ABC 2023, 10(2):95-104
Animal Behavior and Cognition DOI: https://doi.org/10.26451/abc.10.02.01.2023

Horses' Social Evaluation of Human Third-Party Interactions

Takuto Sugimoto* **and Satoshi Hirata**

Wildlife Research Center, Kyoto University

*Corresponding author (Email: sugimoto.takuto.88e@st.kyoto-u.ac.jp)

Citation – Sugimoto, T., & Hirata, S. (2023). Horses' social evaluation of human third-party interactions. *Animal Behavior and Cognition, 10*(2), 95-104. https://doi.org/10.26451/abc.10.02.01.2023

Abstract – Humans evaluate others by observing their interactions with third parties that are not directly related to the observers' interests. Such third-party evaluations have not been well-studied in nonhuman animals. In this study, we investigated whether horses socially evaluate humans based on their third-party interactions. We used a helping paradigm similar to that used in earlier studies with dogs and cats: that is, the horses watched as an experimenter (attempter) tried unsuccessfully to open a container in order to remove an object and then asked another actor on his right (i.e., helper/non-helper) for help. The actor either helped the attempter or refused the request by turning away. After this interaction, the attempter repeated the same procedure with another actor on his left. The actor on the left played the opposite role to the actor on the right. After these two interactions, the two actors offered food to the horse simultaneously. The horses were able to freely choose which actor to take the food from. They showed no preference for the helper over the non-helper. Therefore, in line with the results from the first trials of previous studies in dogs and cats, horses may not have a robust third-party evaluation ability. However, future studies should use other paradigms that are more suitable to the social ecology of horses.

Keywords – Horses, Social evaluation, Third-party evaluation, Social cognition, Horse–human relationships, Domesticated animals

---

Humans live in cooperative societies where they evaluate others and decide with whom they will cooperate in the future. Humans evaluate others based on not only their direct interactions, but also other peoples' interactions with mutual third parties which are not directly related to their interests. This evaluation of third-party interactions might be present from infancy (Hamlin et al., 2007, 2010; Vaish et al., 2010). These evaluations play a part in shaping peoples' reputations, which may benefit or disadvantage them in the future (i.e., indirect reciprocity; Nowak & Sigmund, 2005). Hence, third-party evaluations are considered to be an important factor in maintaining human cooperative societies (Nowak & Sigmund, 2005).

From infancy, humans are able to evaluate third-party interactions. For example, Hamlin et al. (2007) presented 3-month-old infants with animations depicting a character helping another character (neutral) up a slope, and a second situation where a character obstructed them. When asked to choose between the neutral character and one of these characters, although the infants did not prefer the prosocial character, they avoided the antisocial character. Similarly, Hamlin and Wynn (2011) showed 5- and 9-month-old infants puppet interactions in which one puppet helped another puppet open a container to get a rattle, whereas in a second situation a puppet hindered the other puppet from opening the container. When the infants were asked to select a puppet, they avoided the antisocial puppet. Furthermore, 6- and 10-month-old infants not only avoided the antisocial character, but also preferred the prosocial character in the same experiment (Hamlin et al., 2010).

Researchers have tried to clarify the evolutionary origins of human cooperative societies by investigating which species show sensitivity to social evaluations of third-party interactions. This sensitivity in nonhuman animals has mainly been examined in primates (chimpanzees, *Pan troglodytes*: Herrmann et al., 2013; Russell et al., 2008; Subiaul et al., 2008; orangutans, *Pongo pygmaeus*: Hermann et al., 2013; Russell et al., 2008; common marmosets, *Callithrix jacchus*: Kawai et al., 2014) and domestic dogs (*Canis familiaris*) (Kundey et al., 2011; Marshall-Pescini et al., 2011). However, these studies used food exchanges as third-party interactions and examined whether the subjects preferred a generous person who gave food to a beggar or an antisocial person who did not. In these cases, if the subjects preferred the generous person, there is a possibility that the subjects simply chose an actor who was more likely to give them food, thus providing a direct benefit to them. However, the evaluation of third-party interactions by humans does not necessarily involve a direct benefit to the subject.

A few studies have investigated sensitivity in nonhuman animals to third-party interactions that are of no direct relevance to their interests (tufted capuchin monkeys, *Cebus apella*: Anderson et al., 2013; bonobos, *Pan paniscus*: Krupenye & Hare, 2018; bottlenose dolphins, *Tursiops* spp.: Johnson et al., 2018; dogs: McAuliffe et al., 2019). For example, Anderson et al. (2013) used a similar helping paradigm in their study of capuchin monkeys to that used in a human study (Hamlin & Wynn, 2011). A monkey watched third-party interactions between humans. When the human actor asked the other human actor for help opening a container to remove an object from inside, the other actor either helped (i.e., helper) or refused to help by turning away (i.e., non-helper). After these interactions, both actors offered food to the monkey simultaneously. The monkey was allowed to choose which actor to take food from (i.e., the attempter vs. the helper, or the attempter vs. the non-helper). Anderson et al. (2013) found that the monkeys avoided the non-helper and showed no preference for the helper.

Chijiiwa et al. (2015) investigated dogs' sensitivity to third-party interactions in a similar paradigm to that used by Anderson et al. (2013). The dogs observed the following interactions between humans. Their owner tried to open a container to retrieve an object but failed to do so. They then asked one of two people to help them open the container. One of them accepted, while the other refused. In both conditions, another person (i.e., a neutral actor) did nothing. After watching these interactions, the actors (i.e., helper/non-helper) and the neutral actor offered food to the dog simultaneously, and the dog was allowed to choose from whom to take food. The results showed that dogs were less likely to accept food from the non-helper, but showed no preference for the helper.

These studies indicated that monkeys and dogs both showed a negativity bias in that they avoided the non-helper. However, the monkeys in Anderson et al. (2013) received 72 trials, while the dogs in Chijiiwa et al. (2015) received 4 trials. In every single trial, there was a positive direct interaction between the subject and the actor: that is, the subject received food from the actor. Therefore, it is possible that the animals had formed a preference for an actor after the second trial based on the subjects' experience of receiving food from that actor in previous trials. Hence, third-party information should be mixed with direct experiences that can influence the subjects' behavior, especially considering that direct experiences are more reliable than third-party information. For that reason, the subjects' choice in the first trial must be reevaluated. According to Abdai and Miklósi (2016), recalculations of the dogs' choices in the first trial were not significant between the actor (i.e., helper/non-helper) and the neutral actor. In case of the monkeys (Anderson et al., 2013), it is not possible to evaluate the monkeys' choices in the first trial because it was not reported. Moreover, Chijiiwa et al. (2021) found that cats (*Felis catus*) did not prefer or avoid either actor (helper/non-helper) in the first trial using the same scenario as in Chijiiwa et al. (2015). Therefore, it is still unclear whether monkeys, dogs and/or cats can evaluate third-party interactions that are not directly relevant to their interests.

It should be noted, however, that the lack of strong evidence is not due to the animals' inability to discriminate between different human experimenters. In contexts other than third-party evaluations, capuchin monkeys, dogs and cats are capable of discriminating human experimenters who play different roles with or without the presence of food (tufted capuchin monkeys: Kuroshima et al., 2002, 2003; dogs: Gácsi et al., 2004; cats: Ellis et al., 2015; Ito et al., 2016). The lack of a preference for the helper and an avoidance of the non-helper in the subjects of these studies (Anderson et al., 2013, Chijiiwa et al., 2015,

2021) may be because the authors used an object (vinyl tape) which may not be motivating to the animals. Another important point is that in these studies, the researchers asked not whether animals could make a connection between these specific third-party interactions and their own later interactions with those parties, but instead they investigated whether animals showed a preference to a human experimenter if he/she behaved in a friendly manner to another experimenter. This preference was measured by the animals' choice of which experimenter they took food from.

Here, we investigated whether domestic horses (*Equus caballus*) can evaluate third-party interactions between humans using a helping scenario (Anderson et al., 2013; Chijiiwa et al., 2015, 2021). Horses are good candidates for testing nonhuman animals' sensitivity to social evaluations during third-party interactions because horses live in groups and are highly social (Ringhofer et al., 2017); therefore, they are considered to have the ability to evaluate conspecifics. Moreover, they are domesticated animals that share close relationships with humans. Domesticated horses recognize various traits of the humans around them and form preferences for those humans based on their traits. For example, horses can evaluate humans based on previous interactions with them (Sankey et al., 2010) and can find hidden food by following human pointing (Maros et al., 2008; Proops et al., 2010). They are also sensitive to the attentional state of humans and request food from humans who know where food is hidden rather than those who do not (Trösch et al., 2019). Furthermore, horses can discriminate between negative and positive human voices (Smith et al., 2018) and can discriminate children from adults (Jardat et al., 2022).

To our knowledge, there is only one study of third-party evaluation in horses. Trösch, Pellon et al. (2020) examined whether horses discriminated between two unfamiliar people who interacted positively or negatively with an actor horse. After watching videos of positive and negative interactions between the human experimenter and the actor horse, the subject horses were allowed to choose the positive experimenter or the negative experimenter. The horses touched the negative experimenter more frequently than the positive experimenter. Horses have been observed to engage in appeasement behavior which was defined as affiliative interactions between a third horse and an aggressor who had shown aggressive behavior to another horse (Cozzi et al., 2010). Trösch, Pellon et al. (2020) therefore suggested that the horses interpreted the negative interaction as a conflict between the actor horse and the experimenter, and approached the negative experimenter as an appeasement behavior. This suggests that the horses could discriminate between the experimenters based on watching a third-party interaction with a conspecific. However, this study could not rule out the possibility that their discrimination was based on emotional contagion because the actor horse showed its emotional state through facial expressions.

In this study, we investigated the capacity for horses' third-party evaluation of humans more closely by directly comparing a helper with a non-helper using paradigms similar to the ones used in monkeys (Anderson et al., 2013), dogs (Chijiiwa et al., 2015) and cats (Chijiiwa et al., 2021). Although the studies using this paradigm in nonhuman animals did not show a strong positive outcome, the study in human children using this paradigm had a positive result (Hamlin & Wynn, 2011). Importantly, horses have been shown to be able to discriminate between positive and negative human-horse interactions. Therefore, we hypothesized that horses would be able to discriminate between positive and negative interactions in this paradigm involving human-to-human interactions, and we predicted that horses would choose the helper over the non-helper.

Methods

Ethics Statement

The research protocol was approved by the Animal Experimentation Committee of Wildlife Research Center, Kyoto University (WRC-2022-008A).

Subjects

Thirty-two horses (22 males and 10 females) participated in this study. Half of the horses were kept at the Equestrian Club of Kyoto University, Japan, and the other half were kept at the Equestrian Club of Kyoto Sangyo University, Japan. All males were geldings (i.e., they had been castrated). The horses' ages ranged from 3 years to 24 years, with an average age of 14.09 years (*SD* = 5.79) (see Table 1). All subjects had watched humans opening a container and removing an object from inside the container.

Table 1

Subject Horses and their Choices

Breed	Sex[a]	Age (year)	Choice[b]
Thoroughbred	F	8	-[c]
Thoroughbred	M	22	0
Thoroughbred	M	15	0
Thoroughbred	M	20	1
Thoroughbred	F	8	0
Thoroughbred	M	17	-[c]
Thoroughbred	F	15	1
Thoroughbred	M	6	0
Thoroughbred	F	20	0
Thoroughbred	M	13	0
Thoroughbred	M	15	1
Thoroughbred	F	12	0
Thoroughbred	F	6	-[c]
Thoroughbred	M	15	1
Thoroughbred	M	21	1
Thoroughbred	F	18	1
Thoroughbred	F	6	0
Thoroughbred	F	3	0
Thoroughbred	M	17	0
Thoroughbred	M	10	-[c]
Thoroughbred	M	12	0
Thoroughbred	M	6	-[c]
Thoroughbred	M	5	1
Nihon sport	F	19	-[c]
Nihon sport	M	10	0
Nihon sport	M	18	0
Nihon sport	M	18	0
Holstein	M	18	0
PZHK	M	19	-[c]
KWPN	M	14	1
Westfalen	M	21	1
Quarter horse	M	24	0

Note. [a]M, stallion; F, mare; KWPN, Koninklijk Warmbloed Paardenstamboek Nederland; PZHK, Polish Horse Breeders Association. [b]0, the non-helper chosen; 1, the helper chosen. [c]We excluded these horses because of experimental errors and low motivation.

Apparatus

We used a transparent cylindrical container (10-cm diameter, 15-cm height) with a lid and an object inside (a 6-cm diameter roll of vinyl tape). The horses were placed in their stalls and observed the human interactions with their heads hanging out of the stall windows (105-cm length, 87.5-cm width in the Equestrian Club of Kyoto University, 85-cm length, 85-cm width in the Equestrian Club of Kyoto Sangyo

University). The horses were able to move freely in their stalls. We recorded one trial using a video camera (SONY HDR-CX470) mounted on a tripod and positioned behind the three actors.

Procedure

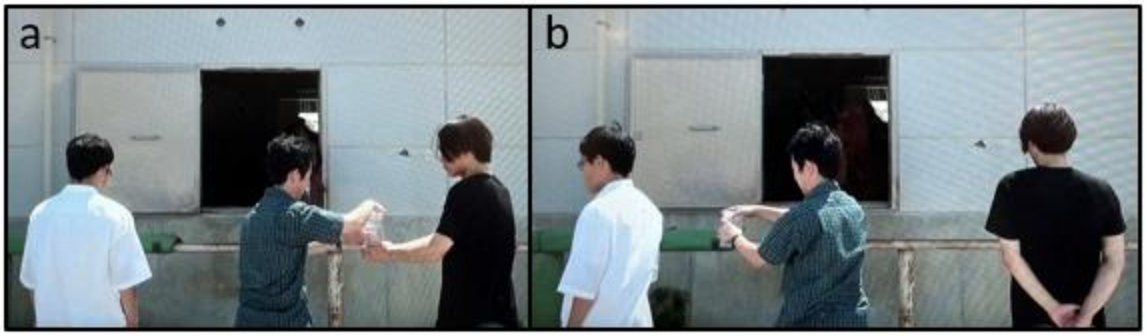
We showed the interactions between the three human actors (A, B, and C) who stood side by side in front of the horses (Figure 1). The three actors were men who were unfamiliar to the horses. The same actor (B) was always the attempter. The roles of the remaining two actors (A and C) were counterbalanced. Each horse received one trial. A trial started when the subject horse looked out of the window, by having its head and neck positioned outside of the window, after the actor B had opened the window which was closed before the trial began. The interactions of the actors A, B and C took place in front of the window. If the horse did not look out of the window, then B called the horse's name and made a noise, and waited until the horse put its head out of the window. When a horse put its head outside of the window, the human actors A, B and C were within the field of view of the horse. The horses observed the following interaction (Figure 2). B (the attempter) tried to take the lid off a container to get the vinyl tape for 5 s. However, because B was unable to open the container, B first asked C, on his right, for help by holding the container towards C. If C is the helper, C responded to the request and held the bottom of the container for 5 s, which enabled B to open the container and remove the object. After B removed the object, B placed the container and the lid on the ground with the object on top of the lid. If C is the non-helper, C refused the request by turning away for 2 s, which left B unsuccessfully attempting to open the container for another 5 s. After the interaction between B and C, B placed the container in front of him. B took another container from the ground and tried to open it for 5 s, however, was again unable to open the container, so B asked A for help. In this case, A played the opposite role to C.

Figure 1

Experimental Scene

Figure 2

Human Interactions Observed by Horses



Note. Panel *a* shows a helping scene where the actor (right) helps the attempter (middle) to open the container, and panel *b* shows a refusal scene where the actor (left) refuses the request for help from the attempter (middle) by turning away.

After B placed the container in front of him, the three actors turned around and A and C switched their positions. This procedure ruled out the possibility that the horse chose the actor based on where the object was taken out (i.e., local enhancement). B turned and stepped forward to offer food (i.e., a piece of carrot) to the horse. When the horse ate the food and the horse's face was in the center of the stall window, B said "yes". After the vocal cue, A and C turned, stepped forward, and extended one arm to offer food on their palms. The horse received food from whichever actor they approached first. The actors' hands were the same distance from the stall window (approximately 85 cm) and were 70 cm apart. To exclude unintentional cues, the three actors did not look at the horse during the demonstration and maintained a neutral expression. The two actors (A and C) also looked at the ground during the choice phase.

Data Analysis

We excluded data from seven horses in our analyses because of errors in the experimental procedure and low motivation (i.e., the horses did not take food from B within 10 s). We used binomial tests to evaluate the horses' performance and determined the effect size of the binomial test for this sample size by using Cohen's *h*. A Bayesian factor analysis was also conducted to obtain a Bayesian factor (*BF*, positivity level = 3). The R package BayesFactor (Morey & Rouder, 2022) was used to calculate the *BF* with the scaling of the prior distribution (logistic distribution) to *rscale* = 0.5 and other settings following the defaults. 10,000 estimations were done using the MCMC method. We could not counterbalance the role of the actors because of the exclusion of these seven horses from the analyses. Therefore, it is possible that the horses' preference for one of the actors may have influenced their choice. We used binomial tests to evaluate whether the horses preferred one of the actors. A Bayesian factor analysis was also conducted to obtain a Bayesian factor (*BF*, positivity level = 3). We used R software (version 4.1.2; R Core Team, 2021) for the analyses.

We analyzed the latency to make a choice and used Wilcoxon rank sum test to investigate whether there was a difference between the latency to choose the helper and the latency to choose the non-helper. Video analysis was carried out using BORIS software (v.7.12.2; Friard & Gamba, 2016). The time from when the two actors offered the food until the horse ate the food from either actor was calculated.

Results

Nine of the 25 horses (36%) chose the helper and 16 horses (64%) chose the non-helper. The frequency was not statistically different from chance (binomial test; p = .230, 95% CI [0.18, 0.57]). We also determined the effect size of the binomial test and found an effect size Cohen's h was 0.56, indicating medium effect. The Bayes factor analysis showed that the Bayes factor of the null hypothesis "Helper's choice ratio = Non-helper's choice ratio" over the alternative hypothesis "Helper's choice ratio ≠ Non-helper's choice ratio" was 1.03 (95%CI [0.23, 0.57]). In addition, we examined the influence of the horses' preference for one of the actors on their choices. Eight of the 25 horses (32%) chose one actor and 17 horses (68%) chose another actor. The frequency was not statistically different from chance (binomial test; p = .108, 95% CI [0.15, 0.54]). The Bayes factor analysis showed that the Bayes factor of the null hypothesis "One actor's choice ratio = Another actor's choice ratio" over the alternative hypothesis "One actor's choice ratio ≠ Another actor's choice ratio" was 0.61 (95%CI [0.20, 0.52]). Also, there was no statistically significant difference in the latency to choose the helper versus the non-helper (Wilcoxon rank sum test: W = 77, p = .791, r = .26, 95% CI [-1.2, 1.7]).

Discussion

This study aimed to investigate whether horses socially evaluate humans by observing third-party interactions between humans. We found no evidence that horses have the capacity for third-party evaluation of humans. This result did not support our hypothesis that horses can evaluate third-party interactions between humans of no direct relevance to their interests. However, the Bayes factor analysis showed that the null hypothesis "Helper's choice ratio = Non-helper's choice ratio" is only 1.03 more likely than the alternative hypothesis, so the evidence is inconclusive.

An explanation for this finding may be that the horses' preference for one of the actors could have influenced their choices because the exclusion of seven horses from the analyses resulted in the inability to counterbalance the actors' roles. Our data analysis showed that the horses did not indicate a preference for one of the actors, but the null hypothesis "One actor's choice ratio = Another actor's choice ratio" is only 0.61 more likely than the alternative hypothesis. Therefore, the horses' preference for one of the actors may have influenced their choices. Future research needs to take additional measures such as examining the baseline of the horse' s preference for the person.

Another potential explanation for these results is that the horses in this study did not understand the meaning or goal of the actors' behavior (i.e., they were trying to open a container to remove an object inside). To our knowledge, one previous study examined the ability of horses to recognize others' goals or intentions through their actions (Trosch, Bertin, et al., 2020). The results of that study suggest that horses may consider humans' goals or intentions and adapt their behavior accordingly. However, the horses in this study had never experienced opening a container to get an object by themselves, though they had seen many humans opening containers and removing objects. Human infants come to understand others' actions by repeatedly observing their actions and the effects associated with the actions after they execute actions (Hunnius & Bekkering, 2014). The ability of horses to understand others' actions may improve if they experience similar behaviors themselves. Therefore, if we were to conduct an experiment after giving horses the chance to experience opening a container to retrieve food themselves, and/or by using more relevant stimuli in the container during the demonstration phase, the horses may be able to evaluate humans based on their third-party interactions.

Age may also have influenced the results. Only one of the five younger horses (< 10 years) chose the helper, while eight of the 18 older horses (≥ 10 years) chose the helper. Although in both cases non-helpers were preferred, the proportion of helpers preferred by age group (20% vs. 44%, respectively) was different. Horses gain more experience interacting with humans as they age, and their comprehension of human interactions may develop over this time. The overall sample size in this study was small, particularly the sample of young horses. Future studies need to increase the sample size, ideally increasing the number of trials with different unfamiliar people. It would also be interesting to further explore a potential age effect by increasing the sample size of young horses.

The results of the present study are consistent with the results of the first trials of previous studies in dogs (Chijiiwa et al., 2015) and cats (Chijiiwa et al., 2021) using a similar paradigm, which showed that dogs and cats do not show preferences for the helper, or avoidance of the non-helper, after having seen interactions between the helper (or the non-helper) and another actor. This helping paradigm yielded positive results in humans (Hamlin et al., 2011), which leads us to question whether the paradigm may be inappropriate for studying social evaluations by dogs, cats and horses. We used this helping paradigm because it allowed us to compare our results with the results of studies using a similar helping paradigm in other animals. However, this helping paradigm was initially devised for tufted capuchin monkeys who are extractive foragers in the wild, using techniques such as cracking shells with stones to retrieve and eat the nuts inside (Fragaszy et al., 2004). Horses are known to show consolation behavior (Cozzi et al., 2010), so they may be able to evaluate third-party interactions if shown human interactions where one person attacks another person and a third person intervenes and consoles the attacked individual. Future studies should use other paradigms that are more suitable to the ecology and natural behavioral repertoire of each animal species.

Acknowledgments

We wish to thank Monamie Ringhofer, Hitomi Chijiiwa, and James R. Anderson for their advice on the experimental design. We also thank the equestrian clubs of Kyoto and Kyoto Sangyo universities for allowing us to use their facilities and work with their animals. We thank Peter Fogarty, MA English 1st Class, from Edanz (https://jp.edanz.com/ac) for editing a draft of this manuscript.

Author Contributions: Takuto Sugimoto: Conceptualization, Methodology, Formal analysis, Investigation, Data Curation, Writing - Original Draft, Visualization, Project administration. **Satoshi Hirata:** Investigation, Writing - Review & Editing, Supervision, Project administration, Funding acquisition.

Funding: This work was financially supported by a JSPS KAKENHI grant for S.H. (grant number, 18H05524).

Conflict of Interest: The authors declare no conflicts of interest.

References

Abdai, J., & Miklósi, Á. (2016). The origin of social evaluation, social eavesdropping, reputation formation, image scoring or what you will. *Frontiers in Psychology*, *7*, 1772. https://doi.org/10.3389/fpsyg.2016.01772

Anderson, J. R., Kuroshima, H., Takimoto, A., & Fujita, K. (2013). Third-party social evaluation of humans by monkeys. *Nature Communications*, *4*, 1561. https://doi.org/10.1038/ncomms2495

Chijiiwa, H., Kuroshima, H., Hori, Y., Anderson, J. R., & Fujita, K. (2015). Dogs avoid people who behave negatively to their owner: Third-party affective evaluation. *Animal Behaviour*, *106*, 123–127. https://doi.org/10.1016/j.anbehav.2015.05.018

Chijiiwa, H., Takagi, S., Arahori, M., Anderson, J. R., Fujita, K., & Kuroshima, H. (2021). Cats (*Felis catus*) show no avoidance of people who behave negatively to their owner. *Animal Behavior and Cognition*, *8*, 23–35. https://doi.org/10.26451/abc.08.01.03.2021

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 Process*, *85*, 185–190. https://doi.org/10.1016/j.beproc.2010.07.007

Ellis, S. L. H., Thompson, H., Guijarro, C., & Zulch, H. E. (2015). The influence of body region, handler familiarity and order of region handled on the domestic cat's response to being stroked. *Applied Animal Behaviour Science*, *173*, 60-67. https://doi.org/10.1016/j.applanim.2014.11.002

Fragaszy, D. M., Visalberghi, E., & Fedigan, L. M. (2004). *The complete capuchin: The biology of the genus Cebus*. Cambridge University Press.

Friard, O., & Gamba, M. (2016). BORIS: A free, versatile open-source event-logging software for video/audio coding and live observations. *Methods in Ecology and Evolution, 7,* 1325-1330. https://doi.org/10.1111/2041-210X.12584

Gácsi, M., Miklósi, Á., Varga, O., Topál, J., & Csányi, V. (2004). Are readers if our face readers of our minds? Dogs (*Canis familiaris*) show situation-dependent recognition of human’s attention. *Animal Cognition, 7,* 144–153. https://doi.org/10.1007/s10071-003-0205-8

Hamlin, J. K., & Wynn, K. (2011). Young infants prefer prosocial to antisocial others. *Cognitive Development*, *26*, 30–39. https://doi.org/10.1016%2Fj.cogdev.2010.09.001
Hamlin, J. K., Wynn, K., & Bloom, P. (2007). Social evaluation by preverbal infants. *Nature*, *450*, 557–559. https://doi.org/10.1038/nature06288
Hamlin, J. K., Wynn, K., & Bloom, P. (2010). Three-month-olds show a negativity bias in their social evaluations. *Developmental Science*, *13*, 923–929. https://doi.org/10.1111/j.1467-7687.2010.00951.x
Herrmann, E., Keupp, S., Hare, B., Vaish, A., & Tomasello, M. (2013). Direct and indirect reputation formation in nonhuman great apes (*Pan paniscus*, *Pan troglodytes*, *Gorilla gorilla*, *Pongo pygmaeus*) and human children (*Homo sapiens*). *Journal of Comparative Psychology*, *127*, 63–75. https://doi.org/10.1037/a0028929
Hunnius, S., & Bekkering, H. (2014). What are you doing? How active and observational experience shape infants' action understanding. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *369*, 20130490. https://doi.org/10.1098/rstb.2013.0490
Ito,Y., Watanabe,A., Takagi,S., Arahori,M., & Saito,A. (2016). Cats beg for food from the human who looks at and calls to them: Ability to understand humans' attentional states. *Psychologia*, *59*, 112-120. https://doi.org/10.2117/psysoc.2016.112
Jardat, P., Ringhofer, M., Yamamoto, S., Gouyet, C., Degrande, R., Parias, C., Reigner, F., Calandreau, L., Lansade, L. (2022). Horses form cross-modal representations of adults and children. *Animal Cognition*, *26*, 369– 377. https://doi.org/10.1007/s10071-022-01667-9
Johnson, C. M., Sullivan, J., Jensen, J., Buck, C., Trexel, J., & St. Leger, J. (2018). Prosocial predictions by bottlenose dolphins (*Tursiops* spp.) based on motion patterns in visual stimuli. *Psychological Science*, *29*, 1405–1413. https://doi.org/10.1177/0956797618771078
Kawai, N., Yasue, M., Banno, T., & Ichinohe, N. (2014). Marmoset monkeys evaluate third-party reciprocity. *Biology Letters*, *10*, 20140058. https://doi.org/10.1098/rsbl.2014.0058
Kuroshima, H., Fujita, K., Adachi, I., Iwata, K., & Fuyuki, A. (2003). A capuchin monkey (*Cebus apella*) understands when people do and do not know the location of food. *Animal Cognition*, *6*, 283-291. https://doi.org/10.1007/s10071-003-0184-9
Kuroshima, H., Fujita, K., & Masuda, T. (2002). Understanding of the relationship between seeing and knowing by capuchin monkeys (*Cebus apella*). *Animal Cognition*, *5*, 41-48. https://doi.org/10.1007/s10071-001-0123-6
Krupenye, C., & Hare, B. (2018). Bonobos prefer individuals that hinder others over those that help. *Current Biology*, *28*, 280–286. https://doi.org/10.1016/j.cub.2017.11.061
Kundey, S. M. A., De Los Reyes, A., Royer, E., Molina, S., Monnier, B., German, R., & Coshun, A. (2011). Reputation-like inference in domestic dogs (*Canis familiaris*). *Animal Cognition*, *14*, 291–302. https://doi.org/10.1007/s10071-010-0362-5
Maros, K., Gácsi, M., & Miklósi, A. (2008). Comprehension of human pointing gestures in horses (*Equus caballus*). *Animal Cognition*, *11*, 457-466. https://doi.org/10.1007/s10071-008-0136-5
Marshall-Pescini, S., Passalacqua, C., Ferrario, A., Valsecchi, P., & Prato-Previde, E. (2011). Social eavesdropping in the domestic dog. *Animal Behaviour*, *81*, 1177–1183. https://doi.org/10.1016/j.anbehav.2011.02.029
McAuliffe, K., Bogese, M., Chang, L. W., Andrews, C. E., Mayer, T., Faranda, A., Hamlin, J. K., & Santos, L. R. (2019). Do dogs prefer helpers in an infant-based social evaluation task? *Frontiers in Psychology*, *10*, 591. https://doi.org/10.3389/fpsyg.2019.00591
Morey, R. D., & Rouder, J. N. (2022). BayesFactor; Computation of bayes factors for common designs (version 0.9. 12-4.4) [Computer software]. R package. https://CRAN.R-project.org/package=BayesFactor
Nowak, M. A., & Sigmund, K. (2005). Evolution of indirect reciprocity. *Nature*, *437*, 1291–1298. https://doi.org/10.1038/nature04131
Proops, L., Walton, M., & McComb, K. (2010). The use of human-given cues by domestic horses, Equus caballus, during an object choice task. *Animal Behavior*, *79*, 1205–1209. https://doi.org/10.1016/j.anbehav.2010.02.015
R Core Team. (2021). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing. https://www.r-project.org/
Ringhofer, M., Inoue, S., Mendonca, R. S., Pereira, C., Matsuzawa, T., Hirata, S., & Yamamoto, S. (2017). Comparison of the social systems of primates and feral horses: Data from a newly established horse research site on Serra D'Arga, northern Portugal. *Primates*, *58*, 479–484. https://doi.org/10.1007/s10329-017-0614-y
Russell, Y. I., Call, J., & Dunbar, R. I. M. (2008). Image scoring in great apes. *Behavioural Processes*, *78*, 108–111. https://doi.org/10.1016/j.beproc.2007.10.009

Sankey, C., Richard-Yris, M.-A., Henry, S., Fureix, C., Nassur, F., & Hausberger, M. (2010). Reinforcement as a mediator of the perception of humans by horses (*Equus caballus*). *Animal Cognition*, *13*(5), 753–764. https://doi.org/10.1007/s10071-010-0326-9

Smith A. V., Proops, L., Grounds, K., Wathan, J., Scott K. S., & McComb, K. (2018). Domestic horses (*Equus caballus*) discriminate between negative and positive human non-verbal vocalisations. *Scientific Reports, 8,* 13052. https://doi.org/10.1038/s41598-018-30777-z

Subiaul, F., Vonk, J., Okamoto-Barth, S., & Barth, J. (2008). Do chimpanzees learn reputation by observation? Evidence from direct and indirect experience with generous and selfish strangers. *Animal Cognition, 11*, 611–623. https://doi.org/10.1007/s10071-008-0151-6

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*, 1035–1040. https://doi.org/10.1007/s10071-020-01396-x

Trösch, M., Pellon, S., Cuzol, F., Parias, C., Nowak, R., Calandreau, L., & Lansade, L. (2020). Horses feel emotions when they watch positive and negative horse-human interactions in a video and transpose what they saw to real life. *Animal Cognition*, *23*, 643–653. https://doi.org/10.1007/s10071-020-01369-0

Trösch, M., Ringhofer, M., Yamamoto, S., Lemarchand, J., Parias, C., Lormant, F., & Lansade, L. (2019). Horses prefer to solicit a person who previously observed a food-hiding process to access this food: A possible indication of attentional state attribution. *Behavioural Processes*, *166*, 103906. https://doi.org/10.1016/j.beproc.2019.103906

Vaish, A., Carpenter, M., & Tomasello, M. (2010). Young children selectively avoid helping people with harmful intentions. *Child Development*, *81*, 1661–1669. https://doi.org/10.1111/j.1467-8624.2010.01500.x