universität wien

MASTERARBEIT

Titel der Masterarbeit

„Is there a Clever Hans effect in dogs?
The influence of the pointing gesture and of the owner-given cues in a two-way object-choice task“

Verfasserin

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angestrebter akademischer Grad

Master of Science (MSc)

Wien, 2011

Studienkennzahl lt. Studienblatt:	A 066 878
Studienrichtung lt. Studienblatt:	Verhaltens-, Neuro- und Kognitionsbiologie
Betreuerin / Betreuer:	Ao. Univ.-Prof. Mag. Dr. Ludwig Huber

Contents

1. ABSTRACT

Dogs are exceptionally successful at locating hidden food in one of two containers based on the pointing gesture of a human experimenter directed to the baited container. Previous studies have repeatedly questioned, however, whether dogs, indeed, rely on the pointing gesture or make their choices based on subtle helping cues of their human handler (typically their owner) who can also observe the pointing. In two experiments, using a standard two-choice task, I investigated whether dogs follow the momentary distal pointing gesture of an experimenter or the cues of their owner. In Experiment 1, the owners' belief whether their dog should follow the pointing or not was systematically manipulated. I either informed one group that the food reward was located in the container the experimenter pointed to and another group that the experimenter pointed to the empty container. In this experiment, I investigated the effects of the owners' subtle, potentially subconscious behavioral cues, and found that such cues, if they at all existed, did not influence the choices of the dogs. Furthermore, in the absence of a pointing gesture dogs chose randomly even though the owner was informed about the location of the reward, and another group of dogs successfully located the food based on the experimenter's pointing gesture also when the owner did not know which container was baited and could not see the pointing.

In Experiment 2, I found that the owners who were instructed to actively influence the choice of their dogs succeeded in sending their dogs to the container they believed to be baited. Their influence was, however, significantly weaker if the experimenter pointed to the other location before the owners were allowed to send their dogs. Thus, after their dogs had seen the experimenter pointing to a container, owners were only able to influence the choice of their dogs if they actively counteracted the gesture of the experimenter, suggesting that subtle, possibly subconscious cues of the owners are not strong enough to determine or influence the choice of dogs in a this task.

2. INTRODUCTION

More than a century ago, a horse called Hans aroused interest in the field of animal behavioral research. Hans was seemingly able to answer mathematical questions by tapping with his hoof so many times as asked as well as to choose a requested color out of several possibilities. It was proposed that the horse understood the questions he was asked and could make mathematical calculations. Instead, after careful examination, the psychologist Oskar Pfungst found that Hans could solve all these tasks by reacting to very subtle, subconscious cues like head jerks or body orientation of the questioner (Pfungst, 1907). This was clearly demonstrated by Hans giving correct "responses" also when the questioner simply thought about a number without asking any question. Curiously, even when the questioner had been informed of his involuntarily offered movements, he could not refrain from further offering such cues and Hans remained successful.

Hans' astonishing performance in reacting to the slightest human movements made scientists cautious when interpreting the performance of animals in behavioral experiments that involve interaction with humans. It has been argued that animals living in close contact with humans may have the opportunity to learn about and to respond to intentional as well as unintentional human behaviors. Indeed, animals of various species (e.g. enculturated great apes, domesticated animals, marine animals, and also human infants) tested in cognitive experiments often grow up in close contact with humans and they are often repeatedly tested in tasks that involve interaction with human experimenters (e.g. in socio-communicative tasks). Therefore, they have the possibility to form associations between subtle human cues and the appropriate behavioral response that yields reward. Thus, instead of solving the given problem on their own they may learn to watch out for and respond to unintentional cueing of the human participants of the task who usually know the correct solution to the problem the animal is supposed to solve. This has been called the "Clever Hans phenomenon"

or "Clever Hans effect" (Sebeok & Rosenthal, 1981). In order to control for such unintentional influences and/or to prevent them, scientists developed special methods. For instance, special apparatuses have been designed in order to minimize the contact between animal and experimenter (e.g. the Wisconsin test apparatus, Harlow & Bromer, 1938). In a study testing dog-human communication, Pongrácz and colleagues (2003) replaced the human partner with a prerecorded, projected image. Although in this latter study dogs performed equally well no matter whether a "real" or a projected human interacted with them, it has been argued that such "technological" modifications of social interactions may lead to the loss of some important information (e.g. acoustic or olfactory features; D'Eath, 1998). Additionally, in some experiments direct contact with the subject may be a key element of the research question in focus, making the complete exclusion of a human participant impossible. In this case, a solution can be to conduct the experiment using a double-blind design, that is, neither the experimenter nor the human participant knows which response is expected in a special task. Still, it is not always possible to exclude the Clever Hans effect and, even when it is possible, it is a question whether the risk of false positive conclusion is reasonably high to invest all the time and complications that may be required to exclude the effect.

It has been suggested for various reasons that when studying the interspecific socio-communicative abilities of domestic dogs controlling for unintentional cueing by the human participants can be especially important (e.g. Miklósi et al., 1998). Dogs spend most of their lives in very close contact with humans and, similarly to Hans, are trained extensively to react to human bodily cues. Hence, most pet dogs can have lots of experience in reading human behavior provided intentionally or unintentionally. Additionally, to avoid separation related anxiety, in many experiments dogs are accompanied and handled by their owner, the person they have most experience with. As such, dogs are good candidates for performing as if being skilled in cognitive tasks while in reality

they follow human behavioral cues indicating the right response - that is they may be subject of the "Clever Hans effect".

Additionally, one can expect that dogs are even better prepared for such learning than Hans was. Dogs have been sharing their phylogenetic history with humans for at least 10,000 years (Vila et al., 1997; Savolainen et al., 2002). This long lasting process of domestication has shaped not only the physical appearance of dogs but also their behavior (Clutton-Brock, 1995). Dogs may have been selected to cooperate and communicate with humans and have evolved increased attentiveness toward humans as well as social cognition to some extent analogous to that of humans (Hare et al., 2002; Miklósi et al., 2004; 2005). In line with this argument, recent research showed that dogs have evolved a special relationship towards their owner that remarkably resembles the attachment bond human infant's form with their mother (Topál et al., 1998; Gácsi et al., 2001; Prato-Previde et al., 2003; Palmer & Custance, 2008). Several studies suggest that dogs pay special attention to humans and are able to learn from observing human behavior (Kubinyi et al., 2003; Topál et al., 2006; Range et al., 2009). Further on, in diverse contexts it has been shown that they readily follow subtle human-given cues as well as human communication directed at them, which can lead to increased benefits as well as to erroneous performance (e.g. Miklósi et al., 1998; Soproni et al., 2001; 2002; Bräuer et al., 2006; Udell et al., 2008, Erdöhegyi et al. 2008; Topál et al. 2009).

Despite of dogs being prepared to read subtle human cues due to their evolutionary history as well as individual experiences, to our knowledge to date only one study has directed to investigate the possible influence of owners' subconscious behavior on the performance of dogs. In this study the information the experimenter gave the owners had a remarkable effect on the outcome of the study (Lit et al., 2011). Owners of drug or explosives detection dogs were asked to perform short searches with their dogs in a room where up to three scents were claimed to be present. In reality, however, no scent was present, and thus, any

indicated alert was wrong. Surprisingly, in many cases owners indicated an alert by their dog. In this study, however, since the behavior of the dogs was not directly assessed by the experimenter it is unclear whether the owners indicated an alert without the dogs showing an alert (i.e. "expectation bias") or whether the owners' expectation of an alert changed the dogs' behavior and elicited an alert on the dogs' part (i.e. "Clever Hans effect").

In several studies, however, the "Clever Hans effect" has been considered seriously as possible influence on the performance of dogs (e.g. Hauser et al., 2011; Kaminski et al., 2011). The experimenters have therefore used control groups to examine this possibility. In a study to test whether dogs imitate selectively, Range et al. (2007) argued that owners might cue their dogs to use either the paw or the mouth when manipulating an apparatus after watching repeated demonstrations of either one or the other method. Therefore, in a control group owners were blindfolded during the demonstrations so that they were not able to see whether the model dog used her paw or mouth and thus, did not know how their dog should perform. In this study, comparing the performance of the dogs of blindfolded owners and of others who could see which method the model dog used, the knowledge of the owner did not influence the action of the dog (Range et al. 2007). Nevertheless, it is still possible that owners can cue their dogs toward the correct solution when the two potential behavioral responses can be differentiated more easily, i.e. when the dog has to choose one of two locations as it is the case in a two-way object-choice task.

This question is of surprisingly high importance, because the success of dogs in certain kinds of two-way object-choice task has led to influential theoretical arguments about the evolution of animal and human cognition. Several animal species have been investigated whether they can locate hidden food if a human indicates with a cue (e.g. an outstretched arm) which of two containers is baited with food. If the human-given pointing gesture is far away from the baited container and is no more present when the subject is finally released to make its

choice (this is the so-called momentary distal pointing, for a review see Miklósi et al., 2006; Reid, 2009)), the domestic dog proves to be more successful than all other non-human species and performs more human-like than chimpanzees for instance (Soproni et al., 2001; Hare et al. 2002; for a review see Reid, 2009). Since dogs respond correctly to the human pointing from an early age on and their performance does not improve with age in contrast to wolves that need also a longer time to develop the same skill (Hare et al., 2002; Gácsi et al., 2009), it has been suggested that evolutionary processes during domestication enhanced the socio-communicative abilities of dogs that make success in the pointing task possible.

Interestingly, also foxes selected for tameness have been found to outperform a randomly bred control group in the pointing task, though they had never been selectively bred for the ability to respond to human communicative cues but for faster approach and friendlier behavior to humans (Hare et al., 2005). Based on these results, the emotional reactivity hypothesis claimed that selection for reduced fear and aggression toward humans in dogs as well as in the tame foxes might have led to better comprehension of human communicative signals simply as a by-product of selection for tameness (Hare et al., 2005). Importantly, the emotional reactivity hypothesis has been generalized to the evolution of human social cognition, assuming that also in the ancestors of humans' selection for increased tolerance lead to the evolution of the higher cooperativeness of humans in comparison to other primates (Hare & Tomasello, 2005). Currently, this theory is one of the most debated evolutionary arguments regarding the unique features of human cognition and social behavior (Tomasello, 2009). Crucially, the conclusion that domestication has enhanced the ability of the dogs to follow human pointing serves as an independent evolutionary argument supporting the emotional reactivity hypothesis (Hare & Tomasello, 2005).

One can raise the question, however, whether dogs outperform chimpanzees in the pointing task because they evolved social skills that help them

follow human pointing or because they can make correct choices based on reacting to the subtle behavioral cues of their owners or other human participants who are present during the object-choice task. That is, as long as we cannot exclude the "Clever Hans effect" in pointing tasks, we cannot be sure that the above described, far-reaching evolutionary argument is correct.

A recent study by Hauser et al. (2011) confirmed that dogs may be influenced by other behavioral cues than the pointing gesture because they found that both the owner and experimenter during a pointing task made mistakes in the experimental procedure (i.e. experimenters pointed for too long, and owners released the dog too early or even tried to direct the dogs towards a container). They did so, even though the experimenter received extensive training prior to the testing and the owners had clear instructions how to behave during the experiment. Hence, one can argue that these additionally provided cues might affect the performance of dogs leading to higher success. In order to avoid false positive results, the authors excluded all trials with visible mistakes or misbehaving by owner and experimenter using video analysis. Even when the behavior of the owner and experimenter was analyzed, we cannot be sure that the human coder noticed the same cues as the dogs may have perceived. On the other hand, Hauser and colleagues did not investigate whether the mistakes of the human participants actually did influence the behavior of the dogs. Potentially, the mistake - either intentional or unintentional - of the owner and experimenter did not actually affect the performance of the dogs. If so, a considerable amount of data was lost without a real reason: Hauser et al. (2011) excluded 19% of all conducted trials from the analyses because owner and experimenter errors were observed.

Due to its theoretical and practical relevance, I set out to investigate whether and to what extent the owners influence the performance of their dogs in a two-way object-choice task using momentary distal pointing. In the first experiment, I examined the potential influence of the owners after being

instructed not to influence their dogs. Here I assumed, as many before me (Hauser et al., 2011; Kaminski et al., 2011; Lit et al., 2011) , that owners might try to help their dogs to succeed intentionally or even unintentionally with subtle cues like head orientation, gaze direction, body orientation or minimal movements. That is, here I tested for the "Clever Hans effect". These subtle cues (that I called inactive influences since the influence on the dog could have been achieved by involuntary behavioral cues or by voluntary cues that were too slight for the experimenter to perceive) are possibly hard to examine since they might not be detectable even when video analyzing the behavior of the owners and they may differ in each dog-owner dyad. I was, however, interested whether they influence the success of the dogs in an object-choice task, and as such, assuming that such subtle cues at least occasionally are present, I compared the success of dogs in four groups in which the owners received different information about the location of the hidden food. Comparing the performance of dogs depending on whether the owner did not know where the food was hidden, to groups where the owner had the belief that the dog should either follow the pointing or go to the other container than the experimenter pointed to, should reveal the impact of owners' inactive influence. In a fourth group the experimenter presented no pointing gesture but the owner was informed about the location of the food in order to test whether the owners can direct their dogs to the right container by inactive cueing.

In the second experiment I explicitly asked owners to try to actively send their dog to a container either without the experimenter presenting a pointing gesture beforehand or actually counteracting the pointing gesture of the experimenter (that is actively sending the dog to the other container than the experimenter previously pointed to). By testing both effects in separate groups, I aimed at clarifying the owners' capacity of influencing their dog's choice performance in an object-choice task if being free to interact with their dogs.

3. EXPERIMENT 1: inactive influence of the owner

As common in cognitive studies with dogs, in this experiment the owners were told not to actively influence the behavior of their dogs and to follow the instructions of the experimenter. I assumed, however, that despite of this instruction they still may influence the choices of their dogs by means of subtle behavioral cues that the owners might offer either intentionally or unintentionally (positioning the dog, pushing it slightly in a certain direction, releasing the dog a bit too early, directing the dog by gaze or body orientation). In order to test for the potential effect of such inactive owner influence I systematically manipulated the belief of the owners about the location of the food. This was done by briefing the owners differently before the experiment or by preventing them from seeing the pointing gesture.

3.1 Methods

3.1.1 Participants

Seventy-five dog-owner pairs were tested in this experiment. Owners were women recruited at the Clever Dog Lab, Vienna. Six dogs had to be excluded due to motivational problems (i.e. not eating the food or not approaching the experimenter during the pre-training) or due to mistakes in the owner's behavior (trying to influence the dog actively, e.g. pointing towards a container, although they were instructed not to do so). The remaining sample of 69 dogs (32 males, 37 females; mean age ± SD: 58 ± 30 months, range 11 to 129 months) consisted of four different breed groups according to the FCI classification (sheepdogs and cattle dogs: N= 16; terriers: N=10; retrievers: N=15; companion and toy dogs: N=9) and mixed breed dogs (N=19) (for more detailed information, see Appendix 1). All dogs had received at least one kind of training (e.g. obedience, agility, rescue, assistance or dummy) on a weekly basis. None of these dogs had previously participated in pointing studies or any other similar cognitive experiment.

To keep the dogs motivated the owners were asked not to feed their dogs 3 to 4 hours before the onset of the experiment. Owners filled in a questionnaire to give detailed information about their dog and their activities with their dog. Testing took place between December 2010 and June 2011.

3.1.2 Experimental set up and material

The experiment took place at the Clever Dog Lab, Vienna. The experimental equipment - consisting of a chair for the owner, a table for baiting the container - was arranged in an experimental room (5 x 6m) as shown in Figure 1. The distance between the dog and the experimenter was two meters and was indicated by tape markings on the floor. The position of the dog was also indicated by a tape marking in front of the owner's chair.

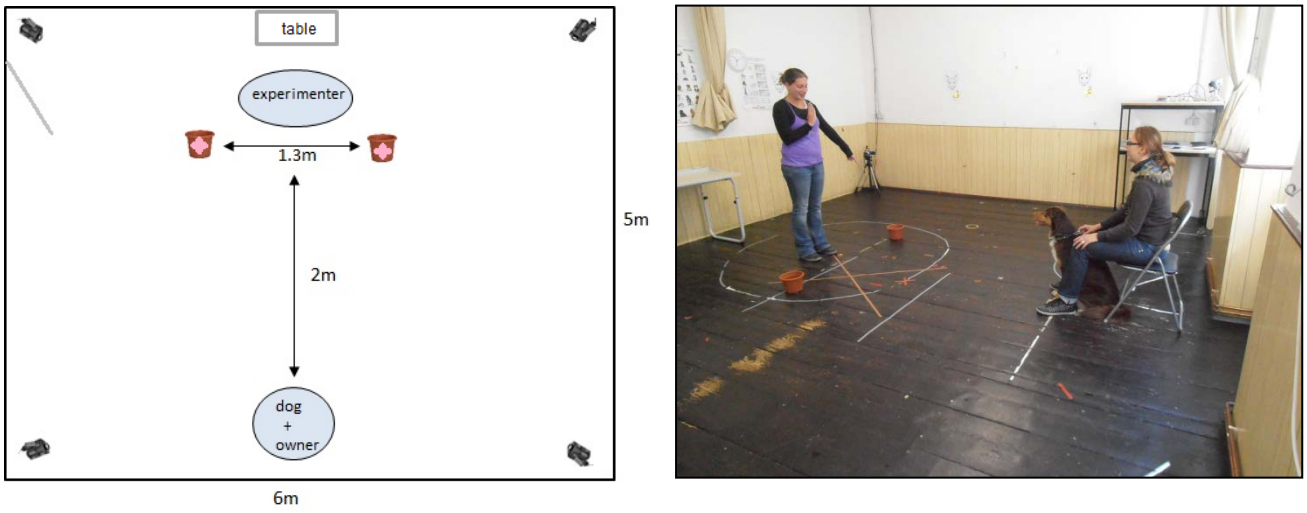

Fig.1. Schematic drawing and photograph of the experimental set up with the position of the owner (sitting behind the dog), the dog and the experimenter, as well as the position of the four video cameras. The pink signs on the container in the drawing (left) indicate that both containers were always baited (the real containers had no signs).

As hiding locations, I used two identical brown plastic flower containers. I used two differently sized sets, adjusted to the size of the dog: d= 16 or 13cm; h= 13 or 10 cm.

I analyzed the behavior of the dog, the owner and the experimenter from recordings of four digital video cameras (2x Sony Exwave HAD, 2x Sony DCR-TRV 25) positioned in the four corners of the testing room. The cameras were connected to a video station (computerized recording system) outside of the testing room. It consisted of a Pinnacle Studio Moviebox creating an AVI output (720 x 576 High resolution video) which was then recorded via the video station using the software VirtualDub.

3.1.3 General Procedure

In four experimental groups I varied the owner's belief about the location of the food, whether the experimenter did or did not point to a container and whether the owner saw the pointing or not (see below for a more detailed description of groups and Tab. 2). The general procedure (briefing, pre-training, testing phase, and debriefing, see Fig. 2), however, was the same for all dog-owner dyads. Importantly, in all groups, in every test trial both containers contained an identical piece of reward (small piece of sausage or cheese (1 cm x 1 cm)).

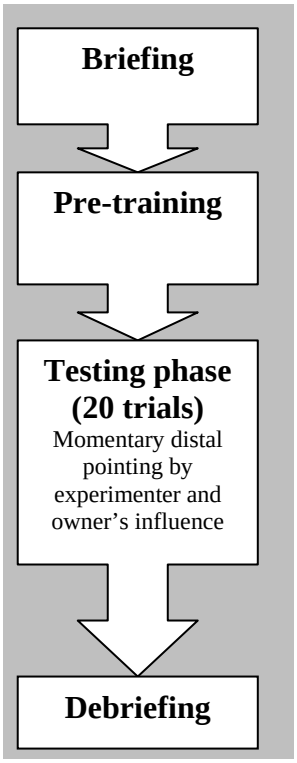

Fig.2. General procedure of Experiment 1+2

Briefing of the owners

During the briefing, the experimenter informed the owner about the aim of the study and the procedure.

Creating a belief which container the subject should choose

In every group, the owners were informed that during the testing phase only one container was baited (despite of actually both containers being baited!) and that the aim of the study was to investigate whether their dog succeeded in finding food. In the different experimental groups, however, it was varied whether or not the owner was provided with information

where the dog can find food, and whether she thought that the food was in the same or the other container the experimenter was pointing at.

Preventing active influence of the owner

The experimenter also instructed the owner not to provide any helping cues for the dog. The experimenter gave them clear instructions where the dog has to sit, to release the dog not until the experimenter was in a certain position (see below), and not to point towards a specific side.

After the briefing, the owner and her dog were led into the experimental room where the owner was allowed to let the dog off the leash to familiarize with the room for 1 to 3 minutes.

Pre-training

The pre-training was conducted to familiarize the dog with the testing situation. The owner sat on the chair holding her dog by the collar. The dog was sitting in front of her facing towards the experimenter. The experimenter, standing at her position, placed the two containers on the floor on her right and left side at the same time, stood up, and called the attention of the dog (by calling the dog's name, and "Look!"). When eye contact was established, she dropped a piece of food into a container in full view of the dog. She then folded both arms in front of her chest, put her hands together and lowered her head. As soon as she was in that position, the owner released the dog and the dog could approach the containers to eat the food. If the dog did not approach by itself, the owner was allowed to give a short command (e.g. "go"). If the dog went to the correct container, the experimenter said 'super, well done' in a praising voice. If the dog went to the wrong container the experimenter said 'no, that was the wrong choice'. After the dog had eaten the food, the owner called the dog and brought it back to the start position.

This procedure was repeated twice for each side. Before the dog could proceed to the testing phase, it was necessary that the dog visited the correct location four consecutive times.

Testing phase

The testing phase took place immediately after the pre-training. Before each trial, the experimenter baited both containers with food, standing at the table with back turned to the owner and dog so that the owner and dog could not see the baiting.

Each trial started with the experimenter placing the containers on the floor and standing up facing the dog. In 3 of the 4 experimental groups (see Tab. 1), after calling the dog, the experimenter presented a momentary distal pointing gesture to one of the 2 containers (i.e. she stretched her ipsilateral arm with extended index finger towards the container for 1 to 2 seconds, the distance between her finger and the container was between 50 and 55 cm). In the "*only inactive cues*" group the experimenter placed the containers on the floor, stood up and neither looked at the dog or called its attention nor presented a pointing gesture.

After this, the experimenter folded her arms in front of her chest and lowered her head. Then the owner released the dog that could approach one of the containers. Importantly, in each trial of all experimental groups, both food containers were baited and the dog was allowed to eat the food no matter which container it visited. The experimenter started talking (either in a praising voice "super, well done" if the dog went to the container she had pointed to or "no, that was the wrong choice" if the dog chose the other container) as soon as the dog had made a clear choice (nose in container). The verbal reinforcement as well as the experimental arrangement (dogs faced towards the experimenter during eating) made it hard for the owner to hear or see whether the dog ate something or not. In the group without a pointing gesture ("*only inactive cues*"), the experimenter verbally reinforced the container that had previously been indicated to the owner

as the correct container (see below for description of groups and Tab. 1). After the dog had eaten the food from one of the containers, the experimenter picked both containers up and the owner called the dog back to the starting position.

Each dog received 20 trials with a break of 10 min after 10 trials. The order of the container side the experimenter verbally praised the dog for (in groups with the pointing gesture dogs were praised for the pointed container; in the group without pointing gesture the previously to the owner named container was praised) was predetermined and semi-randomized (not more than two consecutive trials with food on the same side) with praising the left as well as the right side 10 times.

Debriefing

After the testing phase the owner was asked to fill in a questionnaire (Appendix 2) in order to assess whether she realized that her dog was rewarded also for choosing the container that the owner had believed to be empty and whether she maintained her belief about the aim of the experiment. Afterwards, the experimenter informed the owner about the true background of the study and in which group she had participated.

3.1.4 Experimental groups

Dogs were randomly assigned to one of four different groups (balanced for breed, age and sex). The groups varied according to the owner's belief about the location of the food and whether the experimenter did or did not point to a container (for an overview, see Tab. 1).

"Pointing + owner blindfolded" (N=17): In order to test whether dogs were successful in the momentary distal pointing task, even without helping cues of their owners, in this group owners were blindfolded and were wearing earphones during the test trials. Thus, owners could not help their dogs because they did not

know where the food was. In this group I also wanted to examine whether the dogs followed the momentary distal pointing even if they received a reward after choosing the wrong location, which was possible in this study since always both containers were baited.

Briefing: The experimenter told the owner that she would participate in a pointing task, and, as common in experiments on dog cognition, she would have to wear a blindfold and earphones to prevent giving any subtle cues. The experimenter provided no explicit information about how dogs usually perform in pointing tasks.

Testing phase: The experimenter presented a pointing gesture. The owner received a signal through wireless earphones when to release the dog to avoid additional distraction of the dog via other signals. The experimenter was able to play the signal from a laptop with a small remote control fixed on her wrist. The experimenter praised the dog if it chose the pointed container. If the dog went to the other container the experimenter said ”no, that was the wrong choice”, though the dog could eat a piece of reward also here.

Since the owners were neither informed about the location of the food nor could see or hear the hiding or the pointing, they did not know which container their dog should choose. Consequently, it is extremely unlikely that they could help their dogs to make the right choice by subtle, inactive cues.

“Pointing + inactive cues same direction” (N=18): The question addressed with this group was whether the owners could increase the success of their dogs if they believed that their dogs could find food in the container the experimenter was pointing to, but they were not allowed to actively instruct their dogs.

Briefing: The owners were informed that they were participating in a standard pointing study. The experimenter explained how important it usually is for dogs to use this communicative signal in everyday life, and that it was well known that

dogs performed reliably in this task. That is, the owners were informed that their dog should follow the pointing.

Testing phase: The experimenter presented a pointing gesture, and the owners could see this gesture. The experimenter praised the dog always for the pointed container. If the dog went to the other container the experimenter said "no, that was the wrong choice" though the dog could eat a piece of reward also here.

Owners were able to see the pointing and believed that there was food only in the pointed container. Since they had been told that their dog should follow the pointing, it was possible that they inactively cued their dog and this inactive influence would enhance the performance of these dogs compared to other groups.

"Pointing + inactive cues opposite direction" (N=17): In this group I wanted to investigate whether by means of inactive influence the owners could decrease the number of choices dogs make following the pointing gesture.

Briefing: The owners were informed that they were participating in a study in which I wanted to test the dog's ability to find hidden food based on olfaction. During the explanation of the procedure, the experimenter referred to the dogs' remarkable abilities in detection of drugs and explosives and that dogs are even said to be able to discriminate between identical twins, which eat different diets leading to different body odours (Hepper, 1988). The experimenter further explained that she would always point to the container without food, but it would be expected although dogs have lots of experience with the pointing signal dogs should still follow their nose and go to the baited container. That is, the owners were told that their dog should go to the other container than the experimenter was pointing to.

Testing phase: In this group, the experimenter presented a pointing gesture and the owner was able to see the pointing. The experimenter praised the dog if it chose the pointed container. If the dog went to the other container the

experimenter said “no, that was the wrong choice”, though the dog could eat a piece of reward also here.

Since the owners were able to see the action of the experimenter and expected, that their dogs would ignore the pointing gesture, and instead follow the smell of the sausage, I expected that if owners tried to inactively influence the performance of the dogs this influence would make the dogs follow the pointing in fewer trials compared to the other two groups.

“Only inactive cues” (N=17): Here I investigated whether, in absence of a pointing gesture, owners could inactively influence their dogs to choose the container they believed to be baited.

Briefing: Owners were informed that I was studying the decision making of dogs in a free choice situation presenting two containers one of which was baited. Before each trial, the owner was verbally informed (“right” or “left”) which of the container was baited. The experimenter also informed the owners that both containers were rubbed with sausage and therefore dogs could not base their decision on the smell.

Testing phase: The dog was allowed to make a choice without having seen a pointing gesture before. The experimenter praised the dog always for choosing the container, which had been named for the owner as baited. If the dog went to the other container the experimenter said “no, that was the wrong choice”, though the dog could eat a piece of reward also here.

Tab.1 Overview of 4 experimental groups

Group	Briefing ("aim of the study")	Owner's belief	Experimenter's action	Owner's influence	Praising of experimenter
Pointing + owner blindfolded N=17	Can dogs follow pointing? Owner cannot see pointing.	-	Pointing	-	For choosing pointed container
Pointing + inactive cues same direction N= 18	Dogs can follow pointing. The food is in the container E is pointing to.	Pointed container baited	Pointing	Inactive (potential helping cues)	For choosing pointed container
Pointing + inactive cues opposite direction N= 17	Dogs should follow their nose and not the pointing.	Non-pointed container baited	Pointing	Inactive (potential hindering cues)	For choosing pointed container
only inactive cues N= 17	Decision-making of dogs. Owners informed about location of food.	Container named by E is baited	-	Inactive (potential helping cues)	For choosing the container the owner believed to be baited

E = Experimenter

3.2 Data analysis

In all four groups, the choice of the dogs was coded during the experiment and later also from the video. The number of correct choices was compared with nonparametric statistical methods. In the three groups where a pointing gesture was applied, a choice was coded as correct if the dog chose the container the experimenter pointed at. In the "*only inactive cues*" group a choice was coded as correct if the dog went to the container the experimenter named as baited beforehand. Going to the not pointed or not indicated container was coded as an incorrect choice. If a dog did not choose at all (did not go to a container within 30 seconds) the trials were excluded from analyses (5 dogs chose only on 17 to 19 trials instead of 20, see Appendix 1 for more information). The total percentage of correct responses was calculated over all trials.

To test whether the number of correct choices differed in the first compared to the second 10 trials a Wilcoxon matched pair test was applied. For all groups a one-sample Wilcoxon signed-rank test was applied separately to test the number of correct choices of the group against chance level. For individual performance, a

Binomial Test was applied evaluating how many individuals in each group performed above chance level.

To examine whether the belief about the aim of the study led to an enhancement or decrease in dogs' performance through the possibly inactive influence of the owner in the presence of a pointing gesture, two pairwise comparisons with Mann Whitney U tests were applied.

First, the group without inactive influence (*"Pointing + owner blindfolded")* was compared to the group with the cues directed towards the pointed container (*"Pointing + inactive cues same direction")* to examine whether that led to an enhanced performance of the dogs.

Second, the group without inactive influence (*"Pointing + owner blindfolded")* was compared to the group with the cues directed towards the non-pointed container (*"Pointing + inactive cues opposite direction")* to examine whether that led to a decreased performance of the dogs.

A third pairwise comparison with a Mann Whitney U test was applied to examine the effect of pointing with possibly inactive influence of the owners. Therefore, the group with the cues directed towards the pointed container (*"Pointing + inactive cues same direction")* was compared to the group without a pointing gesture and where the owners were only informed about the location of the bait (*"only inactive cues").*

To evaluate the belief of the owner of how many trials her dog succeeded, a questionnaire was given to the owner after the experiment. This was done to ensure that owners had not realized that their dog got always food no matter to which bowl it went to. It was hypothesized that owners' assessment of the performance of their dogs was in accordance with the belief about the aim of the experiment they were told during the briefing. Owners answered with the following possibilities: My dog succeeded in 0-5 trials, or in 6-10 trials or in 11-15 trials or in 16-20 trials. In the groups where the owner was in full view of the pointing gesture, the answers of the owners were compared to the number of trials

in which the dog actually followed the pointing gesture. In the group without a pointing gesture the answers of the owners were compared to the number of trails in which the dog went to the previously indicated container. For that reason the choices of the dog during the experiment were classified in the same categories like the answer possibilities in the questionnaire (0-5, 6-10, 11-15, 16-20 "correctly" chosen trials). The three comparisons were carried out with sign tests.

All statistical tests were calculated with SPSS 19 and considered significant if $p<0.05$. A sequentially rejective Bonferroni tests for multiple testing was applied (Holm, 1979).

3.3 Results

Comparison of the first 10 trials to the second 10 trials in each group revealed that there were no significant differences in three groups (all p-values > 0.05 in"*pointing + inactive cues same direction", "pointing + inactive cues opposite direction"," only inactive cues";* Holm-Bonferroni corrected: $p \geq 0.05$) indicating that no learning took place within a session. However, in the group with the owner blindfolded and therefore not providing inactive cues towards a certain side, the performance of dogs (i.e. following the pointing gesture) in the second 10 trials decreased significantly compared to the first 10 trials ("*pointing + owner blindfolded":* N=17,Z=-2.776, p= 0.006; Holm-Bonferroni corrected: ≤ 0.05). Therefore, besides the comparison of all 20 trials, the two pair wise comparisons involving this group ("*pointing + owner blindfolded*" vs. "*pointing + inactive cues same direction"*; "*pointing + owner blindfolded*" vs. *"pointing + inactive cues opposite direction")* were also conducted comparing the first 10 trials of each group and the second 10 trials of each group with each other.

Taken at the group level, the comparison of the performance against chance level revealed that dogs in all three groups with a pointing gesture performed better than expected by chance ("*pointing + owner blindfolded":* N=17, Z= -2.924, p= 0.003 ; "*pointing + inactive cues same direction"*: N=18, Z= -3.140, p= 0.002; "*pointing +*

inactive cues opposite direction": N=17, Z=-2.966, p= 0.003; all p-values Holm-Bonferroni corrected≤0.05) whereas dogs in the group *"only inactive cues"*, performed at chance level (N=17, Z= -0.203, p= 0.839; Holm-Bonferroni corrected: p≥0.05; Fig.3).

At the individual level, the analyses showed that in each of the groups with a pointing gesture three dogs performed above chance level (binomial tests: "*pointing + owner blindfolded"*: 3 ; "*pointing + inactive cues same direction"*: 3; "*pointing + inactive cues opposite direction"*:3; Holm-Bonferroni corrected; individuals above chance before Holm-Bonferroni correction: "*pointing + owner blindfolded"*: 6 ; "*pointing + inactive cues same direction"*: 5; "*pointing + inactive cues opposite direction"*: 4). Not a single dog in the group without the pointing gesture performed above chance (p > 0.05 before and after Holm-Bonferroni correction).

Comparing the group "*pointing + owner blindfolded"* to the group "*pointing + inactive cues same direction"* yielded no significant difference between these groups (Mann-Whitney U test: N=35, U= 151.500, p=0.960; Holm-Bonferroni corrected: p≥0.05), indicating that the performance of dogs did not increase when involuntary cueing was made possible (Fig.3). This was also the case when comparing the performance of the dogs in the first 10 trials and the second 10 trials in each group (first 10 trials: Mann-Whitney U test: N=35, U= 116.500, p=0.232; second 10 trials: Mann-Whitney U test: N=35, U= 193.500, p=0.184; Holm-Bonferroni corrected: p≥0.05).

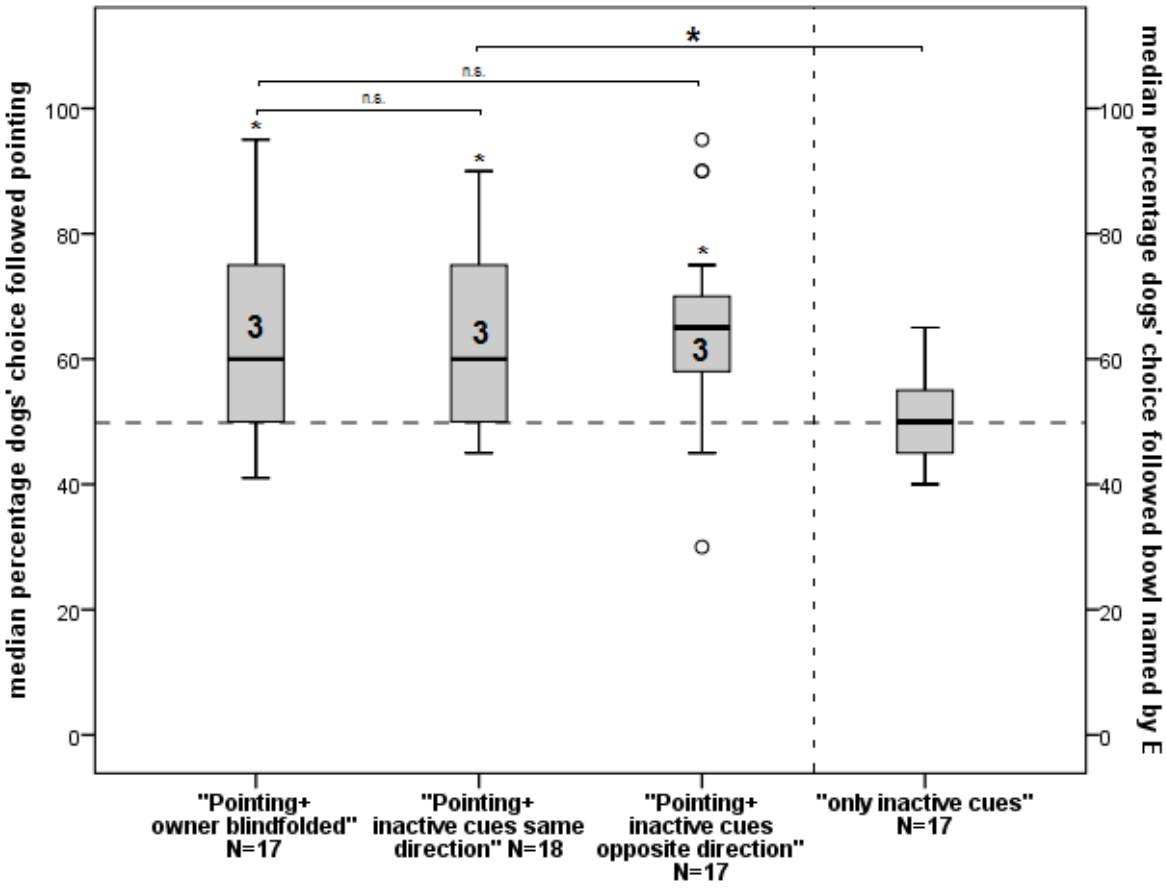

Fig.3. Percentage of dogs' choice. The first three bars represent the choice following the pointing gesture of the experimenter, the fourth bar represents choosing the container the experimenter previously named to the owner as baited. Asterisks directly above the bars indicate a significant difference in group performance from chance level; the numbers in the bars indicate the individuals in that group performing above chance.

The second pairwise comparison with the question if inactive influence of the owner could lead to a decrease in performance of the dogs ("*pointing + owner blindfolded"* compared to "*pointing + inactive cues opposite direction"*) also failed to show a significant difference (Mann-Whitney U test: N=34, U= 157.000, p=0.665, Holm-Bonferroni corrected: p≥0.05). Again, the comparison of the first 10 trials to the second 10 trials revealed that there was no significant difference (first 10 trials: Mann-Whitney U test: N=34, U= 154.500, p=0.734; second 10 trials: Mann-Whitney U test: N=34, U= 157.500, p=0.658; Holm-Bonferroni corrected: p≥0.05).

Comparing the dogs in all 3 groups in which the pointing gesture was presented to the "*only inactive cues*" group revealed a significant difference (Mann-

Whitney U test: N=35, U= 236.000, p=0.005, Holm-Bonferroni corrected: $p \leq 0.05$; Fig.3).

The comparison of the owners' belief about how many trials their dog succeeded in was evaluated with the questionnaire, and showed that the owners assessed the actual performance of their dog differently depending on the group. Owners in the group *"pointing + inactive cues same direction"* assessed the performance of the dog very similar to the actual performance of the dog following the pointing (sign test: N=18, p=0.250; Fig.4).

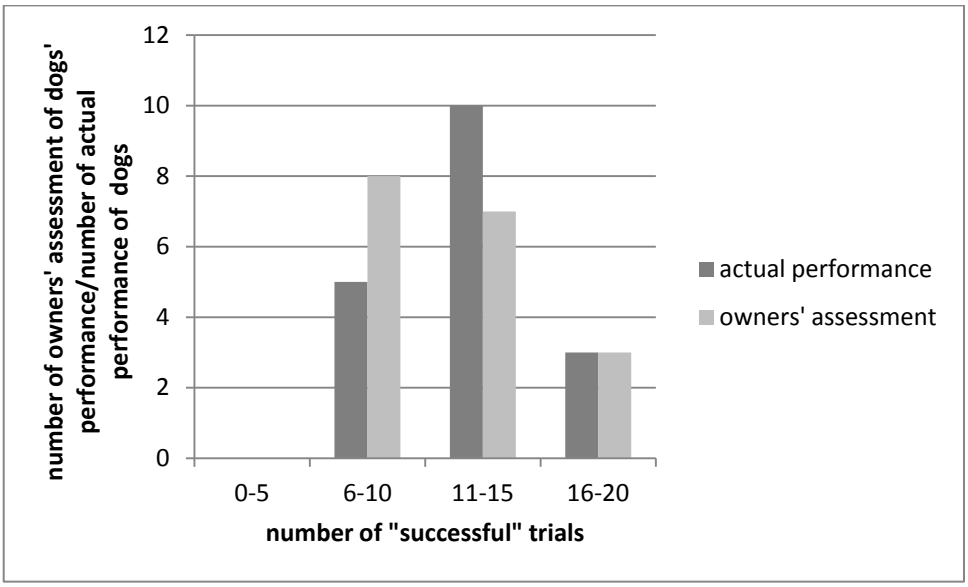

Fig.4. Owners assessment about how often their dog succeeded (i.e. getting the reward) and the actual performance of the dogs in following the pointing in "*pointing+inactive cues same direction*".

Also in the group *"only inactive cues"* the assessment of the correct choice of the dog was similar to the actual "correctly" chosen container (sign test: N=17, p=0.625; Fig.5).

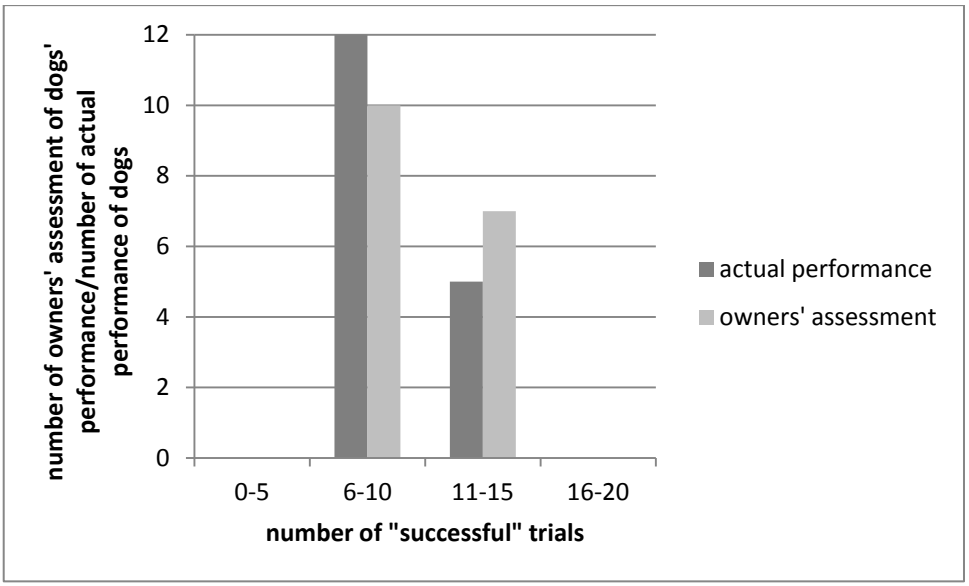

Fig.5. Owners assessment about how often their dog succeeded (i.e. getting the reward) and the actual performance of the dogs in following the previously indicated container in "*only inactive cues*".

In contrast, owners in the group "*pointing + inactive cues opposite direction*" assessed the performance significantly differently to the actual performance of the dogs in following the pointing gesture, thus showing that the owners were still in the belief that their dog should not follow the pointing (sign test: N=17, p=0.012; Fig.6).

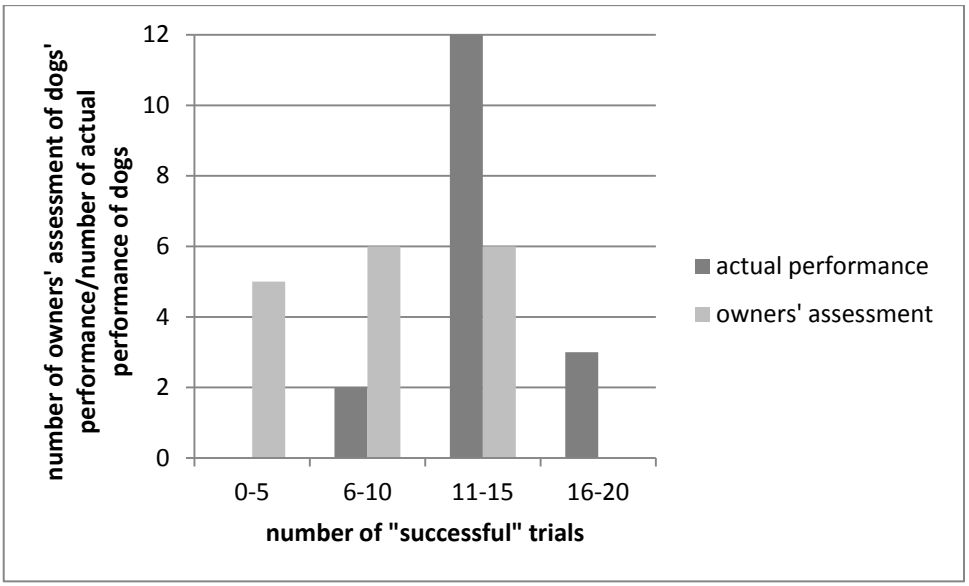

Fig.6. Owners assessment about how often their dog succeeded (i.e. getting the reward) and the actual performance of the dogs in following the previously indicated container in "*pointing+inactive cues opposite direction*".

3.4 Discussion

Regardless of the belief of the owner, dogs tended to follow the momentary distal pointing in all three groups where a pointing gesture was applied. In addition, the individual performance in the groups with pointing gestures was comparable, as three individuals followed the pointing gesture in all groups. Thus, dogs performed equally well, whether the owner was blindfolded (i.e. in absence of inactive helping cues), or in full view – if in the belief that the dogs should reliably follow the pointing (cueing to the same direction as the pointing gesture) as well as if believing that dogs should follow their nose and not the pointing (cueing to opposite side then pointing gesture). In the group where no pointing gesture was presented but the owner was previously informed about the location of the bait, dogs performed at chance level and did not follow any possible inactive cues of the owner. These results suggest that at least in this experiment dogs followed the momentary distal pointing and did not follow the inactive cues of the owner.

However, very interestingly, the performance of the dogs in the group with the owner blindfolded decreased significantly in the second 10 trials. A possible reason could be that since owners did not see whether their dog performed well ("as expected") they encouraged the dog less and therefore, the dogs lost motivation. Recently, it was shown that encouragement plays an important role in cognitive experiments, and could influence the dogs' performance (Topál et al., 1997), and the result of the current study indicates that the missing encouragement by owners might lead to a loss of motivation and attention. An alternative explanation for the decrease in following the pointing gesture in the second 10 trials could be that dogs may have become increasingly due to the change in their owners usual appearance, and behavior, due to the wearing of the blindfold. The attentional focus of humans plays a crucial role for dogs and not being able to see the eyes of their owner might lead to increased insecurity. This is important when considering that dogs usually look back to their owners if confronted with a difficult task (Miklósi et al., 2003). It was supposed that the presence of owners can have - besides the danger of unintentional cueing – another type of influence on the performance of dogs (Miklósi, 2006). It can help dogs to feel more comfortable in an unknown environment and with a strange experimenter and therefore lead to a better performance. In this experiment, the mere presence of the owner might not have been sufficient. However, in this experiment it was not measured whether owners encouraged their dogs less in the blindfolded group, so the reason about the decrease remains speculative.

The assessment of the owners perceived success of their dogs using a questionnaire showed that owners indeed had a different opinion depending on the information they had been given about the experiment. Owners in the group where the dogs should seemingly follow their nose evaluated their dogs' performance significantly different from the actual performance of the dog, i.e. following the pointing, than owners who thought their dog should follow the pointing or go to the previously indicated container.

4. EXPERIMENT 2: active influence of the owner

The results of the first experiment suggested that dogs followed the momentary distal pointing of the experimenter rather than the inactive cues of their owner. However, since it has also been reported that owners also might influence their dogs more actively (e.g. directing it towards a certain location) in the second experiment I examined how much the owner's active influence could affect the choice behavior of dogs in the absence or presence of a pointing gesture. Additionally, to assess the effect of the active influence of the owner on the pointing gesture, I compared the results of this experiment with the results of the "*pointing + owner blindfolded*"-group of Experiment 1.

4.1 Methods

4.1.1 Participants

Thirty-six dog-owner pairs were tested in this experiment. Owners were women recruited at the Clever Dog Lab, Vienna. Five dogs had to be excluded due to motivational problems (i.e. not eating the food or not approaching the experimenter during the pre-training) or due to mistakes in the procedure by the owner (e.g. sending the dog too early, and calling the dog back during the process of decision making although they were instructed not to do so). The remaining sample of 31 dogs (17 males, 14 females; mean age ± SD: 56 ± 35 months, range 12 to 135 months) consisted of four different breed groups according to the FCI classification (sheepdogs and cattle dogs: N=8; terriers: N=4; retrievers: N=8; companion and toy dogs: N=3) and mixed breed dogs (N=8) (for more detailed information, see Appendix 3). All dogs had received at least one kind of training (e.g. obedience, agility, rescue, assistance, or dummy) on a weekly basis. None of these dogs had previously participated in pointing studies or any other similar cognitive experiment.

To keep the dogs motivated the owners were asked not to feed their dogs 3-4 hours before the onset of the experiment. Owners filled in a questionnaire to give detailed information about their dog and their activities with their dog. Testing took place between December 2010 and June 2011.

4.1.2 Experimental set up and materials

The experimental set up was the same as in Experiment 1 (Fig. 1).

4.1.3 General Procedure

The experiment comprised two experimental groups in which the owner actively sent their dogs towards a previously indicated container and the experimenter did or did not point to a container (see below for more detailed description of groups and Tab. 2). However, the general procedure (briefing, pre-training, testing phase, and debriefing, see Fig. 2) was the same for all dog-owner dyads. In both groups, in every test trial both containers contained an identical piece of reward (small piece of sausage or cheese (1 cm x 1 cm)).

Briefing

During the briefing the experimenter informed the owner about the aim of the study and the procedure.

Creating a belief which container the subject should choose

In every group, the owners were informed that during the testing phase only one container contained food (despite of both containers being baited!) and that the aim of the study was to investigate whether their dog could succeed in finding the food.

Active influence

In both experimental groups, the owner was instructed to send the dog actively towards a container previously named by the experimenter. The owner could use

hand signals, pointing gestures, as well as vocal commands but was not allowed to stand up or move away from the chair. The owner was told not to influence or call the dog back if she had already released it and if the dog clearly went towards one of the two containers but had not reached it yet.

After the briefing, the owner and her dog were led into the experimental room where the owner was allowed to let the dog off the leash to familiarize it with the room for 1 to 3 minutes.

Pre-Training

The pre-training was carried out in the same way as in Experiment 1.

Testing phase

The testing phase took lace immediately after the pre-training. Before each trial, the experimenter baited both containers with food, standing at the table with back turned to the owner and dog so that the owner and dog could not see the baiting.

Each trial started with the experimenter placing the containers on the floor and standing up facing the dog. In one experimental group (see Tab. 2), after calling the dog, the experimenter presented a momentary distal pointing gesture to one of the two containers (i.e. she stretched her ipsilateral arm with extended index finger towards the container for 1 to 2 seconds). After this signalling the experimenter folded her arms in front of her chest and lowered her head. Then the owner actively sent the dog and the dog could approach one of the containers. In the other group no pointing gesture was presented and the owner sent her dog as soon as the experimenter had folded her arms in front of her chest.

Importantly, in each trial of all experiments, both food containers were baited without the owner being informed about it and the dog was allowed to eat the food regardless of which container it visited. The experimenter started talking

either in a praising voice "super, well done" if the dog went to the container she had pointed to or "no, that was the wrong choice" if the dog chose the other container. As soon as the dog had made a clear choice (nose in container) the experimenter praised or corrected the dog. The verbal reinforcement as well as the experimental arrangement (dogs faced towards the experimenter during eating) made it hard for the owner to hear or see whether the dog ate something or not. In the group without a pointing gesture ("*only active cues*"), she verbally reinforced the container that had previously been indicated to the owner as the correct container (see below for description of groups and Tab.2). After the dog had eaten the food from one of the containers, the experimenter picked both containers up and the owner called the dog back to the starting position.

Each dog received 20 trials with a break of 10 min after 10 trials. The order of the container side the dog was verbally praised for by the experimenter (in the group *"only active cues"* dogs were praised for the owners' target and in the group "*pointing and active cues opposite direction*" dogs were praised for the by the experimenter pointed container) was predetermined and semi-random (not more than two consecutive trials with the same side) with praising the left as well as the right side 10 times.

Debriefing

The debriefing was carried out in the same way as in Experiment 1.

4.1.4 Experimental groups

Dogs were randomly assigned to one of the two different groups (balanced for breed, age, sex). The groups varied in the belief the owner had about the experiment as well as the actions performed by the experimenter and owner (for an overview, see Tab. 2).

"only active cues": In this group I wanted to investigate whether owners could actively send their dog towards a baited container previously named by the experimenter.

Briefing: Owners were informed that I want to see whether dogs make their decision based on the active signals the owner gives to them. The experimenter told them to try everything to make the dog go to the container where the food was hidden (owners were previously informed about the location of the food) but not to call the dog back if it had already made a clear decision.

Testing phase: The experimenter put the containers on the floor and stood between the two containers. Her hands were folded in front of her chest and her head lowered. As soon as the experimenter was in this position, the owner was allowed to send the dog away to the pre-determined container. The experimenter praised the dog always for choosing the previously indicated baited container. If the dog went to the not indicated container the experimenter said "no, that was the wrong choice" though the dog could eat a piece of reward also here.

Active sending of the dog by the owner was expected to lead to increased successful performance of dogs.

"Pointing + active cues opposite direction": In this group I wanted to find out how much the owner could still succeed in sending the dog actively if they had to counteract a pointing gesture given by the experimenter.

Briefing: Owners were informed that I want to test which is the stronger signal for dogs to help make their decision: a pointing signal given by the experimenter, or the actively sending signal by the owner. The owners were told that the food was in the container which the experimenter did not point at and they should go against the pointing gesture and try everything to send their dogs towards the not-pointed container. Therefore, the owner believed that the dog was only rewarded if it chose the container indicated by the owner and not the pointing of the experimenter.

Testing phase: In this group the experimenter conducted a pointing gesture and the owner was able to see the pointing. As soon as the hand of the experimenter was back at her chest and her head lowered, the owner was allowed to try and send the dog to the container the experimenter did not point at. The experimenter praised the dog if it chose the pointed container. If the dog went to the owner's target, the experimenter said "no, that was the wrong choice" though the dog could eat a piece of reward also here.

I hypothesized that if the active influence of owners in this group was a much stronger cue than the pointing gesture, then dogs should follow the owners cuing more than the pointing gesture given by the experimenter.

Tab.2. Overview of the two experimental groups

Group	**Briefing („aim of the study")**	**Owner's belief**	**Experimenter's action**	**Owner's influence**	**Praising**
Only active cues N= 16	Can owner send dog actively towards a certain location?	Previously indicated container baited	-	active	For choosing owner's target
Pointing + active cues opposite direction N= 15	Can owners counteract the pointing gesture of E?	Previously indicated container baited	pointing	active	For choosing pointed container

E= Experimenter

4.2 Data Analysis

In the two groups, the dog's choice was coded and the number of correct choices was compared with nonparametric statistical methods. The choice was coded as correct if the dog followed the active cuing of the owner. Going to the pointed container was coded as an incorrect choice. The percentage of responses was calculated.

To test whether the number of correct choices differed in the first compared to the second 10 trials a Wilcoxon matched pair test was applied for each group. A one-sample Wilcoxon signed-rank test was applied separately to test the number of correct choices for each group against chance level at the group level. For

individual performance, a Binomial Test was applied evaluating how many individuals in each group performed above chance level. To reveal the effect of the pointing on the performance of dogs (i.e. following the owner), the two groups were compared with a Mann Whitney U test.

Additionally, the data of the group "*pointing + active cues opposite direction*" were compared to the data of the group "*pointing + owner blindfolded*" of Experiment 1 with a Mann Whitney U test to evaluate the effect of the active influence of the owner on the pointing gesture.

All statistical tests were calculated with SPSS 19 and considered significant if $p<0.05$. A sequentially rejective Bonferroni test for multiple testing was applied (Holm, 1979).

4.3 Results

Comparison of the first 10 trials to the second 10 trials in both groups revealed that there were no significant differences (all p-values > 0.05; Holm-Bonferroni corrected: $p\geq0.05$) indicating that no learning within the session took place.

Comparing the performance of dogs in the two groups of Experiment 2 against chance level revealed that dogs in the group "*only active influence"* performed better than expected by chance (N=16, Z=-3.417, p= 0.001; Holm-Bonferroni corrected: $p\leq0.05$) whereas dogs in the group "p*ointing + active cues opposite direction"* performed as a group at chance level in choosing the container indicated by their owners (N=15, Z= -1.891, p= 0.059; Holm-Bonferroni corrected: $p\geq0.05$; Fig.7).

Analyzing the individual performance showed that 10 out of 16 dogs performed above chance in following their owner's active cuing toward a container, but as soon as the pointing gesture was presented, only two dogs out of 15 followed their owner's active cuing towards the container above chance (Holm-Bonferroni corrected; before Holm-Bonferroni correction: "*only active cues*": 11

individuals above chance; "*pointing+active cues opposite direction*": 3 individuals above chance).

The comparison between the two groups showed that they differed significantly (Mann Whitney U:N=31, U=48.500, p=0.005; Holm-Bonferroni corrected: p≤0.05) indicating that dogs in the group with the experimenter's pointing gesture followed the indication of their owner to a lesser extend (Fig.7).

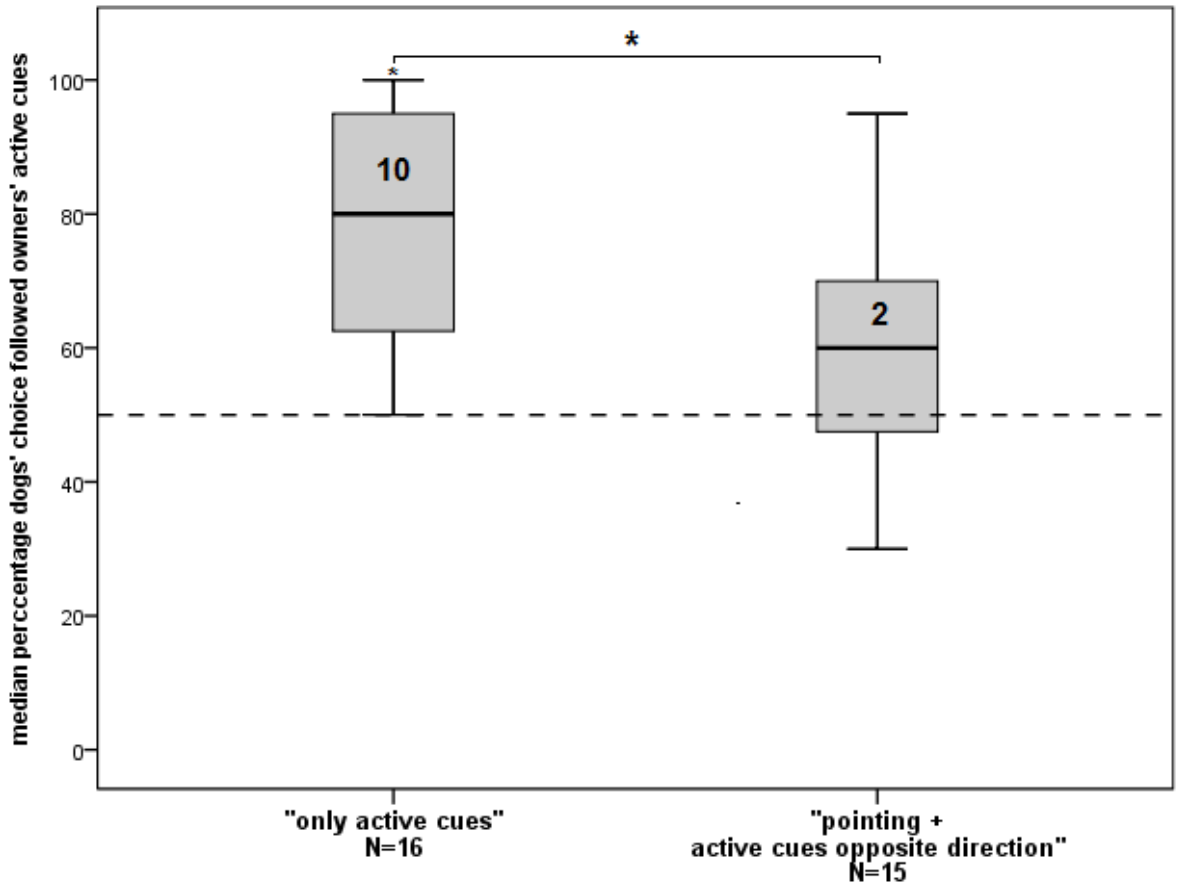

Fig.7. Percentage of dogs' choices to follow the owners' target. Asterisks directly above the bars indicate a significant difference in group performance from chance level; the numbers in the bars indicate the individuals in that group performing above chance.

The comparison of the group "*pointing+ active cues opposite direction*" to the group "*pointing + owner blindfolded*" (Experiment 1) revealed that dogs performed significantly better when the owner did not try to send the dog in the opposite direction (Mann Whitney U: N=32, U=211.500, p= 0.001; Holm-Bonferroni corrected: p≤0.05 ; Fig.8.).

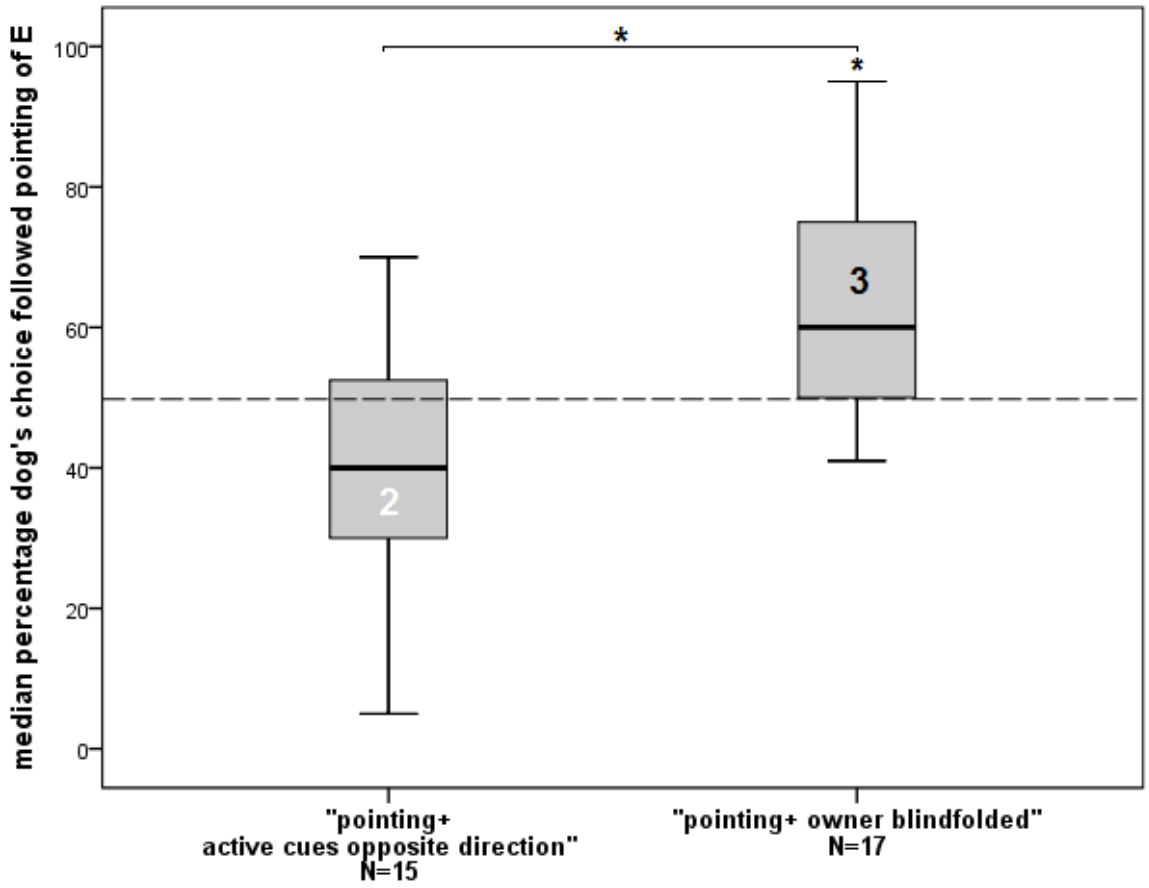

Fig.8. Percentage of dogs' choices to follow the pointing gesture of the experimenter (E). The asterisk directly above the bars indicates a significant difference in group performance from chance level, the black number in the bar indicates the individuals in that group performing above chance, the white number individuals below chance performance (i.e. following the owner).

4.4 Discussion

In this experiment, I wanted to analyse dogs' choice behavior if owners actively influenced the dog in the absence or presence of a pointing gesture.

Owners succeeded in sending the dog to a previously indicated container in the absence of a pointing gesture. At the group level, dogs performed better than expected by chance. At the individual level most of the dogs followed the sending signal of their owner above chance. However, as soon as the experimenter presented a pointing gesture, the group performance of the dogs fell to chance level. Dogs in this group did not follow the pointing to the correct location (no individual performed above chance following the pointing gesture) and only a minority of the group followed the instructions of their owner significantly above

chance. That is especially interesting, when considering that the pointing gesture was always presented before the owners were allowed to send their dog towards the non-pointed container. The comparison with data from Experiment 1 (where no possible influence of the owner was present) showed that if owners actively influenced their dog against the pointing, the dogs' performance dropped significantly.

5. GENERAL DISCUSSION

The aim of this study was to examine whether dogs based their choice in an object-choice task on the inactive or active cues of their owner or whether dogs followed the pointing gesture of an experimenter. In Experiment 1 it was investigated whether the possible inactive (involuntary) influence of owners could lead to an improvement or decrease in dogs' performance in following a pointing gesture. Additionally, it was examined whether owner's knowledge alone about the hiding location of the food was sufficient to guide dog's choice to this location. In Experiment 2, the effect of owners' active influence on the choice of their dogs in the absence or presence of a pointing gesture was established.

Results of Experiment 1 showed that dogs did not base their choice about choosing a container on any possibly existing, inactive helping cues provided by their owners. The performance of dogs was very similar in the groups in which the belief of the owners varied regarding the aim of the study and in which owners could not cue the dog since they were blindfolded. In absence of a pointing gesture dogs chose randomly although the owners were informed about the location of the food. Thus, this first experiment failed to elicit a "Clever Hans effect".

Current research indicates that dogs are responsive to the attentional focus of humans (Soproni et al., 2001; Call et al., 2003; Virányi et al., 2004; Schwab & Huber, 2006). In the case of the horse Hans it was shown that his correct responses in object-choice tasks were indeed dependent on the attention ("concentration",

i.e. involuntarily provided cues like head orientation, body orientation, Pfungst, 1907) of the person standing on front to him. Owners in my experiment were able to watch the pointing gesture (in all but one group), were in close proximity to their dog, and they had a belief about the expected behavior of their dog. Considering this, it was possible that dogs could have reacted to unintentional or intentional cues. However, I have not analyzed the behavior of the owners, I did this for two reasons. First, as mentioned earlier, even if all visible behaviors of the owners could be analyzed (for example as in the study of Hauser et al. (2011)) it could still be possible that dogs react to cues which are not detectable by human observers. Second, it is most likely that any possible existing helping cues vary between dog-owner dyads (e.g. due to differences in training history), or that special groups of dog owners influence their dogs differently (possibly depending on the personality of the owner). So I considered it unlikely to find an overall pattern of cueing. Even though Pfungst observed a similar pattern of behaviors in many humans that helped Hans (and later also Pfungst himself) to answer the questions, he noticed that these subtle cues could be more or less pronounced depending on the questioner and sometimes the head movements were not detectable (Pfungst, 1907). However, the results of Experiment 1 clearly show that even if the owners' belief was strongly manipulated about the expected outcome of the study, and they saw the pointing and could inactively influence their dogs (either towards the pointed or the non-pointed container), the performance of the dogs did not differ from the group with the blindfolded owners. Moreover, the reasonably good performance of the dogs in the group with blindfolded owners was comparable to results of other studies, despite the fact that in this study dogs always got rewarded no matter whether they followed the pointing or not.

Accordingly, it seems that pointing is a surprisingly powerful cue for dogs. This was also demonstrated in a study by Szetei et al. (2003) where it was found that while dogs chose the baited container significantly over chance using physical cues (observation of the baiting, and smell), the mere presence of a human affected

their performance. If the human pointed to the container without food and thus contradicted the physical cues, dogs preferred to follow the social cue given by the human. Kundey et al. (2010) found a similar result where dogs still preferred to approach a container indicated by a human with a static pointing gesture even though the treat was visible to the dog in the other container. After some training, the dogs learnt to go to the transparent container with the treat in it, but as soon as the treat was invisible, they returned to follow the pointing gesture.

The possible mechanisms behind dogs' performance in pointing tasks have been discussed at length in previous publications, and the results of the present study are a very interesting finding. One hypothesis assumes that dogs solve the pointing task due to local enhancement (e.g. protruding body parts; Lakatos et al., 2009). Although the procedural method of the momentary distal pointing ensures that local enhancement is at a minimum, it still cannot be excluded that dogs follow the body parts that attracted their attention toward a certain place. Recently, a study showed that dogs did not follow the pointing gesture if they did not expect to find food (Scheider et al., 2011). Dogs in this study searched longer where the human had pointed at but only if they had previously experienced that they might find food. The authors concluded, that these results contradict the explanation that dogs only form association between the hand of the experimenter and the provided food at that place (Udell et al., 2010) and instead emphasize that dogs have an understanding of the referential character of the gesture.

Dogs' superior performance in pointing tasks has also been suggested to result from their perception of the pointing gesture as an imperative (Kaminski, 2009; Topál et al., 2009). Dogs may follow human imperatives even if the outcome is an inefficient solution but only if they are directly addressed. This explanation is also supported by the finding that dogs have the tendency to follow the pointing gesture even if their previous experience (e.g. seeing that the non-pointed container is baited) is contradicting. Furthermore, dogs need some time to succeed in reversal learning (i.e. going to the non-pointed container) (Kundey et al., 2010).

A third possible explanation why dogs follow the pointing gesture is the most sophisticated one. This hypothesis assumes that dogs succeed because they have an understanding of the communicative and referential character of the pointing gesture. Very recently, Pettersson et al. (2011) conducted an experiment with varying the context during which the dog had to choose in a two-way object-choice task. In their first study, the experimenter pointed at a container in a cooperative or in a competitive context (i.e. prohibiting the dog to go there). From the dogs' point of view the pointing gesture in the helping context and the prohibiting gesture in the non-cooperatively context looked very similar, but the communicative context was different. However, the comparison of these groups revealed no significant difference between them – indicating that only the protruding pointing gesture was important, and not the context in which it was give. Dogs did not perform above chance in the competitive context; many dogs did not choose in the first trial or chose only after they were encouraged to do so. Therefore dogs could have understood the communicative context but were disorientated when they were forced to choose although they were previously told not to do so.

With regards to these three hypotheses it was particularly interesting how dogs performed in this experiment in the group "*pointing + active cues opposite direction*". The pointing clearly had a strong influence on the dogs' performance. Even when the owner was allowed to send her dog actively (using positioning, pointing, verbal cues, and directing the dog manually from the chair), if the experimenter presented a pointing gesture before the owners could send their dog, the performance of dogs decreased significantly. In comparison, dogs in the "*only active cues*" proved to be very successful at following their owners' directions and choosing the correct container. The sending action of the owner was clearly seen as an imperative for the dogs (especially when taking their training experience into account) but in contrast to the group without the pointing gesture, they did not follow this imperative reliably. Since the pointing gesture was always

presented before the owners' action, the indicated container might still have been in the dogs' mind and the directing of their owner towards the opposite side confused the dogs in so far that they chose randomly. The question of how dogs perceived the pointing gesture is not entirely clear, since if dogs saw the pointing as an imperative then the owners' gestures would also have been perceived as an imperative, and should have superseded the experimenter's pointing.

Possibly, the pre-training had such a strong influence on dogs' behavior (as it was perceptually very similar to the testing phase) that dogs had already learnt to follow the indication of the experimenter to a certain location. Contrasting this explanation, no single dog in the "*pointing + active cues opposite direction*" followed the pointing gesture above chance. To answer the question whether the pointing gesture counteracted the active influence of the owner or the other way around, how the dogs would perform if the owners' active influence was presented before the pointing gesture should be examined.

I presume that the current data show that even if the owners were in full view of the experiment and had different opinions about the outcome of the experiment, dogs performance did not differ within the groups. If owners tried to actively influence their dog against the pointing gesture they were significantly less successful compared to when sending their dog without a pointing gesture. Thus, in presence of a pointing gesture owners could only influence the performance of their dog if they actively sent their dog, and were not able to influence the dog trough inactive unconscious cues.

Despite the results of this study, owners might still be able to cue the behavior of their dogs in other tasks. In this study, the dogs directed their attention towards the experimenter; hence, dogs might have focused on the behavior of the experimenter and not on the behavior of their owner. Therefore, even if the owners provided unintentional cues, dogs did not pay sufficient attention and followed the stronger cue, the pointing gesture. It has already been shown that the attention of dogs toward a certain task plays a crucial role for the

dogs' success in the task (Pongrácz et al., 2004). However, the focus of attention towards another human or object holds true for many studies which argue that dogs' success may be due to owners who unconsciously cue their dogs. Therefore, further research should try to disentangle whether in experiments where dogs directly interact with their owners, like in social learning tasks, dogs can be cued by their owners.

Finally, in this study the experimenter was aware of the goal of the study and could have unintentionally influenced the behavior of the dog. Hence, a study with an experimenter with no knowledge about the background and predictions could reveal whether the experimenter might influence the behavior of the dogs.

ACKNOWLEDGEMENTS

This thesis would not have been realizable without the support of many people. First of all, I want to thank Prof. Ludwig Huber for supervising my master thesis and giving me the possibility to work in the fascinating field of research on canine cognition. I am very thankful to Dr. Zsofía Virányi and Dr. Friederike Range, whose invaluable guidance and support with endless patience during the project helped and reassured me. Furthermore, I want to thank all my colleagues of the Clever Dog Lab for supporting me in any respect like ideas and helpful discussions. Especially, I want to thank Mag. Lisa Horn and Lisa Wallis (Msc.) who had always time to help me with all my questions and sorrows.
Of course I offer my regards to all the dog owners who participated in this study – without their patience and understanding - especially after the experiment - this would not have been possible.
Finally, I owe my deepest gratitude to my family and friends, and, of course, to the members of the LHV. All of them supported and encouraged me whenever necessary during good and bad times.

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APPENDIX 1 Table of all dogs that participated in Experiment 1

Dog's name	Breed	Sex	Group	Age (months)	% followed pointing
Abby[b]	Kromfohrländer	F	*pointing + owner blindfolded*	52,77	50
Akira	mix	F	*pointing + owner blindfolded*	53,13	75
Archimedes	Flat coated retriever	M	*pointing + owner blindfolded*	48,50	60
Bateia[a]	Labrador Retriever	F	*pointing + owner blindfolded*	102,87	79
Cash	Australian Shepherd	M	*pointing + owner blindfolded*	60,90	65
Chendra[c]	Belgian Shepherd (Malinois)	F	*pointing + owner blindfolded*	23,90	41
Eddi	Irish Soft Coated Wheaten Terrier	M	*pointing + owner blindfolded*	13,03	50
Keira	mix	F	*pointing + owner blindfolded*	63,03	95
Lilyen	Pumi	F	*pointing + owner blindfolded*	51,73	60
Luke	mix	M	*pointing + owner blindfolded*	24,70	50
Mara	mix	F	*pointing + owner blindfolded*	60,50	85
Nanook	White Shepherd	M	*pointing + owner blindfolded*	82,77	55
Nemi	Parson Russel Terrier	F	*pointing + owner blindfolded*	14,87	65
Olli	poodle (toy)	M	*pointing + owner blindfolded*	50,63	55
Poci	Australian Shepherd	F	*pointing + owner blindfolded*	27,13	75
Quent	Golden Retriever	M	*pointing + owner blindfolded*	37,50	80
Timon	mix	M	*pointing + owner blindfolded*	24,27	45
CD	poodle (toy)	M	*Pointing + inactive cues same direction*	52,77	60
Che	mix	M	*Pointing + inactive cues same direction*	55,43	70
Chinua	Czechoslovakian Wolfdog	F	*Pointing + inactive cues same direction*	46,33	55
Cool	Shetland Sheepdog	M	*Pointing + inactive cues same direction*	34,27	45
Eshmoor	Labrador Retriever	M	*Pointing + inactive cues same direction*	69,50	85
Heydi	mix	F	*Pointing + inactive cues same direction*	76,63	45
Idefix	West Highland White Terrier	M	*Pointing + inactive cues same direction*	94,50	90
Ike	mix	M	*Pointing + inactive cues same direction*	35,63	65
Jenny	poodle (toy)	F	*Pointing + inactive cues same direction*	106,33	85
Juki	Labrador Retriever	M	*Pointing + inactive cues same direction*	78,07	65
Julie	poodle (toy)	F	*Pointing + inactive cues same direction*	106,17	50
Kelly	Flat coated retriever	F	*Pointing + inactive cues same direction*	34,37	60
Lilly	mix	F	*Pointing + inactive cues same direction*	116,90	60
Linette	Airedale Terrier	F	*Pointing + inactive cues same direction*	79,13	75
Mala	Golden Retriever	F	*Pointing + inactive cues same direction*	69,33	45
Sam	Shetland Sheepdog	M	*Pointing + inactive cues same direction*	41,80	75
Suki	Australian Shepherd	F	*Pointing + inactive cues same direction*	30,50	60
Tina	West Highland White Terrier	F	*Pointing + inactive cues same direction*	78,90	50
Aika	mix	F	*Pointing + inactive cues opposite direction*	13,67	90
Archie	Parson Russel Terrier	M	*Pointing + inactive cues opposite direction*	24,37	60
Blacky	mix	M	*Pointing + inactive cues opposite direction*	112,13	65
Chester[a]	Golden Retriever	M	*Pointing + inactive cues opposite direction*	94,53	58
Chilly	Australian Shepherd	M	*Pointing + inactive cues opposite direction*	35,67	60
Emy	Australian Shepherd	F	*Pointing + inactive cues opposite direction*	79,50	70
French	Labrador Retriever	F	*Pointing + inactive cues opposite direction*	54,33	90
Ginger	Parson Russel Terrier	F	*Pointing + inactive cues opposite direction*	72,47	70
Julie	Golden Retriever	F	*Pointing + inactive cues opposite direction*	94,57	60
Keisha	mix	F	*Pointing + inactive cues opposite direction*	68,63	55
Luca	poodle (toy)	M	*Pointing + inactive cues opposite direction*	85,40	45
Luis	Shetland Sheepdog	M	*Pointing + inactive cues opposite direction*	50,67	65
Max[a]	Golden Retriever	M	*Pointing + inactive cues opposite direction*	88,20	95
Missy	Australian Shepherd	F	*Pointing + inactive cues opposite direction*	22,30	75
Momo	Mischling	F	*Pointing + inactive cues opposite direction*	88,97	65
Sokrates	Mischling	M	*Pointing + inactive cues opposite direction*	61,30	55

Zita	Parson Russel Terrier	F	*Pointing + inactive cues opposite direction*	13,93	30
Artos	Golden Retriever	M	*only inactive cues*	84,63	45
Arwen	Labrador Retriever	F	*only inactive cues*	103,77	50
Axel	Labrador Retriever	M	*only inactive cues*	63,77	50
Barolo	poodle	M	*only inactive cues*	10,83	55
Basti	mix	M	*only inactive cues*	74,50	50
Blue	American Staffordshire Terrier	M	*only inactive cues*	22,90	65
Cookie	Airedale Terrier	F	*only inactive cues*	12,23	65
Finlay	mix	M	*only inactive cues*	58,80	45
Gundi	Phalène	F	*only inactive cues*	128,67	45
Joey	mix	M	*only inactive cues*	30,83	45
Kira	Australian Shepherd	F	*only inactive cues*	62,83	40
Lele	Maltese	F	*only inactive cues*	30,30	55
Micky	mix	F	*only inactive cues*	61,37	60
Pebbles	Australian Shepherd	F	*only inactive cues*	43,97	50
Samy	Golden Retriever	F	*only inactive cues*	47,47	45
Schnackerl	mix	F	*only inactive cues*	74,57	45
Sky	Shetland Sheepdog	M	*only inactive cues*	11,43	50
*Emmi	Scottish Collie	F	*pointing + owner blindfolded*	24,83	-
*Moni	mix	F	*Pointing + inactive cues same direction*	123,37	-
*Emely	Golden Retriever	F	*only inactive cues*	40,47	-
*Feeby	Border Collie	F	*only inactive cues*	106,70	-
*Aikyo	mix	F	*only inactive cues*	41,90	-
*Rebecca	miniature Pinscher	F	*only inactive cues*	35,67	-

* indicates dogs that were excluded from the experiment (N=6)
a indicates dogs that chose in 19 instead of 20 trials (N=3)
b indicates the dog that chose in 18 instead of 20 trials (N=1)
c indicates the dog that chose in 17 instead of 20 trials (N=1)

APPENDIX 2 Questionnaire

1. My dog…*

	disagree strongly	disagree little	neither agree nor disagree	agree a little	agree strongly
…sticks to rules, even if he/she feels unobserved (e.g. does not steal food).					
…is not easily distracted.					
…is obedient, follows my commands (e.g. if I call him/her).					
…stressful situations do not change the behavior of my dog.					
…reacts only slowly to reprehensions.					

* Questions are of the Vienna Clever Dog Lab Personality Questionnaire

2. Was the explanation about the experiment sufficient clear to you?

3. Did you feel nervous during the experiment?

4. Was your dog nervous during the experiment?

4a. If yes, did this influence his/her attention and therefore his/her performance negatively?

5. Was it difficult for you to follow exactly the instructions of the experiment?

6. Did the performance of your dog change in the 10 trials after the break compared to the first 10 trials?

7. In how many of the 20 trials did your dog get the sausage? (possible answers: 0-5, 6-10, 11-15, 16-20; and if known exact number of successful trials)

8. Did you expect your dog's performance? Why/Why not?

9. Could you have influenced the decision of your dog during the experiment? How?

APPENDIX 3 Table of all dogs that participated in Experiment 2

Dog's name	**Breed**	**Sex**	***Group***	**Age (months)**	**% followed owner**
Abby	Australian Kelpie	F	*only active cues*	12,23	75
Buster	mix	M	*only active cues*	78,77	85
Chilli	Australian Shepherd	F	*only active cues*	29,17	100
Elroy	Belgian Shepherd (Groenendael)	M	*only active cues*	30,50	60
Flappi	mix	F	*only active cues*	18,87	60
Flora	Golden Retriever	F	*only active cues*	70,97	100
George	Australian Shepherd	M	*only active cues*	21,10	80
Indira	Fox terrier	F	*only active cues*	84,57	50
Jessy	Golden Retriever	F	*only active cues*	89,40	90
Joey	mix	M	*only active cues*	48,77	95
Knocky	Parson Russel Terrier	M	*only active cues*	118,97	60
Lotti	mix	F	*only active cues*	96,83	80
Mephisto	poodle	M	*only active cues*	49,33	80
Mika	poodle (toy)	F	*only active cues*	134,87	95
Shadow	Labrador Retriever	M	*only active cues*	83,30	65
Tyrell	Golden Retriever	M	*only active cues*	26,80	100
Aika	mix	F	*Pointing + active cues opposite direction*	45,93	30
Amy	mix	F	*Pointing + active cues opposite direction*	69,00	70
Chester	poodle (toy)	M	*Pointing + active cues opposite direction*	97,43	45
Diamond	White Shepherd	M	*Pointing + active cues opposite direction*	21,17	65
Flash	Australian Shepherd	M	*Pointing + active cues opposite direction*	114,93	60
Gala	Golden Retriever	F	*Pointing + active cues opposite direction*	50,30	45

Chester	Border Terrier	M	*Pointing + active cues opposite direction*	35,30	35
Indigo	Golden Retriever	M	*Pointing + active cues opposite direction*	24,17	95
Joy	Labrador Retriever	F	*Pointing + active cues opposite direction*	17,60	80
Nui	Labrador Retriever	M	*Pointing + active cues opposite direction*	17,30	70
Palmira	Belgian Shepherd (Tervueren)	F	*Pointing + active cues opposite direction*	67,10	70
Tango	mix	M	*Pointing + active cues opposite direction*	39,63	50
Timo	mix	M	*Pointing + active cues opposite direction*	64,13	75
Tiny	Parson Russel Terrier	M	*Pointing + active cues opposite direction*	110,37	50
Tosca	German Shepherd	F	*Pointing + active cues opposite direction*	78,63	50
*Neo	mix	M	*only active cues*	60,73	-
*Mowgli	poodle	M	*Pointing + active cues opposite direction*	37,13	-
*Ronja	Labrador Retriever	F	*Pointing + active cues opposite direction*	47,53	-
*Pia	mix	F	*Pointing + active cues opposite direction*	54,87	-
*Cosmo	Shetland Sheepdog	M	*Pointing + active cues opposite direction*	16,30	-

* indicates dogs that were excluded from the experiment

SUMMARY

The last years of research on canine cognition showed that domestic dogs are highly skillful in responding to human given cues like diverse pointing gestures (for a review see Reid, 2009). However, several studies criticized the interpretation of the extraordinary skills of dogs in socio-cognitive tasks and instead, the possibility of reacting to unintentional cues of the handler (typically the owner) was emphasized. The daily contact between owner and dog as well as intensive training with dogs bears the risk that dogs learn to react to subtle subconscious cues like head and body orientation to solve cognitive tasks without understanding the problem. This is known as the "Clever Hans effect".

Although the Clever Hans effect was taken as possible 'kill-joy explanation' of the results in several studies, so far it was not investigated whether owners influence the behavior of their dogs during an experiment. This study was therefore conducted to assess two types of owners' influences on the choice behavior of dogs; (i) the potential unintentional influence triggered by subtle body movements or orientations of the owners; (ii) a more active influence of the owner on the choice of dogs.

In the first experiment of the current study I directly investigated whether owners can unintentionally influence the choice behavior of dogs. I confronted the subjects with a two-way object-choice task where the experimenter indicates with an outstretched arm one of two possible location of a hidden piece of food (i.e. pointing). Various groups of owners were differently informed about the location of the food. The owners believed that the dog should either follow the pointing of the experimenter or not follow the pointing gesture of the experimenter.

The comparison of the performance of the dogs in the different groups revealed no significant differences between the experimental groups. This suggests that the owners have not influenced the choice of the dogs unintentionally. If the experimenter presented no pointing gesture, dogs chose randomly.

In the second experiment, I investigated whether owners could influence the choice of their dog by actively commanding the dog to a previously determined location. Owners successfully directed their dogs to one of two locations. However, as the experimenter presented a pointing gesture to the other location, owners were significantly less successful in their attempts to influence their dogs.

In conclusion, the study indicates that the owners' potential unintentional behaviors might have only a minor influence on the behavior of dogs in a two-way object-choice task. More research is necessary to clarify the potential influence of subtle behaviors of the owner on dogs' performance in other cognitive tasks.

ZUSAMMENFASSUNG

In den vergangenen Jahren hat sich im Bereich der Kognitionsforschung gezeigt, dass Hunde äußerst geschickt auf menschliche Zeichen wie verschiedene Zeigegesten reagieren (für eine Übersicht: Reid, 2009). Allerdings wurden die außerordentlichen Fähigkeiten von Hunden in sozio-kognitiven Aufgaben wiederholt kritisiert und die Möglichkeit betont, dass Hunde auf unbewusst gegebene Zeichen des Hundeführers (normalerweise der Hundebesitzer) reagieren könnten. Durch den täglichen Kontakt zwischen Hundebesitzer und Hund sowie durch intensives Training entsteht die Gefahr, dass Hunde lernen, auf kaum wahrnehmbare, unbewusste Zeichen wie Kopf- und Körperorientierung zu reagieren ohne das Problem zu verstehen. Dieser Sachverhalt ist auch als Kluger-Hans-Effekt bekannt.

Obwohl in einigen Studien der Kluge-Hans-Effekt als mögliche Erklärung für die Ergebnisse herangezogen wurde, wurde bis jetzt nicht direkt analysiert, ob Hundebesitzer das Entscheidungsverhalten von Hunden während eines Versuchs beeinflussen können. In dieser Studie untersuchte ich zwei unterschiedliche Arten von Einflüssen, die Hundebesitzer auf ihren Hund haben können.

In Experiment 1 der vorliegenden Studie wollte ich herausfinden, ob Hundebesitzer das Wahlverhalten ihrer Hunde unbewusst beeinflussen können. Als Methode wurde ein so genanntes „Two-Way Object-Choice“ Verfahren gewählt, bei dem der Experimentator mit ausgestrecktem Arm auf einen von zwei möglichen Orten hinzeigt. Unterschiedliche Gruppen von Besitzern wurden unterschiedlich über den Ort des Futters informiert. Hundebesitzer glaubten entweder, dass ihr Hund der Zeigegeste des Experimentators folgen sollte oder dass ihr Hund der Zeigegeste nicht folgen sollte. Der Vergleich der Ergebnisse der Hunde in den unterschiedlichen Gruppen wies keinen signifikanten Unterschied auf. Das deutet darauf hin, dass der Hundebesitzer die Wahl des Hundes nicht

mit unbewussten Signalen beeinflussen konnte. Wurde keine Zeigegeste ausgeführt, wählten die Hunde zufällig einen der beiden Behälter.

In Experiment 2 untersuchte ich, ob Hundebesitzer das Wahlverhalten ihres Hundes beeinflussen konnten, wenn sie den Hund aktiv zu einem der beiden Orte schickten. Der erste Versuch zeigte, dass Hundebesitzer ihre Hunde erfolgreich zu einem im Vorhinein bestimmten Ort schicken konnten. Führte der Experimentator jedoch eine Zeigegeste zum anderen Ort aus, waren die Hundebesitzer mit ihrem aktiven Einfluss signifikant weniger erfolgreich.

Zusammenfassend zeigt die Studie, dass der potentiell vorhandene, unbewusste Einfluss des Besitzers auf das Verhalten des Hundes nur eine geringe Wirkung ausübt. Für zukünftige Studien würde sich anbieten, den Einfluss des Besitzers auch in anderen kognitiven Versuchen zu untersuchen.

DECLARATION

I hereby declare that I wrote this master thesis independently and that I only used the stated sources and auxiliary means. Parts of the thesis that are either directly or indirectly deduced of other publications are marked with references throughout the thesis. This does also apply for tables, figures and pictures.

Hiermit erkläre ich, dass ich diese Masterarbeit selbstständig verfasst habe und nur die angegebenen Quellen und Hilfsmittel angewendet habe. Jene Teile der Arbeit, die entweder sinngemäß oder im Wortlaut aus anderen Publikationen entnommen wurden, sind innerhalb der Arbeit mit Quellenangaben versehen. Dasselbe gilt auch für Tabellen, Grafiken und Bildern.

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