MASTERARBEIT | MASTER'S THESIS

Titel | Title

Somebody help me - Testing horses´ willingness to provide food to conspecifics

verfasst von | submitted by

Melanie Minichberger BSc

angestrebter akademischer Grad | in partial fulfilment of the requirements for the degree of

Master of Science (MSc)

Wien | Vienna, 2025

Studienkennzahl lt. Studienblatt | Degree programme code as it appears on the student record sheet:	UA 066 878
Studienrichtung lt. Studienblatt | Degree programme as it appears on the student record sheet:	Masterstudium Verhaltens-, Neuro- und Kognitionsbiologie
Betreut von | Supervisor:	Jean-Loup Rault

Acknowledgements

This thesis was made possible by the contribution of many people. First, I would like to thank my supervisors Dr. Jim McGetrick and Univ.- Prof. Dr. Jean-Loup Rault for their infinite support and for the countless opportunities to learn and not only challenge my thoughts, but also to encourage me to implement what I think is the best way forward. That was a lesson I would not want to miss.

Huge thanks go to Kimberly Brosche, who was always there to discuss detailed ideas despite her own many projects and proved to be a faster and more accurate source of information than any search engine or encyclopaedia I know. On top of that, I am grateful that she agreed to carry out the inter-rater reliability test with me.

I would like to express my gratitude to Christian Haberl for the ideas on the experimental apparatus and their realisation. Further, Assoz. Prof. Dr. Sonia Kleindorfer kindly agreed to act as my local mentor at the University of Vienna and encouraged me to study horses.

Special thanks are given to Univ.- Prof. Dr.med.vet. Jessika-Maximiliane Cavalleri Dipl. ECEIM for providing the horses for my study. Mag. med.vet. Nora Studer, who introduced me to the horses, and the staff at Haidlhof were of great help to me on site with the organisational requirements and setting up the experiment.

I am deeply thankful for the support of Lukas Brandtner, who was willing to have this study conducted at his stable and who, despite various delays in starting the experiment and ultimately moving the study to another stable, always made me feel welcome and succeeded in keeping me from dwelling on the situation. My family was at my side throughout the entire progress of this thesis. In stressful times, Elisabeth Minichberger made me feel well cared for, and not just with her extraordinary cakes and biscuits. Very special thanks go to Elisabeth Adele Rosa Minichberger for accompanying me on every single step of this journey and for always lending me a sympathetic ear, without exception.

Abstract

Social behaviour is an essential part of the behavioural repertoire of many animals, including the social living horse. Prosociality, defined here as an action in which an individual intends to benefit at least one other individual, has been studied in some mammals and birds. This study pioneers the investigation of prosocial behaviour in the domestic horse (*Equus caballus*). Ten horses were tested pairwise with a feeding apparatus that dispensed food to a conspecific when a button was pushed. None of the horses were familiar with the apparatus or were taught to push a button before the start of the experiment. In the test condition, the two horses were separated by a fence and when one horse pushed the button, food could be reached by the other horse. In the control condition, the food dispenser was removed before the start but the button remained, thus no food was available after pushing the button. If horses are prosocial, they should push the button more often in the test condition, indicating that they want to provide the other horse with food. The horses did learn to push the button, but there was no significant difference in the number of pushes between conditions, giving no indication that horses exhibit prosocial behaviour in this context. The negative results of this study do not rule out the possibility that horses are prosocial but suggest that it is challenging to experimentally test for prosociality in general. Individuals may have prosocial abilities but may not show them at all times and under all circumstances. Further studies, using different paradigms, and in particular considering a more natural test environment, could be better suited to reveal prosocial abilities in horses and contribute to increasing our knowledge of equine social behaviour, which in turn would benefit equine welfare.

Zusammenfassung

Sozialverhalten ist ein essenzieller Bestandteil des Verhaltensrepertoires vieler Tiere, wie das des sozial lebenden Pferdes. Prosozialität, hier definiert als eine Handlung, bei der ein Individuum die Intention hat, zumindest einem anderen Individuum zu einem Vorteil zu verhelfen, wurde bei einigen Säugetieren und Vögeln untersucht. Diese Studie erforscht zum ersten Mal prosoziales Verhalten des domestizierten Pferdes (*Equus caballus*). Zehn Pferde wurden paarweise an einem Futterapparat getestet, welcher auf Knopfdruck Futter an einen Artgenossen ausgab. Keines der Pferde kannte weder den Apparat vor Beginn des Experiments noch hatte es zuvor gelernt, einen Knopf zu betätigen. In der Testkondition waren die beiden Pferde durch einen Zaun voneinander getrennt und wenn ein Pferd den Knopf drückte, war anschließend Futter für das andere Pferd verfügbar. In der Kontrollkondition wurde der Futterspender vor Beginn entfernt, der Knopf verblieb aber im Testareal, wodurch nach einem Knopfdruck kein Futter zugänglich war. Wenn Pferde prosozial sind, sollten sie den Knopf häufiger in der Testbedingung drücken, was darauf hindeuten würde, dass sie das andere Pferd mit Futter versorgen wollen. Die Pferde in diesem Experiment haben gelernt den Knopf zu drücken, aber es gab keinen signifikanten Unterschied in der Anzahl der Knopfdrücke zwischen den Konditionen und somit keinen Hinweis darauf, dass Pferde in diesem Kontext prosoziales Verhalten zeigen. Die negativen Ergebnisse dieser Studie schließen nicht aus, dass Pferde prosozial sind, sondern deuten darauf hin, dass ein experimentelles Testen von Prosozialität herausfordernd ist. Individuen könnten prosoziale Fähigkeiten aufweisen, diese jedoch nicht zu jeder Zeit und unter allen Bedingungen zeigen. Weitere Studien, die sich verschiedener Ansätze und im Besonderen einer natürlicheren Testumgebung bedienen, könnten besser geeignet sein, um prosoziale Fähigkeiten bei Pferden aufzuzeigen und zu einer Steigerung unseres Wissens über das Sozialverhalten von Pferden beitragen, wodurch artgerechte Pferdehaltung gefördert würde.

Table of contents

1 Introduction

According to Tinbergen (1975), animals behave socially when they pay attention to each other´s behaviour, respond to it and act together. He further states that social interactions can either serve the purpose of mating, caring for offspring, organising a group, or fighting (Tinbergen, 1975). Therefore, social behaviour can involve aggression, helping, cooperation, sharing and informing. Studying and trying to understand the social interactions of animals can help to improve their housing conditions in zoos, private households, and farms, indirectly benefiting humans by improving animal health. In their review, Snyder-Mackler et al. (2020) list various social mammals, including horses, that have a longer lifespan if they have more affiliative or supportive social interactions with conspecifics.

Learning about social behaviour could yield new insights into the underlying function, mechanism, and evolution of human behaviour. Harlow & Harlow (1962) state that animals raised with a lack of, or no social contact develop behavioural stereotypes (e.g. biting themselves) and can fail to exhibit certain behaviours necessary for the survival of the species (e.g. mating behaviour). It is hence of great importance to understand the various types of social behaviour, especially in animals held in captivity. This knowledge could improve the wellbeing and performance of farm animals as well as companion animals by adapting the environment to their needs. Furthermore, it could contribute to enhancing the safety of animal handling and avoid misunderstandings in communication between animals and humans, which could otherwise lead to harm on both sides.

Prosocial behaviour is a particularly interesting topic in the field of social behaviour and welfare research. Until recently, welfare research in farm animals has focused on negative social behaviour such as aggression. Jensen & Yngvesson (1998) investigated the effect of weight difference and familiarity between pigs on aggressive behaviour after weaning and regrouping. Fureix et al. (2012) discussed potential underlying causes for a higher frequency of aggressive interactions in horses, such as insufficient space. Cows were found to exhibit less aggressive displacements when the feeding space per cow was increased from 0.5 m to 1 m (DeVries et al., 2004). Aggressive behaviour can result in injuries or death and therefore, decreasing aggressive behaviour can have economic advantages and improve husbandry conditions. Further, aggressive behaviour often is conspicuous as there might be loud vocal expressions and fast movement of the contestants, making it easier to be recognised by caretakers than some positive social behaviours. Including positive interactions in research unravels important information about animal behaviour which might have been overlooked when focussing on negative interactions. Studying prosociality in particular could give insights into why we and other animals behave selflessly and how these behaviours evolved. By creating conditions that increase prosocial behaviours, negative social behaviours could decrease at the same time. Actions of an individual are considered prosocial if they profit at least one other individual and the objective of the performed behaviour must be to have a positive impact on the recipient (Jensen, 2016). Examples of prosocial actions include bringing food to a conspecific or helping another individual in a distressing situation. In contrast, a horse that leaves its warm and soft sleeping spot to relieve its thirst by going to a water container is not acting prosocially, even if another horse takes advantage and occupies the abandoned spot. Social communication can be beneficial for all participants, but an alarm call or a greeting call does not have to be intentional and can simply be a reaction to a stimulus and is thus not prosocial behaviour.

Many species have been tested for prosocial tendencies: Dogs provided other dogs they already knew with food (Quervel-Chaumette et al., 2015), some bottlenose dolphins chose to provide food to a conspecific and themselves instead of choosing the option whereby only they and not the conspecific would be rewarded (Lalot et al., 2021), and some Goffin´s cockatoos managed to pass on the appropriate tool to a partner, who could use it to manipulate an apparatus to obtain food (Laumer et al., 2021). Substantial work has further been carried out on rats, primates and corvids: Rats provided a conspecific with food after having experienced help from different conspecifics in the same task (Rutte & Taborsky, 2007). Chimpanzees preferred the prosocial choice over the selfish choice without receiving apparent communicative signals from the partner requesting to provide food in a Prosocial Choice Test (Horner et al., 2011). Various corvid species, including the azure-winged magpie and the carrion crow, provided group members with food by landing on the perch of a seesaw whereby breeding type and sex affected the rate of the prosocial action (Horn et al., 2020). However, there are also experiments that failed to show prosocial behaviour in some species: Carrion crows and azure-winged magpies did not transfer a token to a conspecific for the latter to be rewarded with food in a Token Transfer Test (Horn et al., 2021). Capuchin monkeys did not differentiate between transferring a token to an adjacent area they themselves could not enter, if there was a receiver in this area, who could exchange the token for food, and if no receiver was in that area (Skerry et al., 2011). Rats were more likely to enter a chamber with a free-ranging conspecific than a chamber with a restrained conspecific that was released as soon as they moved into this chamber (Heslin & Brown, 2021). These contradictory results point out that not every test set-up is appropriate to test for prosociality in every species and that further research needs to shed light on the different forms of expression of prosociality. A discussion on the difficulties in experiments on prosociality was given by Marshall-Pescini et al. (2016). The authors highlighted that when testing for prosocial behaviour, controlling for understanding of the task should be carried out to provide conclusive results. Further, Marshall-Pescini et al. (2016) state that the looking behaviour of the actor towards the partner should be recorded to obtain information on the actor´s attentiveness towards its partner and the partner´s behaviour and thus gain insights into whether the actor understands their own role and the role of their partner in the experiment. The consistent application of considering the tested individual´s comprehension of the test set-up and of the relevance of each participating individual would facilitate comparing the results of multiple studies.

Rault (2019) states that there are various types of prosocial behaviours, including sharing, caring, social teaching, affiliation, cooperation, and other helping behaviours. There are several ways in which prosocial behaviour can provide information about the wellbeing of animals. Rault (2019) highlighted 3 scenarios serving this purpose: A higher amount of prosocial behaviour during or subsequent to a stressful situation, less prosocial behaviour than anticipated in a certain species indicating inadequate (housing) conditions, and a level of prosocial behaviour typical of a particular species, signalling appropriate conditions (Rault, 2019). If the amount of prosocial behaviour exhibited is an indicator for animal welfare and varies with group constellation, it would help to assess the functioning of a social group. Investigations of dairy cows have shown that these animals may profit from specific compositions of their herd. The cows formed stronger relationships with familiar group members and changed their interaction partner according to the activity (e.g. sleeping, feeding) (Gygax et al., 2010). Thus, adapted management practices could, for example, enable animals to form social bonds with the same individuals over a long period of time but also provide a sufficient number of animals to allow for situation-specific preferences in social activities.

Considerable research has been conducted on positive social behaviour in farm animals: Pigs spontaneously learned to cooperatively lift a log to get access to food (Rault et al., 2021), goats reconciled after a conflict (Schino, 1998) and chickens sought contact with conspecifics after experiencing a stressor (Marin et al., 2001). Pigs have also been found to free a group member from an isolated compartment by lifting the handle of the closed compartment door with their snouts (Moscovice et al., 2023). The helping pigs in this study were within their habitual group during test sessions, ruling out the possibility of releasing the trapped pig due to reasons of spatial isolation of the helpers themselves. Whether farm animals truly behave prosocially, that is whether they have the intention to benefit another individual instead of acting out of selfish reasons but with the same outcome for all involved individuals, remains to be tested. One way or another, understanding prosocial behaviour in farm animals can help to improve their wellbeing.

Horses (*Equus caballus*) are another farm animal species that might display prosocial behaviour. Worldwide, millions of horses are used by humans for leisure activities, sport, work, and nutrition. They can act as valuable partners in animal-assisted therapy or contribute to the livelihoods of humans. Bearing in mind that knowledge of equine behaviour can lead to improved performance in each of these categories and would additionally increase the wellbeing of horses by handling and caring for them in a species appropriate way, it is worth investigating it in more detail.

Horses are herd animals and engage in various forms of social behaviour. Their social repertoire includes grooming the partner (Shimada & Suzuki, 2020), maintaining close proximity to group members (Wolter et al., 2018), reconciliation (Cozzi et al., 2010) and playing with conspecifics (McDonnell & Poulin, 2002). To date, prosocial behaviour in horses has not been investigated but there are some indications that prosocial behaviour might exist in horses. Cozzi et al. (2010) showed that horses engage in affiliative interactions shortly after a conflict, whereby the interaction takes place either between the competitors of the conflict or between one of the competitors and a horse not involved in the conflict. For the latter case, in particular, it remains to be tested whether the intention of the non-involved horse is to “comfort” a competitor horse, thus acting prosocially, or whether it shows affiliative behaviour to prevent itself from becoming the victim of further aggression. In terms of cooperation, Feh (1999) found that some low ranking stallions of a free ranging group of Camargue horses formed long term relationships with each other and worked together to defend their mares, resulting in higher reproductive success compared with low ranking males trying to mate with mares from other herds. However, these results need further investigation, as another study found no mating advantages for subordinate males in groups with more than one stallion, even though the dominant males did benefit from the alliances by needing fewer attempts to defend the mares against other horses (Pinto et al., 2022).

This study aims to determine whether domestic horses (*Equus caballus*) show prosocial tendencies. The horses were tested in pairs with a novel device that released food from a dispenser upon pushing a button that controlled the dispensing mechanism. The test paddock was divided by a fence and if a horse pushed the button (Donor-horse), it could not reach the food but the second horse could (Receiver-horse). In a control condition, the food dispenser was removed and the button remained in the test paddock. Thus, pushing the button did not result in the provision of food for the Receiver-horse. The horses were expected to behave prosocially by pushing the button more often in the test condition in which the button and the food dispenser were present than in the control condition.

2 Ethical approval

The present study was approved by the Ethics and Animal Welfare Committee of the University of Veterinary Medicine, Vienna in accordance with the University´s guidelines for Good Scientific Practice. The approval number was ETK-069/03/2022.

3 Methods

3.1 Subjects

A group consisting of ten horses of mixed breeds was included in this study. Of this group, six horses were Haflinger horses, three horses were trotting horses and one horse was a warmblood horse. Their age ranged from 4 to 21 years, with seven females and three castrated males (**Tab. 1**). The horses were kept in two groups at the Erlbacherhaus at Haidlhof, a research and teaching farm of the University of Veterinary Medicine in Vienna (Vetmed). One group, consisting of seven horses, was stationed in a stable and the adjoining paddock and the other group was held on a pasture within view of the first group of horses. Two plastic tents located in the pasture provided shade and protection against stormy weather or rain and the horses had access to grass at all times. Both groups had *ad libitum* access to water, hay and salt licks. All horses were familiar with each other, as the horses in each group had lived in the same enclosure for at least three months prior to testing and the individuals of the two groups had visual access to each other and were able to interact across the fence between the paddock and the pasture. The horses are used for teaching purposes for veterinary students of the University of Veterinary Medicine, Vienna throughout the teaching semester. Over the course of the study, no changes in group composition were made.

Table 1 Subjects: Name, breed, sex, age and place of keeping of the horses used for the study.

Name	Breed	Sex	Age (years)	Place of keeping
Luzie	Haflinger	female	21	stable/paddock
Luxi	Haflinger	female	19	stable/paddock
Soraya November	Trotting horse	female	18	stable/paddock
Impuls	Warmblood horse	male	16	pasture
Tullamore (Ulli)	Trotting horse	female	13	pasture
Lamantscho	Trotting horse	male	10	pasture
Tessa	Haflinger	female	5	stable/paddock
Farina	Haflinger	female	5	stable/paddock
Fortuna	Haflinger	female	5	stable/paddock
Solero	Haflinger	male	4	stable/paddock

3.2 Apparatus

A dog-feeding apparatus (Trixie Dog Activity Memory Trainer 2.0; TRIXIE Heimtierbedarf GmbH & Co. KG, 24963 Tarp, Germany), composed of a food dispenser and a button, was provided to the horses (**Fig. 1**). Both the button and the food dispenser were placed inside a wooden construction to prevent the horses from moving or destroying it (**Fig. 2**). The food dispenser and a feeding bowl were mounted on a wooden board, measuring 100 cm x 50 cm, which, in the same way as the button on a separate board, was fixed to the fence of the test pen (**Fig. 3**). The lower end of the feeding bowl was at a height of about 80 cm and the centre of the button was at a height of about 1 m above the ground. The button was connected to the food dispenser via Bluetooth and horses could release food from the dispenser into the feeding bowl by pushing the button with their muzzle. Inside the food dispenser was a plastic ball that could be filled with food. When successfully pushed, a sound was emitted from the button and a mechanism was triggered, causing the plastic ball to turn and food to fall through a hole into the bowl.

Figure 1 *Feeding apparatus. Food dispenser (left) and button (right). (Photography by Christian Haberl)*

The horses pushed the button by exerting pressure on the transparent part of the button. The food dispenser was filled with feeding pellets (Wölbchen Bussi; AGROBS GmbH, 82541 Degerndorf, Germany), measuring 9 mm in diameter and about 1.5 cm in length and consisting of dried green fibres and beetroot. The size of the hole in the plastic ball through which the food fell could be adjusted by moving a plastic flap. It was reduced to a size such that approximately 3 to 8 pellets fell into the feeding bowl each time the button was pushed. Once a horse had successfully pushed the button, it could see the pellets falling into the feeding bowl and hear them hit the bowl.

Figure 2 A) *Button with a wooden construction placed around for protection. (Photography by Melanie Minichberger)* ***B)*** *Wooden box (top right corner), covering the food dispenser, and feeding bowl (bottom left corner) fixed to a wooden board. (Photography by Christian Haberl)*

Both the wooden board with the food dispenser and the feeding bowl as well as the button in its wooden structure were only inside the test pen during learning/test sessions, in the presence of the experimenter, and were removed from the test pen every day after the session took place.

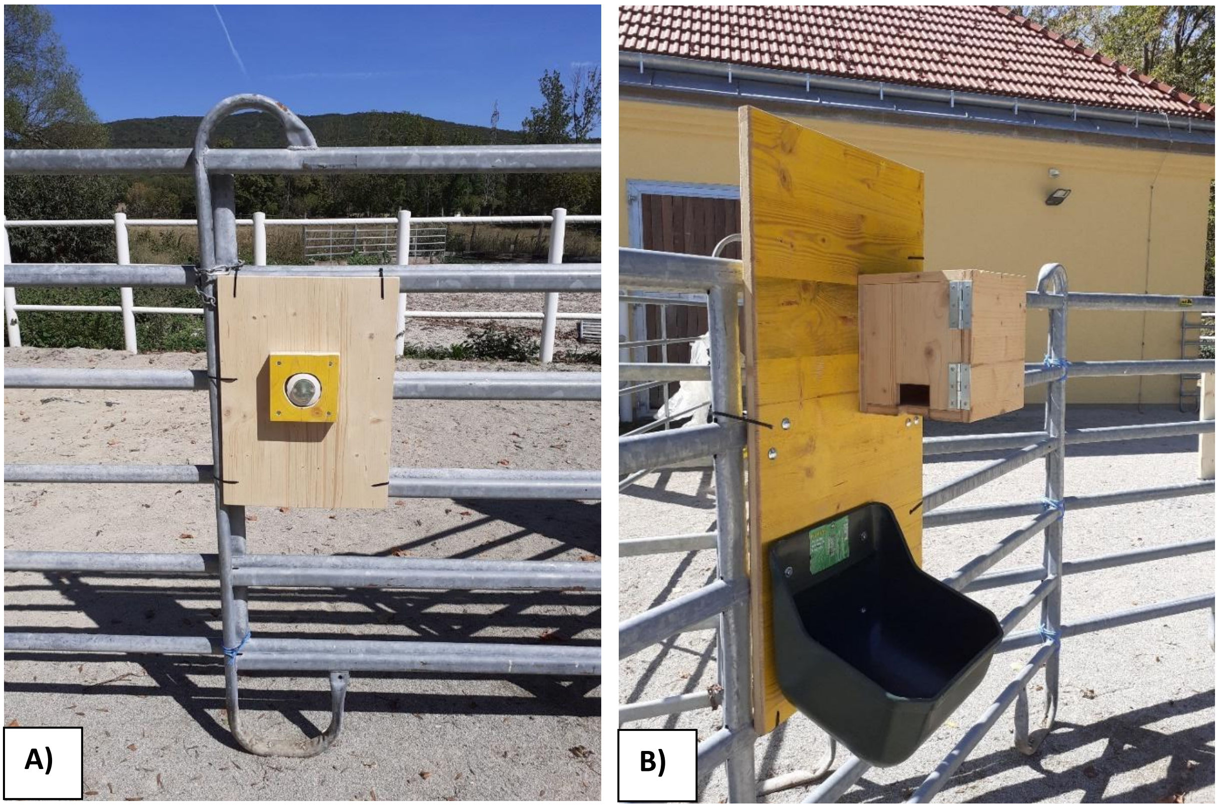

Figure 3 A) Button fixed to the fence of the test pen. B) Feeding bowl and wooden box for food dispenser fixed to the fence of the test pen. (Photographs by Melanie Minichberger)

3.3 Test paddock

The horses learned and were tested inside a paddock (approximately 11 m x 12 m in size) that was normally part of the outdoor enclosure occupied by the group of horses living in and around the Erlbacherhaus. For the duration of the study, it was separated from the rest of the enclosure by a metal fence and divided into two compartments, also separated by a metal fence (**Fig. 4**).

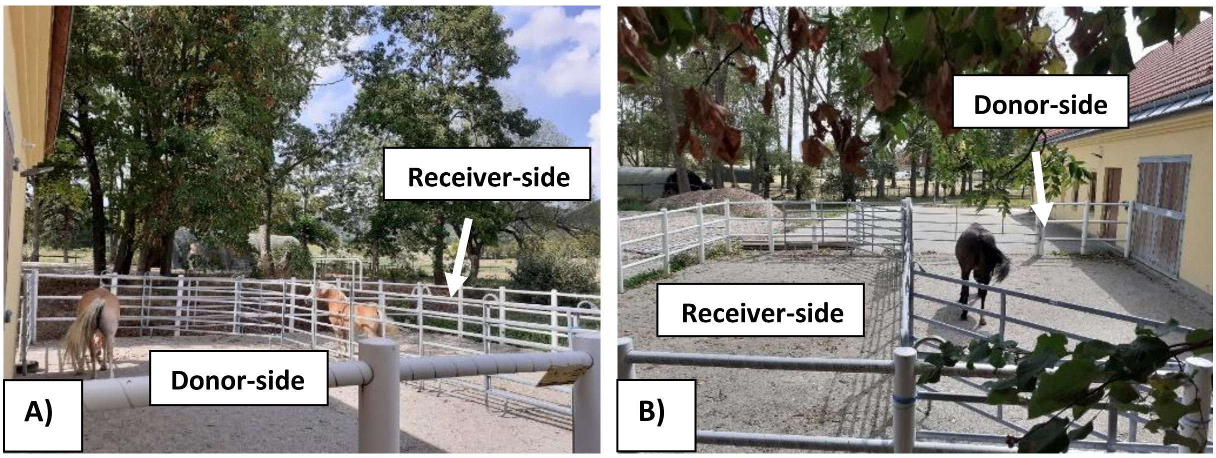

Figure 4 A) Test paddock viewed from the side of the entrance to the Erlbacherhaus. B) Test paddock viewed from the opposite side. (Photographs by Melanie Minichberger)

In one compartment (Donor-side), the button was fixed to this fence. In the other compartment (Receiver-side), the feeding bowl and the food dispenser were fixed to an additional metal fence element in the corner adjacent to the button (**Fig. 5**). During learning and test sessions, there were two horses inside the paddock at the same time, one on the Donor-side and one on the Receiver-side, with the gate separating the two sides closed. This was to ensure that the Donor-horses themselves never had access to the food after they pushed the button. Each compartment was equipped with a bucket of water to ensure that all horses had ad libitum access to water at all times.

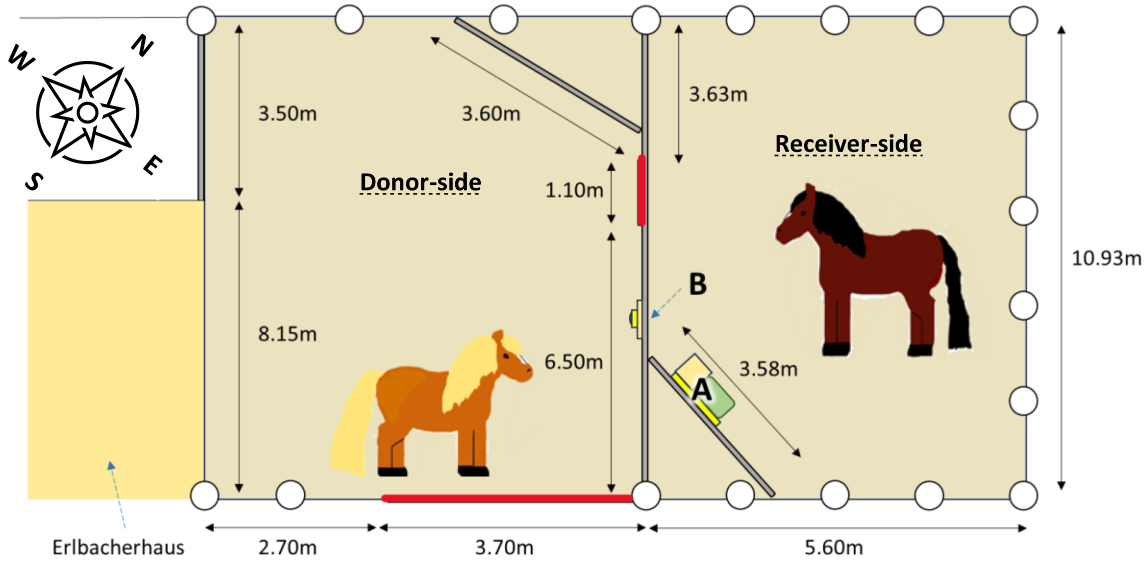

Figure 5 *Schematic illustration of the test paddock viewed from above. Grey bars represent fence elements used to subdivide the paddock; red bars represent the gates through which the horses were brought; white circles represent the posts of the paddock fencing. A: food dispenser and feeding bowl. B: button.*

3.4 Procedure

3.4.1 Learning phase

The learning phase aimed to familiarise the horses with the apparatus and the general set-up of the experiment. It was intended that the horses learn how to push the button and that they can eat from the feeding bowl (after the other horse pushed the button). For this purpose, two horses were brought onto the test paddock: one to the Donor-side and one to the Receiver-side. The horses were left in their compartments by themselves and could explore the paddock or interact with the apparatus. After 5 minutes, the horse from the Donor-side was brought to the Receiver-side and vice versa. The general procedure of the learning phase was carried out in this manner. Five learning stages, each lasting 2-4 days (**Fig. 7**) and with modifications to the process, were intended to increase the pushing behaviour as well as the likelihood compared to the previous stage that the horses would connect the action of pushing the button with the horse on the other side of the fence receiving food. If the frequency of pushing the button did not increase considerably (at least by 10 successful pushes per horse for at least three horses) compared to the day before, the next stage was started after a maximum of 4 days. The learning phase lasted 15 days in total and took place between the 26th of August and the 25th of September 2022.
All 10 horses participated in the learning sessions each day. Which horses were paired together for a session was selected pseudo-randomly, using the website "random.org" (https://www.random.org/integer-sets/), and changed every day, until each horse has had all 9 horses

as a partner at least once. Then, the order of the parings was repeated, starting with the first day of the learning phase. This was maintained throughout the entire study, including the test phase.

3.4.1.1 Stage 1 – Spontaneous learning

Throughout the whole learning phase, one horse entered the test paddock with the experimenter through a gate (3.70 m wide) on the Donor-side at the beginning of the first learning session of a pair that day and was brought to the Receiver-side through a gate (1.10 m wide) of the middle-fence separating the two compartments. The latter was then closed, and a second horse was brought to the Donor-side (**Fig. 5**). In the first stage, each horse was confronted with the apparatus for 2 learning sessions per day (one session on the Donor-side with the button and one session on the Receiver-side with the food dispenser and the feeding bowl) and was left to spontaneously learn the mechanism on their own. Which horse of each pair started on the Donor-side and which on the Receiver-side was pseudo-randomised. The session commenced as soon as the experimenter started the video recording outside the paddock, and lasted 5 minutes. After that, the horses were taken to the respective other side by the experimenter and another 5-minute session was started. The horses were then brought back to their home pen and the next pair of horses was fetched. Using this approach, all 10 horses were given 2 learning sessions per day for 2 consecutive days. On the third and last day of this stage, the set-up was modified in that the button was presented without the yellow wooden construction (**Fig. 6**). This was to test whether the horses would find the button more attractive or easier to push if it protruded from the board to which it was attached compared to when the yellow construction was placed around it for protection.

Figure 6 *Button without yellow wooden construction, mounted in the test paddock during the learning phase. (Photography by Melanie Minichberger)*

3.4.1.2 Stage 2 – Increasing motivation

In order to increase the attractiveness of the button for the horses, one teaspoon of commercially available apple sauce was smeared on the button before each session in this stage. Apart from that, the procedure was similar to stage 1. The horses already were familiar with the taste of apple sauce as they had repeatedly been receiving it together with worm paste (to distract from the strange taste of the latter) as part of their usual health routine. The horses were expected to lick the sauce from the button and successfully push the button while doing so. If a horse licked the button, another teaspoon of apple sauce was spread on the button before the session for the second horse started. No more apple sauce was smeared on the button within a session of one and the same horse. This stage lasted 4 days.

3.4.1.3 Stage 3 – Repeated sessions

On the next 4 days, the procedure was similar to stage 2, except that each horse was on the Donor-side for a total of 10 minutes rather than 5 minutes: One horse was kept on the Donor-side of the paddock for 5 minutes, then it switched to the Receiver-side and was kept there for 5 minutes. Thereafter, the horse switched back to the Donor-side again for 5 minutes and once again to the Receiver-side for 5 minutes after that. For this horse´s partner, the order on which side of the paddock it was placed on that day was exactly the opposite. Thus, each horse was twice on the Donor-side and twice on the Receiver-side in one day. This longer period was carried out in order to accelerate learning opportunity for each horse and improve the horses´ understanding of the mechanism of the apparatus by switching repeatedly from one side to the other while having the chance to act on the apparatus or eat the food immediately after they had been on the other side with the corresponding part of the apparatus.

3.4.1.4 Stage 4 – Demonstration, 2 minutes

Here, the horses were trained for 2 days as in stage 3, that is each horse being on the Donor-side on its own for two sessions per day with the apple sauce smeared on the button. Additionally, each time a horse had been on the Donor-side for 5 minutes by itself, the experimenter took this horse on a rope and lead it in circles to and away from the button for 2 minutes, pushing the button approximately every 20 seconds, each time when standing in front of it with the horse (demonstration). The horse on the Donor-side could watch the experimenter push the button and hear the food fall into the feeding bowl shortly after that. This provided the horses with the opportunity to associate the action of pushing of the button with the falling of the food. Since not all horses had pushed the button in the previous stages, this stage was conducted to motivate these individuals to do so. Each Receiver-horse had multiple opportunities to observe another horse standing in front of the button, to hear the sound of the button and to eat food from the feeding bowl shortly after hearing that sound and watching the Donor-horse close to the button, which in stages 1-3 was only the case when a Donor-horse actually pushed the button. This was intended to increase the probability of the horses pushing the button themselves as they could repeatedly witness how the apparatus worked.

3.4.1.5 Stage 5 – Demonstration, 1 minute

After stage 4, the demonstration by the experimenter was reduced to 1 minute for 2 more days so the Receiver-horse would not end up eating too much food, even if the Donor-horses had pushed the button multiple times beforehand. This was an important measure, given that a sharp increase in food intake may have led to digestive problems in the horses.

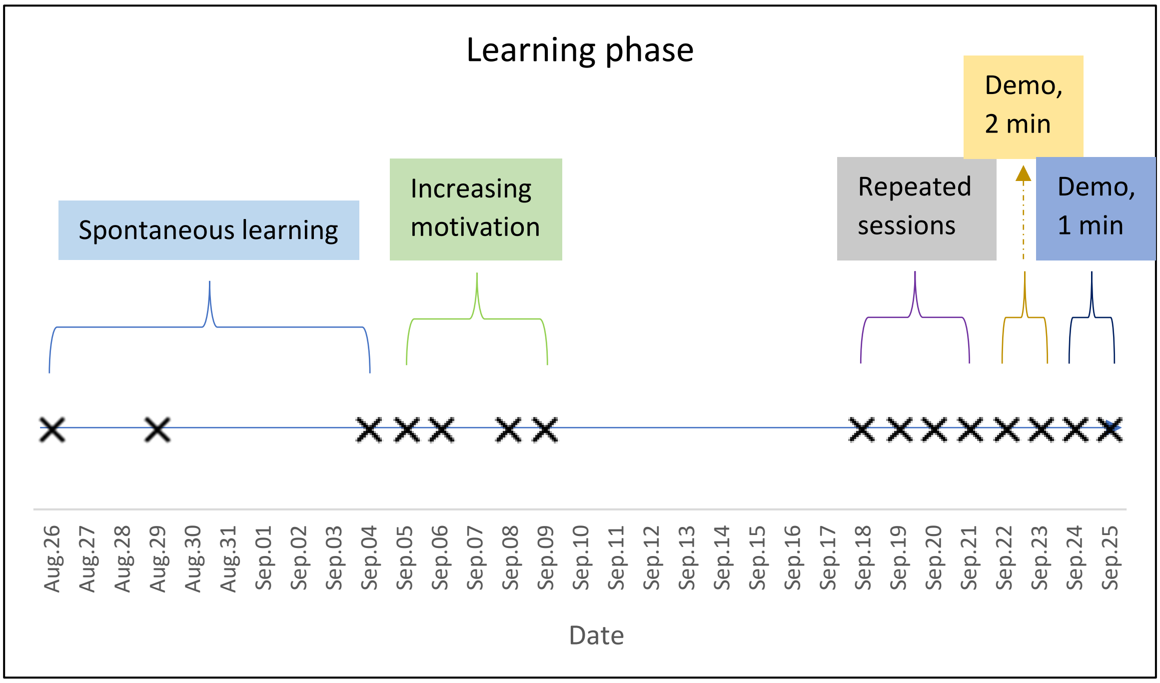

Figure 7 *Learning phase divided into separate stages, and their duration. Each cross marks one day in the learning phase.*

3.4.2 Test phase

The general set-up and procedure of the test phase were similar to those in the learning phase. The primary change was that no apple sauce was smeared on the button throughout the whole phase, so the amount of button pushes could be indicative of how motivated the horses were to actually push the button instead of licking the apple sauce off the latter. There were three different conditions, including two test conditions and one control condition:

3.4.2.1 Test 1

The first test condition started 4 days after the last learning stage had been terminated and lasted 2 days. As in the learning phase, the horses were pseudo-randomly assigned to pairs. Each horse was initially either on the Receiver-side or on the Donor-side for 5 minutes and then switched sides 3 times with its partner horse, as was conducted from stage 4 of the learning phase.

3.4.2.2 Control

For the following 2 days, the control condition took place. The procedure was the same as in test 1, with the exception that the board with the food dispenser and the feeding bowl was removed from the Receiver-side (**Fig. 8**). This was to assess whether the horses pushed the button less when another horse obtained no food than when another horse did obtain food, thus eliminating the possibility that the horses pushed the button for reasons other than providing food to the partner.

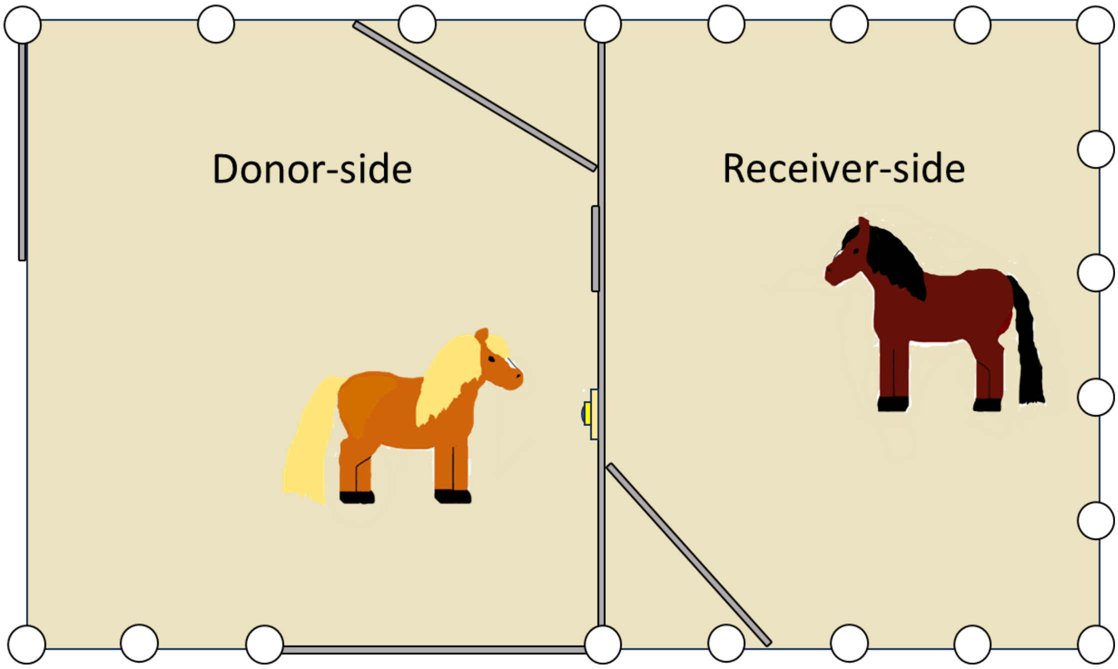

Figure 8 Schematic illustration of the test paddock and horses during the control condition of the test phase. Feeding bowl and food dispenser were removed from the Receiver-side.

3.4.2.3 Test 2

To test whether a potential decrease in pushing the button in the control condition was due to an order effect, the procedure of test 1 was repeated in test 2 for 2 days.

3.4.3 Control of task understanding regarding the function of the apparatus

On the last day of the test phase, after all horses had completed their test sessions, each horse was brought into the test paddock once more for 5 minutes and without a partner, with the door of the fence separating the two sides of the paddock remaining open. This was to determine whether the horses would successfully push the button and walk to the other side to eat the food if given the chance.

3.5 Behavioural observations

During both the learning and the test phase, a camera was set up to record the horses interacting with the apparatus. The number of times the apparatus was successfully manipulated, attempting to push the button, touching the yellow board around the button, and eating from the bowl were assessed on the videos (**Tab. 2**). Successful pushes were identified by the sound the button emitted upon being pushed. The falling of food into the feeding bowl was not used as a point of reference that the button was pushed successfully because pushes could occur at short intervals and the mechanism that caused the food to fall was not triggered unless there were few seconds between pushes. To determine whether the horses successfully pushed the button more often when another horse was close to the feeding bowl, a second camera recorded both sides of the test paddock during the test phase and it was noted whether the Receiver-horse was within a 1-metre radius of the feeding bowl at the time when the Donor-horse pushed. To be able to recognise whether a horse was within 1 metre of the feeding bowl on the videos, the distance from the centre of the feeding bowl to prominent points 1 metre away on the paddock fencing was measured and those points were chosen as markers.

Table 2 Ethogram for interactions with the apparatus. All behaviours were recorded as events, with the frequency of each occurrence being counted.

Behaviour	Description
Successfully pushing the button	The horse touches the button with its muzzle, teeth or tongue hard enough to trigger the mechanism that causes the button to emit a sound.
Unsuccessfully pushing the button	The horse contacts the button (e.g. sniffing, nibbling, licking, pushing) but the contact is not strong enough to trigger the mechanism that causes the button to emit a sound.
Touch board	The horse contacts the yellow wooden construction around the button with its muzzle, teeth or tongue.
Putting muzzle into the bowl	The horse eats the food that has fallen from the apparatus into the bowl.

3.6 Statistics

Statistical analysis was carried out in R Studio (version 2023.06.0+421) using R version 4.2.2 (R Core Team, 2022).

3.6.1 Inter-rater reliability

20% of all videos (including learning and test phase), for the response variables "successfully pushing the button", "unsuccessfully pushing the button" and "touch board" were coded by two independent raters. An intraclass correlation coefficient (ICC) was obtained to assess the accordance between these two raters. For that, the R package "IRR" (version 0.84.1) and a two-way model were used. For "touch board", the ICC was 0.894 and the p-value was < 0.0001, which means a high reliability, which was also the case for "unsuccessfully pushing the button" (ICC = 0.816, $p < 0.0001$) and "successfully pushing the button" (ICC = 0.963, $p < 0.0001$).

3.6.2 Effect of learning stage and day on the proportion of successful pushes

To address the question whether the different **stages** (stage 1-5, see Methods) in the learning phase affected the proportion of **successful** pushes, a Binomial Mixed Effects Model was fitted. The number of successful and unsuccessful pushes were combined with the function "cbind" (version 4.2.2; R Core Team, 2022), creating a proportion of successful pushes out of the total number of pushes (successful/(successful+unsuccessful)) and comprising the response variable. Unsuccessful pushes were counted when there was a contact between a horses´ muzzle, tongue or teeth and the see-

through part of the button as well as the yellow board around the button, without successfully pushing the button. Touches of the yellow board were added here because the horses had not had any contact with the button before (in contrast to the test phase) and therefore the contact with the board was regarded as an interest in the button. Stage, first/second observation of a horse in a day, age and sex were the fixed effects and subject and observation (each observation was given an individual ID, starting with the first observation of the first horse at day 1, ending with the second observation of the last horse on the last day) were included as random effects.
The function “glmer” of the package “lme4” (version 1.1-35.1; Bates et al., 2015) was used to run the model. The random slopes of the single stages (stage 2-stage 6) were dummy coded and centred, before including them in the model. Stage 1 was used as default.

Z-transformation of age and first/second observation to a mean of zero and a standard deviation of 1 was conducted. Collinearity was assessed using the function “vif” (maximum VIF: 1.306) of the package “car” (version 3.1-2) and overdispersion was tested for using the function “testDispersion” of the package “DHARMa” (Hartig, 2022). The model was overdispersed (dispersion = 1.8913, p-value < 0.001).

Stage was omitted from the fixed effects of the model for the full-/null-model comparison. For the likelihood ratio test, the “anova”-function was used to conduct a chi-squared test, assessing whether the two models significantly differ from each other. A post hoc pairwise comparison using the function ”emmeans” of the package “emmeans” (Lenth, 2024) was performed to control for significantly different proportions of pushes between individual stages.

The same model was used to test whether the **day** of the learning phase had an effect on the proportion of successful pushes, with the exception that day was included as a fixed effect instead of stage. For the full-/null-model comparison, day instead of stage was omitted from the fixed effects.

Again, collinearity was assessed using the function “vif” (maximum VIF: 1.193). The function “testDispersion” detected an overdispersion of the model (dispersion = 1.7964, p-value < 0.001).

225 trials (observations) of 10 horses over 15 days were analysed.

3.6.3 Effect of day on the number of successful and unsuccessful pushes in the learning phase

Use was made of a Poisson Mixed Effects Model to test whether **successful and unsuccessful** pushes combined increased during the learning phase. Again, unsuccessful pushes were counted when there was a contact between a horses´ muzzle, tongue or teeth and the see-through part of the button as well as the yellow board around the button. The response variable was the number of successful and unsuccessful pushes added up per day. Day was the fixed effect and number of the observation was the random effect. An offset term of learning sessions was included, accounting for the additional second session per horse from the eighth day.
The function “glmer” of the package “lme4” (version 1.1-35.1; Bates et al., 2015) was used to fit the model. Z-transformation of day was conducted. The model was tested for overdispersion using the function “testDispersion” of the package “DHARMa” (Hartig, 2022). The model was not overdispersed (dispersion = 0.6194, p-value = 0.784).

For the full-/null-model comparison, day was excluded from the first part (the fixed effects part) of the model. The function “anova” was used to perform the likelihood ratio test and to detect a significant difference between the models.

3.6.4 Successful pushes of the button across conditions

A Poisson Mixed Effects Model was used to assess whether condition influenced the frequency of horses **successfully pushing the button** (i.e. resulting in a sound being emitted from the button) in the test phase. A Zero-Inflated Poisson Model and a Zero-Inflated Negative Binomial Model were considered as well, but after correction of the AICs, they both had higher AICs (Zero-Infl. Poisson: 496.7, Zero-Infl. Binomial: 434.4) than the Poisson Mixed Effects Model (386.7) and therefore were not chosen. The number of times horses successfully pushed the button was included as the response variable. Condition (test 1, control, test 2), whether it was the first or second observation of a horse in a day and the age and sex of the Donor-horse were chosen as fixed effects. Subject (i.e. a horse´s identity) was the random effect. The model was fitted using the function “glmer” of the package “lme4” (version 1.1-35.1; Bates et al., 2015). The random slopes of the conditions (test 1, test 2) were dummy coded and centred, before including them in the model. Control condition was used as default. Age and first/second observation were z-transformed to a mean of zero and a standard deviation of 1. The model was assessed for collinearity using the function “vif” (VIF = Variance Inflation Factor) from the package “car” (version 3.1-2) (maximum VIF: 1.029). The function “testDispersion” of the package “DHARMa” (Hartig, 2022) was used to test the model for overdispersion. No overdispersion was detected (dispersion parameter = 0.3628, p-value = 0.824).

For the likelihood ratio test, a full-/null-model comparison was performed whereby for the null-model, condition was excluded from the first part of the model (being the fixed effects part of the model). The “anova”-function was used to assess whether the two models significantly differ from each other.

3.6.5 Unsuccessful pushes of the button across conditions

A Poisson Mixed Effects Model was used to test whether condition affected the frequency of horses **unsuccessfully pushing the button** in the test phase. Unsuccessful pushes occurred when there was a contact between a horses´ muzzle, tongue or teeth and the see-through part of the button, without successfully pushing it so a sound could be heard. It was not taken into account how often the horses touched the yellow board around the button here as there was little difference in how the numbers of touches of the button and the board combined varied between the three conditions compared to the numbers of only the touches of the button. The Poisson Mixed Effects Model had a lower AIC value (242.3) than the Zero-Inflated Negative Binomial Mixed Effects Model (293.0) and the Zero-Inflated Poisson Model (368.5) after correcting the AICs and was therefore preferred. The number of times horses unsuccessfully touched the button was the response variable. Again, condition, first or second observation of a horse in a day and the age and sex of the horse were chosen as fixed effects and subject was included as the random effect.
To fit the model, the function “glmer” of the package “lme4” (version 1.1-35.1; Bates et al., 2015) was used. The random slopes of condition were included after dummy coding and centring.

Z-transformation of age and first/second observation was conducted as stated above, as was checking the model for collinearity with the function “vif” (maximum VIF: 1.029). Again, the model was tested for overdispersion using the function “testDispersion” of the package “DHARMa” (Hartig, 2022). The test for overdispersion was not significant (dispersion = 1.6241, p-value = 0.168).

For the full-/null-model comparison, condition was once more excluded from the first part of the model (being the fixed effects part of the model). Again, the function “anova” was used to conduct a likelihood ratio test and to detect a significant difference between the models.

For both the analysis of successfully pushing the button and of unsuccessfully pushing the button, 120 trials over 4 days (2 trials per day and horse) were included.

3.6.6 Horses pushing the button with a receiver horse at the feeding bowl

The number of occurrences of a donor horse **successfully pushing** the button while a **receiver horse was within 1 metre of the feeding bowl** in the test phase was assessed. This question was addressed descriptively. Here, only the successful pushes of test 1 and test 2 during the test phase were considered (during the control condition, no feeding bowl was present in the test paddock, thus no horse could have been close to the feeding bowl). In total, 135 successful pushes of 7 horses in 4 days were analysed. 3 horses never successfully push the button during the test phase.

4 Results

4.1 Effect of learning stage and day on the proportion of successful pushes

There was a trend on the effect of stage on the proportion of successful pushing behaviour (successful/(successful+unsuccessful)) of the donor horses in the learning phase (full-/null-model comparison: p-value = 0.0634) (**Fig. 9**). The post hoc pairwise comparison revealed no significant difference in the proportion of pushes between individual stages (**Tab. 3**). Age was a significant effect in the full model (**Tab. 4**). The young horses (categorised into 4-5 year olds) had a higher proportion of successful pushes than the older horses (categorised into 10-21 year olds) in all stages except stage 2 (**Tab. 5**), meaning that the younger horses showed a greater difference between successful and unsuccessful pushes.

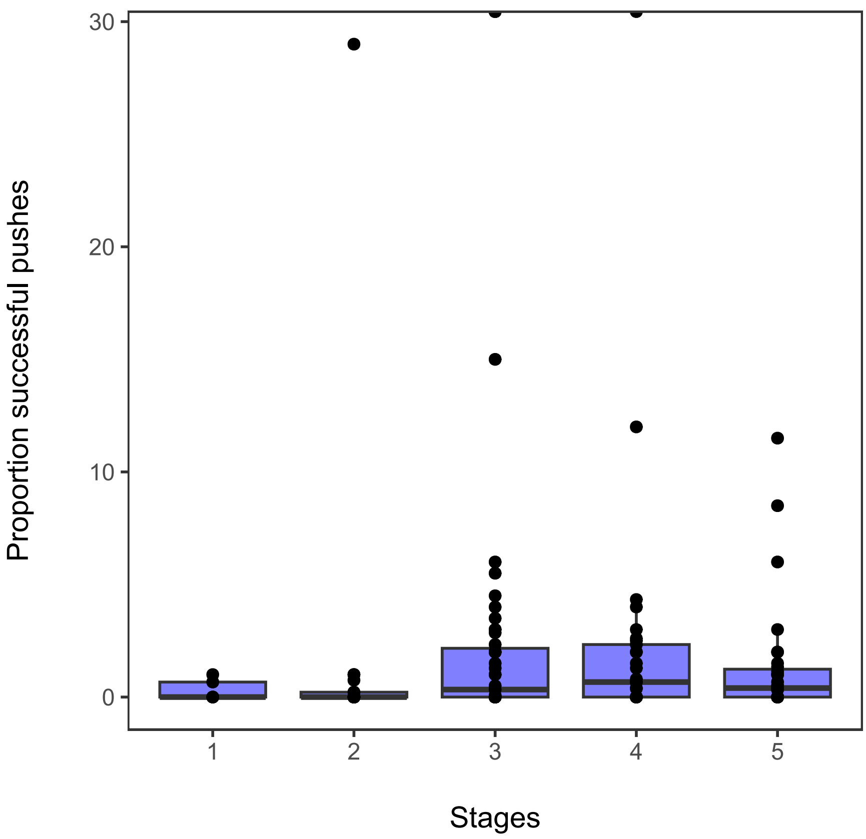

***Figure 9** Proportion of successful pushes per learning stage. Each dot represents the proportion of pushes of one learning session of a horse per day. No proportion could be established if a horse did not push the button at all during a session.*

Table 3 Results of the pairwise comparison of the proportion of successful pushes between individual learning stages.

Contrast	Estimate	Std. Error	Df	z.ratio	p.value
stage1 - stage2	2.678	2.260	Inf	1.185	0.760
stage1 - stage3	-0.751	1.050	Inf	-0.717	0.953
stage1 - stage4	-0.896	1.020	Inf	-0.875	0.906
stage1 - stage5	-0.310	1.010	Inf	-0.305	0.998
stage2 - stage3	-3.429	1.860	Inf	-1.847	0.347
stage2 - stage4	-3.574	1.970	Inf	-1.818	0.363
stage2 - stage5	-2.988	1.990	Inf	-1.503	0.561
stage3 - stage4	-0.144	0.470	Inf	-0.307	0.998
stage3 - stage5	0.442	0.476	Inf	0.928	0.886
stage4 - stage5	0.586	0.450	Inf	1.301	0.691

Table 4 Output of the full model on the proportion of successful pushes in the learning stages.

Term	Estimate	Std. Error	z value	Pr (>|z|)
Intercept	-1.159	0.962	-1.205	0.228
stage 2	-2.678	2.260	-1.185	0.236
stage 3	0.751	1.047	0.717	0.473
stage 4	0.896	1.023	0.875	0.381
stage 5	0.310	1.014	0.305	0.760
sexM	0.248	0.342	0.724	0.469
z.age	**-0.550**	**0.196**	**-2.811**	**0.005**
z.first.second.observation	0.171	0.157	1.091	0.275

Table 5 Proportion of successful pushes (successful/(successful+unsuccessful)) per learning stage of young (4-5 y.) and older (10-21 y.) horses.

	Young horses	Older horses
stage 1	0.4	0.22
stage 2	0.25	0.49
stage 3	0.71	0.5
stage 4	0.66	0.45
stage 5	0.74	0.30

Day did not affect the proportion of successful pushes in the learning phase (full-/null-model comparison: p-value = 0.3169) (**Fig. 10**). The output of the full model is shown in the table below (**Tab. 6**). There were two successful and two unsuccessful pushes on the first day and 91 successful and 53 unsuccessful pushes on the last day. In one case, where an individual ate more than 20 times per session, the trial was stopped to prevent potential digestion problems due to excessive food intake.

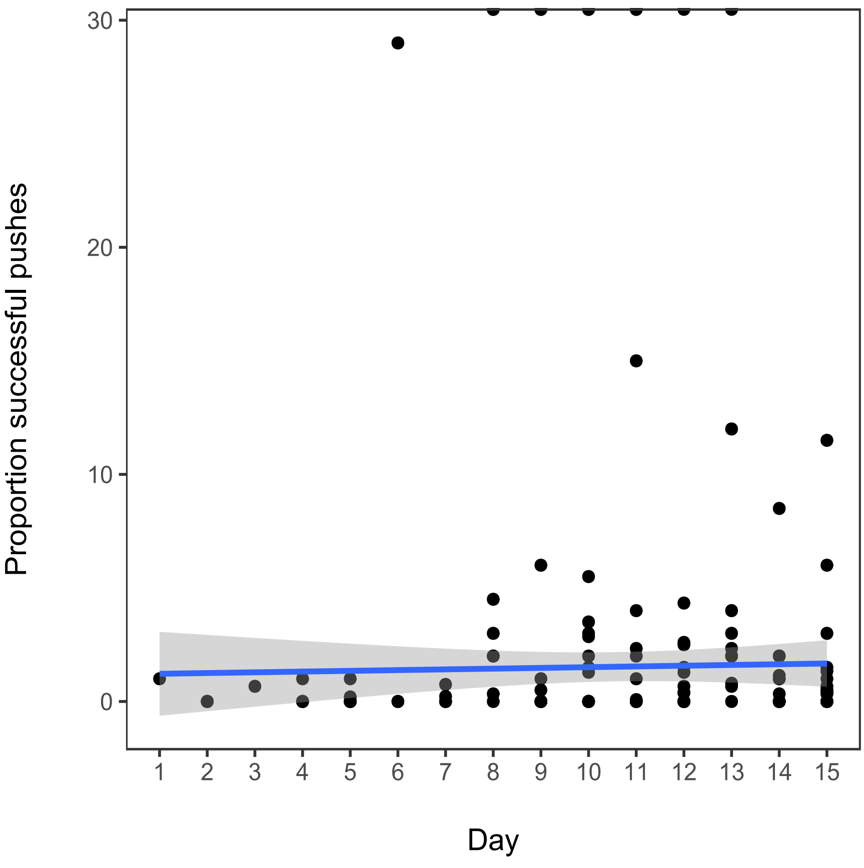

Figure 10 *Proportion of successful pushes per day in the learning phase. Each dot represents the proportion of pushes of one learning session of a horse per day. No proportion could be established if a horse did not push the button at all during a session.*

Table 6 Output of the full model on the proportion of successful pushes per day in the learning phase.

Term	Estimate	Std. Error	z value	Pr (>|z|)
Intercept	-1.141	0.620	-1.842	0.066
day	0.052	0.052	0.995	0.320
sexM	0.085	0.438	0.193	0.847
z.age	-0.435	0.230	-1.891	0.059
z.first.second.observation	0.247	0.158	1.566	0.117

Each horse successfully pushed the button at least 2 times across all 5 stages of the learning phase. The horse with the most successful pushes (Solero) successfully pushed the button 144 times throughout the entire learning phase. Unsuccessful pushes ranged from 7 to 69 pushes per horse. The most proficient horse (Luxi) successfully pushed the button 71% of all her attempts (successful/(successful+unsuccessful)) (**Tab. 7**).

Table 7 Total amount of successful and unsuccessful pushes and the proficiency (represented by the percentage of successful pushes out of all pushing attempts) of each horse during the entire learning phase.

	Successful	**Unsuccessful**	**Proficiency**
Luzie	4	7	36%
Luxi	43	18	71%
Soraya	2	12	14%
Impuls	44	49	47%
Ulli	6	28	18%
Lamantscho	15	39	28%
Farina	40	25	62%
Fortuna	37	25	60%
Tessa	137	67	67%
Solero	144	69	68%

4.2 Effect of day on the number of successful and unsuccessful pushes in the learning phase

The total amount of pushing behaviour (number of successful and unsuccessful pushes of all horses combined) significantly increased over the course of the learning phase (full-/null-model comparison: p-value < 0.001). The output of the full model is shown in the table below (**Tab. 8**). The least pushes of all horses combined occurred on the first day with four pushes and the most pushes were recorded on the last day with 144 pushes (**Fig. 11**).

Table 8 Output of the full model on the number of successful and unsuccessful pushes combined across days in the learning phase.

Term	Estimate	Std. Error	z value	Pr (>|z|)
Intercept	**3.091**	**0.098**	**31.663**	**< 2e-16**
z.day	**0.784**	**0.106**	**7.399**	**1.37e-13**

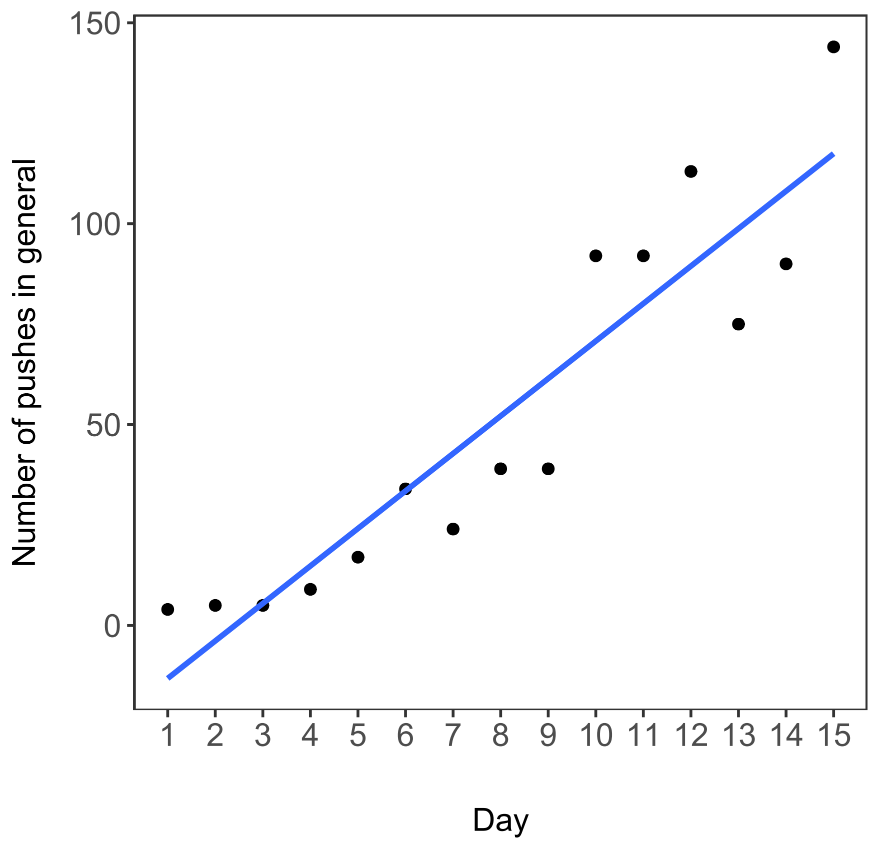

Figure 11 *Successful and unsuccessful pushes combined of all horses per day during the learning phase.*

4.3 Horses´ interaction with the button across conditions

In total, the horses successfully pushed the button 69 times during test 1, 81 times during the control condition and 64 times during test 2. Unsuccessful pushes occurred 25 times during test 1, 30 times during the control condition and 16 times during test 2. Three horses successfully pushed the button in each condition. All horses except one (Soraya) pushed the button unsuccessfully in each condition. There was no effect of condition in the test phase, neither on the overall number of successful pushes (full-/null-model comparison: p-value = 0.2343) (**Fig. 12**) nor on the overall number of unsuccessful pushes (i.e. touching the button without causing food to fall) (full-/null-model comparison: p-value = 0.3315) (**Fig. 13**). There were more successful pushes (214 pushes) than unsuccessful pushes (71 pushes) in all conditions combined.

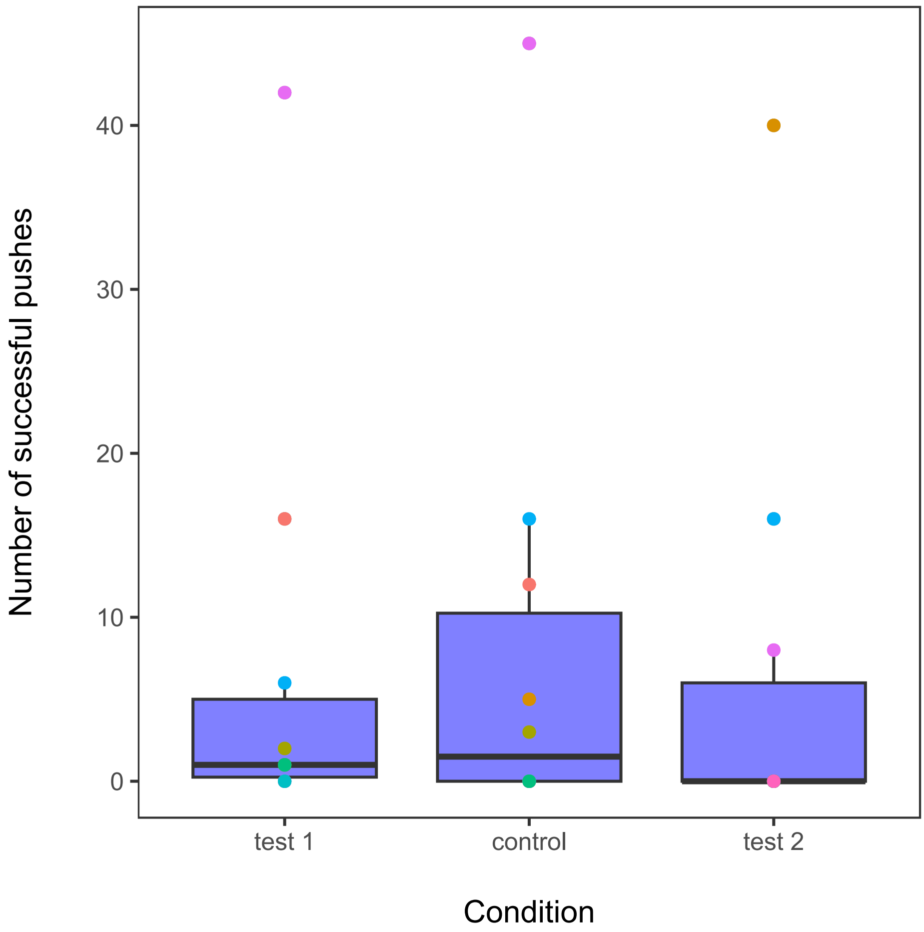

Figure 12 *Number of successful pushes in the three conditions "test 1", "control condition" and "test 2" in the test phase. Each dot represents the total number of successful pushes of one individual in a condition.*

Table 9 Output of the full model on the successful pushes across test conditions.

Term	Estimate	Std. Error	z value	Pr (>|z|)
Intercept	**-1.311**	**0.648**	**-2.023**	**0.043**
condition test 1	-0.201	0.244	-0.823	0.411
condition test 2	-1.506	1.130	-1.333	0.183
sexM	0.163	0.811	0.200	0.841
z.age	**-2.268**	**0.508**	**-4.463**	**8.08e-06**
z.first.second.observation	**0.289**	**0.072**	**4.045**	**5.22e-05**

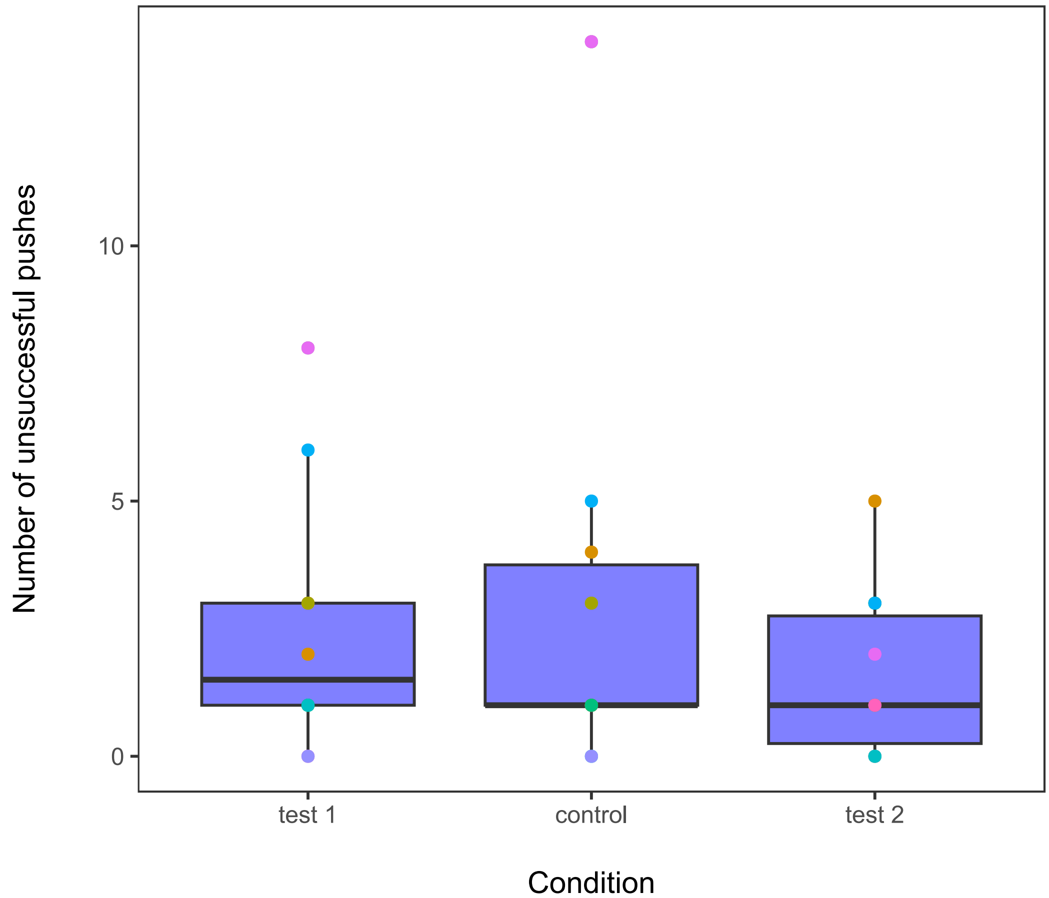

Figure 13 *Number of unsuccessful pushes in the three conditions "test 1", "control condition" and "test 2" in the test phase. Each dot represents the total number of unsuccessful pushes of one individual in a condition.*

Table 10 Output of the full model on the unsuccessful pushes across test conditions.

Term	Estimate	Std. Error	z value	Pr (>|z|)
Intercept	**-0.876**	**0.318**	**-2.755**	**0.006**
condition test 1	-0.182	0.271	-0.673	0.501
condition test 2	-0.651	0.449	-1.450	0.147
sex M	0.281	0.397	0.708	0.479
z.age	**-0.883**	**0.215**	**-4.103**	**4.07e-05**
z.first.second.observation	-0.157	0.121	-1.300	0.194

There was a significant effect of age on the successful pushing behaviour (p-value < 0.001) (**Tab. 9**) (**Fig. 14**). All of the younger horses (categorised into 4-5 year olds) successfully pushed the button more often than older horses (categorised into 10-21 year olds) (**Fig. 15**). Three of the older horses (Luzie, Soraya, Ulli) did not push the button successfully at all during the test phase. Unsuccessful pushes also differed significantly with age (p-value < 0.001), again with younger horses pushing more often (**Tab. 10**).

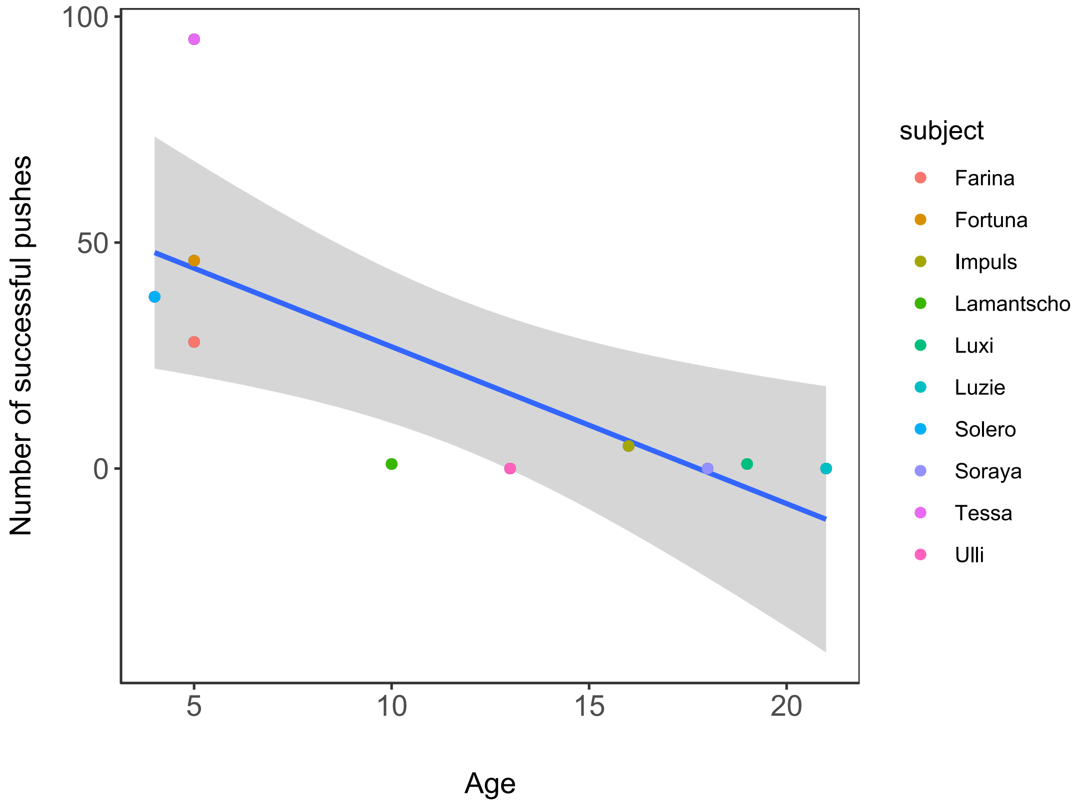

Figure 14 *Number of successful pushes per age during the test phase. Each dot represents the total number of successful pushes of one horse.*

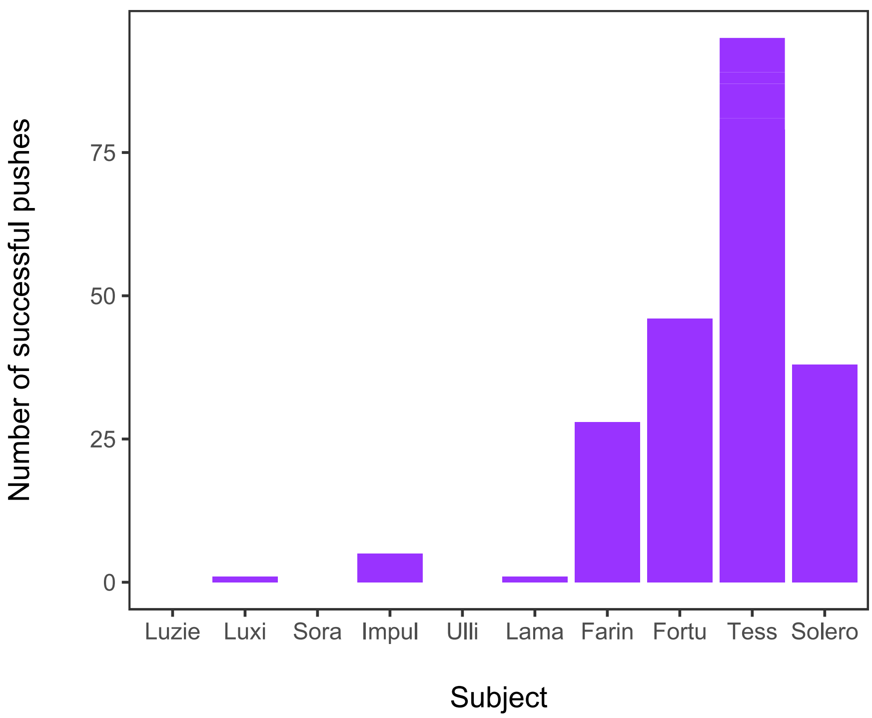

Figure 15 *Successful pushes per individual in the test phase. The horses are sorted from oldest (left) to youngest (right) on the x-axis.*

4.4 Did horses push the button more often while the partner was near the feeding bowl?

Horses successfully pushed the button more often when another horse was within a 1 m radius of the feeding bowl. Out of 135 successful pushes of a donor horse in the test phase (test 1 & test 2), there was a receiver within 1 m of the feeding bowl 115 times (85%) and no receiver 20 times (15%) (**Fig. 16**).

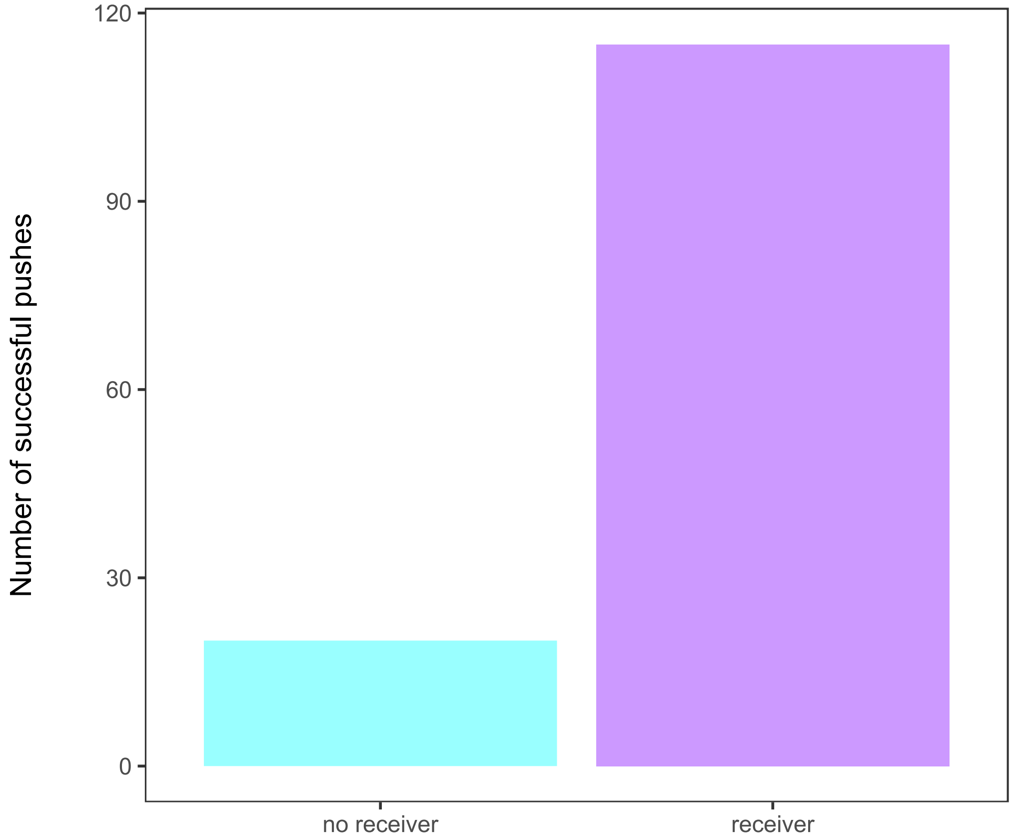

Figure 16 *Number of successful pushes by donor horses with and without a receiver horse being within 1 m of the feeding bowl in the test phase.*

4.5 Control of task understanding regarding the function of the apparatus

When the door of the fence separating the two sides of the test paddock remained open, two horses successfully pushed the button. One of these horses successfully pushed 11 times (Fortuna), the other horse twice (Farina). Only Fortuna walked from the Donor-side to the Receiver-side of the paddock and ate the food from the feeding bowl (Fortuna). She successfully pushed the button 11 times before walking one time to the Receiver-side to eat the food. In total, seven horses walked through the door to the Receiver-side of the paddock and three horses remained on the Donor-side, one of which stuck its nose through the open door (Impuls).

5 Discussion

This study was conducted to test horses' prosocial abilities. A group of horses was tested in pairs in a food-provisioning task whereby one horse could supply the other horse with food without having access to food itself. The Donor-horse had to push a button that caused food to fall into a feeding bowl that the Receiver-horse was able to retrieve. If the Donor-horses pushed the button more frequently in the test condition in which the Receiver-horse was within reach of the feeding bowl than in the control condition where the food dispenser and the feeding bowl were not in the test paddock, this would suggest that horses show prosocial capacities. The results of this study could not demonstrate prosociality in horses as there was no significant difference in pushing behaviour between conditions.

There was no indication that the horses pushed the button of the feeding apparatus intending to provide another horse with food, as there were no more successful or unsuccessful pushes in the test condition than in the control condition. Instead, horses showed slightly more interaction with the button when no food dispenser and feeding bowl were accessible for the Receiver-horse, although not significantly. Thus, the horses in this study did not act prosocially towards a conspecific. However, positive results might be found by using alternative test set-ups. Differences in methodology could lead to varying results in the same species. A study by Dale et al. (2016) found that testing dogs with a token choice paradigm could not exclude social facilitation (in the condition to test this, the conspecific could not reach the food) as an explanation for individuals to choose the prosocial option. The same study found that dogs did exhibit most prosocial behaviour towards a receiver that had access to the food when the act consisted of pulling a rope to deliver food to a conspecific instead to the partner in the social facilitation control.

However, the horses in this study did learn to successfully push the button of an apparatus unknown to them and released food into a feeding bowl by doing so. Whether the horses learned that the action of pushing the button resulted in food falling into a bowl seems unlikely. There was no significant increase in the proportion of successful pushes across days in the learning phase. If the horses understood the apparatus, successful pushes would have been expected to increase whereas unsuccessful pushes should have decreased. Even though a trend could be found when testing for the effect of stage on the proportion of pushes, a post hoc pairwise comparison did not reveal any significant differences between individual stages, which is in line with the results on the effect of days during the learning phase. Interestingly, when looking at the proficiency of the horses, the young horses (4-5 years) showed an increase in proficiency across stages: From stage 3 onwards, at least 65% of all pushing attempts were successful. In contrast, the older horses (≥ 10 years) did not successfully push the button more than 50% of all attempts in either stage. The young horses might have started to push the button harder as a result of eating the apple sauce, which was spread on the button from stage 2 onwards, implying that this age group was more attracted to the apple sauce than the older horses in general were. The exception was one female older horse (Luxi) who successfully pushed the button 71% of the time. The lack of a difference in the proportion when all horses were regarded together suggests that the horses generally started to interact with the button more, thus the unsuccessful pushes also increased instead of decreased. Indeed, the number of successful and unsuccessful pushes combined significantly increased over the course of the learning phase. Extending the learning phase to more than 15 days, as applied here, could lead to an even higher interaction, which could improve the opportunity for horses to understand the function of the whole apparatus. The higher number of pushes the longer the learning phase took indicates that the horses needed a few learning sessions to get used to the set-up and start interacting with the button. One way to address this could be a habituation phase without the feeding apparatus prior to the learning phase, in which the horses could get acquainted with the test paddock, its limited space and the fact that they were separated from their group and the nearest conspecific was separated by a fence.

To the author´s knowledge, this was the first attempt to test horses with a feeding apparatus that only provides food to the partner and thus leaving the actor of the task with no imminent food reward. Horses have been tested with apparatus containing food before, but in these settings the horses that acted on the apparatus gained the food reward for themselves and had no opportunity to provide food to a partner (e.g. Lindberg et al., 1999; Mader & Price, 1980; Smith & Goldman, 1999). Similar versions of the feeding apparatus used in the present study were tested on dogs (e.g. McGetrick et al. 2024 and 2021), but never on horses in an experimental setting. Therefore, the learning phase was used to find a suitable approach to encourage the horses to engage with the apparatus. The first stage (confronting the horses with the apparatus without additional motivation) was replaced after three days by the following stages, due to a lack of interaction with the button. From the fourth day until the end of the learning phase, a familiar treat was placed on the button to provide additional motivation to touch it. The approach of at first letting the horses figure out the mechanism of the apparatus by themselves was chosen in order to obtain as unbiased results as possible if they were to show prosocial behaviour thereafter, meaning that reasons other than prosociality for the horses to successfully push the button were kept to a minimum. Placing the treat on the button had the consequence that the Donor-horse was no longer without any kind of food reward for their action. It could have associated the treat with touching the button and transferred this association to the test phase, which might have led to more or less the same pushing behaviour regardless of the condition during the test phase. Considering the possible association of food with the button, the procedure was nevertheless carried out in that way to investigate whether the horses would be at all successful in pushing the button. This does not mean that the horses would not have been able to learn how the mechanism works on their own if they were given more time. However, the horses were only available to participate in this study for a total of four weeks due to construction work on site and the need to act as training horses for veterinary students. After applying the apple sauce to the button and as the learning phase progressed, each horse succeeded in pushing the button and activating the dispenser. Thus, horses are able to successfully push the button within a few learning sessions, although they may not have intended to push the button but to lick the apple sauce and accidentally pushed the button while doing so.

In the comprehension control, which was conducted to obtain insights into whether the horses understood that the apparatus delivers food upon pressing the button, seven out of ten horses walked to the other side of the test paddock when they had the opportunity. Only one of these seven horses pushed the button and walked to the feeding bowl to eat the food. An eighth horse stuck its nose through the open door to the Receiver-side. Thus, at least eight horses were aware that they could enter the other the side of the paddock, but just one of these horses pushed the button for itself and even this horse only walked to the bowl after several pushes. The results of the comprehension control can be interpreted in more than one way: Either the horses did not understand the function of the apparatus and therefore did not push the button before moving to the feeding bowl or the horses did not connect the open door to the possibility to access the food after pushing. Associative learning is a commonly used tool in training horses, for example when teaching them to move forward by applying pressure with the rider´s leg while sitting on the horse (Baragli et al., 2015): When successfully learned, the horse associates the pressure of the leg with a forward moving behaviour. What is more, a study by Hanggi (2003) suggests that horses do have the ability to form concepts, in this case based on size of various stimuli. Hence, the horses in the present study should in theory not only have been able to associate the open door with free access to the feeding bowl, but they could also have formed a mental concept of a free passage through some kind of barrier by previous experiences and therefore have known that the path to the feeding bowl was unblocked. Given that all participating horses were led back and forth between the two sides of the paddock many times during the learning and the test phase, it was also assumed that they understood that they could use the gate to get to the feeding bowl, and some horses seemed eager to change to the Receiver-side during the sessions. Another explanation is that the horses did connect the pushing of the button with the food but at the same time might have lacked the ability to stop pushing the button long enough to walk to the other side of the paddock to eat the food. However, recent literature did find evidence that horses do have the ability to express behavioural control: In a reward-delay task, horses waited up to 60 seconds in order to gain the high quality food instead of immediately eating the low quality food (Brucks et al., 2022). Further, in a study by Evans et al. (2024), horses initially failed to use inhibitory control when a visual cue was used to signal a Stop-condition, in which the horses could not get a reward by touching a target. When a negative punishment was added to the Stop-condition, the horses abruptly refrained from touching the target, which was interpreted by the authors as a strategic decision-making: they continued touching the target when there was no cost (here a punishment) involved, and they were still rewarded for touching the target from time to time (Evans et al., 2024). The potential failure of behavioural control in the current study could be due to the spatial separation of the location where the action of the task took place and the location of the reward and that the horses had to walk around a fence to get to the food. In previous studies, however, horses were able to solve a detour task around obstacles in order to reach a food reward, but some horses needed at least two trials to succeed (Baragli et al., 2011; McVey et al., 2018; Osthaus et al., 2013; Rørvang et al., 2015). It is therefore possible that, in the present study, more than one horse would have eventually pushed the button and eaten the food, if they had had more time to adjust to the novel situation of an unrestricted access to the feeding bowl and the potentially unsettling fact that they were alone in the test paddock. That being said, the most basic explanation remains that the horses did not understand the function of the apparatus.

Considering the lack of successful feeding from the bowl in the comprehension control, a different approach to teaching horses how the apparatus works might be more efficient, namely that each horse learns to use the apparatus to reward itself prior to testing with a partner. Previous studies have shown that horses are able to learn how to manipulate a device with their muzzle to access a nearby food source, such as pressing a switch (Schütz et al., 2017), pressing a button (Bernauer et al., 2020) or pushing a handle in order to move a lid on a box (Ahrendt et al., 2012). By mounting the feeding bowl close to the button and allowing the horse to feed after successfully pushing the button, horses might associate the action of pushing with the food falling into the feeding bowl more quickly than the procedure of the current study allows them to. However, this approach was not chosen here, as it bears the risk of misinterpretation of positive results in the test phase: There might have been more primitive reasons than prosociality to explain why the horses kept pushing the button when the feeding bowl was no longer on their side of the paddock but on the Receiver-side: The Donor-horse might still have expected a food reward for its action. It might have expected to be able to reach the food, but instead of achieving that goal it could have seen the Receiver-horse eating the food from the bowl in most cases. Having no unblocked access to the feeding bowl because of the Receiver-horse already being there, the Donor-horse could have kept pushing the button and trying to reach the feeding bowl more quickly than the Receiver-horse. Moreover, horses could have experienced the sound of the button as a reward when successfully pushed, as it might have become a conditioned stimulus during the learning phase and could have been perceived as rewarding, despite them not receiving any food in the test phase. Even if the horses had pushed the button more often in the test conditions than in the control condition, which would have indicated that they did not push the button simply because they perceived the sound as rewarding, explanations other than prosociality could still be given for a potential lower frequency of pushing in the control condition. One of these explanations could have been the visual absence of the feeding bowl and the food dispenser and thus the absence of the sound of falling food as well as the apparent lack of opportunity to access the food. However, as there was no significant difference between the test conditions and the control condition it might be worth trying this alternative approach, whereby each horse first learns to push the button and has access to the food in the feeding bowl. In that way, the horses would be familiar with the function of the apparatus before testing them with a partner.

The short learning phase could also have been a limiting factor regarding the horses´ progress in becoming acquainted with the apparatus. The food falling into the feeding bowl caused some individuals to show fear reactions (e.g. backing away from the apparatus). They needed more trials than some of the other horses to habituate to the sound and to learn that the sound signalled the time when the food was available in the feeding bowl. In a study by Gabor & Gerken (2012), ponies were trained to walk into the area of a testing apparatus and push a button within 6 to 13 sessions (one session lasted about 30 min; there was one session on each training day). In Hall et al. (2003), horses were taught by the experimenters to open a box and choose the correct one between two boxes to get a reward in two training sessions on separate days, with each session lasting 20 to 40 minutes. The learning time in the current study can be compared to the training time of other studies, as the horses received 23 learning sessions, each lasting 5 minutes (115 minutes in total). However, in the present study the horses were not trained to perform the task but rather left on their own to learn it. Letting the horses feed from the bowl at the beginning of the learning phase and thus connecting the sound of the falling food to something positive could have helped to reduce the habituation and learning time. Indeed, in many studies on food provisioning, subjects are allowed to eat the food themselves prior to testing for prosocial acts (e.g. Bhattacharjee et al., 2023; Dale et al., 2016; Quervel-Chaumette et al., 2015), which could avoid not only potential neophobic reactions but also might contribute to a basic understanding of the test device for the participating animals. Further, an extended learning period together with the selection of horses that engage with the button more frequently would also take into account the possibility that some individuals could show more prosocial behaviour than others in this experiment, for example due to specific personality traits, like more curious behaviour. If this were the case, a different test set-up would have to be applied for more shy horses.

In the learning phase as well as in the test phase, younger horses (4-5 years) successfully pushed the button more often than older horses (≥ 10 years) and also showed more interaction with the button in general, potentially indicating a higher level of curiosity. This is in line with previous studies, where young horses were more investigative when learning to open a plastic bin (Lindberg et al., 1999) or more explorative when learning to open a feeding apparatus by observation (Krüger et al., 2014). Another reason why some horses pushed the button more often could be that they were more motivated by food (apple sauce). Apart from the fact that all horses that were kept on pasture were older horses (≥ 10 years), these horses also had access to more food (free access to fresh grass in addition to hay) than the horses that were kept on the paddock. Thus, the horses on the pasture may have been more satiated than those on the paddock and therefore less motivated to touch the button. The focal horses under the age of 10 all belonged to the Haflinger breed. Another possible explanation for the higher food motivation and hence the more frequent interaction with the button of these individuals could be the origin of this breed. The Haflinger horse has its roots in the mountain regions of South Tyrol, where forage conditions are scarce, and the breed was repeatedly mated with other breeds that were used to thriving with a low quantity of food (Messner, 2023; Grilz-Seger & Brem, 2023). It therefore stands to reason that Haflinger horses prioritise food intake even more than horse breeds whose origins lie in regions with higher food availability. Interestingly, a study by Lindberg et al. (1999) showed that non-warmbloods, including a Haflinger horse, learned a task faster than did warmblood horses. Together with the younger age of the Haflinger horses used in the current study, these conditions may have contributed further to the higher engagement with the apparatus.

A further explanation for the difference in pushing behaviour between the horses could be that some horses were more focused on their surroundings than were other horses. This could be manifested in a general increase in alertness when being separated from the rest of the herd or in increased alertness in windy weather conditions, or more involvement in sexual behaviour. The gelding Impuls showed signs of stress when brought to the test paddock on one day of the test phase. On that day, one of the mares (Ulli) from the group of horses Impuls was living with was in season (which was apparent because the mare repeatedly passed small amounts of urine, an indicator that a mare is in heat) and Impuls trotted up and down the paddock and whinnied in the direction of Ulli. Consequently, the second horse in the test paddock apparently got distracted by Impuls´ behaviour. When Ulli was brought to the test paddock while she was in season, she showed aggressive behaviour towards the experimental partner horse. Ulli´s behaviour may have caused the partner horse to keep a greater distance from the middle fence thereby reducing its opportunity to interact with the button. A few horses also appeared highly interested in the water buckets, which were put on either side of the test paddock to ensure water supply at all times during the experiment. Instead of these buckets, the horses had self-drinking troughs in their usual enclosures, which could have promoted the buckets to attractive new objects. Some individuals turned the buckets over once or twice a day, causing the water to spill, and started to play with them. Again, this behaviour was mainly observed in younger horses and curiosity and food motivation are possible explanations here as well, as the buckets were used by the management personnel to provide food for certain horses, which may have led to the buckets being associated with food or to them simply smelling of food. A more barren environment may reduce the likelihood of distraction and increase focus on the task of the experiment. In future studies, the test paddock could be set up in an indoor area, where fewer distractions are possible. Additionally, the horses could be acclimatised to the paddock over a longer period of time to avoid an increased stress level during testing. That said, horses that are separated from their group may always be more nervous and easily distracted, as horses are herd animals by nature. As the trait to be tested is also a social one, separating the individuals from their group to perform the task might not be appropriate. Ideally, the test area should be located in a stable where a group of horses is usually kept and where they can freely interact with each other during the experiment. Cooperation in the context of access to food was recently tested in a group setting in pigs (Rault et al., 2021), and squirrel monkeys recently participated in an inequity task, also in a group setting (Vale et al., 2022). To take into account both the reduction of distracting stimuli and the demand to test horses in their regular group, the test area could be set up indoors but with the opportunity for the horses to participate on a voluntary basis and an outdoor area they could access if the individuals are used to these husbandry conditions. As a result, the horses that choose to interact with the apparatus may be better focused on it. Less interested horses could even be attracted to the apparatus by watching other horses complete the task. Some group living species were observed to socially learn a task (Barbary macaques: Garcia-Nisa et al., 2023; Kea parrots: Gudenus et al., 2024; Kune Kune pigs: Veit, 2016). Even though existing data supports less complex mechanisms (e.g. social facilitation) than social learning (here regarded as imitation or goal emulation) in tests with horses (McVey et al., 2018; Rørvang et al., 2018), horses could still profit from the presence of conspecifics when learning the task and be faster to learn.

The horses successfully pushed the button more often when a receiver was close to the feeding bowl than when no horse was close to the bowl. This could be considered evidence for the horses indeed taking notice of the partner horse´s position when pushing the button. An additional motivation for the Donor-horse to push the button could have been soliciting behaviour by the receiver. The horses on the Receiver-side were observed to either put their muzzles into the feeding bowl repeatedly or to even start pawing the ground near the feeding bowl. Both behaviours could have been expressed because the receiver communicated to the donor that the latter should provide food. Malavasi & Huber (2016) found that horses use pointing gestures and other head movements to attract a human´s attention to a food bucket which was out of the horses´ reach, suggesting that horses can use these gestures for intraspecific communication as well. Further, a study by Trösch et al. (2020) showed that horses could be able to interpret goals of another individual´s actions. Based on this, Donor-horses would have been able to understand that Receiver-horses wanted the food. Nevertheless, the horses in this study pushed the button in the control condition as well, in which the receiver could not paw in front of or put the muzzle into the feeding bowl. A more plausible explanation than the horses considering the partner´s presence when pushing for why there were more successful pushes of the button when a receiver was near the bowl is that Receiver-horses generally spent more time near the feeding bowl than anywhere else in the paddock as they waited for food to fall. Even if this is not the case and the Receiver-horse was more likely to be at the bowl just when the Donor-horse actually interacted with the button, this could simply be because the Receiver-horse went to the bowl after the first successful push and was then already present for the subsequent pushes, as the Donor-horses mostly pushed the button successfully more than once within a short period of time. In order to actually address the question of whether a horse pushes the button more often when a receiver is present, a condition would have been required in which there was no horse on the side of the feeding bowl in the test paddock. Using this approach, it would be more apparent to the Donor-horse that no Receiver-horse is near the feeding bowl and a higher number of button pushes when a receiver is present than when no Receiver-horse is within the test paddock could be interpreted as the Donor noticing the presence of another horse and wanting to provide it with food. For this study, there are unfortunately no informative comparable measurements for the pushes at the times when a Receiver-horse was at the feeding bowl vs. when no receiver was at the feeding bowl, as there was a receiver present in the test paddock at all times. Furthermore, there is no data for the probability of a receiver being at the feeding bowl compared to any other location in the paddock, which could have been set in relation to the times that a horse pushed the button when a receiver was present at the feeding bowl compared to when no receiver was present. Thus, the observation that the horses pushed the button more often when a receiver was at the feeding bowl remains speculative.

Horses did start to interact with the novel test apparatus used in this study. Not only did the horses learn to push the button of the apparatus but they also spontaneously learned to feed from the bowl attached below the food dispenser. Given the short learning period, this suggests that the apparatus is a suitable tool for testing horses. Whether or not it is suitable for testing the particular question of prosociality in horses remains open. The application of a longer data collection period using this device could be a way to provide further insights into prosocial behaviour in horses. However, the suitability of the general test set-up to generate positive results has to be considered. The fact that the act of prosociality in this study is the provision of food to a group member could be improper to test this trait as this behaviour is not natural for horses. Under natural conditions, horses feed on grass alongside their group members for several hours per day. There is no need to provide food for conspecifics and it would hardly be possible due to the composition of the forage. Instead of using food to test for prosocial behaviour, observations of prosocial actions of horses under natural conditions could be taken into account when designing an experiment. To date, results of studies examining potential prosocial behaviour in horses (e.g. Cozzi et al., 2010; Feh, 1999; Pinto et al., 2022) are contradictory or the behaviours could be explained by more selfish motivations of the individuals and further investigations are necessary to help gain more accurate insights.

5.1 Conclusion

Here, horses were experimentally tested for prosocial tendencies for the first time. No evidence for prosociality could be found, as the examined horses showed no evidence that they learned the underlying function of the test apparatus and they did not push the button more often in the test conditions than in the control condition in which the partner could not receive any food. All horses did learn to push the button of the apparatus and thus the apparatus itself harbours potential for further studies, not only for the purpose of testing prosociality. To address the question of whether horses are prosocial, an alternative approach seems reasonable, potentially involving a more natural test setting and an extended habituation and training period for the experiment.

6 Literature

Ahrendt L. P., Christensen J. W., Ladewig J. (2012): The ability of horses to learn an instrumental task through social observation. *Applied Animal Behaviour Science*, 139(1-2), 105-113.

Baragli P., Padalino B., Telatin A. (2015): The role of associative and non-associative learning in the training of horses and implications for the welfare (a review). *Annali dell'Istituto Superiore di Sanità*, 51(1), 40-51.

Baragli P., Vitale V., Paoletti E., Sighieri C., Reddon A. R. (2011): Detour behaviour in horses (*Equus caballus*). *Journal of Ethology*, 29(2), 227-234.

Bhattacharjee D., Cousin E., Pflüger L. S., Massen J. J. M. (2023): Prosociality in a despotic society. *iScience*, 26(5), 106587.

Bates D., Maechler M., Bolker B., Walker S. (2015): Fitting Linear Mixed-Effects Models using lme4. *Journal of Statistical Software*, 67(1), 1-48. doi:10.18637/jss.v067.i01.

Bernauer K., Kollross H., Schuetz A., Farmer K., Krueger K. (2020): How do horses (*Equus caballus*) learn from observing human action? *Animal Cognition*, 23(1), 1-9.

Brucks D., Härterich A., König von Borstel U. (2022): Horses wait for more and better rewards in a delay of gratification paradigm. *Frontiers in Psychology*, 13, 954472.

Cozzi A., Sighieri C., Gazzano A., Nicol C. J., Baragli P. (2010): Post-conflict friendly reunion in a permanent group of horses (*Equus caballus*). *Behavioural Processes*, 85(2), 185-190.

Dale R., Quervel-Chaumette M., Huber L., Range F., Marshall-Pescini S., Ryabinin A. E. (2016): Task differences and prosociality; investigating pet dogs' prosocial preferences in a token choice paradigm. *PloS One*, 11(12), e0167750.

DeVries T. J., von Keyserlingk M. A. G., Weary D. M. (2004): Effect of feeding space on the inter-cow distance, aggression, and feeding behavior of free-stall housed lactating dairy cows. *Journal of Dairy Science*, 87(5), 1432-1438.

Evans L., Cameron-Whytock H., Ijichi C. (2024): Whoa, No-Go: Evidence consistent with model-based strategy use in horses during an inhibitory task. *Applied Animal Behaviour Science*, 277, 106339.

Feh C. (1999): Alliances and reproductive success in Camargue stallions. *Animal Behaviour*, 57(3), 705-713.

Fureix C., Bourjade M., Henry S., Sankey C., Hausberger M. (2012): Exploring aggression regulation in managed groups of horses *Equus caballus*. *Applied Animal Behaviour Science*, 138(3-4), 216-228.

Gabor V., Gerken M. (2012): Cognitive testing in horses using a computer based apparatus. *Applied Animal Behaviour Science*, 139(3-4), 242-250.

Garcia-Nisa I., Evans C., Kendal R. L. (2023): The influence of task difficulty, social tolerance and model success on social learning in Barbary macaques. *Scientific Reports*, 13(1), 1176.

Grilz-Seger G., Brem G. (2023): Letzter Glanz und nahender Untergang. In: Brem G. (Ed.), Haflinger im Spiegel der Wissenschaft. Verlag der Österreichische Akademie der Wissenschaften, Wien, 60-65.

Gudenus L. M., Wein A., Folkertsma R., Schwing R. (2024): Feathered lectures - evidence of perceptual factors on social learning in Kea parrots (*Nestor notabilis*). *Animals*, 14(11), 1651.

Gygax L., Neisen G., Wechsler B. (2010): Socio-spatial relationships in dairy cows. *Ethology*, 116(1), 10–23.

Hall C. A., Cassaday H. J., Derrington A. M. (2003): The effect of stimulus height on visual discrimination in horses. *Journal of Animal Science*, 81(7), 1715-1720.

Hanggi E. B. (2003): Discrimination learning based on relative size concepts in horses (*Equus caballus*). *Applied Animal Behaviour Science,* 83(3), 201-213.

Harlow H. F., Harlow M. K. (1962): Social deprivation in monkeys. *Scientific American*, 207(5), 136-147.

Hartig F. (2022): DHARMa: Residual diagnostics for hierarchical (multi-level/mixed) regression models. R package version 0.4.6, http://florianhartig.github.io/DHARMa/.

Heslin K. A., Brown M. F. (2021): No preference for prosocial helping behavior in rats with concurrent social interaction opportunities. *Learning & Behavior*, 49(4), 397-404.

Horn L., Bugnyar T., Griesser M., Hengl M., Izawa E-I., Oortwijn T., Roessler C., Scheer C., Schiestl M., Suyama M., Taylor A. H., Vanhooland L-C., von Bayern A. M. P., Zurcher Y., Massen J. J. M. (2020): Sex-specific effects of cooperative breeding and colonial nesting on prosociality in corvids. *eLife*, 9, Article 58139.

Horn L., Zewald J. S., Bugnyar T., Massen J. J. M. (2021): Carrion rows and azure-winged magpies show no prosocial tendencies when tested in a token transfer paradigm. *Animals*, 11(6), 1526.

Horner V., Carter J. D., Suchak M., de Waal F. B. M. (2011): Spontaneous prosocial choice by chimpanzees. *Proceedings of the National Academy of Sciences - PNAS*, 108(33), 13847-13851.

Jensen K. (2016): Prosociality. *Current Biology*, 26(16), R748, R751.

Jensen P., Yngvesson J. (1998): Aggression between unacquainted pigs - sequential assessment and effects of familiarity and weight. *Applied Animal Behaviour Science*, 58(1), 49-61.

Krüger K., Farmer K., Heinze J. (2014): The effects of age, rank and neophobia on social learning in horses. *Animal Cognition*, 17(3), 645-655.

Lalot M., Delfour F., Mercera B., Bovet D. (2021): Prosociality and reciprocity in bottlenose dolphins (*Tursiops truncatus*). *Animal Cognition*, 24(5), 1075-1086.

Laumer I. B., Massen J. J. M., Boehm P. M., Boehm A., Geisler A, Auersperg A. M. I. (2021): Individual Goffin´s cockatoos (*Cacatua goffiniana*) show flexible targeted helping in a tool transfer task. *Plos One*, 16(6), e0253416.

Lenth F. V. (2024): emmeans: Estimated Marginal Means, aka Least-Squares Means. R package version 1.10.5, https://CRAN.R-project.org/package=emmeans.

Lindberg A. C., Kelland A., Nicol C. J. (1999): Effects of observational learning on acquisition of an operant response in horses. *Applied Animal Behaviour Science*, 61(3), 187–199.

Mader D. R., Price E. O. (1980): Discrimination learning in horses: effects of breed, age and social dominance. *Journal of Animal Science*, 50(5), 962-965.

Malavasi R., Huber L. (2016): Evidence of heterospecific referential communication from domestic horses (*Equus caballus*) to humans. *Animal Cognition*, 19(5), 899-909.

Marin R. H., Freytes P., Guzman D., Jones R. B, (2001): Effects of an acute stressor on fear and on the social reinstatement responses of domestic chicks to cagemates and strangers. *Applied Animal Behaviour Science*, 71(1), 57-66.

Marshall-Pescini S., Dale R., Quervel-Chaumette M., Range F. (2016): Critical issues in experimental studies of prosociality in non-human species. *Animal Cognition*, 19(4), 679-705.

McDonnell S. M., Poulin A. (2002): Equid play ethogram. *Applied Animal Behaviour Science*, 78(2), 263-290.

McGetrick J., Fux L., Schullern-Schrattenhofen J., Rault J-L., Range F. (2024): Do pet dogs reciprocate the receipt of food from familiar and unfamiliar conspecifics? *Ethology*, 130(4).

McGetrick J., Poncet L., Amann M., Schullern-Schrattenhofen J., Fux L., Martinez M., Range F., Clegg S. (2021): Dogs fail to reciprocate the receipt of food from a human in a food-giving task. *Plos One*, 16(7), e0253277.

McVey A., Wilkinson A., Mills D. S. (2018): Social learning in horses: The effect of using a group leader demonstrator on the performance of familiar conspecifics in a detour task. *Applied Animal Behaviour Science*, 209, 47-54.

Messner E. (2023): Ursprung und Entstehung der Rasse Haflinger bis 1918. In: Brem G. (Ed.), Haflinger im Spiegel der Wissenschaft. Verlag der Österreichische Akademie der Wissenschaften, Wien, 13-41.

Moscovice L. R., Eggert A., Manteuffel C., Rault J-L. (2023): Spontaneous helping in pigs is mediated by helper's social attention and distress signals of individuals in need. *Proceedings of the Royal Society. B, Biological sciences*, 290, 20230665.

Osthaus B., Proops L., Hocking I., Burden F. (2013): Spatial cognition and perseveration by horses, donkeys and mules in a simple A-not-B detour task. *Animal Cognition*, 16(2), 301-305.

Pinto P., Mendonça R. S., Hirata S. (2022): Examining the costs and benefits of male-male associations in a group-living equid. *Applied Animal Behaviour Science*, 253, 105660.

Quervel-Chaumette M., Dale R., Marshall-Pescini S., Range, F. (2015): Familiarity affects other-regarding preferences in pet dogs. *Scientific Reports*, 5(1), 18102.

R Core Team (2022): R: A language and environment for statistical computing. *R Foundation for Statistical Computing*, Vienna, Austria. https://www.R-project.org/.

Rault J-L. (2019): Be kind to others: Prosocial behaviours and their implications for animal welfare. *Applied Animal Behaviour Science*, 210, 113-123.

Rault J-L., Camerlink I., Goumon S., Mundry R., Špinka M. (2021): The joint log-lift task: A social foraging paradigm. *Frontiers in Veterinary Science*, 8, 745627.

Rørvang M. V., Ahrendt L. P., Christensen J. W. (2015): Horses fail to use social learning when solving spatial detour tasks. *Animal Cognition*, 18(4), 847-854.

Rørvang M. V., Christensen J. W., Ladewig J., McLean A. (2018): Social Learning in Horses-Fact or Fiction? *Frontiers in Veterinary Science*, 5, 212.

Rutte C., Taborsky M. (2007): Generalized reciprocity in rats. *Plos Biology*, 5(7), e196.

Schino G. (1998): Reconciliation in domestic goats. *Behaviour*, 135(3), 343-356.

Schütz A., Farmer K., Krueger K. (2017): Social learning across species: horses (*Equus caballus*) learn from humans by observation. *Animal Cognition*, 20(3), 567-573.

Shimada M., Suzuki N. (2020): The contribution of mutual grooming to affiliative relationships in a feral misaki horse herd. *Animals*, 10(9), 1564.

Skerry A. E., Sheskin M., Santos L. R. (2011): Capuchin monkeys are not prosocial in an instrumental helping task. *Animal Cognition*, 14(5), 647-654.

Smith S., Goldman L. (1999): Colour discrimination in horses. *Applied Animal Behaviour Science*, 62(1), 13-25.

Snyder-Mackler N., Burger J. R., Gaydosh L., Belsky D. W., Noppert G. A., Campos F. A., Bartolomucci A., Yang C. Y., Aiello A. E., O'Rand A., Harris K. M., Shively C. A., Alberts S. C., Tung J. (2020): Social determinants of health and survival in humans and other animals. *Science (American Association for the Advancement of Science)*, 368(6493), 843, Article 9553.

Tinbergen N. (1975): Tiere untereinander - Formen sozialen Verhaltens. German translation: Otto Koehler; Paul Parey Verlag, Berlin und Hamburg, 3. Original: social behaviour in animals 1-2, 19-20.

Trösch M., Bertin E., Calandreau L., Nowak R., Lansade L. (2020): Unwilling or willing but unable: can horses interpret human actions as goal directed? *Animal Cognition*, 23(5), 1035-1040.

Vale G. L., Williams L., Webb S. N., Schapiro S. J., Brosnan S. F. (2022): Female squirrel monkeys' (*Saimiri boliviensis*) responses to inequity in a group context; testing a link between cooperation and inequity responses. *Animal Behaviour*, 193, 51-62.

Veit A. (2016): Social learning via vertical transmission in Kune Kune pigs (*Sus scrofa domesticus*). Master´s Thesis, University of Vienna.

Wolter R., Stefanski V., Krueger K. (2018): Parameters for the analysis of social bonds in horses. *Animals*, 8(11), 191.