour until the horses were reliably touching the symbol. Each time the horse's head moved close to the symbol, the reward would be offered to the horse. Eventually, the behaviour would only be rewarded when the horse touched the symbol with their nose. Once the horse was touching the symbol without any assistance from the handler, a reward would be offered to the horse within 3 seconds of touching the target.

Training sessions with the O symbol took place for 7 days, each session lasted between 5 and 10 minutes. Each touch of the symbol by the horse's nose was counted. Each session ended once the horses touched the target a total of 20 times, or after 10 minutes had elapsed.

After seven training sessions, Horses 1, 2, 3, and 7 were beginning to touch the symbol and received a scratching reward, and Horses 6 and 8 were occasionally touching the symbol. However, the horses' responses were not reliable or consistent. After seven sessions, these horses moved onto the X-symbol training phase.

Horses 4 and 5 did not respond to the O symbol during training sessions, so, after two sessions, the O-symbol training was ended and the X-symbol training started.

All horses that were touching the O symbol completed seven training sessions. Sessions lasted an average of 6 minutes.

Training sessions for the X symbol also took place over a maximum of 7 days, each session lasted between 3 and 6 minutes. At the start of each session, I had 20 pellets of true fiber in my waist bag. The horse was guided towards the X symbol using a pellet and when the nose contacted the symbol, the horse was allowed to eat the pellet (Figure 4). After 20 touches of the symbol, the session was ended. When the horse touched the symbol 20 times consecutively

without any assistance, their X training sessions ended, and they moved onto the discrimination task.

Figure 4

Horse Extending Neck to Touch the Symbol

During training with the X symbol (food reward), the food was initially offered to the horse directly from the handler. The food was then gradually transferred to the stallion meal trough. At the start of each session, I had 20 treats available, the treats were placed in a waist bag, attached to my waist and out of the horses' sight, the allowed the horse 20 opportunities to respond correctly to the X symbol. The treats were placed into the feeding trough one at a time after the horse touched the X symbol. Sessions for the X symbol lasted, on average, 4 minutes. Horses 1 and 3 met the criteria of 20 touches in two sessions, Horse 4 in four sessions, and Horses 2, 6, 7, and 8 required seven sessions. Horse 5 made no attempts to touch the target to access the food, Horse 5 was therefore dropped from the study.

Horses 3 and 6 were unsure of the stallion feeding trough and were at first unwilling to take the food pellet from the trough. I initially handed the horse the pellet, and gradually moved my hand closer to the feeding trough. Once the horse began taking the food out of my hand in the trough, I started dropping the food directly into the trough.

Discrimination Task

After an average of five (range 2-7) training sessions, and once the horses were reliably touching the X target to gain a food reward (defined as touching the X symbol 20 times in a row with no assistance from the handler), a second blank board with no symbol was placed next to the X symbol. This was to ensure the horses were able to distinguish between two symbols (see Figure 5). The X symbol was alternated from left to right after three correct touches, with reinforcement contingent upon touching the board containing the symbol (and not the empty board). I started each session with 20 treats in my waist bag, for easy access, allowing the horse 20 opportunities to touch the X symbol. The sessions ended when the horse had touched the X 20 times.

After seven training sessions and a correct response rate of 80% in the final session, horses progressed to the discrimination task. Training sessions lasted on average 3 minutes and all horses required seven sessions to successfully learn to discriminate between the X and the blank symbol.

Figure 5

X Symbol Set Up with a Blank Board Beside

Discrimination Test

For the final discrimination test, the X and the O symbols were placed side-by-side with the feeder in the centre (see Figure 6). I started the session with 20 treats available, giving the horse up to 20 opportunities to touch the X symbol. The horse could touch either the X or the O symbol. Each time the horse touched a symbol, the reward associated with that symbol was offered. The number of touches to each symbol was counted and recorded.

Figure 6

Side-By-Side Symbols Set Up For Discrimination Test

Progressive Ratio

If a horse showed a preference for the food reward, a progressive-ratio schedule was implemented the day after the preference assessment. During the progressive-ratio session, both the X and the O symbol were placed side-by-side. The schedule of reinforcement for the reinforcer chosen exclusively by the horse (scratches or food) was progressively thinned within a session, from FR1> FR2> FR3, etc. When the horse first touched the symbol, the horse was given a reward immediately (FR1), the next reinforcer was only delivered if the horse touched the symbol twice (FR2), this process was continued until the horse either switched to the less desired reward or stopped touching the symbols. This condition was used to determine whether the horses would switch to the non-preferred reward if the reward was not offered as frequently. The horse's less-preferred option continued to be delivered on a FR1 schedule of reinforcement.

The results from the sessions were recorded and it was noted whether the horses switched between the symbols. The behaviour of each horse was also noted.

Data Analysis

I observed the horses and used a video camera to record the sessions. The number of times each horse touched each of the targets within a session was the dependent variable.

SPSS (https://www.ibm.com/analytics/spss-statistics-software) was used to run paired-sample *t* tests to compare the mean number of touches for food with the mean number of touches for scratches, and the time and number of training sessions for both the X and O symbol.

Results

Training sessions

The mean time for the training sessions for scratches (O symbol) was 5.91 minutes (95% CI[4.83, 6.99]) and for the treat (X symbol), 3.98 minutes (95% CI[2.8, 5.17]). The mean difference of 1.93, (95% CI[.64, 3.21]) was significant, $t(7) = 3.55$, $p < .009$, $r = .69$.

Horses 4 and 5 were removed from the data for the analysis of the number of training sessions the horses required, as these horses did not respond to the training and only completed two training sessions before moving on to the next criterion. The mean number of training sessions across the remaining six horses for scratches (O Symbol) was 7 sessions (95% CI[7, 7]) and for treats (X symbol), 4.83 sessions (95% CI[3.76, 6.99]). The mean difference was 2.17 (95% CI[-.44,4.77]) and was not significant, $t(5) = 2.14$, $p = .09$, $r = .72$.

Final Discrimination Test

All horses completed the discrimination training sessions for both the O symbol and the X symbol. The results from the 7th session were recorded (Table 4). Seven of the horses achieved over 80% accuracy and moved on to the preference assessment.

Table 4

Results of Final Discrimination Training Session

Horse	Training session 7, X and blank % correct
1	95%
2	92%
3	95%
4	84%
5	0%
6	95%
7	95%
8	100%

Discrimination test

Horses that completed the 7th training session of the discrimination task with a correct response rate of greater than 80% moved on to the final preference assessment.

In the final discrimination test, all seven horses showed a preference for food over scratches in a side-by-side discrimination test. The number of touches the horse made to each symbol was recorded (Table 5). The mean number of touches for the X symbol (food) was 20 (95% CI[20,20]) and the mean number of touches of the O symbol (treats) was 3.43 (95% CI[1.21,8.067]). All horses touched the X symbol (treat) more often than the O symbol (scratches) when the symbols were presented side by side. The mean difference was 16.57 (95% CI[11.62, 21.52]) was significant, $t(6) = 8.20$, $p < .001$, $r = .71$. The symbols remained in the same position throughout the discrimination test.

Horses 2, 6, and 8 touched the X (food) symbol exclusively. Horses 1, 4, and 7 gave a small number of O (scratches) touches, however, quickly switched back to food when a scratch

was offered. Horse 3 touched the O symbol 15 times and her body language suggested she was enjoying the scratches. Horse 5 failed to meet the criteria for the discrimination test.

Table 5

Discrimination Test Results

Horse	Touches in Discrimination Test	
	Treats	Scratches
1	20	2
2	20	0
3	20	15
4	20	4
6	20	0
7	20	3
8	20	0

Progressive ratio

Horses 1, 2, 4, 6, 7, and 8 horses completed the progressive ratio session. Horse 7 switched to scratches when the FR for treats reached FR3. Horses 1, 2, 4, and 8 continued to show a preference for food even as the schedule was thinned. Although all four of these horses did touch the 0 (scratches) symbol during the session, when scratches were offered, they quickly switched back to the food reward. These four horses stopped touching both of the symbols when the FR ratio went past FR3. Horse 6 continued to touch the symbol for the treats through to FR7. This horse made no attempts to touch the scratches symbol at all.

As Horse 3 touched X 20 times and O 15 times, she was not considered to have a preference over her choice of reward, therefore, Horse 3 did not complete the progressive ratio task.

Behavioral observations

I observed the horses' behaviour during the training and preference assessment tasks. Tables 1 and 2 were used to describe the horses' behaviour. During the O-symbol (scratches) training, Horses 2, 4, and 6 behaved restlessly, including looking around with a high head carriage, attempting to graze, and walking away from the symbol. The movements Horses 2, 4, and 6 made were not abrupt and the horses made no attempts to avoid the sign or training area, the behaviour was therefore not anxious behaviour. Horses 2, 4, and 6 were alert and interested during the training sessions and preference assessment tasks (Table 2). Horses 2 and 3 made attempts to groom me during the O-symbol training sessions. Horse 2 also lowered her head at times, suggesting relaxation. Horses 3 and 7 showed signs of enjoyment during the scratches - the horses extended their necks and upper lips when being scratched.

During the X-symbol (food) training sessions, Horses 2, 6, and 8 made several attempts to take food from me before completing the task, this behaviour is known as mugging. This behaviour reduced as the horses began to associate touching the symbol with the food reward. Throughout the study the horses showed behaviours ranging from restlessness to relaxation, but no signs of anxious or stressed behaviours. The restless behaviour was likely to be from the lack of understanding around the task, and as the horses gained more understanding around the association between the symbol and the reward this behaviour reduced. Overall, the results of this study show the horses preferred a food reinforcer over scratches.

Discussion

My findings suggest that horses prefer a food reward over human contact via scratches. The results support research showing that an edible reward is a stronger reinforcer for a horse than a grooming-type reward (Kieson at al., 2020; Sankey et al., 2010).

My study was a replication of Kieson et al.'s (2020) study, and my results were consistent with those of Kieson et al.: Horses prefer food over human contact. However, in the final preference assessment, Horses 1, 3, 4, and 7 did touch the O symbol for a scratching reward. Kieson et al also had a few horses touch the O symbol, for most horses this was limited to one touch. In my study only Horse 3 expressed enjoyment towards the scratches, Horses 1, 4, and 7 quickly switched back to the X (food) symbol. Horse 3 touched the O symbol many times, suggesting she may not have had a preference for the food reward. Overall, the number of touches my horses made was similar to the number reported by Kieson et al., with the exception of one horse in my study that made 15 touches on the O symbol.

In Kieson et al.'s (2020) training sessions, the horses were assigned to one of three groups. The three groups each started the training with a different symbol, one group with a O symbol (scratches), one with a solid square (patting), and one with an X symbol (treats). Kieson et al. found that horses in the O and solid square groups failed to learn to touch the symbol to access a reward. Therefore, I choose to start the training for all horses with the O symbol for scratches to allow all horses the chance to first learn the association between the symbol and the reward. That is, in the event that some horses are able to learn to associate a symbol with human contact, I wanted to maximise the opportunity to identify such horses. During the training sessions, some horses did make attempts to touch the O symbol for scratches, however the horses' touches were inconsistent, suggesting the horses did not learn to touch the symbol to receive a reward of scratches.

As the results from other studies suggested that horses would prefer a food reinforcer (Ellis & Greening, 2016; Kieson et al., 2020; Sankey et al., 2010), the food selected for this study was one considered to have a low value for the horse. The horses in my study all had

access to ample hay and grass throughout the day, as well as feed from a bucket containing a mix of fiber (chaff and sugar beet) and a pellet-based feed. The TrueFiber pellet offered as a reward was not part of the horses' usual diet, but the taste was unlikely to be novel to the horse.

Kieson et al. (2020), however, used a specific horse treat for the food reward, which was saddle snacks. The saddle snacks treat was apple flavored and is designed to be a treat for the horse, and therefore tastier and more desirable than their usual food. The TrueFiber pellet used in my study is designed to be basic bulk feed for the horse. The food reward offered was a pellet of compressed timothy hay, this type of food would be considered an un-novel feed type. Horses have a preference of pellet feeds containing molasses due to its sweet taste. As a horse's diet is made up of largely grass and hay, horses can experience satiation towards hay (Thorne et al., 2005). With a high-value food, a horse is more likely to perform an operant response (Ninomiya et al., 2007). The TrueFibre compressed hay pellet that was used as the reward in this study would hold a low value to a horse as there is no additional molasses (sugar) added to the pellet. Given that the horses in my study preferred this pellet over scratches, it would appear that scratches from a human have very little value to a horse.

In my study, I used my nails to scratch the horses rather than a bamboo back scratcher as Kieson et al. (2020) did, to attempt to increase the value of the scratches to the horse. Studies have shown that horses find been scratched by a human in the wither area relaxing (Feh & De Mazieres, 1993; Normando et al., 2003; Thorbergson et al., 2016). Additionally, I used a preference assessment to locate the horses' preferred areas for scratches and the scratches were delivered directly from the myself, using my fingernails to move in a circular motion. Keison et al. (2020) only offered scratched in the neck/wither area and the scratches were delivered via a short bamboo back scratcher. While grooming between horses usually starts at the wither area

(McGreevy, 2012), this may not always be the horse's preferred site for grooming. The preference assessment was completed before each session to find each horse's preferred grooming spot each day. In the preference assessment, the horses' body language was observed to see how they responded to each area being scratched. The use of the preference assessment allowed me to attempt to locate a horse's preferred scratching site. Kieson et al. only offered the horse one scratching site, this may not have presented the scratches at their maximal reinforcing strength. So, even when scratching was presumably delivered at its maximum strength, it was not as effective as food as a reinforcer.

Feh and De Mazieres (1993) and Normando et al. (2003) both found that horses' heart rates lowered when they scratched the horses for a period of 3 minutes. Feh and De Mazieres (1993) found the horses' preferred site for scratches was the base of the neck, they also found that scratching a non-preferred site had no effect on the horses' heart rate. Finding a horse's preferred scratching spot is helpful to increase the effectiveness of scratching as a reinforcer. Future research should include preference assessments of potential reinforcers to ensure that the reward offered is of maximal strength.

Horse-to-horse physical contact is limited to a mare licking her foal and mutual grooming from fellow horses. Horses only spend 2-3% of their time grooming each other. While studies have shown that the horse's heart rate is lowered during grooming by humans (Feh & De Mazieres, 1993; McGreevy, 2012; Normando et al., 2003) and body language shown during horse-to-human grooming suggests the horse is enjoying the grooming (Hancock et al., 2014; Thorbergson et al., 2016), study into the length of the of time the horse finds the grooming rewarding would help determine if grooming can be a helpful reinforcer. The lowered heart rate

does not mean that grooming is an effective reinforcer, sufficient to promote learning (Sankey, et al., 2010).

The progressive-ratio task was an extension of Keison et al.'s (2020) study. The progressive ratio was used to see if the horses would switch to their less-preferred reward if the schedule of reinforcement for their preferred reward option was thinned. Only one horse switched to the scratching reward. Myers and Mesker (1959) used a fixed ratio schedule to see if a horse would continue to touch a lever to access grain feed. Myers and Mesker found that the horse quicky adapted to the fixed ratio and touched the lever quickly in order to access the grain feed. During my study, the horses' responding rates were not recorded. However, the horses were all willing to continue to touch the X symbol to access food up until FR3, with some horses continuing to touch the symbol until FR 7.

The results from the progressive ratio task suggest horses are willing to continue the behaviour of sign touching as the reinforcement schedule was thinned. Trainers could use a clicker as a secondary reinforcer paired with a primary reinforcer (food). Once the clicker has become an effective secondary reinforcer, the frequency of the food (the primary reinforcer) can be reduced. The clicker allows trainers to reinforce behaviour quickly and allows the horses to distinguish a correct response from an incorrect response (Williams et al., 2004). Further research using a clicker (secondary reinforcer) to reinforce behaviour on a continuous schedule, with a primary reinforcer (food) being offered on a fixed ratio schedule to reduce the frequency of the primary reinforcer is needed. The use of a clicker as a secondary reinforcer allows the rider to reward the horse easily when on the horse's back. Using the clicker as the reinforcing stimulus will also reduce unwanted behaviours that can sometimes appear when food is used as a primary reinforcer, such as mugging.

Secondary reinforcers must be paired with a primary reinforcer to become a conditioned reinforcer. The value of the primary reinforcer used for the pairing will determine how effective the secondary reinforcer is (McCall & Burgin, 2002). This further highlights the need for trainers to understand what reinforcers a horse values more, because if the horse does not find the primary reinforcement rewarding they are unlikely to perform the behaviour.

All horses used in my study were familiar with being handled by several different humans and desensitized to different situations. This could have affected the horses' behaviour during the study, because, as these horses had been habituated to different settings and stimuli, the behaviours they expressed were less problematic than those of Kieson et al. (2020). All horses were accustomed to being tied up and being handled in different environments. The horses were all handled in some way daily in addition to the research project. Overall, the horses in my study showed fewer negative or anxious behaviour's than Kieson et al.'s (2020) horses. Horses 2, 3, and 7 showed positive behaviours during the O (scratches) training sessions. These positive behaviours included trying to groom the handler, lowering of the head, and extending the neck and upper lip. The lowered head is a sign of relaxation; when a horse is relaxed, the horse's neck is extended towards the ground. The extending of the neck and lip are considered to be signs of intense pleasure and show the handler that the horse is enjoying the scratching session (Mills & Nankervis, 1999).

Horses 2, 4, and 6 displayed restless behaviours during the O (scratches) training lessons, including walking away from the sign, attempting to graze, and looking around. These restless behaviours could also suggest an increase in psychological arousal. The horses holding their head higher and looking around is an alert/interested behaviour (Table 2), where the horse is expressing interest in something, but they are not trying to avoid it (Hall et al., 2014). When the

horse is frightened, they move away from the object and avoid the procedure (Hall et al., 2014). Kieson et al. (2020) found their horses expressed behaviours indicating psychological arousal, these behaviours included muscle tension, head and neck position, and increase in movement. All of the horses in Kieson et al.'s study expressed arousal behaviours. They also expressed more behaviours that suggested arousal than the horses in my study did. These behaviours included pawing, pinned ears, and biting the target.

Horses 2 and 3 made attempts to groom me during the scratches, making physical contact with me, suggesting that they were enjoying the scratches and were seeking the human attention.

None of the horses showed signs of frustration such as pawing. Domestic horses paw the ground when they become frustrated, often because they are being restrained in some way. This could be not having access to food or being held back from joining other horses (McGreevy, 2012).

During the study, none of the horses made any vocalisation sounds. Horses make vocal sounds to communicate with other horses, a neigh is used to maintain or regain contact with other horses. Snorting can have different meanings, it can be heard after a fear response or been startled. Horses also often snort after clearing their airways (McGreevy, 2012).

A horse's behaviour offers trainers an immediate way to assess how the horse is feeling. However, as horses are prey animals, the behavioural signs of fear may not always show the horse's underlying mental distress (Yarnell at el., 2013). To accurately assess the horse's stress levels, measuring the changes in the stress hormone cortisol, the horse's eye temperature and the heart rate would be required (Yarnell at el., 2013). Future research measuring the horses' cortisol levels and heart rates while receiving scratches and food would help trainers understand how the horse interprets these stimuli.

During the X symbol training, Horses 2, 6, and 8 attempted to mug me for the food reward. Mugging is one of the negative behaviours that positive reinforcement can promote in horses (McLean & Christensen 2017). The horse harasses the handler until the food is delivered. Sign tracking is another downfall of positive reinforcement. Sign tracking is when the horse becomes obsessed with the reward and attempts to be close to the rewarding agent at all time (Mclean & Christensen, 2017). Although none of the horses showed sign-tracking behaviour, the horses were aware when I had the treat bag on, and attempted to make contact with myself to locate the treats. This could have influenced the horses' behaviour, as the presence of the treat bag may have encouraged the horse to touch the symbol. Horses can have an increased arousal when anticipating food (Hall et al., 2018). This increased arousal can also lead to the mugging behaviour.

All horses in the study were known to me. Therefore, it was not possible to compare the results for a difference between a known handler and an unknown handler. Further study into horse-human relationships and positive reinforcement training could help identify if horses find scratching rewarding when receiving scratches from their owner. As horses can recognize familiar people (Lampe & Andre, 2012), and horses' experiences with humans can affect the horses' responses towards these humans (Hartmann, Rehn, Christensen, Peetz, & McGreevy, 2021), horses are likely to have different reactions around their owners than around unfamiliar people.

The sample size of my study was smaller than that of Kieson et al. (2020) due to the Covid-19 lock down making it difficult to access horses that were not owned by myself. While the sample size was smaller, my *t* tests found significant differences, so a larger sample size was not needed. However, due to the small sample size, it was not possible to compare the results of

those horses regularly handled by myself and those who had a different main handler. Having a larger sample size would have allowed for a comparison in the data between familiar and unfamiliar handlers.

Many horse owners use verbal praise to reward their horses. However, horse owners usually use verbal praise without first pairing the praise with a primary reinforcer such as food (McLean & Christensen, 2017). More research on how to increase the effectiveness of verbal praise will be helpful for the horse community. Having a way to reinforce a horse's behaviour when riding is a helpful tool for trainers, offering a food reward when riding a horse is usually not possible as the trainer is on the horse's back and cannot offer the horse a treat. Using equipment to measure the horse's heart rate, eye temperature, and stress hormones while a reinforcer is being delivered would help increase horse trainers' knowledge around what horses find reinforcing. The results of my study suggest that a horse only finds food reinforcing, and that, despite horses being considered to be a social animal, human contact via scratches does not seem to be reinforcing for the horse.

Conclusion

My study showed that horses find food more reinforcing than scratches when given the choice in a side-by-side preference assessment task. The use of food helps horses' bond with humans and helps promote learning. Further research is required to help horse trainers understand the type of human interactions a horse prefers and if these interactions hold value to the horse.

The use of symbols to allow the horse to communicate their preferences is a helpful way for trainers to understand what a horse value more. The training process took between 2 and 7 sessions to teach the horse to associate a behaviour with a reward, the higher the horse valued the

reward the quicker the horse learnt the behaviour. The process was easy and is something which trainers could easily add to their training programmes. When horse trainers are aware of what a horse holds a higher value for, they can maximize this reinforcer to train new behaviours.

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