Title: First report of reindeer (*Rangifer tarandus tarandus*) response to human-given cues.

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Abstract: Many argue that the animal understanding of human referential communication is a by-product of domestication. However, the domestication hypothesis is not unanimously supported as some non-domesticated species such as sea lions, dolphins or African elephants perform well in the understanding of human pointing gesture. There is a need to study species with different levels of domestication across different taxa to understand the emerging communicative socio-cognitive skills in animals that provide them with the ability to comprehend the human-given cues. We conducted a pilot study to assess the performance of eight sledging reindeer at following a commonly used human-given cue (a pointing gesture associated with gaze at the target and local enhancement) in a two-way choice task. Domestic reindeer are considered semi-captive, because of their husbandry system in free-ranging conditions, with limited control of their reproduction. We observed that the willingness of the reindeer to participate in the test was age-related, with the younger individuals which lack experience with humans being reluctant to approach the experimenters. Within the more experienced working sledging reindeer, two individuals showed excellent skills and followed the human-given cues 9 out of 10 times. Reindeer show great potential in following a human indication to locate hidden food with minimal training when properly tamed. The effect of previous experience with humans requires further investigation. This is the first demonstration in cervids of an ability to make use of experimenter-given cues in an object-choice task.
Keywords: human-animal relationship, pointing, social cognition, referential communication, working animals.

Introduction

Working animals such as equines, shepherd dogs or logging elephants, spend hours each day in close contact with humans, involving complex interactions to fulfil specific tasks. The capacity of animals and humans to communicate is a crucial part of their working relationship (Kalof, 2017), and partly relies on the animals' ability to understand human-given cues. Humans widely use the manual pointing gesture for referential communication to share a focus of intentions (Leavens and Hopkins 1999). This gesture is often associated with gazing at the target and being closer to it. The human referential communication is commonly used in animal cognitive experiments to investigate their understanding of human-given cues. In such experiments, a human experimenter indicates an object to go to among other identical objects using the pointing gesture, and/or by gazing at it and/or standing next to it, to test if the animal follows the human-given cues and moves towards the targeted object. Several studies suggest that the success of animals at responding to human-given cues can be driven by the effect of selection processes involved in the domestication and the coevolution with humans. The most famous example comes from dog puppies (*Canis familiaris*) that are more skilled than wolf puppies (*Canis lupus*) at responding to human cues even if both species have been raised in similar conditions (Virányi et al. 2008; Gácsi et al. 2009). Many other domesticated mammals such as cats (*Felis catus*), ferrets (*Mustela putorius*), pigs (*Sus scrofa domesticus*), goats (*Capra aegagrus hircus*) and horses (*Equus caballus*) have been found to be able to use referential communication with humans (Krause et al. 2018; Jardat and Lansade 2021). However, the domestication hypothesis is not unanimously supported as some non-domesticated species such as sea lions (*Zalophus californianus*) (Malassis and Delfour 2015), dolphins (*Tursiops truncatus*) (Herman et al. 1999) and African elephants (*Loxodonta africana*) (Smet and Byrne 2014) show great performances in the understanding of human pointing gesture. There is a need for studies on species with different levels of domestication across different taxa to understand the emerging communicative socio-cognitive

skills in animals that provide them with the ability to comprehend the human-given cues (Miklósi and Soproni 2006).

One interesting example of working animals, for which communication with humans has been overlooked, is the sledging reindeer (*Rangifer tarandus tarandus*). Domestic reindeer are considered semi-captive, because of their husbandry system in free-ranging conditions, with limited control of their reproduction. Sledging reindeer are only trained or used for work during winter and live freely with the herd during the rest of the year, meaning that their time in close contact with humans is limited to a few months per year. Working reindeer (sledge and saddle) have been trained and used as draft animals since humans started to herd reindeer. Although harness parts found in Siberia were dated from 2000 years ago (Losey et al. 2021), reindeer herding on a large scale only expanded among the Sámi in northern Fennoscandia during the sixteenth and seventeenth centuries (Bergman et al. 2013). The working reindeer were used for draught tasks and mobility of people well into the twentieth century (Salmi et al. 2022). While their use tended to decrease after the introduction of new technologies such as snow mobiles, sledging reindeer are making a comeback for tourist safaris in the past decades. Nordic countries now base an essential part of their marketing strategies on animal tourism and sell reindeer and husky sledging tours as one of their main attractions (Garcia-Rosel et al. 2018). The number of sledging reindeer is therefore expected to grow and, hence, there is a need to investigate human-reindeer interactions and the potential consequences for the animals. In this pilot study, we explore the ability of eight sledging reindeer to respond to human-given cues using a global informing cue – associating pointing gesture, proximity, and gaze at the object – which reproduce what humans would naturally do to communicate with their animal. With this experimental design we first aim to explore if reindeer are receptive to usual and basic communication cues from humans. In that way we want to highlight the potential of reindeer as a new model to then study deer cognition in more detail. Reindeer are the only species of cervids used as working animals. Studying

tamed individuals, which are used to regular human handling, is a unique opportunity to experimentally explore the cognitive abilities of cervid species.

Methods

Study population: For this study we used eight male reindeer from the Reindeer Journey farm based in Finnish Lapland. The sample size was defined according to the number of individuals available at the farm. The herders from this farm have been herding reindeer for generations and are professional sledging reindeer trainers. The reindeer used in our study ranged in age from 3 to 12 years and differ in their level of training: four of them were active working reindeer, two were working for their first season and two were still in the last stage of training meaning that they would start working with tourists in the next winter (See details in Table 1).

Sledging reindeer training process: The reindeer training starts from their first winter and training sessions follow every subsequent winter until the herder estimates them ready to work with tourists (about 3 to 4 years old). Every winter, the male calves (about 6 months old) and other young males in training are separated from the herd to be grouped in enclosures next to the farm and are kept there until being reunited with the herd when the snow melts. During this time, the reindeer will get habituated to humans. Each of them will be trained to calmly walk on a leash and will be progressively introduced to the harness, and then the sledge until they can pull the sledge with a person in it. Then, they will learn how to walk in a “raito”, a line of reindeer pulling sledges tied to each other. Once they are ready to work, they will be castrated before joining the working reindeer at a tourist station in the following winter for their first season of work (Herders oral communication; Garcia-Rosel et al. 2018).

Experimental design: The experiments were carried out in Finnish Lapland in March 2022 at the Reindeer Journey farm for the two individuals in training, and at a reindeer park located in Levi, where the working reindeer spend the tourist season. The tests were performed in a place familiar to

the reindeer, a wooden paddock where they are taken for training just next to their enclosure where they could see the other reindeer and would not suffer from isolation.

The Training Phase: The goal of the training phase was to teach the reindeer that it could get food from a bucket, and to assess its motivation to move towards the buckets on its own. This training led to a final task, where the reindeer was held at a starting point by an assistant, and a closed bucket containing lichen was put on the ground 2m away in front of the reindeer and with the trainer standing behind the bucket. The reindeer was released and had to move towards the bucket and touch the lid with the muzzle for it to be opened by the trainer. Three to six trials were performed one after another. The reindeer must have approached and touched the lid of the bucket three times in a row to be selected for the pointing test. If the reindeer did not reach the criterion within the six trials, it was not selected for the pointing test. Altogether, four reindeer failed to pass the training phase and four individuals passed the training phase and participated in the following pointing test.

The Pointing Test: Two buckets with a lid on and lichen inside were placed 1.5 m apart from each other on both sides of the experimenter. The starting point was the same as in the training. To point out the bucket, the experimenter moved one step from the centre of the two buckets towards one of them and pointed at it with the back slightly bent and the hand about 30 cm above the bucket, staring at the bucket (fig 1) The idea was to mimic the natural way humans would inform an animal about the location of an object. The reindeer was then released and free to choose one of the buckets. The pointing lasted until the reindeer made a choice. In a **successful trial,** the reindeer chose the bucket pointed at by the experimenter by touching the lid with its muzzle. The experimenter then quickly opened the lid, so the reindeer could access the lichen. Thereafter, the assistant led the reindeer back to the starting point for the next trial. In a **failed trial,** the reindeer chose the bucket not pointed at by the experimenter. In that case, the pointing experimenter caught the reindeer by the halter and did not open the bucket's lid. The assistant led the reindeer back to the starting point. The pointing experimenter then performed a motivational trial before continuing with the next pointing

trial. The motivational trial consisted of one repeat of the training trial. In total, ten pointing trials were performed – not including the potential motivation trials. The side of the pointing was pseudo-randomised, so each side was pointed at five times and the same bucket was never pointed at more

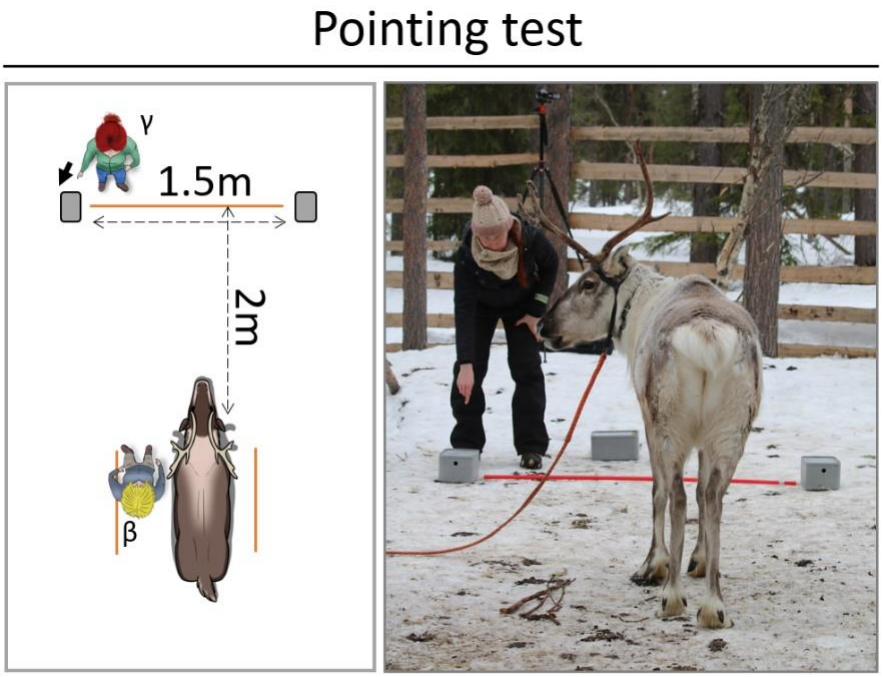

Figure 1: left - Pointing test with an example of a pointing trial. "β": unfamiliar research assistant. "γ": Pointing experimenter. right - Picture presenting the real condition of the pointing test

than twice in a row. The pointing test was always performed by an experimenter different from the training phase to avoid a preliminary association of the person with a food reward.

Statistical analyses: Statistical analyses were performed using the statistical software R, version 3.6.3 (R Core Team 2022). We used a Wilcoxon test to analyse if the success to pass the training phase was affected by the age of the reindeer. For the four reindeer which passed the training phase and participated in the pointing task, their overall performance was considered a success when they reached 8/10 successful trials, as they followed the human pointing gesture significantly more often than expected by chance (binomial test with greater alternative, $p \leq 0.05$).

Ethics: The reindeer owner provided an informed consent for them and their reindeer via the completion of an information form provided in Finnish. Data were stored according to the EU General Data Protection Regulation Act 12 to 14 (2016/679). The owner had the right to withdraw their

consent at any point of the study. This study was evaluated by the Project Authorization Board of the Southern Finland Regional Administration Agency (ESAVI) responsible for the Legal Security and Permits (decision: ESAVI/5563/2022).

Openness and Transparency:

We report how we determined our sample size, all data exclusions (if any), all manipulations, and all measures in the study.

Results and Discussion:

Overall, four out of the eight reindeer completed the training. The four individuals which failed the training were significantly younger (mean ± SD: 3.5 ± 0.58) than those which succeeded and subsequently participated in the pointing test (mean ± SD: 8.25 ± 2.63) (Wilcoxon, ***p* = 0.028; *w* = 0**). The youngest reindeer have less experience with human handling as two of them were still in training and the two others were performing their first season with tourists. To minimise the stress as they get habituated to their working environment, young sledging reindeer do not yet interact too much with unfamiliar humans during their first season of work. Therefore, these reindeer showed some signs of stress when being handled by unfamiliar persons during the training phase. It was difficult for them to focus on the food reward, and they would rather go away than to collect the food from the bucket. On the other hand, the reindeer that had more work experience and were more used to interact with people were very eager to participate in the training and highly motivated by the food reward. From the four individuals that participated in the pointing task, two had a very high success rate (Success: 9/10, binomial test, ***p* = 0.011**). Such a high success rate may indicate that some reindeer are capable of spontaneously comprehending human-given cues. A third reindeer had six successes out of ten; this is not high enough to consider that it chose the pointed bucket more often than expected by chance (Success: 6/10, binomial test, $p = 0.377$). However, this reindeer showed a form of side persistence as it always chose the pointed bucket first and then would go to the same bucket during the following trial. It would switch back to following the pointing cue after a failure.

Finally, the last reindeer systematically chose the wrong bucket; this result indicates that this individual genuinely avoided the pointed bucket (Success: 0/10, binomial test, $p = 1$). This reindeer had the longest history with humans, and did not show more avoidance behaviours than the others during the experiment. The herders described him as less affectionate towards strangers and less curious than the other reindeer that participated in the study.

Performing in a pointing task requires the animal to be habituated to humans, and therefore all individuals from non-domesticated species which succeed in following the human pointing gesture were captive and tamed animals from zoos - sea lions (Malassis and Delfour 2015), dolphins (Herman et al. 1999), African elephants (Smet and Byrne 2014) and grey seals (Shapiro et al. 2003). Even if our study does not allow to disentangle the effects of local enhancement (i.e., the informer moving near the bucket) and manual pointing, it is interesting that sledging reindeer, which only spend wintertime working with humans and live wild for most of the year almost no contact with humans, are capable of high performances when it comes to following human-given cues. Our results are in line with the idea that animals may not need to be born and reared in complete human controlled environments to develop socio-cognitive skills towards humans. They are also in line with the recent findings of Liehrmann et al. (2023) showing that horses living in pasture with conspecifics all year long had better success in the pointing task than horses living in individual paddocks. An appropriate environment respecting the natural behavioural and physiological need of the species may promote the development of socio-cognitive skills that could also be applied to interact with humans.

Although these reindeer are not spending all year interacting daily with humans, it seems that their proximity to humans still affects their performance. The four youngest reindeer were likely too stressed to pass the training phase. It appears that reindeer need time and several seasons of training and working to become less stressed when handled by humans. Accordingly, reindeer participating in experiments involving human interaction should be properly habituated and able to relax in the presence of strangers to perform. The familiarity of the experimenter should also be

considered. Working Asian elephants responded better to the call of someone familiar and agreed more often to walk on a novel surface when commanded by a familiar handler (Crawley et al. 2021; Liehrmann et al. 2021). Horses with shorter relationships with their owner showed increased reluctance to approach novel objects and surfaces (Liehrmann et al. 2022). Working dogs showed better obedience to verbal stimuli given by familiar humans compared to strangers (Scandurra et al. 2017). A study from de Mouzon,et al. (2022) observed that cats respond to pet-directed speech only when addressed by their owner. Hence, it could be interesting to test the effect of the human pointer's familiarity with the individual reindeer in further studies.

Finally, the high range of different responses observed within the four individuals which took part to the task indicates that factors such as individual personality may strongly affect their performance. For instance, bolder dogs performed better at working trials compared to shyer dogs (Svartberg 2002). In farms, fearful animals are often more difficult to handle and to manage (Grandin 1987; Hemsworth 2003). Working Asian elephants have been scored on attentiveness indicating how well individuals listen, react, and respond to their environment; better-scoring elephants had better quality communication with their handler (Seltmann et al. 2018). However, we lack empirical studies on reindeer and various other species to be able to form a clear picture of how animal personality can affect human-animal interactions. In summary, as a free-ranging and semi-domesticated species, reindeer show great potential in following a human indication to locate hidden food with minimal training when properly tamed. The effect of previous experience with humans requires further investigation and analysing the heart rate or cortisol levels during the experiments could indicate if the reindeer performance relates to their stress level. Further investigations are also needed to identify the individual cues to which reindeer rely on to make choices and which ones they comprehend best (e.g. pointing gesture, gazing or local enhancement). To our knowledge, this pilot study is the first demonstration in cervids of an ability to follow the experimenter-given cues in an object-choice task.

Table 1: Table presenting the eight reindeer participating in the study and their score to the pointing test. "*" indicates than the reindeer followed pointing gesture significantly above chance.

REINDEER ID	AGE (YEARS)	TRAINING LEVEL	SUCCESS	P VALUE
0001	12	8th season of work	0/10	1
0002	8	4th season of work	9/10	0.011*
0003	7	4th season of work	6/10	0.377
0004	6	3dr season of work	9/10	0.011*
0005	4	1st season of work	Failed training	NA
0006	4	1st season of work	Failed training	NA
0007	3	Last season of training	Failed training	NA
0008	3	Last season of training	Failed training	NA

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