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Emotional Contagion and Mimicry of Behavior between Horses and their Handlers

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Abstract

This study is about emotional contagion and mimicry of behavior between horses and their handlers. Behavioral mimicry is defined as doing what others are doing, and appears to be strongly connected with social affiliative behavior. I investigated mimicry through head tests and walk tests to see if horses changed their movement together with a familiar human handler, also evaluating any effects of the horse's age, sex, breed type, and housing. I wanted to determine if there was a correlation between the amount of affiliative behavior shown by the horse to their familiar handler and the degree of the horse's behavioral mimicry of the handler's movements. Emotional contagion is considered to occur when it appears that an observer spontaneously copies the emotional state of a demonstrator and exhibits an expected behavioral reaction to that emotion. I used an object test to see if a familiar human handler's reaction to an unfamiliar object affected the horse's reaction. I also investigated whether the object type, and horse's age, sex, breed type or housing influenced the horse's behavioral response.

Forty test horses and 20 control horses were observed to investigate mimicry of walking and head movement. The walking test involved 18 sets of 5 walking steps. During the experimental protocol, the handler demonstrated 6 changes of walking style (and effect was measured after 5) repeated 3 times in one of 6 different predefined orders. The head movement test involved two repetitions of a downward head movement by the handler while standing. For the control horses, the walking and head movement tests involved the handler walking with a single walking type and standing straight, respectively. Affiliative behavior of the test horses towards the handler was assessed on a visual analog scale on 5 occasions during the testing routine. To look at emotional contagion, 40 horses were each exposed to four objects, where the human acted as if afraid (test) of two objects and calm (control) towards two objects, in random order (afraid condition or calm condition first). All horses were tested in a flat area, most often a riding arena. The horses wore a halter and were loosely connected to a familiar handler holding a slack lead rope.

Horses in the experimental condition showed a significant level of mimicry of both head ($P<0.001$) and walking ($P<0.001$ movements compared to the control group, and younger horses showed more mimicry than older horses. There were no effects of sex, breed or housing on behavioral mimicry. Both mimicry of walking and mimicry of head movement were correlated with the level of affiliative behavior shown to the handler. The results indicated that the horses' behavioral 'fear' reaction was significantly ($P<0.006$) affected by the humans' reaction type towards each object (calm or afraid). There was also an effect of object type on the horses' reaction whereas no effects of age, sex, breed, or housing on emotional contagion from handler to horse were detected. The result of this study support the hypothesis that horses show both behavioral mimicry and emotional contagion towards familiar handlers.

Abstrakt

Dette studiet ser på “emotional contagion” fra nå kalt emosjonell speiling og “mimicry of behavior” heretter kalt fysisk speiling, mellom hest og menneske. Fysisk speiling er definert som å gjøre det samme som andre, og ser ut til å være sterkt knyttet til affiliative atferder. Jeg har sett på fysisk speiling gjennom hode tester og gå tester for å se om hesten endrer sine bevegelser sammen med et kjent menneske, og hvordan hestens alder, kjønn, rase type og oppstalling påvirker dette. Formålet med oppgaven var å se om det var korrelasjon mellom mengde affiliative atferder vist fra hesten til menneske og mengde speiling av menneskets bevegelse. Emosjonell speiling er sett på som når observatøren spontant kopierer den emosjonelle tilstanden til demonstratoren og viser en atferds reaksjon på denne emosjonen. For å se hvordan menneskets reaksjon påvirket hestens reaksjon brukte jeg en objekt test. Jeg så også på om objekttype, og hestens alder, kjønn, rasetype eller oppstalling påvirket hestens atferds respons.

Førti test-hester og 20 kontroll-hester ble observert for å se på fysisk speiling gjennom hode-bevegelse og gå-test. Gå-testen involverte 18 sett av 5 steg. Under eksperimentet viste mennesket 6 forskjellige gå-typer, repetert tre ganger. Testen ble gjort i 6 forskjellige rekkefølger som var bestemt på forhånd og tilfeldig tildelt hvert menneske. Hode-bevegelse-testen ble repetert to ganger, og bestod i at mennesket sto ved siden av hesten og bøyde hodet nedover, etter at beskjed om å bøye hodet var gitt telte jeg til fem før måling ble gjort. For kontroll hester gikk mennesket i en jevn gange uten endringer for gå-testen og sto stille uten å bøye hodet for hode - testen. Afffiliative atferder fra test hesten mot eier ble sett på via en visuell analog skala fem ganger gjennom undersøkelsen. For å se på emosjonell speiling ble 40 hester leid rundt fire objekter og menneske oppførte seg som om de var redde på to av objektene og rolig (kontroll) på to av objektene. Rekkefølgen på test og kontroll var tilfeldig så noen tester startet med redd menneske og noen med rolig. Alle hestene ble testet på et flatt område, oftest på en ridebane/ ridehus. Hestene ble testet i grime og slakt leietau, og ble håndtert av et kjent menneske.

Testhestene viste signifikant mer fysisk speiling av både hode bevegelse og gå type i forhold til kontroll gruppa, og yngre hester viste mer speiling en elder hester. Det var ingen effekt av kjønn, rasetype eller oppstalling på fysisk speiling. Både speiling av gange ($P<0.001$) og hode ($P<0.001$) bevegelse var korelert med mengde affilitive atferder vist mot mennesket. Resultatet viser at hestens fryktatferds reaksjon var signifikant ($P<0.006$) påvirket av menneskets reaksjon på objektene. Det var også en effekt av objekt type på hestenes reaksjon, men ingen effekt av alder, kjønn, rase type, eller oppstalling ble funnet. Resultatet av denne studien støtter hypotesene om at hester viser fysisk speiling og emosjonell speiling mot et kjent menneske.

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1. Introduction

Using an older and more experienced horse when teaching a young horse how to function during handling and training by humans is a common practice (Murphy & Arkins 2007). This is also a technique used when an unexperienced horse is learning to function in new housing management systems (Nicol 2002; Christensen et al. 2006). Additionally, the concept that horses mirror humans is widely accepted in the horse world. You often find it discussed in horse books (Kohanov 2001; Hallberg 2008; Branderup 2013), blogs (Barber 2014; Biggs 2014; Durham 2014) and movies (Meehl 2011). One of the blogs used this description:

> “Your horse can be your mirror in a couple of ways. One way in which he is just like you, like a mirror image. A bit like some dogs are just like their owners. Have you ever come across a horse that is fast, flighty and nervous? The horse tells the story. Is the owner also fast, flighty and nervous? In another way, your horse can be a direct reflection of you. That is, a direct result of your leadership and horsemanship skills. Take the same flighty, nervous horse and now put him in the hands of someone who is calm, laid -back and easygoing. The horse will soon take on these characteristics himself” (Biggs 2014).

Another wrote:

> “Horses offer a different kind of mirror that not only reflects what we display on the outside, but what is true of our insides. And with this reflection, horses offer the opportunity to reconcile both the desired and disowned parts of who we are in order to reveal a more authentic version of ourselves” (Durham 2014).

The idea that mirroring is important in equine assisted therapy is quite common; see, for example, reviews by Frewin & Gardiner (2005) and Letini & Knox (2009). It is applied in “Equine Facilitated Psychotherapy,” where two conceptual models are used. One is a triangle of client, animal and therapist where the therapist observes the behavior of the animal and client and the animal's behavior is interpreted to the client who is then encouraged to reflect on his or her own behavior. In the other, there is a client, animal, therapist and animal handler, where the handler observes and describes how the other two are affecting the animal. Both methods use the horse to analyze the human's behavior and emotions (Lentini & Knox 2009). Vidrine et al. (2002) writes that when interacting with people, horses offer immediate, non - verbal feedback. The horses "mirror" emotion and feeling that can be used in the therapeutic setting to help the clients and the therapists see and talk about emotional states. Roberts et al. (2004) also uses the description of the horse as a living, breathing biofeedback machine that reveals internal processes in real time. She says that:

> "Equine Facilitated Psychotherapy is not just pet therapy. Horses are unique in their response to humans because they are prey animals, not predators, and their survival demands that they be extremely sensitive to the environment… Horses respond to the internal state of the person, no matter how much the person tries to disguise it" (p. 33).

Here is another interesting idea, not only that the horse will mirror the emotions of humans, but also that it is not possible to hide and disguise your real emotions from the horse. Therefore, a horse can be perceived as a large mirror to promote conscious attention to our specific behaviors. This is considered to encourage authentic communication and awareness of our secret intentions (Letini & Knox 2009). A study by Kern-Godal et al. (2016) looked at how participants experience use of horses in therapy, were the participants reported that the horse reflected or "mirrored" their behavior and emotions, giving them a better awareness of their own behavior and emotions. One of the participants described it like this:

> "If I'm calm then the horse is calm and if I make a sudden movement or think of something else, and appear to be unfocused, or just mess around, the horse will be like that as well. So horse therapy means a lot to me in a way because I have to be present and consistent. And then when I am, that's a pretty good state of mind to be in" Kern-Godal et al. (2016).

Even though the idea of horses mirroring humans is widespread, there has been very little research on this topic, I therefore wanted to look at these phenomena in my thesis.

2. Literature review

2.1 Mimicry and emotional contagion

This thesis is about emotional contagion and mimicry of behavior in horses. Mimicry can be defined as “doing what others are doing”, where the doing can come in many different forms and shapes, both verbal and non- verbal (Stel & Vonk, 2010). There seems to be a bi–directional relationship between nonconscious mimicry on one side and liking and affiliation on the other. Mimicry gives affiliation and affiliation can be seen through unconscious mimicry (Lakin et al. 2003a; Lakin et al. 2003b). Emotional contagion means that an observer is considered to spontaneously copy the emotional state of a demonstrator and then show their own affective reaction to that emotional state (Nakahasi & Ohtsuki 2015).

When looking at what factors could influence emotional contagion and mimicry in humans, you find topics like social relationship and social status (Baaren 2009). This are some of the same topics found when looking at social learning in non-human animals (Galef & Laland 2005; Gariepy et al. 2014) and I have therefore chosen to look into the social learning literature in animals, and horses specifically, to understand important points relevant when establishing my methods.

2.2. Social learning

Learning lets an animal acquire, store and use information about their surroundings, giving them the opportunity to fine tune their behavior when the world around them changes (Galef & Laland 2005). The surroundings will change not only between different generations, but also many times through one individual's lifetime, so learning what actions are useful is important. The processes used in information-acquiring systems that give an individual the ability to change its behavior in an adaptive manner are under the influence of natural selection (Galef & Laland 2005). Social learning refers to the process in which individuals learn from others instead of through individual learning (Gariepy et al. 2014)

There are many different definitions of social learning. Shettleworth (2013) uses the wide definition «all learning from other individuals», and this describes many diverse learning mechanisms. Individuals with more experience have a bigger reservoir of potentially useful behaviors and knowledge. Learning from them may help other naïve individuals to shorten their learning process compared to learning it themselves (Galef & Laland 2005). Figuring out what to do and how to do it can be a lot of work and dangerous in some circumstances. Important decisions like what food to eat and what motor patterns can be used to access food, how much time to spend foraging in one place, what predators to avoid and how to avoid them can be influenced by others (Galef & Laland 2005).

To test social learning one requires demonstrators, individuals that already know how to perform the behavior of interest, and naïve observers exposed to the to-be-learned behavior of the demonstrators. Observers are then tested for performance of the target behavior in the absence of the demonstrator (Shettleworth 2013).

2.2.1. Social learning in horses

The assumption that horses learn from each other is widespread, and used for training and horse assisted therapy (Kohanov 2001; Nicol 2002; Vidrine et al. 2002; Robert et al. 2004; Frewin & Gardiner 2005; Christensen et al. 2006; Murphy and Arkins 2007; Hallberg 2008; Letini & Know 2009; Meehl 2011; Branderup 2013; Barber 2014; Biggs 2014; Durham 2014; Kern- Godal et al. 2016). However, even with the practical assumption that horses will learn from others, few studies have been done on whether and how well horses learn from conspecifics, and the studies done have showed mixed results (Nicol 2002; Murphy & Arkins 2007; Bunbaker & Udell 2016). Murphy & Arkins (2007) suggest that the inconsistent evidence might be due to differences in study design and lack of multiple controls rather than absence of social learning skills in the horse. Some of the literature fails to control for prior experience of the horse and relationships between individuals and this might make it hard to draw conclusions (Krueger & Flauger 2007).

Baer et al. (1983) did a bucket test with 16 horses, where eight horses functioned as controls and eight as observers. Observer horses had watched a demonstrator eat from a target bucket (a white bucket on a white wall, separated from the other bucket, a black bucket on a black wall, with a barrier) five days before the testing started whereas control horses had been shown the two different-colored buckets in the same manner but without a demonstrator present. Both observer and control horses were standing in the starting box during their preparation period. The white bucket (always containing food) and the black bucket (without food) was randomly placed each day during training and testing. During the test, individual horses were let loose from the starting box at one end of the area. If the horses chose the white bucket they got to eat the reward, concentrated food, before they were placed back to the start position for another trial. If they chose the wrong bucket, they did not get food before being taken back to the starting position again. The learning criterion was seven out of eight trials right, and the last five had to be in a row. The maximum number of trials in one day was 20 and the horses were tested for 15 days. The data did not show social learning, but did show individual learning through different trials. The first day of testing was excluded because of unexpected disturbances in the environment which might have a strong influence on the outcome. As Galef & Laland (2005) point out, social learning is more likely to happen in a situation where the animal has little knowledge and therefore chooses to use information from others. The task of choosing a white instead of a black bucket is an easy task to gain knowledge about yourself, which might make individual learning unlikely.

Baker & Crawford (1986) looked at how a demonstrator could influence an observer's choice of buckets without finding any sign of social learning. The horses chose one of two buckets where one of them contained grain. There was nine young (2-3 year old) horses in the control and nine (2-3 year old) in the observer group, and two mature demonstrators. Observers stood in the starting box and watched demonstrator eat food three times a day for five days from either a black or a white bucket, while the control horses stayed in the starting box without the demonstrator in the arena for the average time a demonstration lasted. After that, both controls and observers got five trials a day over 15 days, but showed no sign of social learning. Throughout training and subsequent testing, only one of two feed buckets held feed each day. If one of the buckets was empty the demonstrator should chose the other on its next trial, but despite eight consecutive days of training to find the feed buckets with grain, the two demonstrators occasionally returned a second time to an empty feed buckets during the first two days of the experiment. The solution to this was that from the third day of testing the handler blocked the demonstrator from choosing the incorrect feed bucket so it could only choose the one with the grain (Baker & Crawford 1986) although that finding that the demonstrator is not able to consistently make the right choice after training can be argued to mean that the experimental setting is not suited for horses.

Clarke et al. (1996) also conducted a bucket test. The observers watched a demonstrator choose one out of two buckets 20 times over two days. When tested, the observer horses were let loose individually in the test area to see if they would choose the same bucket as the demonstrator. Both buckets had grain so that the horses would not learn the task by individual learning. The time it took before horses went to where the buckets were placed was significantly shorter in observers than control horses suggesting that they used local enhancement learning to find the food faster. However, the observer horses were not more likely to choose the same bucket as the demonstrator in each trial. In this study, the protocol for familiarization between demonstrator and observers was at least 18 hours of stabling beside each other before the test. This might not be sufficient for social accustomization which may have had a negative effect on the learning outcome (Murphy & Arkins 2007).

Krueger & Heinze (2008) tested if horses learn to fallow a human from other horses using the “round pen technique”, seeing if the horses learned to follow a human faster if they watched a demonstrator horse that followed a human than if they watched a demonstrator horse that did not follow a human. In the test, the demonstrator horse was first chased in the round pen for two minutes before being given the possibility to follow the experimenter. If the horse chose not to follow the experimenter, the consequence was that it was again chased in the round pen. Then the same procedure was followed with the observer, and the observer’s behavior was compared to their demonstrator. They found that observer horses learned from demonstrator horses when the demonstrator was a known horse and dominant towards them but failed to show observational learning towards an unknown or subordinate horse. This was also true when the demonstrator did not make the right choice, leading to more chasing from the human.

Rørvang et al. (2015) used a spatial detour task (maze) to study horses’ ability to use social learning. They had two groups, one with young demonstrators and one with older demonstrators. The observers watched the demonstrators being led three times through the maze before being allowed to try the task themselves. The control horses only watched the demonstrator eat at the endpoint of the maze. They noted that the observers seemed not to pay attention during the demonstrations.

Lindberg et al. (1999) tested horses’ ability to learn to open a box by looking at a demonstrator. Observers watched demonstrator horses open the box with a food reward inside by pressing on a pedal but they showed no faster task solving than control horses. Instead, age seemed to be an important factor where younger horses performed better.

Ahrendt et al. (2012) looked at horses' ability to learn how to solve a task from a known individual when interactions were permitted during the demonstration. In the test, the horses were supposed to remove a lid from boxes containing a food reward. They did two tests, one with 11 and one with 44 horses. Observer horses watched the demonstrator open a box 10 times within seven minutes, and the demonstrator was allowed to eat for about 10 seconds for every time it opened the box. Afterwards, the observer had ten minutes to open the box. Both the demonstrator and control horses were loose during the demonstration. The control horses had ten minutes alone with the box. Four of the observers and one of the control horses managed the learning criteria which was opening the box twice. In the second test, six of 23 observers and five of 21 control horses reached the learning criterion and there seemed not to be any social learning present. In the first test, the demonstrator was chosen for not being aggressive and a fast learner but there still was some aggressive behavior both from demonstrator and observers. In the second test, the demonstrators were chosen more randomly and the level of aggression was high enough that the horses were held on lead ropes for safety reasons.

Krueger et al. (2014) studied at horses' ability to learn from other horses to open a drawer containing food. They found that younger, lower-ranking and more exploratory horses could learn to open the drawer after observing older herd members, and the older the horses were the less likely they were to learn from others. The younger observers learned faster and completed more trials than older horses. Krueger and colleagues proposed that, if social learning is an adaptive specialization to the social environment, older individuals may choose not to risk the potential cost of learning complex and ineffective behaviors from younger individuals.

To summarize, if we look at past research on social learning in horses, some important factors can be seen. Setting up the test so that it is more likely that the horse will chose social learning assuming it has the capability to use both social and individual learning is important for being able to detect social learning. In Baer et al.‘s (1982) test, they found that the horses showed individual learning through the different trials instead of social learning. As Galef & Laland (2005) write, social learning is more likely to happen in a situation where the animal has little knowledge and therefore chooses to use information from others. Therefore, instead of using the same test many times, it might be a better idea to use different tasks through the trials, and make sure that the result does found does not come from improvement through trials. The individual’s social situation is also important, as Krueger & Heinze (2008) found both social status and familiarity are important. Age, and how exploratory the horses are, also influenced social learning (Krueger et al. 2014). Murphy & Arkins (2007) suggest that using individuals that are familiar to each other is important for social learning. Another important challenge can be aggression (Ahrendt et al. 2012) and whether the observers find paying attention to the demonstrator (Rørvang et al. 2015).

2.2.2 Is it useful to learn socially?

To learn from other individuals instead of taking the risk associated with learning by trial and error with individual learning is adaptive in many situations, but copying all behaviors of another individual is unlikely to be an adaptive strategy. Instead, the environment and individuals involved can change how adaptive learning socially is at different times (Galef & Laland. 2005). If all individuals were scrounging information from others and no one was producing new information by learning individually, there would soon be nothing useful to learn (Galef & Laland 2005). It's important for animals to be selective of when to copy others and whom to copy from (Laland 2004).

It varies between individuals whom they learn from socially (Gariepy et al. 2014) and the identity and characteristics of the demonstrator are important for the likelihood that others will learn from the demonstrator's behavior (Galef & Laland 2005). One of the most important factors is age, as juveniles will typically learn more from adults than vice versa (Galef & Laland 2005).

There are many different mechanisms that are included in social learning and the brain substrates involved are often skills used on non-social cognitive and motivational processes. These mechanisms include effects of others on attention, learning stimulus or action value through observation, motor stimulation and imitation and active instruction using movements or sounds. The ability to recognize individuals and remember their actions is an important building block in social learning (Gariepy et al. 2014).

Horses are sensitive to the actions and behaviors of others, including humans. They have a strong memory of humans and past interactions, and can remember if the interactions were positive or negative experiences over time (Sankey et al. 2010; Stone 2010; Lampe & Andre 2012). They are good at recognizing different humans and use visual, olfactory and auditory signals to do this (Stone 2010; Lampe & Andre 2012; Proops & McComb 2012). Horses are sensitive towards human attention. They are more obedient to a familiar person looking at them when giving a verbal cue than if the person is being inattentive to them (Sankey et al. 2011). When a human has access to food rewards, horses prefer to approach the person facing them and looking at the horses, suggesting that they can understand where the human's focus is directed (Proops & McComb 2010).

Past training style may have a strong effect on horses' ability to learn human- guided tasks and can therefore have a large influence on cognition testing outcomes (Dorey et al. 2014). Likewise, Proops et al. (2013) found that the horse's experiences through life had a strong influence on their ability to solve cognitive tasks. To be able to read human attention, they need to have extensive experience with human interactions. There are a lot of other factors, including sex, breed, social status and genotype can influence a horse's learning style and abilities and which are therefore important when testing horses' cognitive abilities (Brunbaker & Udell 2016).

2.3. Synchrony of behavior in horses

Behavioral synchrony within a group means that all or some of the individuals in the group are engaged in an activity simultaneously (Souris et al. 2006). Synchrony is an important feature in social ungulates and can help to reduce difficulties from insect harassment (Klimov, 1988, found in Souris et al. 2006) to predation (Jarman, 1974; Bertram, 1978, found in Souris et al. 2006).

Tyler (1971) observed social facilitation in a semi-feral population of New forest ponies. Because her description seems to look at the same phenomenon as in articles reporting synchrony I have chosen to discuss it here. She found that when one pony laid down or stood resting, its group companions would usually lay down or stand resting around it, and if one began to graze after a resting bout, the rest would also start grazing. Synchrony was common both within groups and between groups and involved behavior patterns like resting, grazing, walking, rolling and eliminative behavior. In movement, the researchers observed co-ordination of movement, like walking up and down valleys, to shade or drinking places, and grazing movements.

Other researchers have found behavioral synchrony in a herd of newly released Prezwalski horses (Souris et al. 2006). Mares had an average of 87-91% synchrony, first harem stallion 87%, and second harem stallion 73%. The highest behavioral synchrony was observed during grazing 91%, followed by resting 89%, moving 85% and the lowest for standing 51%.

Rifa and colleges (1990) looked at synchrony of behavior in a group of 12 feral horses. They focused on complete synchrony and partial synchrony, where partial synchrony was defined as when more than 50 % of the horses were engaged in the same behavior. The researchers concluded that synchrony of behavior existed in horses and that the amount of synchrony was influenced by the type of behavior. To see the entire group of horses engaging in the same behavior was not a frequent event, but still happened in around 10 % of the data. Of the complete synchrony behavior, 92% was feeding and the remaining 8% was standing resting. It seems to be very rare to find the whole group resting by lying down, as this only happened in 1% of the total observed behaviors. The behaviors found in partial synchrony were feeding 65%, standing resting 35% and walking 0,3%. There was no partial synchrony in behaviors like mutual grooming or lying down. They found synchrony in 64% of behaviors between mothers and their foals, which showed percentages of synchrony of feeding (59.3%), standing resting (40%), walking (0.4%) and mutual grooming (0.3%). The stallion was more likely to be synchronized in active behavior like eating than in behaviors like resting. When the stallion slept, there were always at least 2 mares awake.

2.4. Mimicry of behavior

I'm here looking at behavioral mimicry, not mimicry of appearance. Mimicry is defined as "doing what others are doing", the doing in this case can be movement, expressions, posture and verbal (Stel & Vonk 2010). There seems to be a bi-directional relationship between nonconscious mimicry on one side and liking and affiliation on the other. Mimicry gives affiliation and affiliation can be seen through unconscious mimicry (Lakin et al. 2003a; Lakin et al. 2003b; Rauchbauer et al. 2015). Mimicry of others is a form of implicit affiliative signal that works in flexible ways with social surroundings and requirements (Rauchbauer et al. 2015).

The wording in different studies varies, as some use mimicry, some rapid mimicry (within one second), some chameleon effect, some unconscious imitation, and some use imitation even though they are talking about unconsciously copying others' behaviors (Ross et al. 2008; Baaren et al. 2009; Paukner et al. 2009; Heyes et al. 2011; Ross et al. 2011; Mancini et al. 2013; Palagi et al. 2015).

In 1999 Chartland and Bargh looked at mimicry calling it the Chameleon effect. The Chameleon effect refers to when people mimic postures, facial expressions and behaviors of others in their social environment. This mimicry helps interactions and increases liking between individuals (Chartrand & Bargh 1999). The mimicry happens outside of conscious awareness without the participants' intent to mimic each other (Chartland & Bargh 1999; Lakin et al. 2003a; Lakin et al. 2003b).

Stel & Vonk (2010) looked at how mimickers and mimickees are feeling about each other. They found that both mimickers and mimickees became more affectively attuned than if mimicry did not occur. This affected how they felt about the other person after the interaction. Both mimickers and mimickees reported that they felt they had bonded with each other and that their interactions were smoother. Mimicry is beneficial for the positive feelings towards both the interaction partner (e.g. empathy and bonding) and the interaction itself (Stel & Vonk 2010).

Mimicry is an unconscious behavior but it's also affected by the individuals involved. People are more likely to mimic others that they like, and more likely to mimic people with power, for example their boss (Lakin et al. 2003a).

One of the studies on social mimicry in humans has found increased mimicry both when happy faces and out of group (ethnic group membership) faces where shown, but the neurological background for mimicry in these two situations was different (Rauchbauer et al. 2015). Mimicry when happy faces was showed was associated with increased activation in the right temporo-parietal junction (TPJ), right dorsal premotor cortex (dPMC) and superior parietal lobule (SPL). Mimicry as a response to out of group faces was related to increased activation in the left ventral premotor cortex (vPMC) and inferior parietal lobule (IPL), bilateral anterior insula, and mid-cingulate cortex (MCC). Rauchbauer and colleges (2015) suggest that mimicry of happy and out of group faces have different functions. In situations with smiling faces, the mimicry seemed to come from reciprocation of the affiliative signal whereas appeasement towards a strange and possibly threatening partner may be the facilitator in mimicry of out of group faces. Social cues appear to influence the regulatory processes resulting in mimicry (Rauchbauer et al. 2015).

Lakin et al. (2003a) looked to see if having a social goal affected mimicry. They had one group without a goal, one with a nonconscious affiliation goal (that where primed with words like -affiliate, friend, together without being explicitly told to cooperate) and one group told to cooperate. People with an affiliative conscious or nonconscious goal were more likely to mimic their partner than people without an affiliative goal, suggesting that a need to affiliate effect mimicry. Lakin et al. (2003a) did a second study with two groups, where they used two partners to see how feeling unsure or unsuccessful in their first interaction would affect mimicry in their second interaction. One group had no goals, and the other were told that they should cooperate. In the group without goals they found that there was no difference of mimicry in the second test if they were unsuccessful or unsure about their attempt to affiliate in the first test. But if the goal was to cooperate, they were much more likely to mimic the second partner if they were unsuccessful with their first interaction. The person who played the partner rated how the interaction with each person went and analysis of this showed that the most liked participant was the one who was primed with an affiliate goal and had failed in their first attempt.

Lakin et al. (2003b) argued that mimicry has had an important role in human evolution in enhancing communication and thereby giving survival value. They proposed that mimicry has evolved a social function in increasing affiliation and fostering relationships with others. Lakin et al. (2003b) make the argument that, given how evolutionarily important social groups have been to humans, it would be essential that group members feel connected to each other, motivating them to live in harmony, and that behaviors facilitating this group feeling would be extremely important. Individuals mimicking others would be more likely to function well and be included in the group.

2.4.1 Mimicry in animals

Mimicry is not only found in people but also in orangutans (*Pongo pygmaeus)* (Ross et al. 2008), chimpanzees (*Pan troglodytes) (*Ross et al. 2011), geladas (*Theropithecus gelada*) (Mancini et al. 2013), capuchin monkeys (Paukner et al. 2009) and dogs (*Canis lupus familiaris*) (Palagi et al. 2015). Most of the studies done on mimicry in animals focus on facial expressions, but both Paukner et al. (2009) and Palagi et al. (2015) looked at mimicry of the whole body. All of these studies also focused on mimicry in relation to affiliation (Ross et al. 2008; Ross et al. 2011; Mancini et al. 2013; Paukner et al. 2009; Palagi et al. 2015).

Ross et al. (2008) looked at rapid facial mimicry in orangutans focusing on rapid mimicry of facial expression, looking for mimicry within one second. They used mimicry of open – mouth face, a facial expression that, in great apes, is likely to convey positive emotions. The orangutans in the study mimicked open- mouth faces in playful interactions within 1 s (mean response latency: 0.4 s) supporting their hypothesis that rapid involuntary facial mimicry occurs not only in humans but in non-human primates as well. They suggested that finding rapid facial mimicry in orangutans would mean that non-human mammals like humans are prone to involuntary facial mimicry. Even though there was mimicry between some individuals 9 out of 25 orangutans did not show rapid facial mimicry of open- mouth faces. Rapid facial mimicking of orangutans, despite its automatic attributes, might be superimposed by socio-emotional factors as it is with humans. They propose that responses of rapid involuntary facial mimicry were affected by positive emotional states in non-human primates prior to human evolution.

Mimicry of laughter is found in Chimpanzees. Ross et al. (2011) looked at spontaneous laugher (without laughter previous five seconds), rapid laugh replication (within one second after another chimpanzee's laughter) and delayed laugh replication (within the next four seconds after another chimpanzee's laughter) and found that all of these occur during play. They wanted to see if mimicry was connected to liking and found that play bouts lasted significantly longer when they were accompanied by laugh replications compared to spontaneous laughter, but there was no difference in play duration with rapid and delayed laugh replications. Play bouts with spontaneous laughter lasted significantly longer than play bouts without laughter.

Mimicry is not only found in great apes, but monkeys as well. Mancini et al. (2013) looked at rapid facial mimicry during play in a Cercopithecoid species, geladas. They predicted that rapid facial mimicry would be present in geladas because they engage in a high level of social play, have a high level of social affiliation, and use playful facial displays. Contagious yawning is found, suggesting that they are sensitive to the facial expressions of others. They predicted that there should be more rapid facial mimicry, faster and more accurate, in mother- infant play dyads than between other subjects. They found rapid facial mimicry both between mother – infant dyads than when an infant was playing with an unrelated individual, and that mother – infant play was characterized by high levels of rapid facial mimicry and had the fastest responses.

Capuchin monkeys showed a preference for humans who mimicked them over humans who did not (Paukner et al. 2009). They looked longer at human mimicking them, spent more time in proximity (normal affiliative social behavior for capuchin monkeys) and chose to interact more with a human mimicking them than a human not mimicking them. The authors used the term nonconscious imitation or just imitation but I have chosen to use the term mimicking instead (Paukner et al. 2009). Paukner et al. (2009) did a series of test on mimicry. The tests were done in a cage with three parts that the capuchin monkeys could chose to move freely in. The experimenters stood on each end of the cage. For the mimicry manipulation phases, a ball was used and one of the experimenters played with the ball and the other mimicked the monkey play. In the first experiment, they tested the amount of time the monkeys used looking at each experimenter. They started with a test to see if the capuchin monkeys showed any preference for one of the persons and found none. Then they had the manipulation phase where one of the experimenters mimicked the monkey and one just played with the ball. After the manipulation phase, they changed places so that they were standing on the opposite ends of the cage and again tested the monkeys and found that they looked longer at the mimicking person. In the next experiment, they looked to see if there was any difference in which person the monkeys preferred to stay close to using the same method as in the first experiment. They found no difference between where the monkeys preferred to be in the first round. After the manipulation period, the monkeys preferred staying close to the mimicking experimenter. In the third round with experiments, they tested to see if it was not just the attention that made the monkeys prefer the mimicking person. They set the test up close to the same way as the earlier ones, but instead of one person mimicking and the other not, one person was standing with their back towards the monkeys and the other one facing the monkeys. They found no difference in the first round on the monkeys preferring one person over the other. The monkeys did look more at the person facing them during the manipulation period, but afterwards when both persons stood facing the cage this effect did not last. Unlike the mimicry experiment, monkeys now spent similar amounts of time in front of both experimenters showing that attention alone did not influence liking in the same way as mimicry did. The last experiment they did was a token exchange task. This had the same method as the first two experiments except now instead of measuring the monkeys' gaze or proximity to the experimenters, this time a token exchange task was used. In the first round, they as in the earlier experiments checked and found no effect of monkeys' preference for experimenters. Then they had the manipulation face and afterwards found that the monkeys preferred token exchange with the person who mimicked them in the manipulation phase. The token exchange and reward was the same whether the monkey chose to do the exchange with the mimicking or non-mimicking person (Paukner et al. 2009).

Palagi et al. (2015) look at both facial and body rapid mimicry in the domestic dog in social play. They found rapid mimicry both in facial and body behavior. They measured the duration of play sessions and found that play sessions with mimicry lasted longer than play sessions without mimicry. Since dogs played more with other dogs they liked and play sessions that had mimicry lasted longer, they suggested that, as in humans, mimicry was connected with liking in dogs. They also collected background information about the subjects involved and found that mimicry was strongly affected by familiarity between the individuals involved. The stronger the social bonding between the subjects, the higher the level of rapid mimicry. This finding suggests that the social environment modulates mimicry in dogs as in humans.

2.5. Emotional contagion

Emotional contagion means that the observer appears to spontaneously copy the emotional state of the demonstrator and then show their own affective reaction to that emotional state (Nakahasi & Ohtsuki 2015). If one looks at emotional contagion from an evolutionary perspective, it can be considered as a way of getting information about the environment from other individuals. An example is if one individual reacts to something in the environment and shows behavior suggestive of the emotion of fear. This gives the observer the possibility to react as if something dangerous is happening before they see it themselves and therefore perform appropriate behaviors to avoid danger earlier (Nakahasi & Ohtsuki 2015). Emotional contagion is seen at as a basic form of emotional empathy, though they are also two different concepts. Emotional contagion refers to copying others emotion, but emotional empathy can include arousal of a different emotion than the one the target is feeling (Nakahasi & Ohtsuki 2015).

People are fully aware that they can use conscious assessments to get information about others, but are less aware that they can gain even more by focusing on their own emotional reactions during social encounters. As they nonconsciously and automatically mimic their companions' fleeting expressions of emotion, they often seem to feel pale reflections of the other person's feelings. By attending to this stream of tiny moment-to-moment reactions, people seem to "feel themselves into" the emotional landscapes inhabited by their interaction partners (Hatfield et al. 1993). They propose that emotional contagion in humans happens through mimicry and feedback processes. Humans will automatically and continuously mimic and synchronize with the facial expressions, voices, postures, movement and instrumental behavior of others. We are probably not able consciously to mimic others very effectively: unconscious mimicking happens much faster. An individual's emotional experience is continuously affected by feedback from facial, vocal, posture and movement cues. When people produce facial expressions of fear, anger, sadness, or disgust, they are more likely to feel the emotion associated with those specific expressions (Adelmann & Zajoc 1989; Hatfield et al.1993; Strack et al. 1998; Davis et al. 2009; Finxi & Rosenthal 2016). Therefore, when people mimic others behaviors and movement, they also seem to feel emotional feedback from the behaviors they perform Hatfield et al. (1993).

The effect of mimicry on empathy might happens through facial feedback possesses (Stel and Vonk 2010). The mimicker is adopting the mimicked's facial expressions and then facial muscles send signals to the brain and the corresponding emotions are felt. In this way mimicry, together with facial feedback mechanisms, may enable the possibility to feel what others are experiencing (Stel and Vonk 2010).

2.5.1 Example of emotional contagion in horses

Christensen et al. (2008) studied at horses' fear reaction to a novel stimulus with and without a habituated demonstrator. The horses in the study were minimally handled two-year-old stallions, with 18 horses used as subjects and 18 as companions. Of the 18 companion horses, 9 were habituated to test stimulus and the other 9 were non-habituated. During the test, the pairs of subject and companion horses were exposed to the stimuli and heart rate was registered. Afterwards, subject horses were exposed to the stimulus on their own. The study indicated that naïve horses had a significantly lower reactivity score, used a significantly shorter time returning to the food, and had a significantly lower heart rate when together with a habituated companion. This effect lasted later when the test horses were exposed to the stimuli, a garbage plastic bag that fell down, alone. There was a significant correlation between test horses and their companions (Christensen et al. 2008).

Keeling and colleagues (2009) looked to see if a physiological reaction suggestive of fear was contagious between people and horses by measuring heart rate. For each horse- human pair, the person walked (10 horses, 20 people) or rode (17 horses, 17 people) a 30-meter distance between two points A and B, both marked with cones, four times. Before they walked the fourth time, participants were told that an umbrella would be opened. The umbrella was not opened, so all four passes were the same for the horses. The heart rate between A and B was calculated for each horse and person. The heart rate of horses and people decreased from pass 1-3, but on pass four, it increased for the person leading the horse ($P<0.06$), and for the person riding the horse ($p<0.05$). The horses had a significantly higher ($p<0.05$) heart rate both when lead and when ridden even though the fourth pass was the same as the three earlier ones for the horse.

3. Hypothesis and predictions

Mimicry earlier defined as “doing what others are doing” (Stel and Vonk 2010) and is unconscious but strongly influenced by the situation and individuals involved (Lakin et al. 2003a; Lakin et al. 2003b; Rauchbauer et al. 2015). Mimicry has so far not been reported in horses, but found in other mammals. Synchrony of behavior, defined as all or some of the individuals in the group engaged in an activity simultaneously (Souris et al. 2006), is found in horses (Rifa et al. 1990; Souris et al. 2006). Tyler (1971) also found that horses often engage in the same behavior as their herd mates. Horses are also sensitive to humans’ actions and behaviors (Sankey et al. 2010; Stone 2010; Lampe & Andre 2012) and sensitive towards humans’ attention (Proops & McComb 2010; Sankey et al. 2011). My first hypothesis is therefore:

Hypothesis 1 - Horses mimic changes in the walking style and body posture of a familiar handler.

Predictions:

- Prediction 1: Horses adjust their walking style to be similar to that of their handler at a level greater than what occurs spontaneously with a handler who does not change walking style.
- Prediction 2: Horses lower their head when their handler bends their body downward at a level greater than what occurs spontaneously with a handler who stands still.
- Prediction 3: Horse mimicry responses to handler walking and body movements are similar across horse sex and breed type, but greater in younger (less experienced) horses, and in horses living in a social environment than horses stabled alone (i.e. horses in outside housing groups have more mimicry than horses stabled in a box and alone when outdoors).

In both humans and animals there seem to be a bi–directional relationship between nonconscious mimicry on one side and liking and affiliation on the other. (Chartrand & Bargh 1999; Lakin et al. 2003a; Lakin et al. 2003b; Ross et al. 2008; Paukner et al. 2009; Stel & Vonk 2010; Ross et al. 2011; Mancini et al. 2013; Palagi et al. 2015; Rauchbauer et al. 2015). It's also proposed that emotional contagion in humans occurs through mimicry and feedback processes linking mimicry and emotional contagion (Hatfield et al. 1993). Some studies on emotional contagion have done this through looking at mimicry, arguing that even though the concepts are not the same they seem to be linked (Palagi et al. 2015). My second hypothesis therefore concerns affiliation in relation to mimicry.

Hypothesis 2 - The level of contagion exhibited by a horse towards a familiar handler is affected by the degree of affiliative behavior shown by the horse towards the handler.

Prediction:

- Prediction 4: Horses with higher affiliation scores towards their handler in visual analogue scale assessments have higher contagion scores in walking and head movement tests and in responses to novel objects than horses with lower affiliative scores towards their handler.

Emotional contagion, means that the observer spontaneously copies the emotional state of the demonstrator and then shows their own affective reaction to that emotional state. Christensen et al. (2008) found that a demonstrator horse affected the fear response in an observer horse, and Keeling et al. (2009) that the heart rate of both horse and human went up when the human expected a frightening situation that did not occur. My third hypothesis was therefore:

Hypothesis 3 - Horses show emotional contagion of fear towards novel objects depending on the reaction shown by a familiar human handler towards the objects.

Predictions:

- Prediction 5: Horses lead by a handler acting afraid towards a novel object show a stronger fear reaction towards the object than horses lead by a handler acting calm.
- Prediction 6: The type of novel object affects the fear responses of horses.
- Prediction 7: Fear contagion in response to handler reactions to novel objects is similar across horse sex, breed type and housing, but stronger in the youngest (less experienced) horses.

4. Methods

4.1 Horses, housing and husbandry

Forty horses participated in the experimental protocol (Table 1). The horses were privately owned and tested with their main caretaker, referred to as the handler. Most of the handlers were the horse owners, but some horses were tested with a person who took care of/exercised the horse a couple of days a week. I considered it important that all horses were tested with a familiar human.

The horses were between 2 and 24 years old, with a mean age of 11, 7 years, and were housed at 8 different boarding facilities. They were housed continuously in outdoor groups (n=6), in a box at night and an outdoor group in the daytime (n=28), or in a box at night and alone in an outdoor paddock in the daytime (n=6). All horses where tested in a familiar riding arena at their boarding facility, so they were calm and used to the surroundings. I wanted both sexes equally represented, thus 21 of the horses were mares and 19 were geldings.

I recruited horses from a cross-section of breeds to be representative of horses in general. The horses were organized into two broad categories, warmblood and coldblood horses. The warmblood category included Warmblood riding horse, Standardbred (trotter), Oldenburger, Connemara/ Welsh mix, Frieser/ PRE mix, Quarter horse, New Forest pony, and Sport pony. The coldblood category included Norwegian coldblood trotter, Islandic horse, Shetland pony and Welsh/Haflinger, Fjording, Gotlandsrus.

The horses were trained in various styles, ranging from horses competing in trotting, dressage, jumping and gaited horse shows, to hobby horses in many different disciplines. Some of the horses were mostly exercised through liberty training and trick work.

Table 1. Test horses (n=40) used in the mimicry and objects tests.

Horse number	Sex	Age (years)	Stabling[1]	Breed type
1	mare	12	b+g	warmblood
2	gelding	7	g	warmblood
3	mare	11	b+g	coldblood
4	mare	24	b+g	warmblood
5	mare	11	b+g	coldblood
6	gelding	22	b+g	warmblood
7	gelding	10	b+g	warmblood
8	mare	24	b+g	coldblood
9	gelding	5	b+g	coldblood
10	mare	2	b+g	warmblood
11	mare	5	b+g	warmblood
12	mare	7	b+g	coldblood
13	gelding	5	b+g	coldblood
14	mare	7	b+a	warmblood
15	gelding	17	b+g	warmblood
16	gelding	7	b+g	warmblood
17	gelding	6	b+g	coldblood
18	gelding	18	b+a	warmblood
19	gelding	11	b+a	warmblood
20	gelding	17	g	coldblood
21	mare	14	g	coldblood
22	gelding	9	b+g	warmblood
23	mare	21	b+g	coldblood
24	gelding	8	b+g	coldblood
25	mare	10	b+g	coldblood
26	mare	7	b+g	coldblood
27	mare	13	g	coldblood
28	gelding	8	b+g	warmblood
29	gelding	7	b+g	warmblood
30	mare	14	b+g	warmblood
31	mare	15	g	coldblood
32	mare	16	b+a	warmblood
33	gelding	16	b+g	warmblood
34	gelding	16	b+g	coldblood
35	gelding	13	g	coldblood
36	mare	13	b+a	warmblood
37	gelding	9	b+a	warmblood
38	gelding	4	b+g	coldblood
39	mare	17	b+g	coldblood
40	mare	9	b+g	coldblood

[1] b+a: box indoors, alone outdoors; b+g: box indoors, grouped outdoors; g: grouped outdoors continuously

Table 2. Control horses (n=20) used in the mimicry tests

Horse number	Sex	Age (years)	Stabling[1]	Breed type
1	gelding	13	g	warmblood
2	mare		g	warmblood
3	gelding	7	b+a	warmblood
4	gelding	13	g	
5	gelding	6	b+g	warmblood
6	mare	13	b+a	warmblood
7	gelding		b+a	warmblood
8	gelding		b+a	warmblood
9	mare		b+a	warmblood
10	gelding		b+a	warmblood
11	mare	4	g	warmblood
12	gelding	3	g	warmblood
13	mare	7	g	coldblood
14	mare	17	g	coldblood
15	gelding	16	g	coldblood
16	mare	11	g	coldblood
17	mare	13	g	coldblood
18	mare	7	g	coldblood
19	gelding	4	g	coldblood
20	gelding	10	g	coldblood

[1] b+a: box indoors, alone outdoors; b+g: box indoors, grouped outdoors; g: grouped outdoors continuously

4.2 Experimental design

The experimental protocol contained four different tests, 1. “object test”, 2. “walk test”, 3. “head test”, 4. measurements of “affiliative behaviors”. Also a control test was done on “walk test” and “head test”.

To look at the first hypothesis, emotional contagion of fear reaction, I used an object test where the handler acted either calm or afraid of different objects before I measured the horse’s behavior. To look at the second hypothesis, mimicry of behavior I used head test and walk test. For the last hypothesis about connection between mimicry of behavior and affiliation, I looked at correlations between mimicry of behavior found in walk and object test and affiliation found through a visual analog scale.

Each horse assigned to the experimental protocol (n=40) went through all the tests. I started with a visual analog scale test, then head test, another visual analog scale test, description of different walking types to the handler, a visual analog scale test, walk test, a visual analog scale test, a head test, a visual analog scale test and then four object tests. There were all together five visual analog scale tests, two head test, 18 changes in walking and four objects in the object tests. The control horses (n=20) went through a walk control test, where the handler was not changing their walk, and head control test where the human was standing still in the same position as in the head test, walk was measured 18 times and head two times.

I wanted the tests to be easy to administer at different stables with different horses. Therefore, all tests were done with a halter and lead rope together with the horse’s main handler. That way, the test could be done without an enclosed area, which was not available at all stables. The test also had to be fast, easy and something both horses and handlers felt safe participating in. The experimental protocol took 10-15 minutes to test each horse, and the only equipment needed to set up the test was four objects for the emotional contagion test.

The control was also done in halter and lead rope with the handler in the same position besides the horses as in the main test, the control took about 5 minutes for each horse.

4.3. Data collection

4.3.1 Walk test

Prior to testing under the experimental protocol, the experimenter explained and showed the different types of walk to the handler to make sure they understood the task. This facilitated that all humans performed the different walks as similarly as possible. The horse and human would then start walking with "walking together" as the goal. "Walking together" was the starting point for the test: Horse and human would walk beside each other, lead rope hanging loose. There would be at least 10 cm between horse and handler so they were not pushing on each other. The human was positioned beside the horse's shoulder, and would match their step to the horse's front feet. The length and height of the steps should be the same for horse and human, thus the horse's and the human's right foot were moving at the same time, and the horse's and the human's left foot were moving at the same time. The lead rope should be of such length that it did not influence the horse before the horse was around one meter in front of or behind the human.

In most cases the horse and human would "walk together" quite fast just from walking forward with the human placed beside the horse's shoulder. If needed, the human would be consciously matching their steps with the horse's feet, so that their feet were moving together. The horse and the human would get a couple of minutes to find the rhythm so that it did not demand a lot of focus for the human to stay in "walk together". If the horse and the human were not able to "walk together" the protocol was to exclude them from the test, but that was not necessary with any of the horses. For some horses, the handler needed to change the length and rhythm of their own steps a little more than others. This was especially relevant to very big or small horses (for example, Shetland ponies).

When the owner and the horse were "walking together", the test started. The experimenter told the person to change her/his walk into the different categories described in the ethogram (table 3). Each change should be made gradually through 1-2 seconds, where the person used the mental picture of changing the steps together with the horse. After the human was told to change their walk the experimenter would count five steps, then look to see if the horse and human were still moving as in “walk together”. For the horse to still walk in the same way as the human, after the change, it needed to mimic the human’s walk. Before a new task was given, horse and human had time to focus on each other and the human could change their walk back to “walk together” if needed. This was especially relevant if there were disturbances in the surroundings. When a task was given, the result was always measured five steps later.

We used six different categories for testing “mimicry of walk”: “high steps”, “low steps”, “long steps” and “short steps”, “crossing feet towards horse” and “crossing feet away from horse” (table 3). The categories were used in an order that maximized the differences, for example “high steps” and “low steps”, “long steps” and “short steps” instead of “high steps” and “long steps”, “short steps” and “low steps”. Each routine with six different types of walk was repeated three times giving 18 changes all together. To make sure the order of the different tasks was not influencing the results, the data collection sheets were prepared with the task coming in six different pre-determined orders. There were between five and nine horses for each order with a median of six.

Table 3. Ethogram for mimicry in walking

Condition	Description
Pre-condition:	
Walk together	This is the starting point for the test. Horse and human walk beside each other, lead rope hanging loose. There should be at least 10 cm between horse and person so they are not pushing on each other. The human is placed beside the horse's shoulder and matches steps to the horse front feet. The length and height of the steps should be the same. Horse and human's right foot move at the same time, and the horse and human's left foot move at the same time.
Test- condition:	
Short steps	The human walks with short steps, approximately 10 cm, lifting feet a normal height from the ground.
Long steps	The human walks with as long steps as they can without losing balance/rhythm in their walk (different between different people).
High steps	The human lifts knees up high while walking. They can use the picture of walking over something that is around 15 cm high for each step.
Low Steps	Walk without lifting feet from the ground, shuffling feet for each step.
Crossing feet towards horse	Human participant walks sideways towards the horse, crossing their legs.
Crossing feet away from horse	Human participant walks sideways away from horse crossing their legs.

Preliminary observations showed that looking to see if the horse and human changed their feet at the same time was difficult, as the change was happening over a very short time-period. Instead, I measured if the horse's and the human's walk were still the same *after* the human had made a change. If the human changed their walk in a major way and five steps later horse and human were still “walking together”, the horse was recorded as having mimicked the human’s walk.

To have data about in what frequency horses spontaneously changed their walk we used a control protocol with 20 horses. We did the test in the same way as when testing mimicry in walk, but this time the human walked in an even walk and we counted five steps and measured if we could see any of the six changes, this was done 18 times for each horse.

4.3.2 Head test

For horses in the experimental protocol, the human moved their upper body towards the ground from the hip and upwards. Before the test started, the experimenter described and showed the exercise.

After the human handler lowered their head, the experimenter counted to five before the horse's reaction was measured. No movement, or upwards movement, was recorded as 0. The horse moving its head downwards no more than 10 cm was recorded as 1, the horse moving its head down more than 10 cm was recorded as 2, and the horse moving its head down more than 20 cm as 3. The horse's lead rope was long enough that the human's movement was not influencing the halter. This test was executed two times.

To measure to what degree head movement would happen spontaneously we did control tests with 20 horses. This time the human was standing still beside the horse's shoulder and not moving. I counted to five, then measured any head movement. Head test was done twice.

4.3.3. Affiliative behaviors

For the 40 test horses, the affiliative behaviors were assessed and recorded on a visual analog scale five times. Each visual analog scale assessment was based on an average impression of the horse's behavior from the time from the last assessment was made. Using the visual analog scale gave the opportunity to assess affiliative behaviors even if they differed between different horses. We did not tell the owners about the visual analog scale before the test, to avoid influencing the results, but they were briefed about it after the tasks were completed.

Table 4. Description visual analog scale

	Description
0-20%	The horse shows no interest in the human, or the behaviors directed towards the human are aggressive. The horse gives the impression that it wants to be somewhere else by leaning away from their owner, with a tens body posture/ tensing facial muscles. The horses can be restless, moving back and forth, turning their head and stare at the surroundings.
20-40%	The horse gives the impression of being neutral towards the human. There are few affiliative behaviors and the horse accepts grooming from the human, but there is no mutual interaction.
40-60%	The horse shows some affiliative behaviors towards the human. Affiliative behaviors can be: leaning into the handler grooming it, touch or investigate human‘s body or face with their nose, standing close together and touching or almost touching. Both horse and human looks comfortable with the contact (e.g. a horse standing close to a human who leans away are not measured as high on affiliative score).
60-80%	The horse shows many affiliative behaviors towards the human. Affiliative behaviors can be: leaning into the handler grooming it, touch or investigate human‘s body or face with their nose, standing close together and touching or almost touching. Both horse and human looks comfortable with the contact (e.g. a horse standing close

	to a human who leans away are not measured as high on affiliative score).
80-100%	The horse is showing close to continuous attention and affiliative behaviors towards the human when not given other tasks. Affiliative behaviors can be: leaning into the handler grooming it, touch or investigate human‘s body or face with their nose, standing close together and touching or almost touching. Both horse and human looks comfortable with the contact (e.g. a horse standing close to a human who leans away are not measured as high on affiliative score).

4.3.4 Object test

To explore how the human's demonstrated reaction to an unfamiliar object influenced the observing horse's behavioral reaction, I used an object test with four objects. With two of the objects the human acted afraid and with two of the objects the human acted calm (control condition).

In the test, each human and horse pair (n=40) walked around two object along a standard path, with the same length of lead rope in each test. The human walked closest to the objects, to ensure that if the horse was scared it would move away from the human, making the situation safer for the human. This also made sure that the situation was as similar as possible for all horses. In this part of the test, the human was asked to lead the horse as they normally would do. If they chose to hold the lead rope very short (giving the horse less than a half meter rope) they were asked to lengthen the lead rope.

Before the test started, two of the four objects were placed out in a triangle with the horse in one corner, and the objects in the two other corners. There was approximately ten meters between each corner (Fig. 1). The horse was placed at the starting point before the objects were moved so they were not scared by the objects being moved behind them.

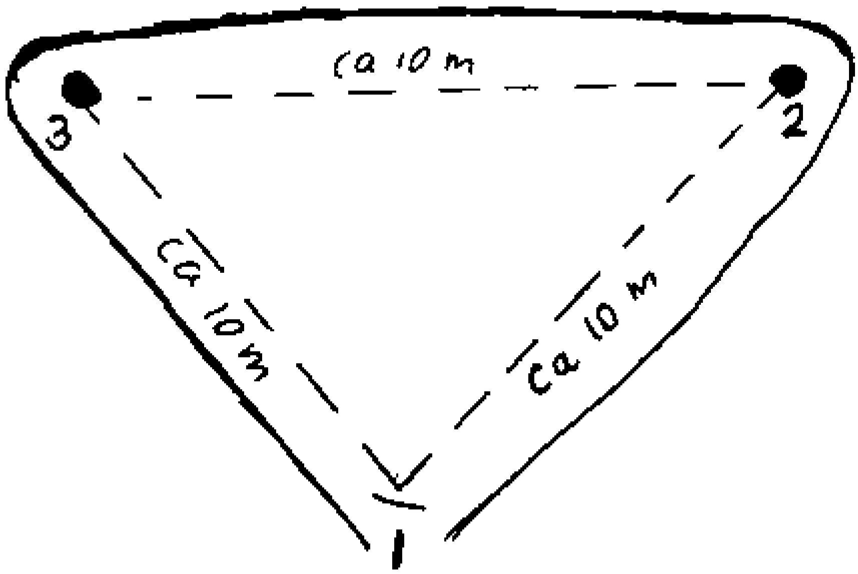

Fig. 1 Novel object path- the path could be walked both from the right and from the left depending on handler's preference. 1. starting position, 2. object one, 3. object two. The handler walked closest to the objects so if they did the path from the right side they walked on the left side of their horse, if they walked the path from the left side they walked on the horse's right side.

After the two first objects were placed, the handler got to choose between the hands of the experimenter, and in one of the hands there was a coin. If the handler chose the hand with the coin, they were to act as if they were afraid of the two first objects, and if they chose the hand without a coin, they were to act calm. Between the two stages of the test, the experimenter took away the two first objects and added the two last objects. If the handler had acted as if they were afraid of the first two objects, they now acted calm and the other way around. Each horse was therefore tested with two objects with a calm human and with two objects with a human acting afraid, but in different orders (calm – afraid or afraid – calm).

The objects used in the tests were an umbrella, a sheep fur, a black plastic bag on a stick and a tarpaulin (Fig. 2). The same four objects were used with all horses. The goal was choosing objects that were not a familiar part of most horses' environment, but also to use objects that were not too scary. I did not want situations where horses got afraid of places or objects in the future. Because of this, the horses who had a strong reaction to an object got some time to calm down before we continued. The order of the objects was randomly chosen for each horse.

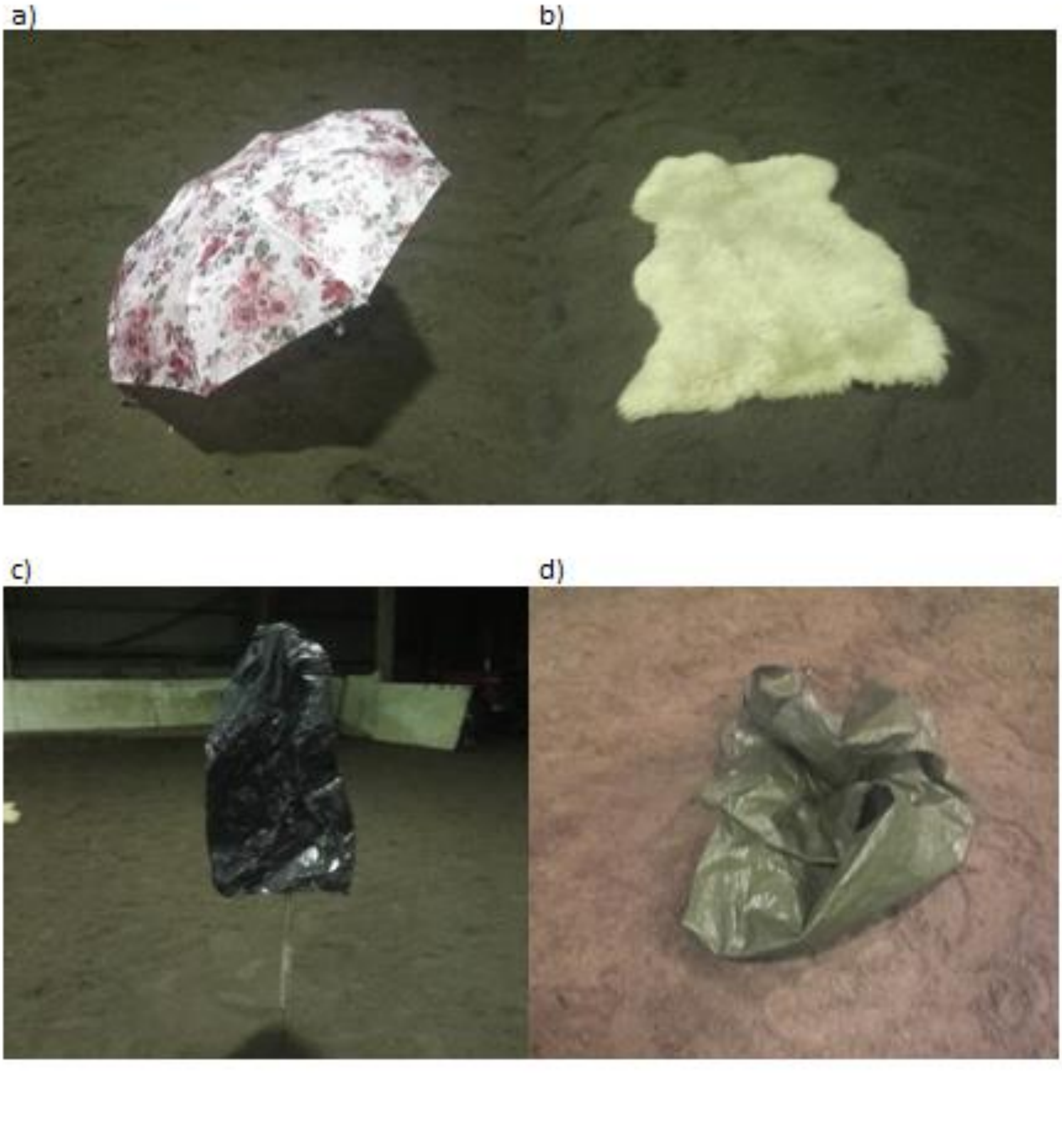

Fig. 2. Objects used in the novel object test. A) Umbrella, b) Sheep fur, c) Garbage bag and d) Tarpaulin.

When the humans acted afraid of the objects, they were pretending there was a mouse/ spider/ wasp/ something else they thought were scary. They were told to tense up their body, stare at the objects, hold the lead rope harder but not shortening it, maybe hesitate a little and generally act like they were afraid of the objects, their pat and speed the same as in the control test. The owners started acting from the start position and when they had past the first object they were told to focus on the second. They walked the same path as with the objects that they were not acting afraid of. When they were acting calm, they were told to walk around the objects and act as if the novel objects were things that had been left out in the riding arena a thousand times before.

The horse's reaction was measured to each object using a reactivity score scale (Table 2). I used an ethogram of reactivity scores adapted from Christensen et al. (2008). Changes from the original ethogram were mostly because the horses in our test were not standing still eating, but instead walking around the objects.

Table 5. Ethogram of reactivity scores

	Description
0 None	The horse does not react to the test stimulus, walking as if it's not there. Horse who without any signs of fear touches or moves the object is also placed in this category.
1 Looking	The horse is looking at the object, but the horse is not alert (see below) and does not hesitate when walking. They might slightly tens their face and body.
2 Alert	The horse is vigilant with elevated neck, with or without tail elevation, head and ears oriented towards the object, the horse body is tense and the horse may move up to 2 steps away from the path.
3 Move away	The horse moves 3 or more steps sideways away from the path in reaction to the novel object, typically followed by alertness.
4 Flight	The horse turns/jumps away from the path in a sudden movement followed by alertness and possibly snorting. Horse walks as far away from the object as it can, stops or tries to avoid the situation.

4.4. Ethical statement

Knowing about the measuring of affiliative behaviors before the test starts would probably influence the behaviors of the person leading the horse and this in turn would influence the behavior of the horse. Therefore, the owners of the horse got a vague description of the test, but were also told that they would get more information after they were finished. They were then told about the measuring of affiliative behaviors and asked if they were still okay with their horse's data being a part of the study, and all the participants answered yes. In this way, the handlers did not know about the affiliative behaviors, but they still were not feeling like they were tricked into agreeing to be a part of something. They were told about the mimicry part before the test since it would be clear anyway because of the method.

To plan the method so that it was easy both for people and horses was important to me. I wanted the test to not be mentally and physically demanding, and to not give a fear reaction strong enough to make the horses in the test more afraid in the future. This focus probably also helped when recruiting horses and handlers to the test, as very few who I asked chose not to participate.

In this study, all data and analyses were focused on the horses. No invasive procedures were performed on the horses, all data were purely observational, and no personal data were recorded from the participants. Therefore, formal ethical approvals were not needed.

4.5. Statistical analysis

To see if there was any difference in the horse's fear reaction if the human was acting calm or afraid in the object tests, I used a Chi-squared test. To look at effects of acting afraid versus calm, different object types, age, sex, stabling and breed type on whether horses reacted to the object (scores 1-4, pooled due to low numbers in some categories) or not (score 0), I used a Generalized Linear Mixed Model with binomial distribution, with horse as the subject and residuals as a random effect. To compare the proportion of 18 tests in which each test horse and control horse showed mimicry in the walk tests I used a Student's t- test. I also used a Student't t-test to compare the test and control horses' results from the two head movement observations per horse, calculated from the sum of the two head movement scores (from the scale of 0 to 3) as a proportion of the maximum possible value of 6. To look at effects of age, sex, stabling and breed type on mimicry (yes or no) of walking and head movement, I used Generalized Linear Mixed Model with horses as the subjects and a binomial distribution. When looking at correlation between mimicry of walk and affiliative behaviors, and mimicry of head movement and affiliative behaviors I used a spearman correlation test.

5. Results

5.1. Mimicry of behavior

5.1.1 Mimicry of walk

The mean number of tests out of 18 in which horses showed mimicry of walking style was 12.08± 2.96 in the test group and 0.65± 0.75 in the control group, giving a significant effect of the handler's influence (t-test= 22.97, df =47.9, p<0,001, Figure 3). When testing mimicry of walk with 483 positive scores out of a total of 720 (i.e. 40 horses x 18 scores), 69 were positive for high steps, 61 for low steps, 81 for long steps, 82 for short steps, 100 for crossing feet away and 90 for crossing feet towards. In the control testing, there were a total of 360 tests (i.e. 20 horses x 18 scores) and in this I found changes in walk only 12 times. Seven of these were crossing feet towards, two were crossing feet away and four were small steps.

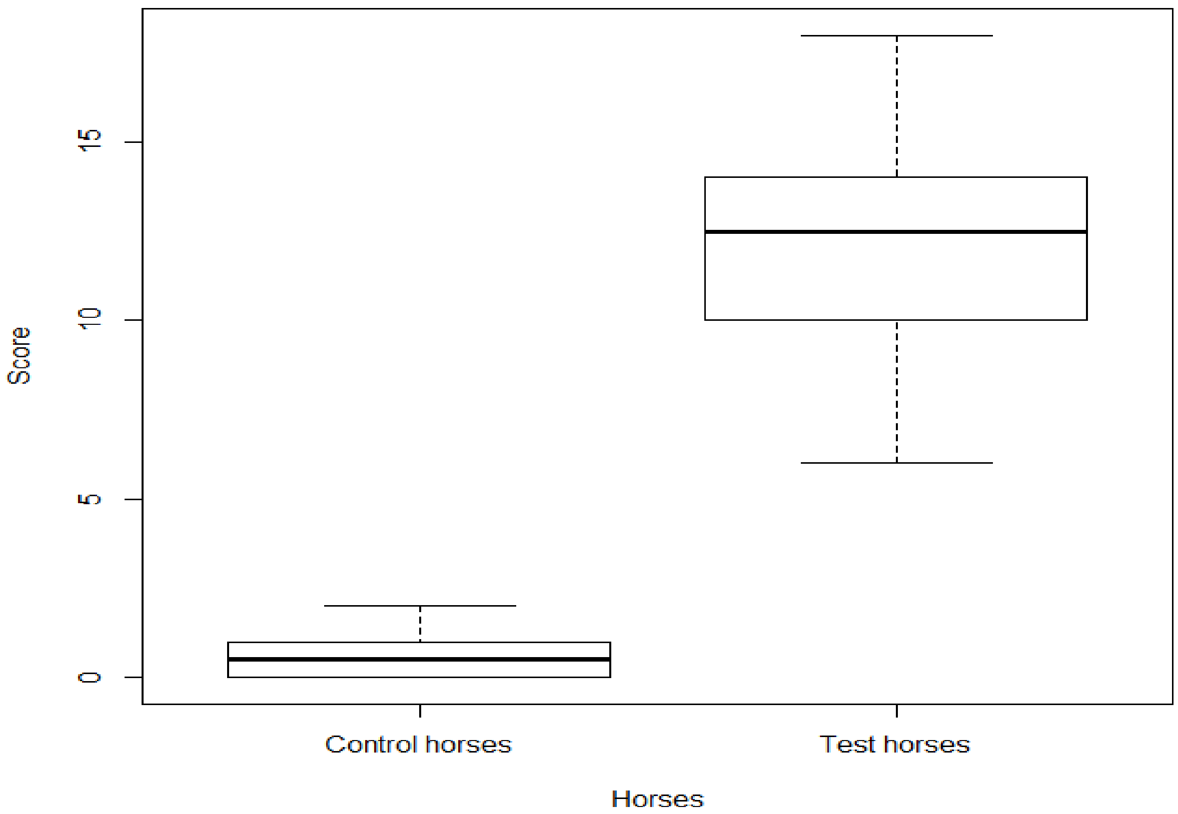

Fig. 3. Scores (0=no mimicry, 1= mimicry, in 18 observations per horse) of test horses (n=40) and control horses (n=20) (t-test = 22.97, df =47.9, p<0.001).

5.1.2. Mimicry of head movement

There was a significant difference in how much horses lowered their head when the handlers lowered theirs ($t=-8.07$, $df= 43.28$, $p<0.001$, Figure 4). The total mean score (on scale from 0 to 3, with two tests per horse, giving possible scores from 0 to 6) for lowering the head when the human was standing still (control) was 0.15 ± 0.37 and when the human lowered their head was 3.00 ± 2.17.

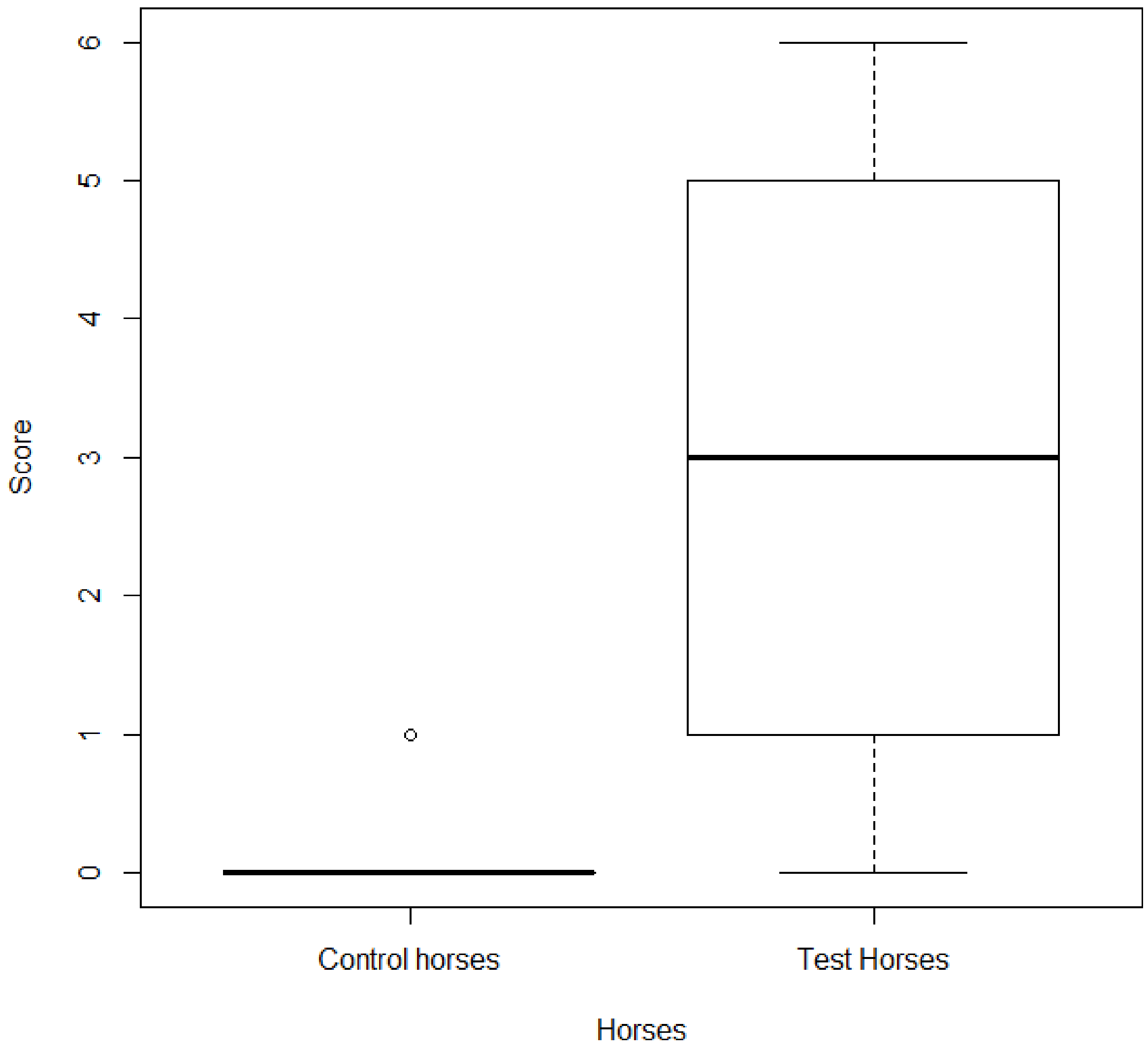

Fig. 4 Score for head lowering on a scale from 0-3 tested two times on each horse (test horses, n=40; control horses, n=20). The maximum score each horse could get was 6 (t=-8.07, df= 43.28, p<0.001).

5.1.3. Effect of age, sex, stabling and breed type

Because head movement had limited data for each horse I chose to only look at how age, sex, stabling and breed influenced mimicry of walk. There was a significant effect of age ($F=4.87_{1, 34,}$ $p=0.034$; Figure 5) on mimicry of walk, with mimicry declining with age. There were no effects of sex ($F_{1, 34}=0.17,$ $p=0.685$; Figure 6), stabling ($F_{2, 34}=0.28,$ $p=0.759$; Figure 7) or breed type ($F_{1, 34,}=0.01$ $p=0.909$; Figure 8) on mimicry of walk.

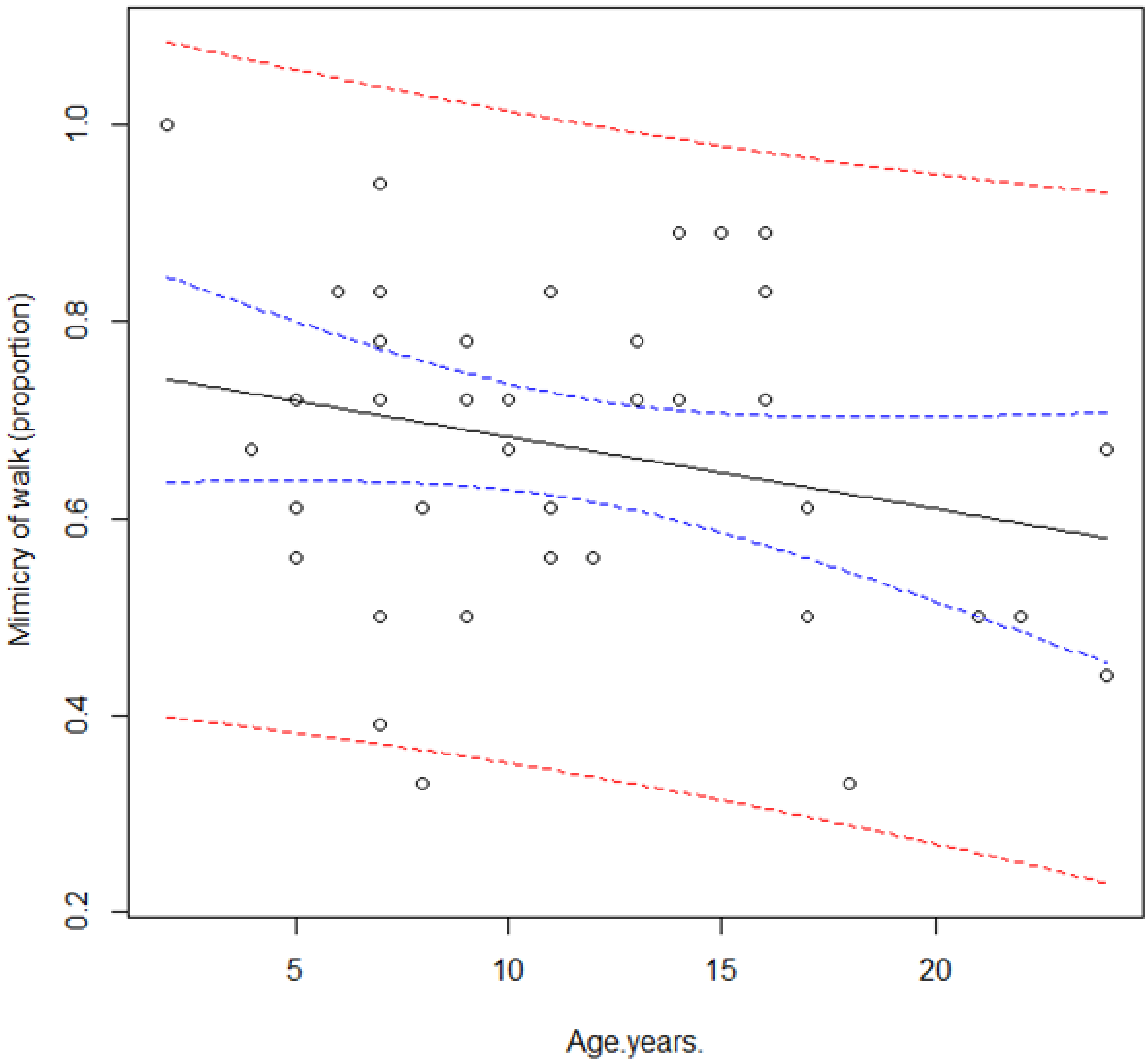

Fig. 5. Effect of age (years) on mimicry of walk for each horse. The proportion of mimicry of walk was found through 18 tests for each of 40 horses ($F_{1, 34}=4.87,$ $p=0.034$).

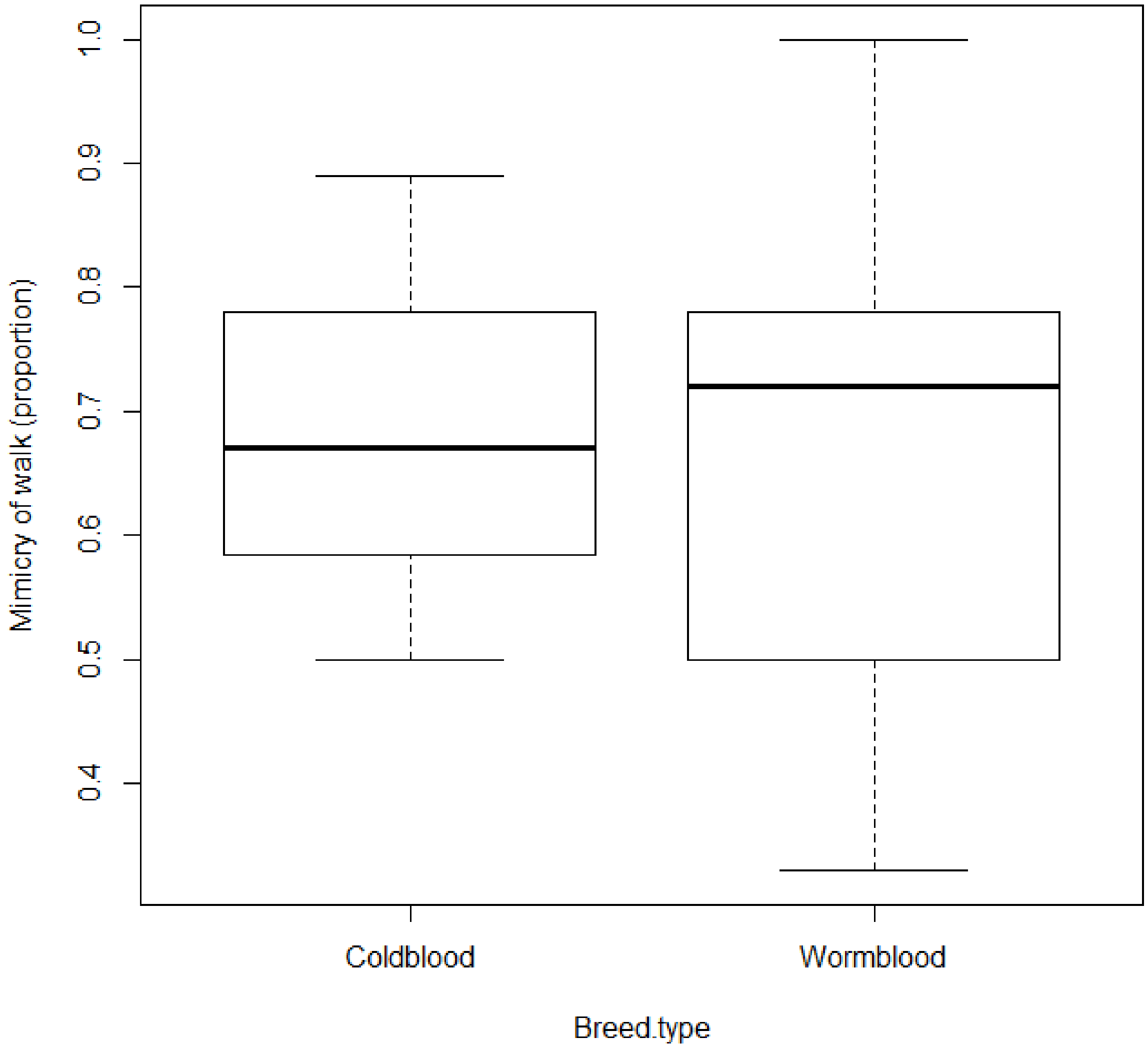

Fig. 6. Effect of sex, geldings (n=19) and mares (n=21), on the median proportion of mimicry of walk. There were no stallions tested. The proportion of mimicry of walk was found through 18 tests for each horse ($F=0.17_{\ 1,\ 34,}$ $p=0.685$).

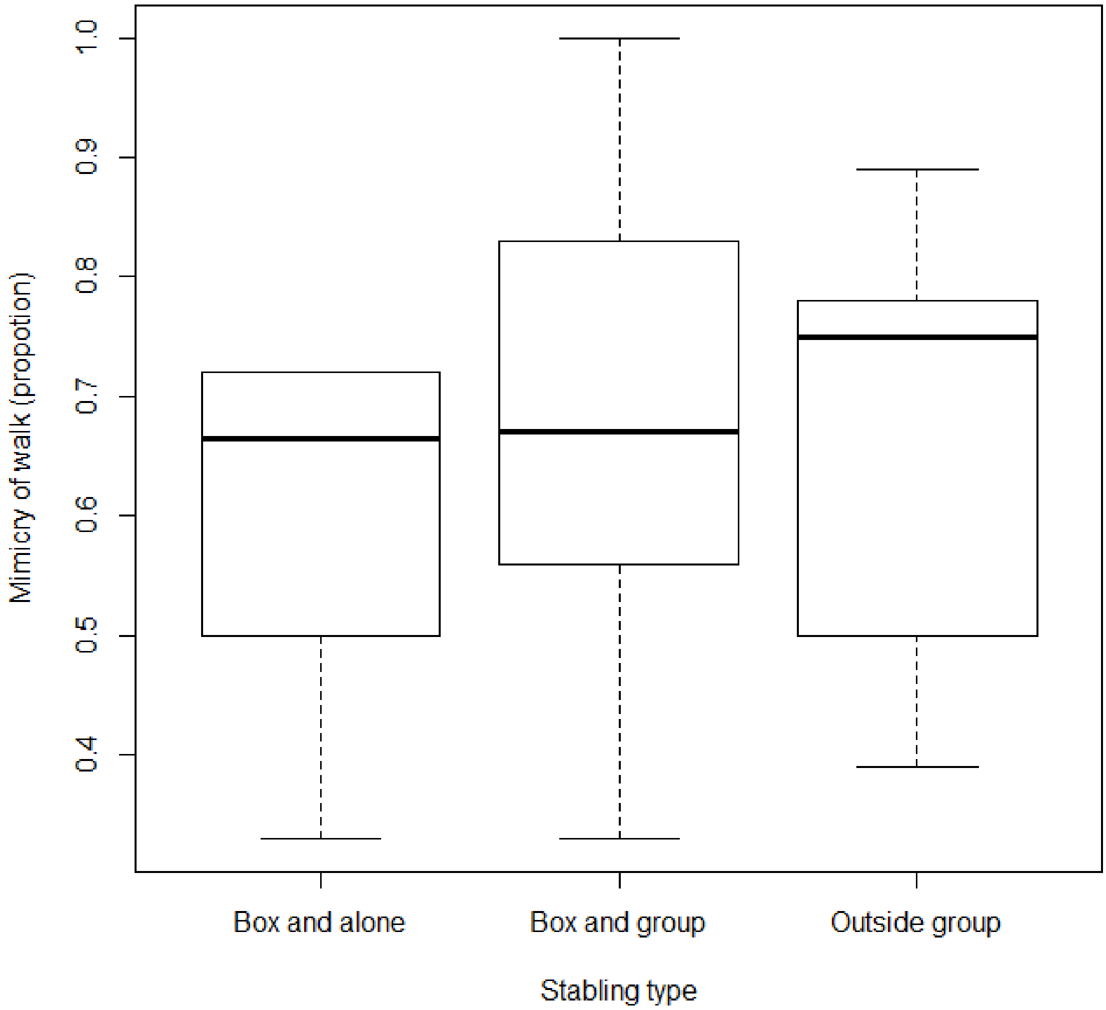

Fig. 7. Effect of stabling type on median proportion mimicry of walk for each horse. The horses were stabled in box at night and alone at daytime (n=6), box at night and group at daytime (n=28) or in group housing night and day (n=6). The proportion of mimicry of walk was found through 18 tests for each horse ($F=0.28_{2,34}$, p=0.759).

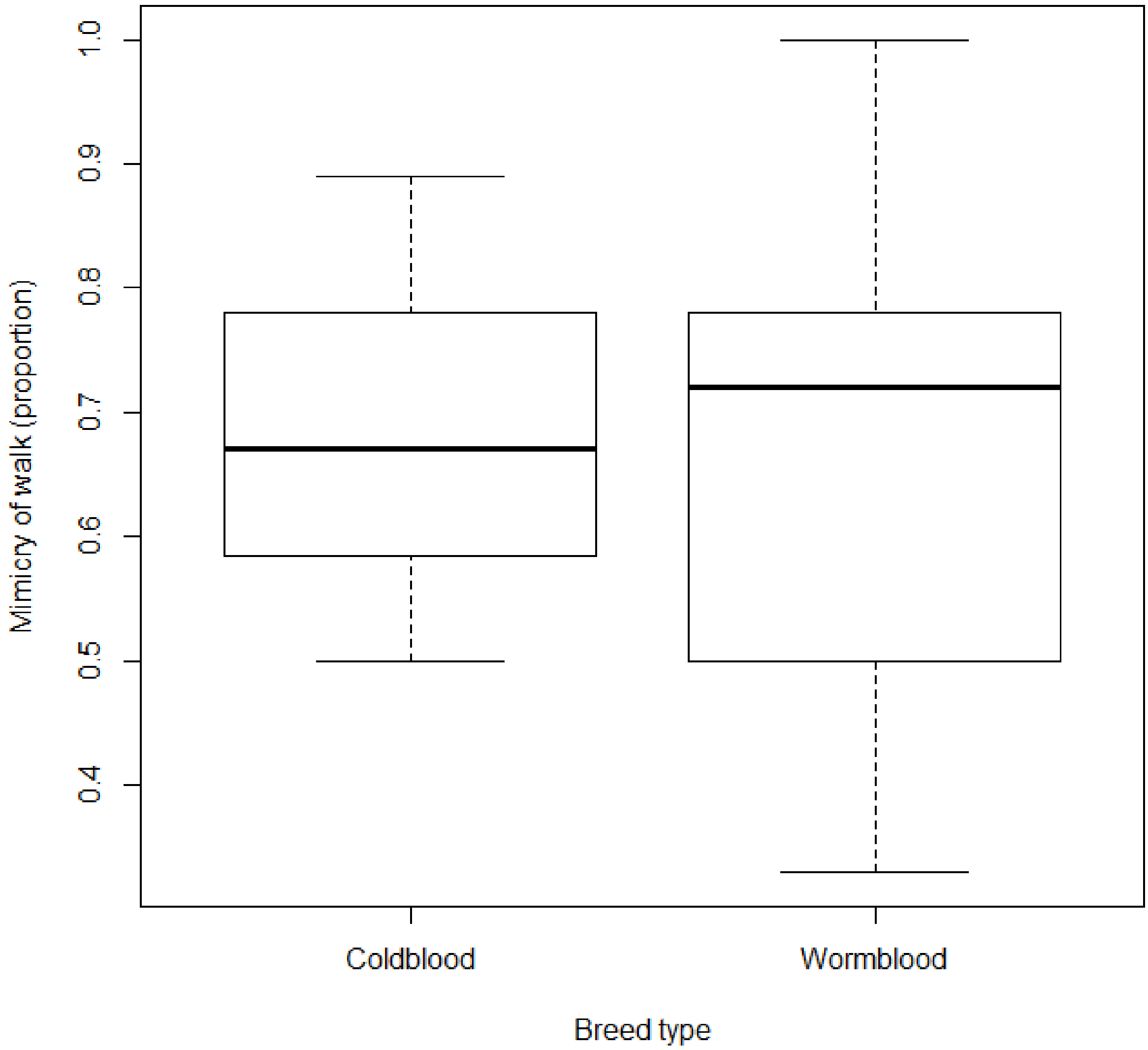

Fig. 8. Effect of breed type on mimicry of walk. For analyzing, the horses were categorized at warmblood (n=21) or coldblood (n =19). The median proportion of mimicry of walk was found through 18 tests for each horse ($F=0.01_{1, 34,}$ $p=0.909$).

5.2 Mimicry and affiliative behaviors

5.2.1 Mimicry of walk and affiliative behaviors

When looking at proportional score of “Mimicry of walk” for each horse and proportional score of “Affiliative behaviors” they were significantly correlated (Spearman correlation coefficient: r=0.74, df=38, p<.001, Figure 9).

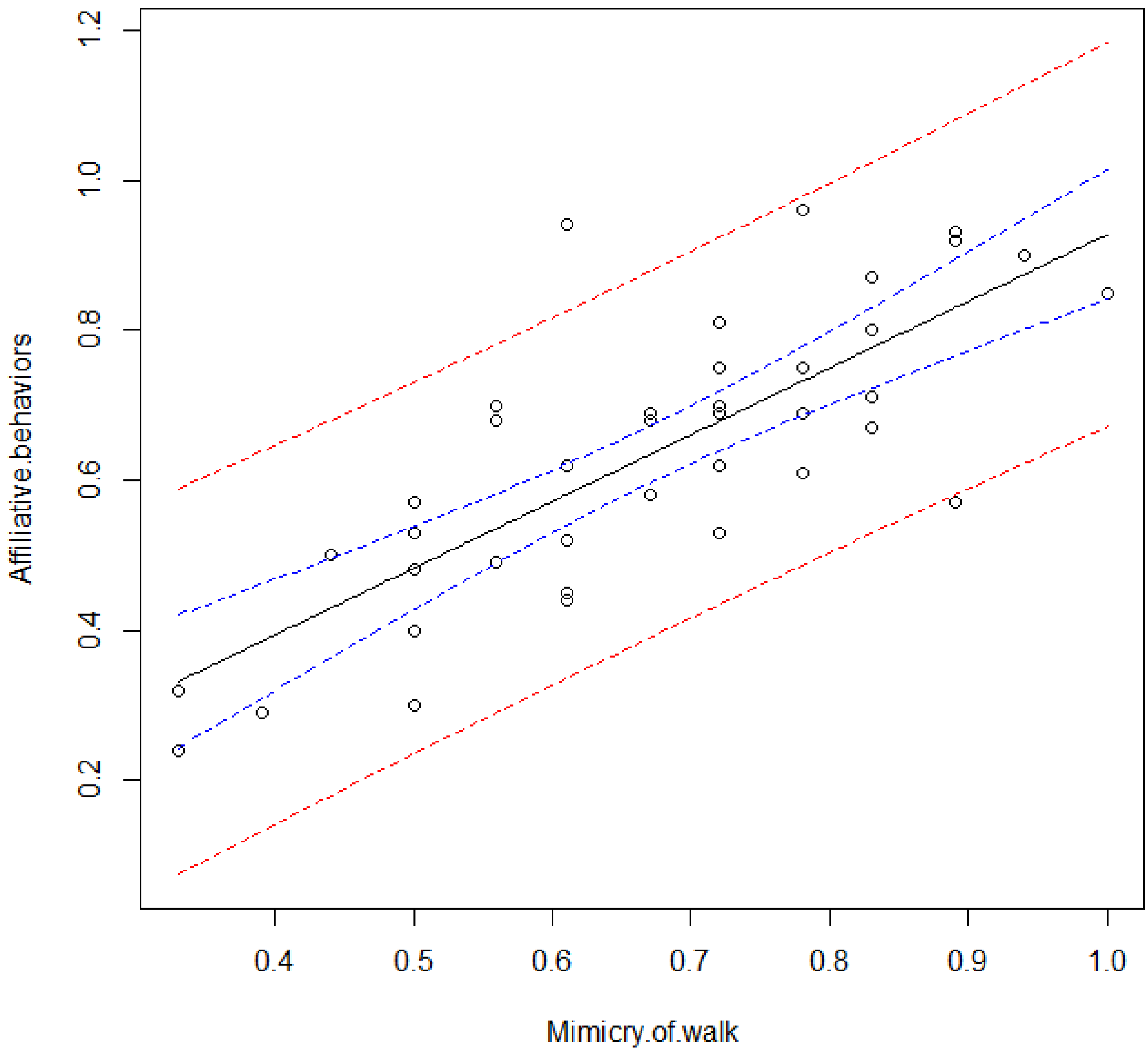

Fig. 9. Correlation between affiliative behaviors and mimicry of walk. Affiliative behaviors are shown as the horses' mean proportions on a visual analog scale repeated five times. Mimicry of walk is the proportion of 18 tests per horse (Spearman correlation coefficient: r=0.74, df=38, p<.001).

5.2.2 Mimicry of head movement and affiliative behaviors

The proportional score of “Mimicry of head movement” for each horse and proportional score of “Affiliative behaviors” were significantly correlated (Spearman correlation coefficient: r=0.67, df=38, p<0.001, Figure 10).

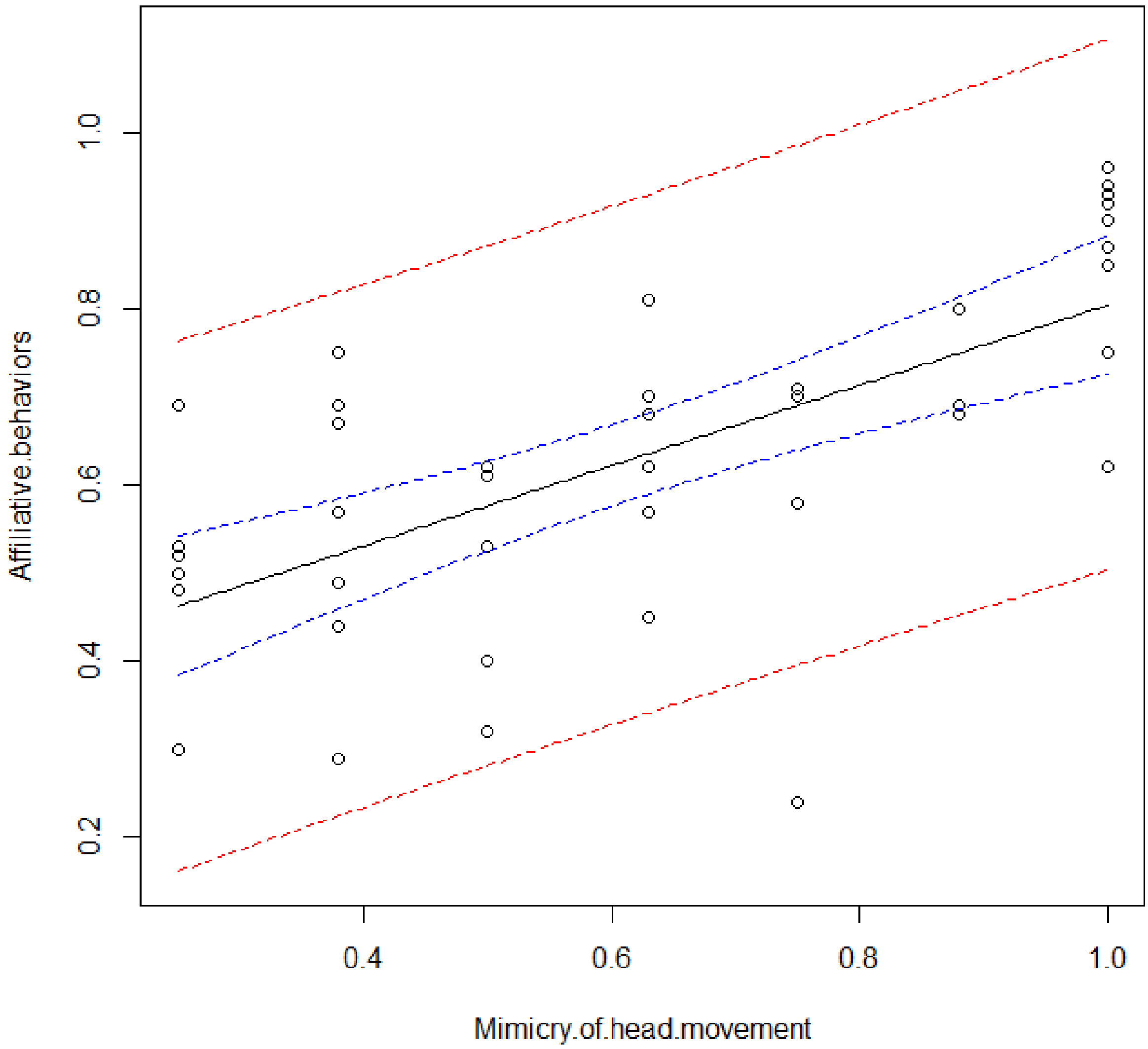

Fig. 10. Correlation between affiliative behaviors and mimicry of walk. Affiliative behaviors are proportions and measured using a visual analog scale five times for each of 40 test horses. Mimicry of walk is a proportion of 18 tests per horse (Spearman correlation coefficient: r=0.67, df=38, p<0.001).

5.3. Object test

5.3.1. Horse reactivity score

Each horse was tested on two objects with a human acting afraid and on two objects with the human acting calm. This gave 80 test results with a calm human and 80 with a human acting afraid. The horse's reaction to the objects was measured with a scale from zero to four, where zero was no fear reaction and four the strongest fear reaction.

When the handler was acting calm most of the horses, 65 had 0 - no reaction to the test objects. 11 of the horses was measured to 1- looking, two to 2 - alert, one to 3- move away and one to 4- flight. When the handlers leading them were acting afraid 45 of the horses was measured to 0- no reaction, 16 was measured to 1- looking, nine to 2- alert, six to 3- move away and four to two 4- flight. There was a significant difference in how the horses scored on the test (Chi^2=14.39, df = 4, P < 0.006, Figure 11).

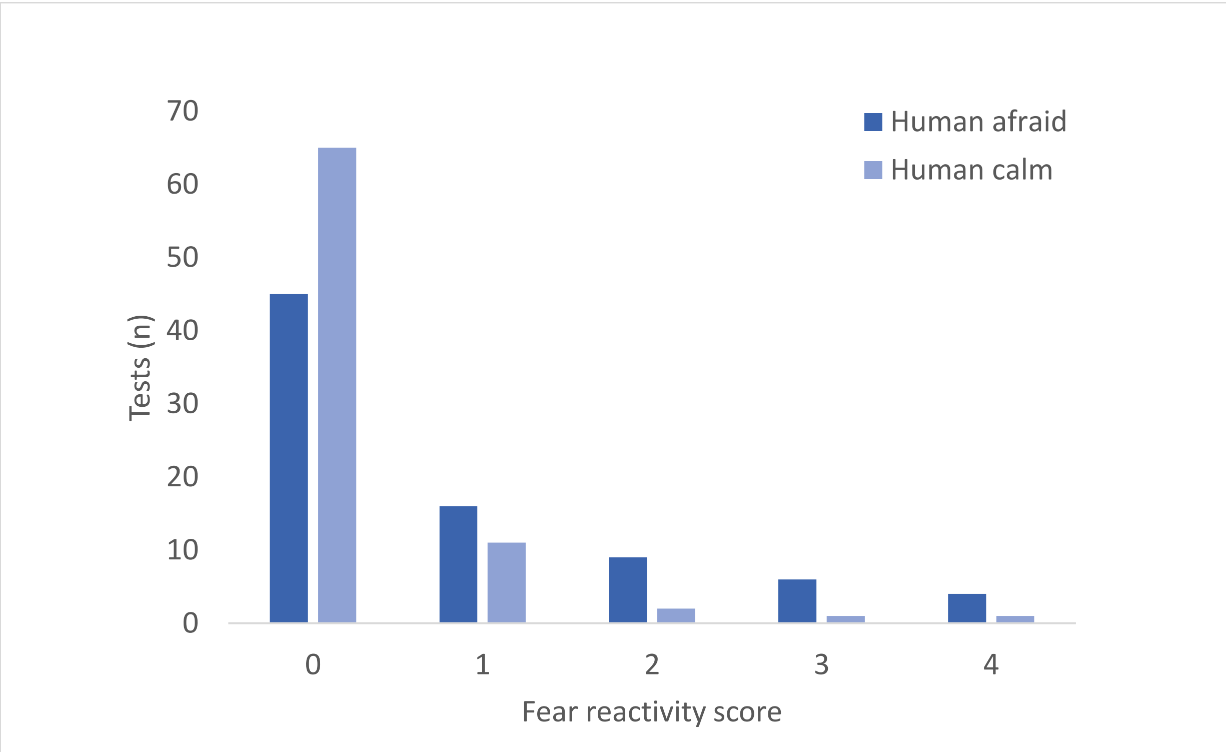

Fig. 11. Horse reactivity score test from 0-4, 0- no reaction, 1- looking, 2- alert, 3- move away and 4 -flight. All horses (n 40) went through two tests with a human acting afraid and two test with human acting calm giving 160 tests.

5.3.2. Effect of different objects

Different objects had an effect on the horse's behavior ($F_{3, 116}$=3.36, p= 0.021; Figure 12). The horses showed no reaction on 28 of the tests with the tarpaulin, 32 with the sheep fur, 30 with the garbage bag and 20 with the umbrella. There were six horses that showed 1- looking with the tarpaulin, five horses with the sheep fur, six with the garbage bag and ten with the umbrella. There were three horses that showed 2- alert with the tarpaulin, two horses with the sheep fur, one with the garbage bag and five with the umbrella. There were two horses that showed 3- move away with the tarpaulin, one with the sheep fur, three with the garbage bag and one with the umbrella. Reaction 4- flight was seen by one horse with the tarpaulin, zero horses with the sheep fur, zero with the garbage bag and four with the umbrella.

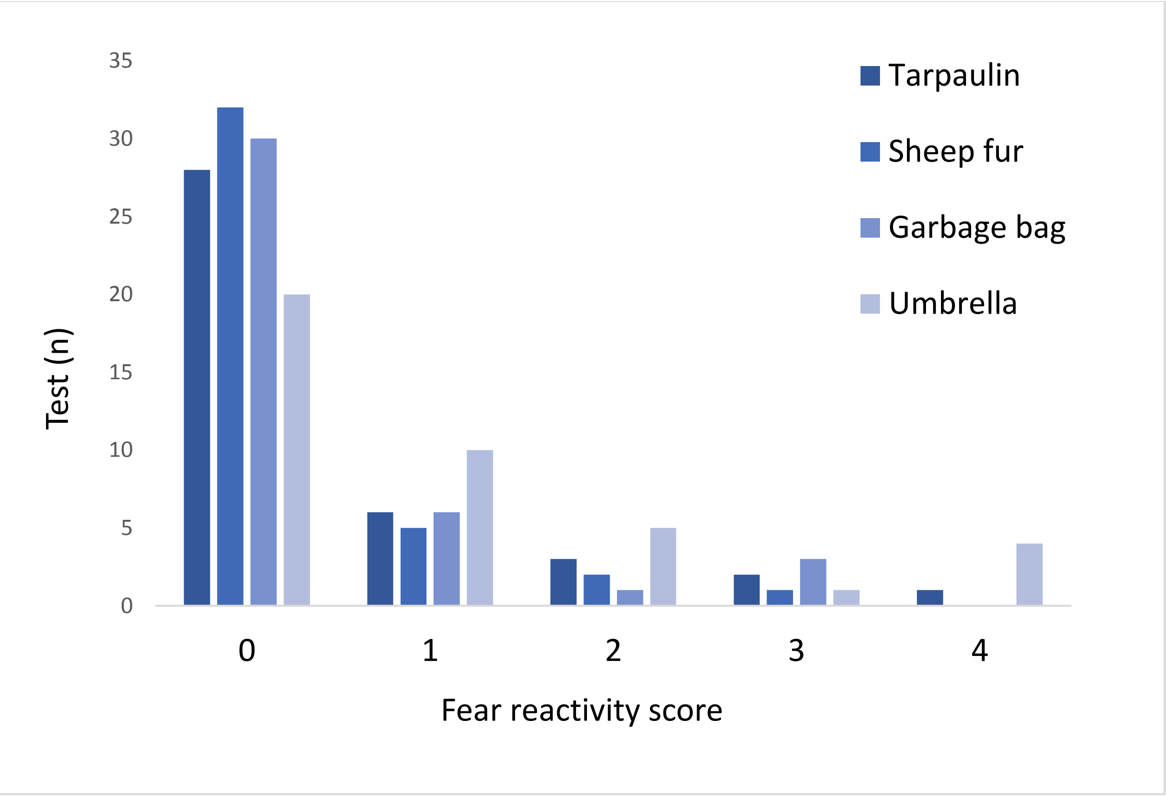

Fig. 12. Effect of different objects on fear reactivity score. The horses (n = 40) did one test with each of the four different objects, giving 160 tests altogether. (F=3.36 $_{3.116}$, p= 0.021)

5.4.3 Effect of age, sex, stabling and breed type

There was no effect of age ($F_{1, 35}$ =0.51, p= 0.481), sex ($F_{1, 34}$ =0.05, p=0.818), stabling ($F_{2, 34}$=1.27, p= 0.294), or breed type ($F_{1, 34}$ = 0, 12, p= 0.735) on whether or not the horse showed a reaction to the objects.

6. Discussion

6.1. Mimicry of behavior

Prediction 1, was that horses would adjust their walking style to be similar to that of their handler at a level greater than would occur spontaneously with a human walking without any changes in walking style. There was a significant difference between the two. Horses changed with the human on average 12.08± 2.96 out of 18 tests, and 0.65± 0.75 out of 18 test if the humans’ walk was stable showing that the changes in the walk were relatively rare without the human influence.

Prediction 2, was that horses lower their head when their handler bends their body downward at a level greater than occurring spontaneously. Here I found a significant difference as well, where the horses were more likely to lower their head in response to the human’s movement than if the human stayed still.

This result suggests that mimicry, unconsciously engaging in the same behavior as another individual, can be found in horses. Mimicry is found in people, orangutans (Ross et al. 2008), chimpanzees (Ross et al. 2011), geladas (Mancini et al. 2013), capuchin monkeys (Paukner et al. 2009) and dogs (Palagi et al. 2015) but as far as I know it has not been looked at in horses before now.

When planning the method, I planned to exclude horses and handlers that were not able to do “walk together”. In practice, it turned out that this was surprisingly easy. If the owner was walking alongside the horse’s shoulder and walking forward in most cases they ended up in walk together without the handler having to alter their gait. If the handler had to make an adjustment most often it was because they were walking completely the other way around with right and left foot together and the same length of steps and speed. There were some horses that were small, big or had stiff shoulders where the human had to alter their basic gait with shorter or longer steps to walk together with the horse.

One challenge I met was something happening in the surroundings that disturbed the horses, such as other horses, people or snow falling from the roof. To not selectively influence the result, I would always measure five steps after asking for a change, meaning that some of the 0 scores in the collected data come from disturbances in the surroundings. To make this influence as small as possible I did not ask for a change before horses again where relaxed and walking together. Head movement was more influenced by disturbances since there were only two measurements.

Prediction 3, was that horse mimicry responses to handler walking and body movements would be similar across horse sex and breed, but greater in younger (less experienced) horses, and in horses living in a social environment than horses stabled alone, i.g. horses in outside housing groups would have more mimicry than horses stabled in a box and alone when outdoors. There was an age effect as predicted. This fits with (Galef & Laland 2005) who writes that age is important, and that young individuals are more likely to learn from adults and (Krueger et al. 2014) who found this effect in horses. It’s interesting that this effect is visible even thou all age groups was represented, but there was no that many young individuals. There was one two year old in the study and the rest was five year and older.

Lakin et al. (2003b) makes the argument that mimicry had an important role in human evolution in helping communication and thereby giving survival value. They propose that mimicry has later evolved serving a social function in increasing affiliation and helping to foster relationships with others. If one accepts this argument it is also fitting for horses since the group and a functioning herd has been important during their evolution under natural conditions and behaviors that enhanced group stability likely improved fitness. Why then should this also function with humans as the social influence? Paukner et al. (2009) also reported affiliation and mimicry between capuchin monkeys suggesting that maybe the effects of mimicking is instead more general, instead of just being focused on the same species.

6.2. Mimicry and affiliative behaviors

Prediction 4, was that horses with higher affiliation scores towards handler in visual analogue scale assessments would have higher mimicry scores in walking tests and the results showed that these variables were significantly correlated. This is consistent with the idea that both in humans and animals there seems to be a bi–directional relationship between nonconscious mimicry on one side and liking and affiliation on the other as found in other species (Chartrand & Bargh 1999; Lakin et al. 2003a; Lakin et al. 2003b; Ross et al. 2008; Paukner et al. 2009; Stel & Vonk 2010; Ross et al. 2011; Mancini et al. 2013; Palagi et al. 2015; Rauchbauer et al. 2015).

On the measurements of affiliative behaviors, I wanted something that was easy to do between the other tests and without drawing to much attention, since at the time of testing the handlers did not know about the measurements. I also wanted to do a measurement that had space for affiliation and liking to be shown in different ways. Some of the horse and owners were standing beside each other, touching or almost touching but still not bumping into each other. They were constantly interacting and being together while waiting, talking and so on. But there were also others who had horses that where trained to keep distance to the owner, but still clearly enjoyed spontaneous touch and grooming, and were relaxed but focused on their handler. At the same time, you could have horses and humans standing close, bumping into each other, apparently being annoyed and so on. Using a visual analog scale gave flexibility for scoring different ways of showing affiliative behavior between horse and human.

6.3. Emotional contagion

Emotional contagion means that the observer spontaneously copies the emotional state of the demonstrator and then shows their own affective reaction to that emotional state (Nakahasi & Ohtsuki 2015). I chose to look at fear reaction because horses are prey animals, so a fast fear reaction to a potentially dangerous situation is important to them. As Nakahasi & Ohtsuki (2015) point out, from an evolutionary perspective a fast reaction to another individual`s fear, before seeing the danger yourself will likely help the animal survive and therefore give the individual a higher fitness. Prediction 5, was that horses lead by a handler acting afraid towards a novel object would show a stronger fear reaction towards the object than horses lead by a handler acting calm. The result showed that there was a significant difference in the horse's fear reaction when the human was acting calm and afraid.

In this thesis, I have assumed that the underlying emotion is fear when we see behaviors that include startle, vigilance, avoidance and fleeing. Knowing that the horses experience the subjective emotion of fear when they show these behaviors assumed to indicate fear is of course impossible to know with certainty.

This finding corresponds with the Christensen et al. (2008) study on contagion of fear reaction between horses where they looked at the test horse fear reaction with and without a habituated companion. In their study the effect of the companion's reactions on the test horse also lasted later when the observer was tested alone. This implies that using a calm and self-assured horse can give a lasting impression when training a naïve horse. This study found an effect of emotional contagion from human to horses, so having a calm and self-assured human when meeting new objects and situations is likely to be important. Since experience with a situation is likely to make individuals rely more on their own experience (Galef & Lanand 2005) the first exposure to new situations is most sensitive towards the companion. The result also matches Keeling and colleagues' (2009) study where they looked to see if a fear reaction was contagious between people and horses by measuring heart rate. That study looked at what the horses' reaction would be if the human expected something frightening to happen (though the situation did not occur), finding that the horses heart rate went up as a reaction to the human's fear reaction.

In my study, I was depending on the humans' acting skills which varied greatly. Some did a very good job, and for example convinced themselves that there were spiders inside the object (one actually asked to go check the next object when she was going to act calm because she felt she was not able to let go of the fear reaction without checking first). But there were also handlers who did not seem to change their body language at all, or who did then burst out in giggles, not many of the people was this extreme but it show that there is some disturbances in the result from human acting skills. This means that for some of the horses the result could probably have been unreliable. I could have used the same people testing different horses. But I wanted the study to be as general on horse- human interactions as I could make it meaning I wanted to do it with different people. I also wanted to use familiar individuals, because it means that the horse and human had a relationship from before and their affiliation might reflect that relationship. Using different humans also meant that I could easily use horses from different management and training systems and that misunderstandings in communication would be minimized, since horses and human knew each other already.

Another interesting point was that some of the horses had a strong fear reaction when the human was acting afraid, but they seemed to not react towards the objects but the surroundings in general, changing their focus from place to place. They did look at the objects but just for a short time period, giving the impression that they may not have expected danger from the objects specifically. In contrast other horses intensely focused on the objects, and the objects also gave the owners something to focus on.

Prediction 6, was that the type of novel object affected the responses of the horses, and I did find effect of object. When planning the method one of my goal was to use objects that would have similar effects on the horses, although I predicted there would be some differences because the objects were not identical. I did not want to use the same object four times, as repetition would probably give a strong habituation influence on the horses' reaction. Instead

I chose four different objects, and randomly used them as scary objects and not scary objects so that the potential effect of the objects should not overshadow the effect of the human's actions.

There was a big difference in how the horses handled exposure to the objects probably due to individual horse and handler differences, and earlier training and other experiences as (Dorey et al. 2014; Proops et al. 2013) point out can be important. There were some horses (n=12) that did not show any reaction to any of the objects. I could have used more frightening objects, but I did not want a situation where some of the horses participating in the study were afraid of objects, situation or place in the future. This was both ethically important in regard to the horse, but also the owners who agreed to help by letting their horses be a part of the study. The horses that showed very strong fear reaction to the objects got some time with the owner to relax and be okay with the objects again. This also helped against the horses having a stronger fear reaction on the second set of tests because of arousal left from the first tests when the 'handler afraid' condition occurred first.

Prediction 7, was that fear contagion in response to handler reactions to novel objects would be similar across horse sex, breed and housing, but stronger in the youngest (less experienced) horses. The result showed no effect of horse sex, breed, housing and age. In the measurement, there was an about equal representation of sex (n=19 and 21), breed group (n=19 and 21), and the age was well distributed from two to 24-years-old. Still to look at effect of young horses versus older horses it might be an idea to look at two groups for example 0-3-year-old not yet started serious training, and over 6 years old with more extensive handling and therefore experience. In my study, it`s only one horse that would then belong in young category. When it comes to housing, there were 28 horses in boxes at night and outside at day time and only six horses in box and alone at day time and six horses in the outside housing in groups. To see if there are any effects of social contact it might be worth comparing horses that are housed alone all the time with horses in groups, and with 20 horses in each category. It would also be a good idea to control for earlier stabling experience if possible.

6.4. Practical applications

One area where use of mimicry and emotional contagion is already quite common is using horses in human therapy see Frewin & Gardiner (2005) and Letini & Know (2009). Horses are used to discuss, understand and interpreted the patients' behaviors and emotions.

There are very many things we want the horse to be able to handle, and preferably when being in a positive emotional state, from trailer loading to unexpected stimuli in the surroundings. Since we know that the horse emotional state is affected by other horses (Christensen et al. 2008) and humans as found in this study and by Keeling et al. (2009), having calm horses and people around the unexperienced horse is likely to be helpful. This also means that taking the human's emotional state into account when planning the training is important for avoiding dangerous situations and setting up the training so not only the horse but also the human feel safe.

In humans, Hatfield et al. (1993) write about the possibility of using emotional contagion to feel into another person's emotion. Instead of only using the information you can consciously gather you also use the information you unconsciously pick up through mimicry. This study only looked at how the horses are affected by the human, but if we assume that it's a two-way process, this would give the opportunity for people to have another way of reading the horse's emotional state. Used with care it might give the opportunity to adjust the horse's training, for example working on new object, earlier than if we have to wait for when we are able to analyze the emotional state consciously through behavioral analysis.

If we start by looking at the basic training of our horses, we want them walking nicely beside us, in the same speed and direction. Very often when we are training on this it becomes a lot of corrections, don't walk so fast, don't go there, don't stop and so on until the horse walks in the wanted way by avoiding all the wrong behaviors. When walking at the horse's shoulder, mimicking the horse's walk and then changing the way of walking the horses on average mimicked the change 12 out of 18 times. Twelve out of 18 times gives very many opportunities to reward a wanted behavior and strengthen it. That way instead of the training being about teaching the horse everything we do not want it to do when walking until only what we want is left, the training will be about what we want. This we can also use in further training like teaching the horse commands for the different gaits, walk, trot, and canter. And also when we want to influence how the horse move in the different gaits.

The connection with affiliation is very interesting. Often when there is problems in the interactions between horse and human it leads to frustration. Since also for humans mimicry is connected with liking working with the wanted behaviors trough mimicry it might help cooperation and liking, both from human and horse side.

For much training with the horse a lot of knowledge and practical skills are needed. Skills take years to learn and knowledge needs time and experience to be understood. Using mimicry on the other side opens the door to possibilities that can be more intuitive and easier to use, also for a beginner.

For me as an equine massage therapist the walking together also inspired another use. When the horse and the human walked together and changed their walk it was easier to see where the stiffness in body movements for the horse were located, for example, in relation to free shoulder movement.

6.5. Future research

In this study, I focused on fear reaction, but it could also be interesting to look at a wider and more dynamic setting. One idea might be to look at heart rate and behavioral signals in a setting where thing change up and down with both fun, relaxation and challenging moments. With a little planning, it would be possible to set up a testing day that would take horse and person through different emotions. For example, through challenging and scary settings with new objects, fun and play with some exercises trained with positive reinforcement, grooming and relaxation and through the day measure heart rate. Another possibility would be to do the same with horse and persons when horses are used in a therapeutic setting. Here there are also likely to be strong changes in emotions, and ethical approval would be needed for such a study. Another challenge is that both positive and negative emotions would give a stronger heart rate. How then to differentiate between them? It‘s possible to use an ethogram, but at the moment there is no good ethogram with detailed enough signs of emotional states in horses except for fear and pain. Step one would therefore be to find behavioral signs of emotions that are detailed enough to use for differentiation between emotions. Then step two could be to use this ethogram on horses in a testing setting.

When we look at earlier research on social learning in horses we find that the study methods used so far mostly do not find social learning in horses (Nicol 2002; Murphy & Arkins 2007; Bunbaker & Udell 2016). Still as discussed in the practical application chapter, anecdotally I found that it‘s very useful in practice, both on a basic movement level, but also on a more advanced level when using dressage as physical therapy for horses, asking them to put more weight on one leg than the other. Also in regard to trick training I have experienced and heard stories about horses that have learned to do tricks by watching other horses being trained. Three situations (with different horses) comes to mind, one with target and two with fetch.

One possible way to look at this is with the Do as I do method used on dogs, where they learn to imitate a human’s behavior on command with known behaviors before this is generalized so that the dog can also can learn new and unknown behaviors though imitation (Fugazza

2014). I worked a little on trying to train this with horses but met two challenges with the method. The first was inconsistency in the horses’ response, they were able to learn to do three different exercises on command with stimulus control so that they could do the task asked, but this did not mean that they would still do it on command the next training session. Also they had a very strong preference for visual signals so it might be an Idea to use visual signals for the different exercises instead of verbal. I did not get further than the preparation training because I felt the time was too limited and that the method needed some improvement to function with the horses.

7. Conclusions

The horses in the study significantly mimicked their human handler's walking style (Prediction 1) and head movement (Prediction 2) compared to control horses supporting Hypothesis 1, that horses mimic changes in the walking style and body posture of a familiar handler. There was no effect of sex or breed on mimicry of walking as expected (Prediction 3). There was an effect of age, with younger horses showing more mimicry of walking than older horses in agreement with Prediction 3, but contrary to the prediction no effect of housing type was detected. The proportion of positive results for mimicry and the level of affiliative behavior were significantly correlated both for mimicry of walk and mimicry of head movement (Prediction 4) supporting Hypothesis 2, the level of mimicry exhibited by a horse towards a familiar handler is affected by the degree of affiliative behavior shown by the horse towards the handler. I found that the horse's fear reaction was significantly affected by whether the human was acting calm or afraid of test objects, in agreement with Prediction 5. These results support Hypothesis 3, that horses show emotional contagion of fear towards novel objects depending on the reaction shown by a familiar human handler towards the objects. There was some effect of the novel objects (agreeing with Prediction 6) and there was no effect of age, sex, housing type or breed type although an age effect was predicted (Prediction 7). Overall, the results of this study support the conclusion that behavioral mimicry and emotional contagion exist between horses and their handlers.

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