EQUINE PREFERENCES FOR FOOD REWARDS VERSUS HUMAN CONTACT AND IMPLICATIONS FOR INTERSPECIES SOCIAL BONDING

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Abstract: The primary focus of the dissertation is to study horse preference for human contact versus food rewards. The study uses horses' ability to differentiate between visual symbols with different meanings in order to test the horses' preference for human contact versus food reward. Humans use food rewards as positive reinforcement for training horses, but there is little evidence to show that human contact (scratching or patting) has reward value for horses or if domestic horses perceive human touch as social bonding. Most horse training is based on negative reinforcement, but food is a known positive reinforcer. This study looks at how horses may perceive human interaction as a form of positive reward by examining whether scratching and patting can serve as a reward for a behavior and how this compares to known rewards (treats) based on horses' ability to use symbols to show preferences. The second purpose of this study is to explore horse-human social bonding opportunities based on the unique backgrounds of each horse subject and variations in behaviors towards known and unknown humans. The study counted the number of times each horse touched each target (touch counts) and recorded any behaviors. The touch counts for each symbol for the last trial were compared using Observation Oriented Modelling (OOM), a non-parametric approach to analyze patterns in data. Based on the observed pattern analysis of touch counts, all horses in this studied showed preference for treats over human contact, regardless of handling or training histories. Analysis of behavioral changes during each testing session shows that each horse demonstrated states of arousal which supports existing literature that novel food increases arousal in horses. Emerging research in equine ethology suggests that horses only touch conspecifics with whom they have already bonded and this touch is always mutual and takes place after periods of arousal. The human need for touch and food exchange for purposes of social bonding may not align with the social needs of horses.

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CHAPTER I

INTRODUCTION

Horses have, and continue to be, an important component of many cultures around the world. Historically, humans have used horses for transportation, work, warfare, and pleasure (Barclay, 1980), but industrial and technological developments in the last century have replaced horses with cars and machinery, leaving horses to fill new roles in society. Horses are still used for work and transportation in numerous countries around the world, but in many areas their role has changed to one of companion or therapeutic partner (Keaveney, 2008). The techniques used to train and interact with horses, however, have remained similar to their historical use as transportation and work animals (McGreevy, 2007).

The transition of horses from transportation tools into companion or therapeutic animals requires a shift in human-horse interactions from training and constraint to one of mutual partnership. Traditional training and even modern horsemanship techniques rely primarily on negative reinforcement (usually in the form of pressure and release) (Bierke, Meinen, Wilkens, Leponiemi, & Hiney, 2013; Cooper, 2007; Murphy & Arkins, 2007b). With the development of behavioral science, comparative psychology, and learning theory, researchers have studied the effect of positive reinforcement on horses using novel food rewards (Craig, Varnon, Pollock, & Abramson, 2015; Ninomiya, Sato, Kusunose, Mitumasu, & Obara, 2007; Sankey, Henry, Gorecka-Burzda, Richard-Yris, & Martine Hausberger, 2010; Sankey, Richard-Yris, Leroy, Henry, & Hausberger, 2010; Sankey, Richard-Yris, Henry, et al., 2010). Horse owners and professionals sometimes use food rewards with horses, but usually rely on human contact (scratching or patting) as a means of giving a reward after a horse has performed a desired task. The main purpose of this study is to determine the value of treats versus human contact as a reward in positive reinforcement training.

Although food rewards continue to be used for behavioral research in which horses demonstrated improved learning and reduced stress with food rewards versus negative reinforcement (Craig et al., 2015; Sankey, Henry, et al., 2010), novel food and food rewards have also been shown to elicit increased heartrate, heartrate variability, and arousal behaviors in horses (Peters, Bleijenberg, Dierendonck, Harst, & Spruijt, 2012). Individuals involved with horses tend to use scratching or patting as a means of physically rewarding their horse partner, but there is little evidence to show if human contact is of value to the horse when compared with treats (Sankey, Henry, et al., 2010), especially under conditions when the horse is already aroused (as with equitation sports). The importance of identifying how horses perceive and react to human interactions becomes especially important in Equine-Assisted Activities and Therapies (EAAT) that involve using the human-horse interaction to help the client build interpersonal skills and empathy (Kieson & Abramson, 2016) or when individual horse owners build companion relationships with their horse (Keaveney, 2008). Therefore, in addition to counting the number of times a horse touches a target for a given reward, the behaviors of each horse were also recorded to examine their level of arousal and response to each treatment.

Studies in anthrozoology, the study of animal-human interactions, support the use of varied rewards to facilitate interspecies collaborations, especially if the varied reinforcements align with stimuli that naturally occur in the species' environments. In human-dog relationships, for example, canines have been shown to respond to rewards of treats in addition to vocal and physical interactions (Cook, Prichard, Spivak, & Berns, 2016; Kerepesi, Doka, & Miklosi, 2015; McGreevy, Starling, Branson, Cobb, & Calnon, 2012; Nagasawa et al., 2015; Payne, DeAraugo, Bennett, & McGreevy, 2015; Pongracz, Hegedus, Sanjurjo, Kovari, & Miklosi, 2013) and have shown preferences for human contact over food rewards in choice experiments (Cook et al., 2016) suggesting that dogs see human interaction of equal or greater value than novel food rewards. For dogs, both food sharing and vocalizations are used in social interactions between conspecifics and induce arousal (Chiandetti, Avella, Fongaro, & Cerri, 2016; Lupfer-Johnson & Ross, 2007) which can be used to train and promote human-dog bonds. Horses, however, do not respond to food in the same way they respond to touch by humans. Horses have been shown to demonstrate increased heartrate, heartrate variability, and arousal behaviors with novel food (Peters et al., 2012), but show decreased heartrate with wither scratching by a human (Feh & de Mazierès, 1993).

Unlike research findings between humans and companion animals such as dogs, studies of horse-human interactions have shown that food is more effective than touch at motivating horse performance. Research indicates that horses trained with food rewards respond to behavioral shaping better than those trained with grooming (scratching) (Sankey, Henry, et al., 2010). Mutual grooming in horses is often considered a means of reducing stress (VanDierendonck & Spruijt, 2012) rather than increasing arousal or motivation. This is contrary to what has been found in dogs where physical interaction with a human is often used for play and inducing or creating arousal as a means of reward (Feuerbacher & Wynne, 2015). Therefore, depending on the species, humans can engage in physical and social interactions that elicit arousal from domestic animals with or without the use of food. In some cases, as with dogs and cats, human-animal interactions may include play and other forms of social cues during times of eustress and physiological arousal that can be used as a means of reward. In horses, however, physical interaction as a means of reward is usually performed through scratching or patting which, according to research, creates a decrease in heartrate (Feh & de Mazierès, 1993) and is used by conspecifics to decrease arousal (VanDierendonck & Spruijt, 2012). Therefore, the use of scratching as a reward may not create the required arousal or motivation needed to repeat a task under behavioral shaping.

Individual breeds, past environmental experiences, and associations with humans can also play a role in the behavioral responses of equines to handlers. Horses have the ability to differentiate between individual people (Lampe & Andre, 2012; Proops & McComb, 2012) and change their behaviors based on previous experiences with different handlers (Fureix, Pagès, et al., 2009; Sankey, Richard-Yris, Leroy, et al., 2010) suggesting that the interactions between an individual human and an individual horse can affect the behavioral responses of the horse to that specific human. The changes in behaviors based on individual humans suggests that the unique experiences and learned associations of each individual horse need to be considered with regards to their handling history as well as previous associations with humans or the individual handler involved in the interaction. Furthermore, the interaction of researchers with individual horses during the duration of the experiment also need to be considered since these associations can develop throughout the course of the study. Since the researchers has a long history with the horses, the horses also interacted with an additional researcher who was not known to the horses prior to the study.

In order to develop better understanding of horse perception and behavioral responses to human interaction, this study was designed to look at the reward value of scratching and petting by a human when compared to known rewards (food) based on horses' ability to use symbols to show preferences (Mejdell, Buvik, Jørgensen, & Bøe, 2016) and differentiate between humans (Lampe & Andre, 2012; Proops & McComb, 2012). The study also considered behavioral responses during the interactions to gauge arousal levels as a result of food (Peters et al., 2012) in order to account for potential variations in behavioral patterns. Individual horse behaviors were also recorded to examine unique variations between individuals to determine any links between behavioral differences and past histories and experiences with humans and human interactions.

The initial findings indicate that horses prefer treats to human contact under the task-oriented conditions. The horses also demonstrated behaviors indicating physiological arousal which would suggest that heighted states of arousal may influence preference for interactions. This further supports the need for more research to determine the types of interactions horses prefer 9with conspecifics or humans) under different arousal conditions.

CHAPTER II

HORSE BEHAIVOR AND LEARNING

In order to properly assess horse behaviors in studies, researchers need to observe each horse as not just a member of a species or a sample set, but also as an individual who may express certain behaviors based on previous learned experiences. Most researchers and horse owners do not have horses from the time of the horse's birth, nor are horse environments standardized in research to the same extent as they are for rodents or other common research animals. It must therefore be assumed that horses involved in research (or any other domestic or managed environment) have learned associations to people and environments prior to encountering the current study or interactive context. Researchers must therefore rely on accurate interpretations of current behavioral responses to stimuli within their control. Every animal, object, person, environment, and movement will elicit a response and the researcher must recognize that each individual horse may respond differently to the same stimulus.

Although observing and assessing horse behavior is critical to understanding horses, it is equally important to consider individual differences and variations in behavior when applying horse behavior to the horse-human interaction. Since individual horses create unique memories associated with individual humans (Sankey, Richard-Yris, Leroy, et al., 2010; Sankey, Richard-Yris, Henry, et al., 2010) taking the time to observe individual variations in interactions can help give much greater insight into how individual horses respond to specific stimuli or individual humans. It is therefore essential to observe the horse in the pasture environment with other known conspecifics (if the horse is not housed in a pasture environment, the horse should be observed in its normal housing environment with the conspecifics with whom it regularly interacts) which means establishing a baseline of behaviors for each horse. Horses should then be closely observed under study conditions to determine relevant changes in behavioral patterns that indicate responses to the study, including specific horse-human interactions involving researchers and participants. It is also important to consider past experiences or experiments the horses may have had with the researcher and new researchers or assistants should be used as a means of controlling for these histories.

Researchers need to have a working knowledge of equine behavioral psychology and the basic meaning of behaviors prior to engaging in horse behavior research of any kind. This includes noting behaviors that indicate stress, escape, exploratory, curiosity, or even apathy. Observing and cataloging behaviors is critical to not only understand how each horse has processed similar experiences in the past, but also how he or she is experiencing them in the present. The horses used in this study are of varying ages, breeds, and genders and all have different histories with humans so the researchers needed to account for individual histories of the horses and baseline behavioral patterns when assessing behaviors during the study.

Stress and Arousal Behaviors

Physiological arousal is a term used to indicate the engagement of the hypothalamic pituitary adrenal (HPA) axis which can be associated with a fear response as well as an arousal response due to excitement. In order to properly interpret a horse's behavior, it is important to consider the context of the behavior, past experiences of the individual, and species-specific variations in arousal behaviors.

The HPA axis triggers the same neurobiological pathways regardless if the stress is physical or psychological (Gunnar & Quevedo, 2007). It will therefore trigger the same or similar behaviors regardless of the origin of the stressor. The physiological and behavioral indicators of stress may therefore appear the same regardless of the cause. Physiological arousal, therefore, will manifest in similar behavioral patterns in individual horses whether the horse is mildly stressed due to a perceived irritation or a result of increased arousal from excitement (Peters et al., 2012). Since horses, like any species, are limited in their ability to express behaviors, researchers must therefore consider the behavioral indicators of stress and the potential environmental or psychological origins that triggered the stress behaviors.

A behavior that once evolved as a response to an agitation or irritation to a mild stimulus (e.g. an insect) will often be expressed in response to other mild irritation, whether this irritation is physical or psychological. The ability to swish the tail, for example, may have evolved for the purpose of responding to a mild irritation of an insect and often successfully dislodges the irritant. If the irritation continues, however, the behavior increases to a much more violent tail swishing and eventually leads to biting of the insect with the mouth and even to a buck (if the irritant is not dislodged through the attempted bite) (Clegg, Buckley, Friend, & McGreevy, 2008; Dallaire, 1993; Schmidt, Aurich, Möstl, Müller, & Aurich, 2010; Yarnell, Hall, Royle, & Walker, 2015).

These same responses can be seen under other environmental circumstances that cause the same degrees of stress. The degree to which the horse experiences the stress can then be seen in the degree to which the horse exhibits a response. Mild irritation or arousal can be observed through mild stress response and the larger stresses through larger, often escape, responses (Table 1).

The HPA axis and cortisol play a role in physiological arousal which also triggers curiosity, play, excitement, and motivation to move (used in conjunction with the dopaminergic neural pathways) (Del Giudice, Ellis, & Shirtcliff, 2011; Gunnar & Quevedo, 2007). Stress can occur as distress in situations where the outcome is uncertain and as eustress (pleasure and excitement) in circumstances where the outcome is predictable (Dickerson & Kemeny, 2004; Hostinar, Sullivan, & Gunnar, 2014).

Individual horses will vary their responses to stressors and environmental circumstances based on their past experiences with stressors (Ishizaka, Aurich, Ille, Aurich, & Nagel, 2017), humans (Baragli, Gazzano, Martelli, & Sighieri, 2009; Birke et al., 2011; Cbamove, Crawley-hartrick, & Stafford, 2002; Fureix, Pagès, et al., 2009; Sankey, Richard-Yris, Leroy, et al., 2010; Sankey, Richard-Yris, Henry, et al., 2010), and other animals. The release of cortisol and increased heartrate have been shown to correlate with behaviors such as increased muscle tension and higher head and neck position (König von Borstel, Euent, Graf, König, & Gauly, 2011) and increase in movement, tail swishing, and seeking behaviors (Hall, Kay, & Yarnell, 2014; Peters et al., 2012; von Lewinski et al., 2013). Horses experiencing physiological arousal are likely to exhibit any of the behaviors indicative of stress in horses. Since novel food can cause an increase in arousal in horses (Christensen, Keeling, & Nielsen, 2005; Peters et al., 2012), it is important to consider the potential for arousal behaviors in this study where food is used as a means of positive reinforcement.

Table 1. Horse behaviors indicative of stress

Severity of Stress	Mild	Moderate	Severe
Category of Behavioral Stress Response	Irritation	Confusion, Severe Irritation, Mild Escape	Escape Behaviors
Exhibited Stress Behavior	Swishing tail Pinned ears Tense jaw Widened eyes Restlessness (walking) Swiping hind or foreleg under belly Higher head position Pawing at ground (seeking behavior)	Lifting of hind leg/threatening to kick Extreme tail swishing Small kick/crow hop Inability to stand still (Fast walk/trot) Pinned ears with lowered head	Kicking (one or both legs) Bucking Gallop/Canter Pinned ears with teeth bared/biting Rearing Striking with front legs Charging

Since the researches use treats as a food reward, it is therefore expected that the horses would experience some arousal during the study and would exhibit behavioral indicators of aroused states. Noting these behaviors would therefore allow for the researchers to determine if any individual horse experienced arousal and, by comparing it to baseline behaviors in the pasture, would allow for the researchers to determine if the arousal was caused by the study conditions.

Horse Social Interactions

Social bonding behaviors and behavioral indicators of pleasure are less studied than those indicative of stress. Play and mutual grooming only occur between familiar conspecifics, but is often more common in domestic horses or under stress conditions (Christensen et al., 2002;

VanDierendonck et al., 2009; VanDierendonck & Spruijt, 2012). Proximity and time seem to play a major role in equine social bonding behavior (Vandierendonck, De Vries, & Schilder, 1995), but more research is needed in this area. Table 2 shows examples of potential expressed behaviors in bonding, eustress, and pleasure.

The horses in this study were observed for behaviors during trials that would indicate changes from baseline behavior and examined under the context of human interaction (treat versus human interaction). Behaviors in Table 1 would indicate arousal and behaviors in Table 2 would indicate a more relaxed state. Since the limited research in horse-horse social bonding behavior aligns more with the indicators outlined in Table 2, the study looked at behavioral differences in individuals and whether they indicated arousal or potential response to bonding with humans.

Scratching is often used by humans to engage in bonding or to reward horses for behaviors. A bamboo backscratcher was used in this study in order to incorporate a standardized means of testing human scratching. Tools (lunging equipment, halters, leads, whips, etc.) are used as a means of presenting negative reinforcement in horse training (Bierke et al., 2013; Innes & McBride, 2008) as well as studying negative reinforcement and associations during experimental studies (Briefer Freymond et al., 2014; Hendriksen, Elmgreen, & Ladewig, 2011). These types of tools and equipment are also used in studies testing equine-human interactions and equine perceptions of humans (Fureix, Pagès, et al., 2009; Sankey, Richard-Yris, Henry, et al., 2010). The use of tools in negative reinforcement have been shown to affect the perception of horses to the humans (Sankey, Richard-Yris, Henry, et al., 2010), indicating that the reinforcement is associated with the human regardless of the tool (but may also be associated with the tool in use). Since horses create strong associations and memories of individual humans based on past experiences (Sankey, Richard-Yris, Leroy, et al., 2010; Sankey, Richard-Yris, Henry, et al., 2010) the research suggests that tools can also create specific associations under positive reinforcement interactions in addition to when used for negative reinforcement.

Horse Learning

Humans can use the principles of learning theory and operant conditioning to shape the behaviors of horses during training or for research. In learning theory, operant and instrumental conditioning refer to the relatively permanent change in behavior as a result of experiences of an animal (or human) has with its environment as a result of obtaining or avoiding a stimulus (Abramson & Kieson, 2016; Abramson, Curb, Barber, Mitchel, & Sokolowski, 2011; McLean & Christensen, 2017). In operant conditioning, the subject can express a behavior at a pace of its choosing (such as pressing a lever or touching a target) and the behavior is often shaped through the addition of a reward (positive reinforcement) immediately following the presentation of the behavior.

Horse behavior is often shaped through the use of negative reinforcement (the removal of an aversive stimulus once the behavior is expressed) (McLean & Christensen, 2017) but research has shown that horses can also learn through positive reinforcement through the use of novel food rewards (Christensen et al., 2005; Lloyd & Lloyd, 2013; Murphy & Arkins, 2007a; Ninomiya, Mitsumasu, Aoyama, & Kusunose, 2007; Rochais et al., 2014). Horses have not shown a strong response to behavioral shaping through the use of human scratching (Sankey, Henry, et al., 2010) although scratching and patting are still used by horse owners to reward a horse's behavior. Therefore, positive reinforcement refers to behavior that is reinforced with the addition of a stimulus with the intent that the horse will repeat the desired behavior in anticipation of the expected stimulus.

The researchers in this study used the principles of positive reinforcement in operant conditioning to shape the behavior of horses in touching targets and as a means of assessing the value of the treatments associated with the different symbols presented to the horses. Rewards of known value were given to the horses in order to shape their behavior in touching the targets then different treatments were tested for their reward value using different symbols to signify different rewards. Since operant conditioning relies on the value of the reward as a means of increasing the likelihood of a behavior to be repeated under positive reinforcement, the study examines the value of each treatment as a reward for touching a target. Specifically, the study compares the reward values of treats, patting by a human, and scratching by a human. The implications of the results, combined with knowledge in horse behavior, can provide more insight into the horse perception of horse-human interactions and the implications for horse-human social bonding.

Table 2. Horse behaviors indicative of social bonding, eustress, and relaxation

Psychological Response	Social Bonding	Eustress*	Relaxation
Potential Trigger	Seeking social contact (due to isolation) High stress (looking to lower stress) Demonstrate safe relationship	HPA response to predictable and safe outcomes Juvenile expression to practice adult behaviors, develop muscles, release energy Curiosity	Parasympathetic response: Lowered heart rate, lowered cortisol, relaxation of muscles
Exhibited Behavior	Mutual grooming Maintaining close proximity Following slowly (more research is needed in this area)	Play: this can look like stress, but is usually slower, more deliberate engagement with other horses rather than escape or fighting (i.e. slow chase, mock biting at hocks, slow and deliberate rearing/striking, slow mounting, slow threats of biting with no broken skin) Voluntary exploration of new stimuli	Parallel neck Closed or relaxed eyes (Use caution with the following two assessments) Resting rear leg Still tail

*Since the HPA axis is engaged, the horse may exhibit similar behaviors as distress. Behaviors will be controlled, however, with fewer trials of new behaviors or elevated escape behaviors.

CHAPTER III

MATERIALS AND METHODS

The study was submitted and approved by the Oklahoma State University Institutional Animal Care and Use Committee (approval number ACUP AS-17-5)

Three distinct symbols were created to represent the three treatments in this study and were chosen based on previous research demonstrating horses' ability to differentiate between symbols (Mejdell et al., 2016). The symbols in this study were created to signify different preferences for treatments: An X signified food treatment, O signified scratching by the human researcher, and a solid square signified patting by the human. Once the horses were taught to associate each symbol with a different treatment, the horses would then be given a choice to determine the reward value of each treatment. Preference would be determined by counting the number of times they touched the target to receive the treatment and observations of behavioral patterns that might indicate psychological and arousal state.

Materials

Three symbols (X, O, and solid square) were printed on standard letter paper (8.5x11 inches), one symbol per paper in black ink with printed portion measuring approximately 7x6 inches. These symbols were chosen based on horses' ability to differentiate between solid and open shapes (Hanggi, 1999) and their ability to differentiate between shapes (Mejdell et al., 2016). The symbols were glued to 9x12 inch solid canvas panels and laminated to make them weather-resistant. Velcro strips were added to the back of each symbol and complimentary Velcro strips were adhered to two 15x18x1/4 inch pressed fiber boards (heavy boards made from compressed fiber) outfitted with twine at each corner to that they could be adapted to different areas or fences for the study setup (Figure 1 and Figure 2). A plastic fence bucket was used for treat placement.

The study took place in a section of a pasture that was familiar to all horse subjects. The study space was approximately 30x30 feet in size with open metal pipe fencing and within sight of the entire herd of 14 horses and 1 donkey. The study environment was composed of an open pipe fence and dirt footing. The targets and buckets were attached to a portion of the fence that was a minimum of 15 feet from the pasture in which the other horses were housed. The environment in which the study took place was familiar to the horses and was part of their normal pasture space. The horses in this study live and graze in a lush pasture for 24 hours of the day and were within sight of conspecifics at all times during study sessions.

Horse Population

Eleven (N = 11) horses (6 geldings and 5 mares with age range 8 – 20) with known histories of human interactions (training and handling histories) and located in central Oklahoma were tested on six different days with two different researchers (one familiar and one unfamiliar) and two symbol sequences to account for weather and testing variables. The 11 horses were chosen because of their varied breeds and experiences with humans (Table 3) and were part of a herd of 13. Out of the original 13 horses, one horse did not respond to either touch (scratching or patting) or treats as a means of reinforcement for behavioral shaping and therefore was not included in the final study. The additional horse not used in the study became too aroused with treats and was not safe to handle. The variations in breeds and backgrounds provided the researchers with a variety of horses that would better represent a wide range of horse-human relations than groups of horses with similar breeding and experiences. The number of horses in this study is comparable to other focused behavioral studies between horses and humans.

All of the 11 horses used in the study had previous experiences with humans, but no previous research or target experience and were chosen because of their varied experiences with human interaction (training, handling, and riding). The horses were all familiar with one (familiar) researcher but had no experience with the other (unfamiliar) researcher. Nine of the horses had been trained to ride but had not been ridden for at least two years. The remaining two horses had never been ridden. Two of the horses, H3 and H5, had previous trauma-related experiences with humans which made them difficult to halter. One of the riding horses, H2, was known to follow humans (See Table 3). They were within sight of humans daily and the nine riding horses were haltered once a month for hoof-trimming. The nine riding horses were trained using traditional training or natural horsemanship techniques (negative reinforcement).

Table 3. Individual horse ages, breeds, and experiences with humans

Horse	Age (years)	Breed	Experience with Human Interactions
H1	12	Paint	Traditionally trained to ride, frequent human interactions, new to study herd, easy to catch and retrieve from pasture
H2	20	Clydesdale	Traditionally trained to ride, frequent human interactions, has a history of seeking out humans in pasture, easy to catch and retrieve from pasture.
H3	18	Paint	Traditionally trained to ride, typically difficult to catch and retrieve from pasture, typically avoids human interactions in pasture.
H4	10	Percheron-Paint Cross	Trained to ride with natural horsemanship, frequent human interactions, naturally curious towards new humans, easy to catch and retrieve from pasture.
H5	12	Norwegian Fjord	Traditionally trained to ride, frequent human interactions, has a history of bucking and bolting under stress, typically avoids humans in pasture and has a history of being difficult to catch.
H6	14	Shire-Thoroughbred Cross	Trained to ride with natural horsemanship, frequent human interactions, naturally curious towards new humans, easy to catch and retrieve from pasture.
H7	16	Shire-Thoroughbred Cross	Trained to ride with natural horsemanship, naturally curious towards new humans, easy to catch and retrieve from pasture.
H8	20	Quarter Horse	Traditionally trained to ride, frequent human interactions, easy to catch and retrieve from pasture.
H9	12	Paint	Not trained to ride, infrequent human interactions, easy to catch and retrieve from pasture.
H10	14	Belgian-Quarter Horse Cross	Trained to ride with natural horsemanship, easy to catch and retrieve from pasture.
H11	8	Dales Pony	Trained to ride with natural horsemanship, naturally curious towards new humans, easy to catch and retrieve from pasture.

Methods

Empty pressed boards with Velcro were tied to the fence with the center approximately 3 feet from the ground or, for taller horses, at the height of the horse's chest for ease of touching and access to symbol. The bucket was hung (and tied) to the fence directly below the target (Figure 1). For the initial stages of the study, the horses wore halters that were familiar to them and were loosely tied to the fence on which the targets were hung. Tying them to the fence allowed for easier and faster shaping for target-touching. For tying, the horses all wore halters to which there were accustomed and a 12ft lead of smooth yacht rope threaded through a tie ring. The tie ring allows for the rope to slide through the ring and the horse to escape if necessary. Researchers and assistants were expected to cease any trials where the horse showed signs of fear and distress.

For the last two sessions they were not tied nor wore halters and were loose in the study area. Allowing them freedom to move around provided horses with greater opportunities to choose behaviors.

Figure 1. Single symbol setup

Learning to Touch the Targets

To control for preference to treatments (scratching, patting, treats), the researchers split the horses into three groups (two groups of n = 4 and one group of n = 3) in which each group was trained to touch the target using a different treatment as a form of reward. Each group was assigned to a different target and therefore a different treatment or reward to shape the desired behavior of touching their nose to the middle of the printed symbol. Horses in the groups where human interaction (scratching and patting) were used as a means of providing reward for behavior shaping did not respond to shaping. Only horses in the group where treats were used to shape behavior were able to learn the target-touching task. Therefore, in order for all horses to be able to perform the desired task of touching the target, all horses were trained using treats to touch the target. Once they learned to touch the target, they were then taught to differentiate between targets after the touching behavior had been established.

Treats were “Saddle Snacks” by Manna Pro (manufacturer part number 1000047, available at Tractor Supply throughout the United States) and were broken by hand into smaller pieces of 1cm in diameter and between 1cm and 4cm in length. The horses were trained to touch the target first by learning to associate the sound of the treat in the bucket so they could associate the bucket with where to retrieve the reward. Once the horse associated the bucket with where to retrieve the food reward, the researchers used behavioral shaping to teach the horse to touch the target with its nose. In shaping, small efforts are rewarded as the animal gets close to achieving the goal task: Ultimately, the goal behavior (in this case the horse touching its nose to the target) is the only behavior that receives a reward. For the purpose of this study, the researchers shaped the horse’s behavior by waiting for the horse to exhibit behaviors close the goal behavior of touching the target with its nose. As the horse’s nose got closer to the target, another treat was tossed into the bucket. Treats were only given when the horse’s nose was closer to the target than the previous attempt. Finally, the horse was only given a treat in the bucket when its nose touched the center of the target.

Discrimination Task

Each horse was trained to touch the target (X) for a food reward (given in a bucket). Once the horses learned to touch the (X) target, another pressed board was added to the fence next to the original one (Figure 2). The X target was then moved between the two boards to ensure that the horse would touch the symbol and not just the empty board. Once the horse demonstrated spatial differentiation, the symbols were then changed to reflect wither scratching (O) or patting (square). The horse would touch the target with its nose and receive the designated treatment. As the horse voluntarily repeated touching the target, the designated treatment would be applied until the horse either ceased touching or it touched the target 20 times. To help standardize scratching, researchers used a bamboo back scratcher to apply scratching to the horse's neck on the left side halfway between the pole and the withers. Researchers were also trained to moderate pressure for patting in the same area as the scratching. These areas and techniques were chosen based on observed interactions of horse professionals and owners with their horses. Symbols were shown side-by-side and changed during the choice and differentiation exercise. Behaviors were observed and recorded as field notes.

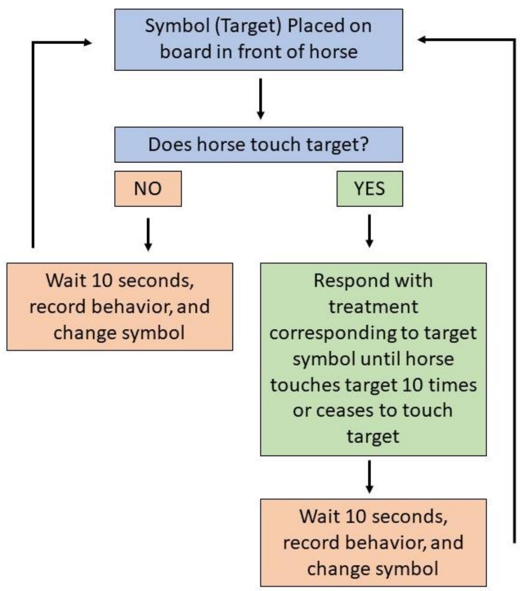
Figure 2. Side-by-side symbol setup

Performance Task

A single pressed board and bucket were attached to the fence and each horse was then subjected to a varied sequence of targets with each symbol appearing at least twice during each sequence session. Due to time constraints of weather and daylight, each horse was subjected to only one session per day for six days. Each session lasted between 10 and 15 minutes and the duration of sessions varied based on horse and the time needed to chew the treat reward or number of times the horse chose to touch the circle or square targets). Horses alternated days with the familiar and unfamiliar researcher so that each horse experienced three sessions with each researcher.

Each time a target appeared, the horse could touch it a maximum of ten times and the corresponding treatment would be delivered within one second of the horse touching the target. During the behavioral shaping phase, it was determined that the horse would touch the treat target in excess of 50 times, so the ten-touch count was chosen to maximize resources (treats) and provide enough opportunities for the horse to touch the scratch or pat targets to compare with the treat target. The horse was given ten seconds after application of the treatment to touch the target again. If the target was not touched again within ten seconds of application of the treatment, the target was changed to the next symbol in the sequence. The ten seconds was determined during the symbol differentiation process where horses were observed touching targets within ten seconds if they were motivated to touch at all (Figure 3).

Figure 3. Study procedure diagram



Horses were not tied to the fence for the last session and all sessions were recorded with a GoPro camera (Hero model number CHDHA-301). Researchers recorded number of times the target was touched, behaviors, and inter-trial intervals as well as individual behaviors during sessions.

Behavioral Observations

Individual behaviors during the sessions were recorded with video and variations of behaviors were noted (with field notes) during the duration of the study with regards to behaviors before, during, and after each session. Individual expression of behaviors were noted based on level of movement and arousal as well as individual differences with regards to behaviors expressed during symbol changes (Table 4) and compared to known studies of motivation and arousal behaviors (Table 1) (Peters et al., 2012) to determine if behaviors were indicators of arousal. All horses were observed in their normal pasture settings throughout the day to determine a baseline comparison for behavioral changes.

Individual histories of horses with regards to human interactions (Table 3), typical horse behaviors under different environmental conditions, and training histories were also recorded through notes and oral interviews with owners and handlers.

All horses demonstrated arousal behaviors during times when the target symbol was a circle (scratch) or square (pat), although they varied slightly between horses (Table 4). Observed arousal behaviors included pawing at the bucket or ground, increased head and neck position, increased muscle tension, and biting the target). All (N = 11) horses demonstrated increased movement and head carriage compared to baseline, five horses exhibited pawing behavior, two repeatedly bit the target, one repeatedly licked the fence and bucket, and the remaining paced. According to research in horse ethology, these are all indicative of arousal behaviors (Peters et al., 2012) and were observed during every study session. These same behaviors rarely appeared during pasture observations.

Statistical Analysis

The horses were not a random sample of a larger population and therefore the researchers used the Observation Oriented Modeling (OOM) software to run data analysis on the patterns observed in the raw data. Instead of aggregate statistics and Null Hypothesis Significance Testing (NHST) which assume population parameters, OOM interprets individual data, deep structure, and gives opportunities to examine causal processes for each sample and allows for a priori and post-hoc data analysis based on observed data (Grice, 2015; Grice, Barrett, Schlimgen, & Abramson, 2012). The lack of assumptions or necessary a priori means that OOM is ideal for behavioral studies in horses since the sample sizes are usually small, there is no requirement for statistical expertise, and allows for adaptation to the observed data. OOM has been used in a variety of behavioral observation studies, including ones on horses and behaviors related to timing intervals and treat rewards (Craig et al., 2015).

For this study, the final touch counts for each horse were run through post-hoc pattern analysis (*Pattern Analysis – Concatenated Observations*) using OOM software. Behavioral qualitative notes and codes were compared to OOM results to determine any differences between individuals.

Table 4. Observed behavioral patterns during presentation of symbols indicating scratching or patting.

Horse	Observed Behavior During Scratching or Patting Symbols (when horses did not touch target)	Touch Counts for Final Trial (for familiar researcher)		
		Treats	Scratches	Pats
H1	Tense muscles, pawing at ground	10	0	5
H2	Tense muscles, high neck, pawing at ground	10	1	1
H3	Tense muscles	10	0	1
H4	Tense muscles, high neck, stepped back from target and stood still.	10	1	1
H5	Tense muscles, pinned ears, high neck, biting target and tearing target off of panel	10	1	1
H6	Tense muscles, pinned ears, high neck, pawing at ground	10	0	0
H7	Tense muscles, high neck, biting target and tearing target off of panel	10	1	1
H8	Tense muscles, licking bucket until target changed	10	0	1
H9	Tense muscles, high neck, pawing ground	10	1	2
H10	Tense muscles, high neck, pawing at ground	10	1	1
H11	Tense muscles, high neck, pawing at ground	10	1	0

CHAPTER IV

RESULTS

The results from the OOM analysis showed that all eleven horses demonstrated preference for treats over human interactions regardless of background or familiarity with human.

Behavioral Shaping

With the original design, the study called for using patting and scratching as a potential reward for shaping two groups of horses to touch the target. The reluctance of the horses to respond to touch as a behavioral reward supports current research showing that treats are more effective than grooming when used as a reward for training with positive reinforcement (Ninomiya, Mitsumasu, et al., 2007; Sankey, Henry, et al., 2010). In order to determine if the horses in this study would respond to scratching or patting as a reinforcement treatment, the horses were split into three groups (two groups of 4 and one group of 3) and each group was assigned a specific target (scratching, patting, or treats) for the preliminary shaping of the target touching behavior. None of the horses responded to behavioral shaping using scratching or patting and only the horses in the treat group learned to touch the target with their noses. As a result, the researchers used treats to train all of the horses to touch the target. Once the horses learned to touch the target, the researchers then changed the symbols and integrated the other treatments (scratching and patting) as responses to target touching. Once the horses learned to differentiate the symbols and therefore differentiate the predicted treatments, all horses greatly reduced or stopped touching the symbols that indicated human interactions. Potential reasons may be related to the low arousal levels of horses during social interactions (Table 2) versus the heighted arousal states that result from novel food and were evident in this study (Table 1 & 4). Touch between horses and touch between human and horse may not align with higher states of physiological arousal.

Touch Counts for Horses

The horses' past experiences with human handling, training, and potential trauma were taken into consideration for each horse with regards to how their individual experiences may have influenced their behaviors during the study. The resulting touch counts and OOM results showed no connection with regards to preference for human interaction versus treats. Horses that historically demonstrated approach and curiosity behaviors with regards to all humans, familiar and unfamiliar, demonstrated high preference for treats over scratches or pats with no difference between familiar or unfamiliar persons. Only one horse (H1) showed a higher level of willingness to touch the square (indicating patting) target compared to other horses. This particular horse had no significant differences in handling history compared to the other horses but was a newer addition to the herd and had previously been accustomed to repeated patting behaviors at its previous housing environment. This might indicate a tolerance for patting or a conditioned response to patting if it had previously been associated with another reward (e.g. treat).

Familiarity of researchers did not have an effect on the outcome of the study. The touch counts for the horses in the final sessions for both familiar and unfamiliar researchers were similar and the horses' behaviors did not differ based on past experiences the individual researchers.

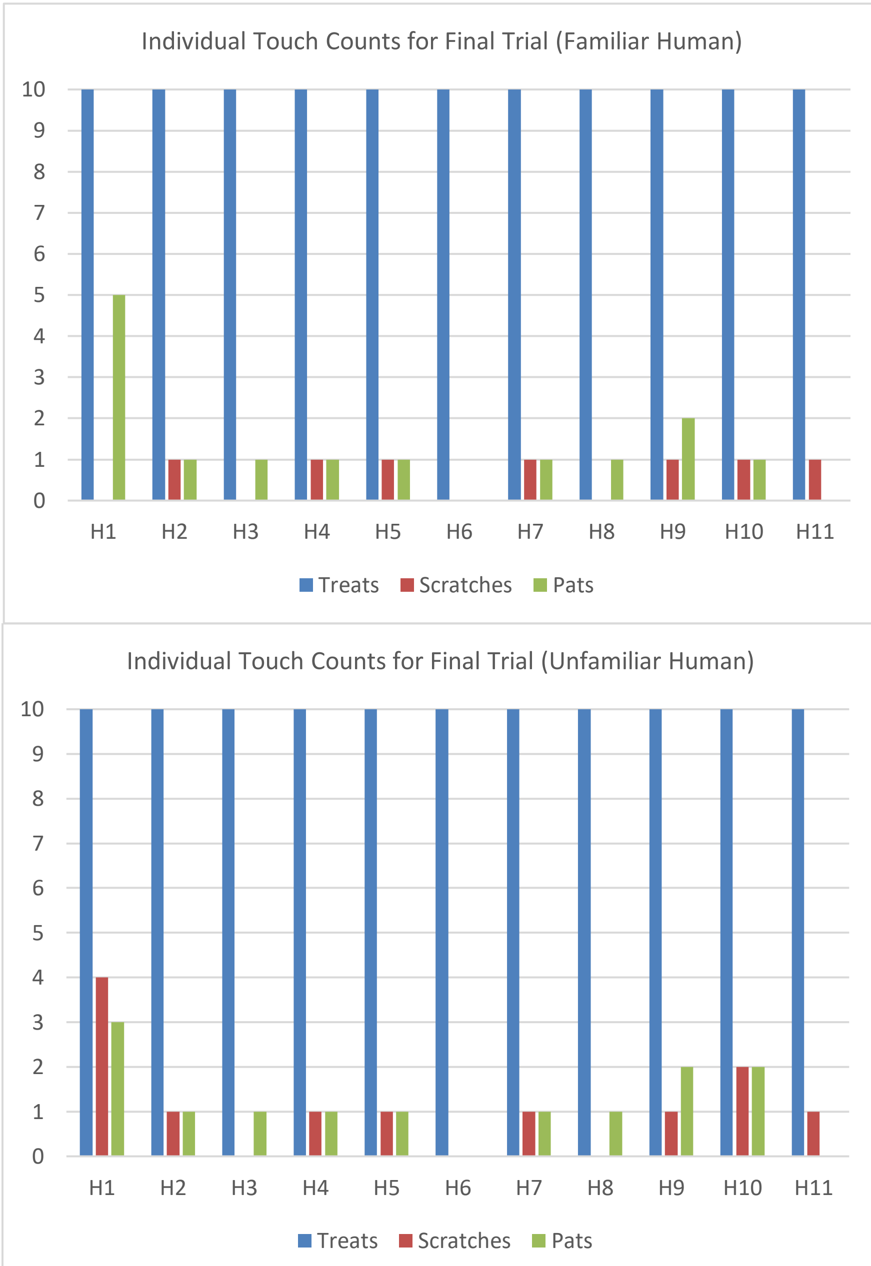
Discrimination task

In the first preference task where horses were taught to discriminate between symbols, all eleven horses expressed preference for treats over human contact in the side-by-side discrimination phase as well as the preference phase. All horses chose to touch the treat (X) target in lieu of either scratching (circle) or patting (square) when the X was presented alongside either the other targets. In this scenario, the horse never chose to touch the patting or scratching symbol when given the option of touching the treat symbol. Furthermore, when scratching and patting targets were presented side-by-side, the horse chose to touch neither. It is important to note that the horses were not touched unless they touched a target that indicated touching as a treatment. The researchers did not scratch, pat, or touch the horses during the experiment unless the horses touched a target that indicate a touch treatment

Preference

During the preference phase, all eleven horses showed distinct preference for the treat (X) symbol compared to the other symbols. Similar results were found for both the familiar and unfamiliar researcher in the last trials for each horse (Figures 4 & 5)

Figure 4. Individual touch counts for final trial for familiar versus unfamiliar humans



For this study, the data for the final touch counts were entered into OOM and analyzed using the *Pattern Analysis – Concatenated Observations* since there were multiple qualities/categories (in this case symbols and corresponding treatments) for each horse. In Pattern Analysis, the raw data is plotted on a grid and a pattern is determined based on the observed data points (Figure 4). The data is then run through an analysis to determine what percentage of the data fists with the pattern. This is called Percentage Correct Classification (PCC) and is reported as a percentage. A greater PCC value equates to a higher degree of alignment between the data and the pattern. The data are also shuffled to determine how likely the actual (or higher) PCC would be found if the raw data were to be randomly rearranged 1000 times. The result is called a *c*-value and represents the reported chance (as a numeric value) that the randomly shuffled data would produce the same or greater PCC as the original data. A low *c*-value equates a low percentage that a random data set would equate to the same or greater PCC index as the original data.

The final touch counts for horses interacting with a familiar and unfamiliar humans were run through the Pattern Analysis – Concatenated Orderings function based on the pattern in Figure 4 (Familiar Human) and run according to the observed data (as opposed to deep structure). The resulting PCC index for all observed (33 correctly classified observations) was 93.94 for the familiar human, suggesting that the indicated pattern correctly represents the data 93.94% of the time. The resulting PCC index for all observed (33 correctly classified observations) was 87.88 for the unfamiliar human, suggesting that the indicated pattern correctly represents the data 87.88% of the time. A randomization of 100 trials of shuffling the data for both familiar and unfamiliar humans resulted in a *c*-value of less than .001 suggesting that the observed PCC and pattern is representative of the data and is not a result of random chance.

Figure 5. Observed data and post-hoc pattern analysis for concatenated orderings in OOM for final touch counts for horses interacting with familiar and unfamiliar humans.

Familiar Human

Concatenated Observations

Units	treats	scratches	pats
Touches0		4	2
Touches1		7	7
Touches2			1
Touches3			
Touches4			
Touches5			1
Touches6			
Touches7			
Touches8			
Touches9			
Touches10	11		

PCC = 93.94
c-value <.001

Unfamiliar Human

Concatenated Observations

Units	treats	scratches	pats
Touches0		3	2
Touches1		6	7
Touches2		1	1
Touches3			1
Touches4		1	
Touches5			
Touches6			
Touches7			
Touches8			
Touches9			
Touches10	11		

PCC = 87.88
c-value <.001

Behavioral Observations

Individual horse behaviors were also observed during the study. Individual horses who had historically avoided humans in pastures and had typically run or otherwise avoided being caught, showed an immediate decrease in these avoidance behaviors after the first retrieval from pasture for this experiment (during the shaping stage). Furthermore, during the discrimination and preference stages, when the horse ceased touching the symbols indicating human interaction (scratching and patting), each horse demonstrated a unique pattern of behaviors indicative of arousal. All observed behaviors indicated levels of arousal according to known equine ethology (Peters et al., 2012) which were only present during the study session and not during baseline observations in the pasture. Baseline observations for all horses included lowered head position for grazing, head and neck parallel to the ground (resting), and slow walking movements during grazing. The difference in behaviors during the study and indication of arousal indicated that the study or rewards given during the study induced higher levels of arousal. Furthermore, for the sessions when the horses were not haltered or tied, the horses would willingly trot/run into the study area and approach the target without prompting.

All observed behaviors during the study sessions differed from their normal relaxed (head down, grazing, or sedentary) behavior in pasture settings during other parts of the day indicating a heighted arousal state during the experimental times (Table 4). The horses that had histories of avoiding humans demonstrated a willingness to approach and be caught after a single training session. Furthermore, when not haltered and presented with the opportunity to enter the study area without prompting, all of the horses would willingly trot/run into the study area and approach the target without the use of any reinforcement, halters, or leads. Although the horses had different histories with regards to human interactions and training, all of them still demonstrated preference for treats over human interaction during this study. There were no correlations between age, breed, or history and arousal behaviors or touch counts which suggests that individual differences in horses did not play a contributing role in their preferences for treats or arousal.

CHAPTER V

DISCUSSION

The purpose of this study was to determine the horse preference for treats versus human interactions and potential implications for horse-human bonding. The results from this study found that all eleven horses preferred treats over human interaction under choice conditions and that all of them exhibited signs of arousal during study times. These findings support existing research suggests that horses respond to novel food (like treats) with behaviors indicating physiological arousal (Ninomiya, Mitsumasu, et al., 2007; Peters et al., 2012) and that horses respond to treats more than scratches during behavioral shaping and training (Ninomiya, Mitsumasu, et al., 2007; Sankey, Henry, et al., 2010). Although all eleven horses chose treats over human interactions, the findings still align with existing and emerging research into possibilities for horse-human social bonding.

Specifically, the findings of this study indicate that horses prefer food rewards over human interaction under task-oriented conditions. The horses in this study indicated arousal behaviors (Table 4) which could potentially influence preference for human interactions. Research shows that horses display arousal behaviors with novel food (Ninomiya, Mitsumasu, et. al., 2007; Peters et. al., 2012), but under grooming conditions horses have shown to have lower heartrates when scratched (Feh & de Mazierès, 1993) and often display more relaxed behaviors during social bonding with conspecifics (Table 2) (Vandierendonck et al., 1995). Since the novel food induces arousal and bonding often occurs more in line with relaxed behaviors, the setup of this study may have created environments more conducive to learning and less conducive to social bonding opportunities. Since there is little research in horse-horse social bonding and only emerging literature in interspecies bonding between horses and humans, the results of this study further support the need for more research to determine horse preference for interactions (with conspecifics or humans) under different arousal conditions. Considering the variation in backgrounds of individual horses, however, this brings up further opportunities to explore how horses may choose to interact with humans under various conditions and how this may influence handling and welfare.

Future variations in this study would benefit from changes in interactions or treatment types. The study limited human interactions to the neck area of the horse, so future research could use scratching or patting at different areas on the body or use different symbols to give horses preferences of where on their body they would like to be scratched or patted. Furthermore, this study only looked at the preferences of eleven horses in one location and additional studies would be needed to see if the results could be replicated with other herds and people. Since the horses varied with regards to their histories with humans, training, and handling experiences, an additional study could utilize a herd of individuals with consistent histories in order to account for all variables, including human handling, in order to act as a control.

With regards to learned associations, past experiences with humans can influence the behaviors or perceptions of horses towards individual handlers. Horses can differentiate between individual people (Lampe & Andre, 2012; Proops & McComb, 2012) and will change their perception based on past interactions with those individuals (Fureix, Pagès, et al., 2009). The researchers in this experiment used a short bamboo backscratcher to facilitate the scratching and promote the horses' association of the researcher with the potential reward. Tools are used in studies of negative reinforcement to demonstrate equine learned associations between reinforcement and individual humans (Briefer Freymond et al., 2014; Fureix, Pagès, et al., 2009; Hendriksen et al., 2011;

Sankey, Richard-Yris, Henry, et al., 2010), suggesting that horses may also create associations between positive reinforcement and individual humans when using appropriate tools. It is possible, however, that the use of this tool could influence the horses' perceptions of scratching since this was not direct human contact and the use of direct hand scratching could potential result in different responses to human interactions. More studies need to be done to determine if a horse would prefer direct contact versus the use of a tool. Furthermore, since treats were given in a bucket versus by hand, additional studies should be done to see if horses show preference for treats from a human hand versus buckets.

It may also be possible that horses perceive humans as no more than novel environmental objects (Fureix, Jego, Sankey, & Hausberger, 2009) and differences in preferences may be a result of individual horse experiences (Baragli et al., 2009). As a result, the researchers did a partial replication of this study with a separate herd of 15 horses of varying histories, sizes, ages, and breeds (all housed in open pasture), in which hand scratching was implemented. Preliminary results were identical to those found with the bamboo scratcher with all horses touching the treat target without hesitation and refusing to touch either the patting or scratching when either was presented.

The observed behaviors of the horses during the study session (Table 4) indicated a level of arousal that may have played a role in the final touch counts (examples of arousal behaviors are in Table 1). Arousal behaviors in horses are based on engagement of the HPA axis and are expressed as stress or excitement under different conditions. In research, arousal and stress are measured through cortisol (Stucke, Große Ruse, & Lebelt, 2015; Yarnell, Hall, & Billett, 2013), eye temperature (Yarnell et al., 2013), and heartrate variability (König von Borstel et al., 2011; Stucke et al., 2015) and have been shown to correlate to behaviors such as increased muscle tension and head and neck position (König von Borstel et al., 2011; König von Borstel, Pasing, & Gauly, 2011) in addition to increased movement (Hall et al., 2014; Peters et al., 2012; von

Lewinski et al., 2013). Although most equines exhibit muscle tension in the neck and back, position of body, and movement as signs of arousal, specific behavioral indicators of stress differ between individual horses (Fazio, Medica, Cravana, & Ferlazzo, 2013; Yarnell et al., 2013). The observed behavioral changes in this study varied between individuals (Table 4), but the observed behaviors of each individual remained consistent throughout the study. Each horse demonstrated a unique pattern of behaviors indicative of arousal and the pattern remained consistent for each horse.

Arousal behaviors may have influenced preferences for human interaction. In this study, the HPA axis (which is responsible for the release of cortisol, increased heartrate, and corresponding arousal behaviors) may not have had time to return to baseline between the treat reward and the scratching and patting treatments. The heartrate of horses has been shown to decrease when a human scratches the withers (Feh & de Mazierès, 1993) and current research indicates that mutual grooming in horses may indicate a coping mechanism (Kimura, 1998; VanDierendonck & Spruijt, 2012). The physiological response to scratching and motivation to seek out physical contact with conspecifics may suggest that scratching activates the parasympathetic system. If treats triggered a release of cortisol and the activation of the HPA axis in this study, the horses may not have had adequate time to recover from the arousal to demonstrate a willingness to seek out or respond to physical interactions from the human researcher.

If the treats and the target task were responsible for increasing arousal, it may be necessary to study the preference for human interaction under non-arousing conditions. Further research is needed to determine if horses may indicate different preferences if treats are eliminated and arousal levels are monitored through either behavioral or physiological indicators. Additionally, arousal conditions, especially those where horses voluntarily engage in activities, may present opportunities to explore other ways to interact with horses during periods of eustress.

To further explore the use of human interactions as rewards, the authors suggest finding behaviors and physiological indicators that correlate with bonding in other species, notably oxytocin and vasopressin. As a primary hormonal indicator of social bonding, oxytocin provides strong support for interspecies bonding (Carter & Wilkinson, 2015; Coulon et al., 2013; Nagasawa et al., 2015) and is a neurobiological indicator for motivation to seek conspecific or familiars (Heinrichs, von Dawans, & Domes, 2009; Taylor, 2006; Walum et al., 2008). Dogs respond to human touch, vocal tones, and treats as reinforcers (Cook et al., 2016) and positive oxytocin feedback in both human and dog (Nagasawa et al., 2015), but existing research in herbivore-human interactions shows no such indicators of oxytocin responses in animals (Coulon et al., 2013). Without establishing correlations between equine social bonding behavior and oxytocin levels, it is difficult to establish behavioral models for horse responses to human interactions with regards to emotional reward. With improved oxytocin measurements and tests, there is potential for using hormonal markers to provide insight into equine social bonding behavior and the potentials of understanding horse-human social bonds.

CHAPTER VI

CONCLUSION

The findings in this study indicate that horses prefer treats to human interactions under the task-discrimination conditions. The horses also demonstrated behaviors such as increased frequency of movement, head height, and increased muscle tension (Table 3) indicating physiological arousal which would suggest that heighted states of arousal may influence preference for interactions or rewards. This further supports the need for more research to determine the types of interactions horses prefer (with conspecifics or humans) under different arousal conditions and to determine how stress and arousal influence the willingness to interact with humans.

The study creates opportunities to explore individual horse preferences for rewards and interactions in future studies. The horses in this study had varied backgrounds with regards to human interactions and the experiment presents a potential method through which to examine individual horse preferences for types of interactions. With the use of targets and availability of choice to indicate preference, the study provides new opportunities to examine horse decision-making and preference under different environmental conditions and stimuli.

Horses continue to play a major role in our society and as they transition from work into therapy and companionship, researchers and professionals must be prepared to create environments that facilitate psychological and physical health for the horse partners This is an emerging field of both research and practice and as science begins to engage with this topic,

we will continue to reassess our approach, methods, and suggestions as to how to view horses in the context of equine-assisted therapies and companionships and how to create environments that facilitate growth for both horses and humans. Thank you for being a part of this process.

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APPENDICES

Appendix 1

Table 5. Final Touch Counts for Familiar and Unfamiliar Researchers based on Treatment Type

	Familiar Researcher - Treatment Type			**Unfamiliar Researcher - Treatment Type**		
Horse	**Treat**	**Scratch**	**Pat**	**Treat**	**Scratch**	**Pat**
H1	10	0	5	10	4	3
H2	10	1	1	10	1	1
H3	10	0	1	10	0	1
H4	10	1	1	10	1	1
H5	10	1	1	10	1	1
H6	10	0	0	10	0	0
H7	10	1	1	10	1	1
H8	10	0	1	10	0	1
H9	10	1	2	10	1	2
H10	10	1	1	10	2	2
H11	10	1	0	10	1	0

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