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Master Thesis

Understanding of human communicative motives in domestic dogs

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Sammanfattning

Abstract:

I investigated the understanding of human communicative motives in domestic dogs. Dogs use human communicative cues, like the pointing gesture when searching for hidden food, but it is uncertain how dogs interpret human communication. 32 dogs were presented with two communicative contexts in an object choice task experimental design. In a cooperative context the experimenter informed the subject where food was hidden by pointing and giving a verbal indication. In a competitive context the experimenter held out her arm towards the correct location in a stop gesture and firmly said no. To be successful in the competitive context the subject had to understand the experimenters communicative motive and make an inference from the prohibition (i.e. she would only prohibit it if there was something good there). The average correct choices were compared between the conditions. The dogs successfully followed the cooperative communication. They showed a trend towards choosing the baited cup in the competitive condition. A second study tested if the stop gesture affected the dogs' choice, since it is not known how dogs interpret gestures. The pointing cue was now presented with the prohibiting command and the stop gesture was presented with the cooperative verbal cue. The dogs used the cooperative communication but did not understand the competitive context. A difference between the contexts was found. The dogs did not differentiate between the gestures. In conclusion dogs do not make inferences from competitive communication or prohibition but are specialized in utilizing cooperative communication.

Nyckelord

Keyword:

Communicative motive, Dogs, Social cognition, Forbiddance, Object choice task

Preface

This masters project was conducted at the Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany

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1. Abstract

I investigated the understanding of human communicative motives in domestic dogs. Dogs use human communicative cues, like the pointing gesture when searching for hidden food, but it is uncertain how dogs interpret human communication. 32 dogs were presented with two communicative contexts in an object choice task experimental design. In a cooperative context the experimenter informed the subject where food was hidden by pointing and giving a verbal indication. In a competitive context the experimenter held out her arm towards the correct location in a stop gesture and firmly said no. To be successful in the competitive context the subject had to understand the experimenters communicative motive and make an inference from the prohibition (i.e. she would only prohibit it if there was something good there). The average correct choices were compared between the conditions. The dogs successfully followed the cooperative communication. They showed a trend towards choosing the baited cup in the competitive condition. A second study tested if the stop gesture affected the dogs' choice, since it is not known how dogs interpret gestures. The pointing cue was now presented with the prohibiting command and the stop gesture was presented with the cooperative verbal cue. The dogs used the cooperative communication but did not understand the competitive context. A difference between the contexts was found. The dogs did not differentiate between the gestures. In conclusion dogs do not make inferences from competitive communication or prohibition but are specialized in utilizing cooperative communication.

Key words

Communicative motives, Dogs, Social cognition, Forbiddance, Object choice task

2. List of abbreviations

HP-Helene Pettersson

OC-Object choice task

MPI-Max Planck Institute for Evolutionary Anthropology

3. Introduction

Dogs utilize human cooperative social signals, such as various kinds of pointing, when trying to find hidden food (e.g. Soproni et al, 2001, 2002, Agnetta et al, 2000, Hare et al, 2002, Hare and Tomasello, 1999, for review see Miklosi and Soproni, 2006). The most common experimental procedure used to test dogs' use of human communication is called the object choice task. In the object choice task a reward is hidden, out of view from the dog, in one of two or more different containers. The dog then receives a cue from the human indicating where the reward is located. This cue can be various forms of a pointing gesture, gazes or other bodily gestures. During the experimental procedure controls are used to show that the dogs do not use additional cues such as smell to find the reward (Miklosi, 2007). Dogs have been shown to be very skilled in the object choice testing procedure. This is interesting because it seems special social cognitive abilities are necessary to be successful in this test. Dogs outperform apes (Hare et al, 2002, Bräuer et al, 2006, Miklosi et al, 1998) and wolves (Hare et al, 2002, Miklosi et al, 2003, Viryani, 2008), both of whom are only successful after intense socialization and/or training. Dogs follow the cues spontaneously. The dogs' social bias towards listening to humans seems to even outweigh their reliance on their olfactory sense (Szetei, et al 2003).

Domestication might be an important factor affecting social cognition (Hare et al, 2002, Hare et al, 2005, Hare and Tomasello, 2005). Indeed other domesticated species such as; goats,

(Kaminski et al, 2005), cats (Miklosi et al, 2005), horses (Maros et al, 2008,) and domesticated foxes (Hare et al, 2005) have also been shown to utilize human communicative gestures in the object choice task. During early domestication processes the main selection pressure on dogs and other species was probably promoting tameness and acting against fear of humans (Hare and Tomasello, 2005). The emotions reactivity hypothesis proposes that this change in temperament would increase the ability for developing further social cognitive skills (Hare and Tomasello, 2005). Hare et al, 2005 conducted a study on domesticated foxes that supports this theory. The foxes in the experiment had been bred in two different strains as part of a long term study on domestication (See Trut, 1999). One strain was bred for tameness towards humans, more precisely towards approaching the human hand, and thus became domesticated. The other was bred irrespective of their behaviour towards humans (Trut, 1999, Hare et al, 2005). Hare et al, (2005) tested the ability of kits from both strains of foxes to follow the human pointing gesture in an object choice task. The domesticated foxes used the human pointing gesture with the same skill as dog puppies, whereas the control foxes did not utilize the cue. The emotions reactivity hypothesis also states that a change in temperament enabled development for social cognition in humans (Moll and Tomasello, 2007, Hare and Tomasello, 2005). Humans changed from being mainly competitive with other individuals as apes are, towards promoting cooperation and true altruism within home groups and this might have enabled humans to develop our special social cognition (Moll and Tomasello, 2007).

Herrmann and Tomasello, (2006), conducted a study examining if apes and infant children differed in their ability to understand human intentions in communicative situations. They used the object choice experimental design and presented the subjects with two different communicative motives, one prohibiting condition and one informative condition. In the prohibiting condition the experimenter first established a competitive relationship to the subject. The difference from a traditional object choice design, as described above, was that the experimenter then forbade the subject to take the baited cup rather than informing it of the reward location. The question was whether the subjects could use the prohibiting motive and the competitive relationship to realize that the forbidden cup held the reward. In order to do so the subject had to make the inference that “she would only forbid it if there was something good there” (Herrmann and Tomasello, 2006). In the informing condition the experimenter instead had a cooperative relationship with the subjects and in the object choice test the subjects were informed of where the food was hidden with a pointing gesture. The apes succeeded in the competitive condition as did children aged 18 months. Neither of these groups succeeded in the informing condition. Children aged 24 months conversely succeeded only in the informing condition. Herrmann and Tomasello (2006) see this as evidence that all groups could understand communicative motives, but that the apes’ ability to do so is limited to competitive situations.

In my study I will use a similar experimental procedure to Herrmann and Tomasello (2006), to answer the question if dogs have an understanding of human communicative motives. As previous studies have shown that dogs are sensitive to human cooperative communication and are highly skilled in following pointing cues in the object choice experimental design, it is likely that they will be successful in the cooperative situation. However it is still unknown whether dogs interpret the gestures used in the object choice task as informing about the location of the food. Since dogs are often raised to obey humans and have probably been bred to do so as well, it might be that they see human gestures, like the pointing gesture, as imperatives, i.e. directions about where to go and not as referring to the food. In that case the dogs’ reaction in the competitive condition should be to prefer the empty cup since the humans order them to avoid the baited cup.

Another alternative is that the dogs interpret the communication as being about the cup or food. According to this hypothesis if the dogs are successful in the competitive condition that would provide positive evidence that they have an understanding about the experimenters' motive. This is because to be successful in the competitive condition, they must be able to make an inference from the prohibition and the competitive motive to know where the food is (See Herrman and Tomasello, 2006). The dogs must be able to understand that the experimenter would only prohibit something that the dog wants. A negative result in the competitive condition can be interpreted in several different ways. If the dogs completely avoid the baited cup or possibly improve across trials it could be that they indeed see human gestures as imperatives. However if the dogs results are negative but the choices more random it would indicate that they do not see the gesture as an order, but cannot interpret the experimenters communicative intention in the competitive scenario either.

Thus, I hypothesize that the dogs will differ between the conditions, i.e. that they will be successful in the cooperative condition but not in the competitive condition. In the competitive condition they might prefer the baited cup or chose randomly depending on how they interpret the gesture and react to the prohibition.

Since dogs are generally taught to follow human commands, it might also be that they do not approach the forbidden cup out of obedience even if they know where the food is hidden. However it has been shown that dogs are sensitive to humans attentional states and are less likely to obey commands when the human is attending elsewhere than the dog (Call et al, 2003). Therefore, the dogs in our study will have a fair chance to show their understanding of the competitive motive without being intimidated, only if the experimenter is attending elsewhere when the dogs make their choice.

4. Methods

4.1 Subjects

32 dogs of various breeds and ages were tested (see Table 1). The dogs were registered in a database at the Max Planck Institute for Evolutionary Anthropology where the owners had volunteered them for tests. All dogs lived with their owners as pets in a German middle sized town. The dogs had no special education beyond normal obedience, except for one dog that had a hunting education. The dogs had participated in 0-2 similar test situations before, but all were naïve to the testing equipment and exact test procedure.

Table 1 Subject information. The OC column states how many tests using an object choice design the dogs have previously participated in. These dogs completed the whole test procedure and are the ones on which the data is based.

Subject	Sex	Breed	Age	OC
Balu ¹	M	German shorthaired Pointer	3	2
Baro	M	Berner Sennen	8	1
Bleibda	M	German Shepherd	6	2
Caja	F	Mix	4	2
Carrie	F	German wirehaired Pointer	3	1
Cora	F	Labrador	8	1
Drops	M	Parson Jack Russell	6	0
Emma	F	Weimeraner	2	0
Evita	F	Labrador	6	1
Fanny	F	Golden Retriever	10	2
Finnwolf	M	American White Shepherd	3	1
Gerry	M	Mix	4	0
Hanna	F	Golden Retriever	1,5	0
Jacko	M	Labrador	1	2
Kimi	F	Border Collie	8.5	2
Loki	M	Doberman	3	0
Luna	F	Mix	3	2
Max	M	Mix	8	1
Merlin	M	Dalmatian	8	2
Mira	F	Mix	6	2
Nele	F	Labrador	3	2
Ole	M	Mix	3	1
Panda	M	Mix	10	2
Paula	F	Mix	2	2
Paula K	F	Mix	5	1
Pipo	M	Mix	10	1
Pitty	F	Rottweiler	9	2
Senta	F	Mix	12	1
Wanja	M	Mix	6	2
Yukon	M	German Shepherd	8	1
Yula	F	Labrador	4	2
Zuela	F	Golden Retriever	2	0

4.2 Material

The testing equipment consisted of a box made from Plexiglas (See fig. 1). The food was hidden under one of two opaque paper cups on each side of the box. The lid was sliding and closed with magnets on either side, ensuring only one choice was possible. Food inaccessible and invisible to the dog was hidden in each compartment of the box to mask olfactory cues from the bait. Dry dog food (brand frolic) was used as bait, and a set of curtains was used to block the dogs view when necessary (see fig2 for experimental set up). All testing was recorded using a Panasonic NVDS60 videocamera.

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¹ Balu has hunting education

Fig.1 Box used for baiting (140cm x 16cm x 20 cm.) (Picture taken from Scheider, 2006)

4.3 Experimental set up

All testing took place at the Max Planck Institute for Evolutionary Anthropology, Germany, in special test rooms used for dog studies. Three people were needed during the experiment, two different test experimenters (E1 and E2), who established either a cooperative or a competitive relationship with each dog before the test trials, and one assistant experimenter (AE) who remained neutral to the dog. During both the warm up and the test trials the dogs were situated in front of the box at a pre determined mark, 120 cm away from the center of the box. The experimenter (E1, E2) was standing on the other side 90 cm away from the center of the box facing the dog. This meant that in the test trials the distance between the experimenters hand and the cup was roughly 110 cm. AE was holding the dog, standing on its right side. The curtain was placed right before the dogs, only a few centimeters away (See fig 2,3 for experimental set up). The pretest was conducted in another, smaller room and without any testing equipment other than food.

Fig 2 Experimental set up.

Fig 3 Schematic view of experimental set up

4.4 Procedure

The test procedure was based on the procedure used in Herrmann and Tomasello, (2006). The dogs were tested in two experimental conditions, one cooperative condition and one competitive. AE baited the cups in the warm up, where E1 or E2 held the dog. In the test trials these roles were reversed so that AE held the dog. E1 and E2 were female so that the dogs would not develop a preference based on gender differences for one or the other experimenter.

First each dog participated in a warm up phase during which the dogs learned about the test equipment. After the warm up the dogs were exposed to a pre test during which the relationship between the test experimenter, (E1 or E2), and the dog was established. After the pre test the dogs entered the experimental phase. The dogs were exposed to both experimental conditions on the same day, with a break of about ten minutes between the two. After the last

experimental trial, the dogs were exposed to an obedience test. The whole procedure from warm up until finish took between 40 minutes-1 hour for each dog.

4.4.1 Warm up

The warm up was conducted before the test so the dogs learned how to use the testing equipment. The baiting in the warm up was done by AE and the dogs were always allowed to see where she placed the food. During half of the warm up phase the dog was held by E1 and during the other half it was held by E2. Who held what dog first was counterbalanced. The dogs first learned how to get food from under the cups and were familiarized with the box. Then the cups were positioned inside the box as in Fig.1. AE then baited one cup. She manipulated both cups, always touching the left cup first. If the left cup was to remain empty this was simply shown to the dog and if it was to be baited the food placement was clearly shown to the dog. Then the right cup was treated accordingly. Which cup was to be baited was semi-randomized and counterbalanced so the dogs got equal amounts of food on both sides of the box. However, one side was only baited a maximum of two times in a row. After the baiting procedure, AE returned to the center of the box and the dog was allowed to choose. In order to be allowed to continue to the test trials, all subjects had to pass (i.e. choose the correct cup and take the food) six consecutive warm up trials, three to the left and three to the right. If the dog had not passed these criteria within 30 minutes, it was not allowed to participate in the test.

4.4.2 Pre test

During the pre test E1 or E2, depending on condition, was alone with the dog in a separate test room. She was sitting on the floor and did not speak to the dog during the pre test.

In the cooperative version of the pre test E placed a piece of food on the floor and the dog was allowed to eat the food. This was repeated a further two times.

In the competitive version E also placed a piece of food on the floor but when the dog was about to take it she quickly took it away again. This was also repeated two times. Immediately after the competitive pre test, AE gave the dogs three pieces of food to ensure equal saturation in both conditions.

The cooperative pre test took place immediately before the cooperative test trials and the competitive pre test took place immediately before the competitive test trials.

4.4.3 Test trials

See fig. 2 for experimental set up. The beginning of the test was the same in both conditions. E1 or E2, (depending on condition), first showed the dog the food she was going to hide. Then AE closed the curtain so the dog could not see the baiting and the experimenter hid the food under one of the two cups. The order of the baiting was semi-randomized for each dog, with the constraint that food was only placed on the same side a maximum of twice in a row. The baiting was counterbalanced so the food was hidden the same number of times on each side of the box. E always touched the left cup first, irrespective of where the food was going to be hidden. Care was taken to make equal noise on both sides of the box and after the baiting E also made a noise in the center so the dog would not be guided to either side by auditory cues. After the baiting, E returned to her starting position and AE opened the curtain. E called the dogs' name until it was attending to her. Then the dog received one of two possible cues.

Cooperative test trials: E said “pass auf” in a high pitched voice and pointed two times towards the baited cup, using the arm cross-lateral to the cup (see fig.4a). At the same time she alternated her gaze between the dog and the cup three times.

Competitive test trials: E forbade the dog to approach the baited cup by speaking out a command meaning No² in a low pitched, forbidding, voice and she simultaneously made a stop gesture two times towards the baited cup using the arm cross-lateral to that cup. She alternated her gaze as in the cooperative condition (see fig.4b).

After the cue was given, E turned her back towards the box and the dog was released by AE. AE also turned around so that no one was observing the dog when it made its choice. If the dog chose the baited cup it was allowed to eat the food and was then taken back to the starting position by AE. If the dog chose the empty cup it was taken back to the starting position by AE and from there the experimenter showed the dog where the food was without it being allowed to eat it. If the dog had not chosen a side within 1 minute after the release, the trial was coded as no choice and repeated in the end of the test session. The same trial was repeated a maximum of three times for each dog. 11 dogs needed to have at least 1 trial repeated. Importantly, if the dog did not move from the starting position when it was released it was verbally encouraged to do so by AE who would say “go”, “go take it” or “search³”. The dogs received the conditions in blocks with six trials each. Half of the dogs started with the cooperative block and the other half started with the competitive block. Which experimenter had what relationship with each dog was also counterbalanced and half of the dogs were first exposed to E1 and the other half was first exposed to E2.

a) b)
Fig.4 The cues a) Pointing gesture and b) Stop gesture.

4.4.4 Obedience test

The dogs had to pass an obedience test to show the command used in the test really worked as a command. This was done last, after all the test trials so it would not affect the dogs performance in the test. The obedience was done by AE in the same room as the pre test. Food was placed on the floor between the dog and the human and the dog was told not to take the food. As commando AE used the same word used in the test. To pass this phase the dog had to leave the food for 20 seconds. If the dog did not pass the first time, the trial was repeated two times. If the dog did not pass any of these, it was excluded from the test.

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² We used the word that the owner said the dogs were most often exposed to when forbidden to take food. This could be aus, nein, pfui or wehe.

³ Geh, geh nim's and such in German

4.5 Coding

All trials were coded from the video material by HP. A choice was considered made if the dog touched the cup so it moved. The latency from the moment the dog was released from the leash by AE until it touched the cup was also coded from recordings of the tests by HP. 20% of the choice data and 20% of the latency data were also coded by a person unfamiliar to the test for reliability. Reliability for choice was 100%. Reliability for latency was excellent, cooperative trials: Pearsons correlation= 0.99, $p= 0.00$, competitive trials: Pearsons correlation= 0.98, $p< 0.001$.

One subject received only 5 of the 6 trials in the cooperative condition due to her not choosing. Therefore a percentage of correct choices for each subject was calculated and used in the data analysis.

4.6 Statistical analysis

For statistical analysis SPSS version 15.0 was used, significant levels were always 0.05 and all tests were two-tailed. Difference between conditions was analyzed using a repeated measures ANOVA with the within subjects variables cooperative and competitive. The conditions were also tested for difference from chance choice using one samples t-test against a test value of 0.5. Difference in latency of choice between the conditions was tested using a repeated measures ANOVA with the within subjects variables cooperative and competitive. A 2x2 repeated measures ANOVA was used to test for order effect of starting condition with the within subjects variables condition cooperative vs. condition competitive and between subjects variables starting order cooperative vs. starting order competitive. A 2x2 repeated measures ANOVA was used to test for experimenter differences with the within subjects variables condition cooperative and condition competitive and the between subjects variable experimenter one and experimenter two. A paired samples t-test comparing the first 3 trials and the last 3 trials for each condition was made to test for a learning effect. The dogs' choices on the first trial they were exposed to were tested against chance using the binomial test and compared to each other using a Chi-squared test.

5. Results

5.1 Main results

In the cooperative condition the dogs chose the baited cup more often than would be expected from a chance choice, ($t_{(31)}=4.25$; $p< 0.001$), with an average of 63% (see Fig 5). In the competitive condition the dogs' choices were not different from a chance choice, but the dogs showed a tendency towards choosing the baited cup ($t_{(31)}=1.78$; $p=0.09$). In the competitive condition they chose the baited cup on average 57% of the choices (see Fig. 5). The ANOVA did not detect a difference in choice depending on condition as there was no main effect of condition on the dogs' choices, ($F_{(1,30)}= 2.118$; $p= 0.156$).

Fig 5 Average percentage of correct choices +SEM of the averages, N32. * indicates significant difference from chance.

The dogs differed in latency between the conditions as there was a main effect of condition on the dogs' latency between release and choice, ($F_{(1,31)}=11.530$; $p=0.02$) and they hesitated longer in the competitive condition, ($t_{(31)}=2.1$; $p=0.002$), with an average latency of 9.6 sec in the competitive condition against the cooperative average, 4.7 sec (See Fig.6).

Fig. 6 Average latencies + SEM of the averages for the two conditions. * indicates a significant difference between the columns.

There was no effect of starting order, ($F_{(1,30)}=0.301$; $p=0.587$) and there was no interaction between starting order and condition, ($F_{(1,30)}=0.923$; $p=0.344$). The dogs did not choose differently depending on experimenter, no main effect of experimenter was found, ($F_{(1,30)}=0.0$; $p=0.984$) and there was no interaction between condition and experimenter, ($F_{(1,30)}=1.150$; $p=0.292$). No learning effect was found, (Cooperative: $t_{(2)}=4.30$; $p=0.38$, Competitive: $t_{(2)}=4.30$; $p=1$)

5.2 First trial data

Looking only at first trial data, (N16 for both conditions) 88% of the dogs chose the baited cup on the first trial in the cooperative condition. This was significantly different from 50% using the binomial test, ($p=0.004$). 50% of the dogs chose the baited cup on the first trial in the competitive condition, which is a random choice. There was a statistically significant difference between the conditions using a chi-squared test, ($\chi^2_{(1)}=5.236$; $p=0.02$).

6. Discussion

The dogs were able to use the cooperative cue and this is consistent with most previous studies and was also the prediction of this study. In the competitive condition the dogs did not choose the baited cup above chance, but they did show a trend towards preferring the baited cup. However looking at the first trial data, the dogs choose exactly like chance would predict in the competitive condition and were significantly better in the cooperative condition. This

could mean that something during the test affected the dogs' choices. The significant difference in latency shows that the dogs did perceive the conditions as different. Noteworthy, no improvement in performance across trials was found during the test.

There was a great variation between the subjects, where some dogs did very well in the competitive condition whereas some dogs clearly preferred the empty cup. This could mean that the dogs used different strategies in the test. The warm up phase of the test was rather long, for some dogs 30 minutes, where the experimenter, AE, gave no cue when the dogs needed to find the food. This might have affected the dogs' interpretation of the test situation and perhaps made them rely less on the experimenter and more on some alternative strategy when trying to find the food in the test. The clear difference in latency between the two conditions shows that the dogs needed longer to decide which cup to choose in the competitive condition. This could have been a reaction to the prohibition. However, Call et al, (2003), shows that dogs do not hesitate to take forbidden food when the experimenter has their back turned. Also, in my study, when the dog had not moved for a certain amount of time it was encouraged to choose, so if the dogs knew where the food was they should've taken it. However, individual sensitivity to intimidation might also explain the difference between the subjects' choices as some dogs might have been less inclined to disobey the command and thus always obeyed in spite of the experimenters' inattention.

It is not clear how dogs interpret human gestures. If the dogs see the gestures as informing they would in the object choice task understand that the pointing indicates to them where the food is by referring to one of the cups, especially in the cooperative context. However, it might be that a pointing gesture is seen more as an imperative, i.e. that the human is telling the dog either to go in a certain direction (cooperative context) or not to go in a certain direction (competitive context). The dog does then not make any inference of where the food is from this, but simply do as the human wants. This explanation does not seem to fit my results since the dogs did not prefer the empty cup in the competitive condition, but chose randomly from trial 1. If the first option is true however, and the dogs see the gesture as telling them where the food is, they might have seen the stop gesture as contradictory to the command. The stop gesture looked physically very similar to the pointing gesture, the only difference was that in the stop gesture the palm of the hand was directed towards the baited cup, whereas in the pointing gesture it was the index finger. If a point normally suggests "the food is there" and the experimenter at the same time says no, then the dog would not know what to do if it had no real sense of what forbiddance means and did not understand the competitive motive of the experimenter. It is possible then that it would ignore the command and follow the gesture, but not really make any inference from the communicative motive at all. The dog would rather see the verbal and the gestural cue as separate indications. According to this hypothesis individual differences would be expected depending on how well the dogs "disconnect" the prohibition command and concentrate only on the gestural cue. A third alternative is that dogs do not understand the pointing as informing of where the food is, but don't see it as an imperative to go somewhere either. In this scenario it is possible that if they are not directly encouraged to follow the pointing gesture they don't pay attention to it and thus choose randomly.

A way of testing if the stop gesture really was perceived in a similar way to the pointing gesture would be to test the dogs' reactions to the stop gesture in a cooperative context and to the pointing gesture in a competitive context. This reasoning also means that the gesture may be a confounding factor in itself and it would perhaps be best to test the dogs' comprehension of motives by actually touching the cup when giving the cue, so there is no referential confusion.

Study 2

A follow up study was conducted in order to clarify the results from the first study and test the hypothesis that dogs see the stop gesture as similar to a pointing gesture. I predicted that the dogs would be able to use both a pointing gesture and a stop gesture as a cue in a cooperative context. I also predicted that the pointing gesture given in a competitive context would make the prohibition more clear to the dogs and that they therefore would avoid the baited cup to a greater extent. In addition a new cue was introduced, where the experimenter instead of making a gesture approaches the cup directly and either gives the prohibition or encourages the dog to take the food. I predicted that the dogs would use the cooperative cue, but not be able to infer the location of the food in the competitive context.

7. Materials and Methods

7.1 Subjects

24 new dogs were tested. The dogs had no special education other than normal obedience and lived as pets in and around a medium sized town in Germany. The dogs had experienced 0-3 similar test situations before but all were naïve to the testing equipment and exact test procedure (see Table 2).

Table 2. Subject information. Column OC shows the number of object choice tests the dog has previously participated in. These dogs completed the whole follow up test procedure and are the ones on which the data is based. None of these dogs participated in study 1.

Subject	Sex	Breed	Age	OC
Amur	M	Mix	1.5	1
Ben	M	Mix	10	2
Bodo	M	Mix	5	1
Boss	M	Minature Schnauzer	5	0
Bruno	M	Golden Retriever	8	1
Cessy	F	Labrador	4	2
Contessa	F	Labrador	6	2
Daisy	F	Labrador	5	1
Emeli	F	Labrador	4	1
Helga	F	Mix	7	3
Jazz	M	Border Collie	4	2
Jessi	F	Mix	6	2
Joy	F	Mix	8	0
Kira	F	Riesenschnauzer	6	0
Laika	F	German Shepherd	7	1
Merlin	M	Mix	6	0
Nikos	M	German Shepherd	5	0
Paula	F	Labrador	2	1
Shila	F	Mix	1.5	1
Taira	F	Mix	1.5	2
Tina	F	German Shepherd	8	2
Sunny	F	Jack Russell	3	0
Walter	M	Weimeraner	5	1
Vincent	M	Labrador	4	1

7.2 Material

The same test equipment as in study 1 was used⁴.

7.3 Experimental set up

All testing took place at the Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany, in special test rooms used for dog studies. The experimental set up was exactly the same as in study 1 (see Fig. 2 and 3).

7.4 Procedure

As in study 1, all dogs were tested in two contexts, one competitive and one cooperative. The persons needed in the test were thus the same as in study 1, two test experimenters and one neutral assistant experimenter. As in study 1, E1 and E2 were both female. In this study we wanted to test the dogs' reactions to three different gestural cues within the two conditions. As there were more conditions than in the first study, dogs received 2 sessions which were run on two consecutive days. This means that on one day the dogs were tested in all competitive conditions and on the other day all cooperative conditions. Between both sessions was a maximum break of three days. The general test procedure was exactly the same as in study 1, on both days the dogs were first exposed to a warm up, then a pre test and then the test trials. The warm up on the first day was longer than the warm up on the second day, see below. The procedure on each day took about 1 hour for each dog.

7.4.1 Warm up

The warm up phase of this study was made shorter than that of study 1. This was due to the fact that during a long warm up the dogs might establish their own strategies for how to find the food other than using the experimenters cue. Also since the experimental phase was longer in this study, a long warm up might have affected the dogs' motivation in the test phase. On the first day, the warm up was conducted exactly as in study 1 with the major difference that before continuing to the test trials the dogs only had to pass two warm up trials, one on each side of the box. Thus the order of the baiting was not randomized, but the cups were always baited in a left, right, left, right order. On the second day the dogs did not need the procedure of learning about the cups and box, but only had to pass two warm up trials one on each side of the box. Thus on the second day the dog was held only by the experimenter that was going to test the dog on that day. On the first day the dog was held as in study 1.

7.4.2 Pre test

The pretests were conducted exactly as in study 1. The cooperative pre test was conducted immediately before the cooperative test trials on the cooperative day and the competitive pre test took place immediately before the competitive test trials on the competitive day.

7.4.3 Test trials

Within each context (cooperative and competitive) the dogs' responses to three different gestural cues were tested. These gestural cues were the same for both conditions. As in study 1 the cueing was made by E1 or E2 respectively and AE held the dog.

The beginning of the test trials and baiting procedure were exactly the same as in study 1.

The cues were:

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⁴ Two dogs had food allergies and were given special food, that was equivalent to frolics.

Pointing: The pointing gesture was exactly the same as the pointing gesture in the cooperative condition of study 1 (see Fig. 4a).

Stop: The stop gesture was exactly the same as the competitive stop gesture of study 1 (See Fig. 4b).

Approach: In the approach cue the experimenter approached the box going to the cups one at a time and looking under these. At the baited cup she said either the positive pass auf, or the negative command, depending on condition. Then she alternated her gaze between the cup and the dog three times. At the empty cup she remained neutral and did not look at the dog. Care was taken to spend equal amount of time at each cup. The order in which she approached the cups was counterbalanced and semi-randomized, with the constraint that she only approached the same cup two times in a row.

Each cue was presented in both communicative contexts

In the cooperative context the gestural cues were combined with the cooperative experimenter saying pass auf, in a high pitched voice towards the baited cup.

In the competitive context the gestural cues were combined with the competitive experimenter saying a command meaning no in a prohibiting voice⁵.

As in study 1, both the experimenter and AE turned their back to the box after the cue was given. The consequences of the choices were the same as in study 1. 13 dogs had at least 1 trial repeated.

The gestural cues were presented in blocks consisting of six trials within each condition. Thus each dog was exposed to 18 cooperative test trials and 18 competitive test trials and the total number of test trials over the two days was 36. If a trial needed to be repeated this was done within the block, so before the dog was exposed to the succeeding gestural cue. The order for which the dogs were exposed to the conditions were counterbalanced like in study 1, as was which experimenter had what relationship to each dog and what experimenter the dog was exposed to first. Within each condition, the order in which the dogs were exposed to the blocks of cues was also counterbalanced.

7.5 Coding

All trials were coded as in study 1 from the videomaterial by HP. 20% of the trials were also coded by a person unfamiliar to the test for reliability. Reliability was 100%. 6 dogs received fewer trials than the others, due to them not choosing or experimental errors. Therefore a mean percentage of correct choices for each subject was calculated and used in the data analysis.

7.6 Statistical analysis

All statistical analysis was done in SPSS version 15.0 and significant levels were always 0.05. All tests were two-tailed. Differences between contexts and cues were analyzed using a 3x2 repeated measures ANOVA with the cues (point, approach and stop) as within subject variables and context (cooperative and competitive) as between subject variables. The cues within each context were also tested for difference from chance choice using one samples t-tests against a test value of 0.5. A repeated measures 3x2 ANOVA with the within variables

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⁵ See note 1

cue (point, stop and approach) and the between variables context (cooperative, competitive), was used to test if the dogs differed in latency from release until choice between the conditions. A 6x2 repeated measures ANOVA with the within subjects variables cue (cooperative point, cooperative approach, cooperative stop, competitive point, competitive approach and competitive stop) and between subjects variables starting context (cooperative or competitive) was used to test if starting order had an effect on choice. A 6x2 ANOVA with the within subjects variables cue (as before) and between subjects variable experimenter (experimenter 1 and experimenter 2) was used to test for a difference in choice depending on experimenter. Two 3x3 repeated measures ANOVAs (one for each context; cooperative and competitive) with the within subjects variables cue and the between subjects variables starting cue (the cue the dog was exposed to first) were used to see if starting cue had an effect on choice. As before first trial data was analyzed for difference from chance using the binomial test and for differences between the contexts using a chi-squared test.

8. Results

8.1 Main result

As can be seen in Fig 7, the dogs chose above chance in all of the cooperative cues: (Point: $t_{(23)}=2.713$; $p=0.012$, average 61.1% Approach: $t_{(23)}=2.61$; $p=0.044$, average 57%, Stop: $t_{(23)}=2.132$; $p=0.016$, average 60%) see Fig 7. They were not above chance in any of the competitive cues, (Point $t_{(23)}=0.671$; $p>0.05$ average, 53%, Approach: $t_{(23)}=1.037$; $p>0.05$ average 55%, Stop: $t_{(23)}=0.996$; $p>0.05$ average 54%).

The dogs did not choose different depending on context as there was no main effect of cue, ($F_{(2,92)}=0.039$; $p=0.962$) or of context, ($F_{(1,46)}=2.73$; $p=0.105$) and there was no interaction between cue and context, ($F_{(2,92)}=0.287$; $p=0.751$).

Fig. 7 Average percentage correct choices + SEM of the averages, N24. * indicates significant difference from chance.

The dogs differed in latency from release until choice between the cooperative and competitive as there was a main effect of cue: $F_{(1,46)}=3.534$, $p=0.033$, there was no interaction between cue and context; $F_{(1,46)}=0.319$, $p>0.05$, and there was a main effect of context:

$F_{(1,46)}=4.016$, $p=0.051$. The average latency times show that the dogs hesitated longer in all competitive contexts than in the cooperative contexts, see fig 8. The averages were for competitive: point= 5,5 sec, approach=5,3 sec, stop=7 sec. The averages for cooperative were: point=2,7 sec, approach=2,6 sec and stop=3,5 sec.

Fig.8. Average latency times from release until choice + SEM of the averages.

An indication of a main effect of starting context was found ($F_{(1,22)}=2.318$; $p=0.142$), but there was no interaction between cue and starting order, ($F_{(5,110)}=1.423$; $p=0.221$). No effect of starting cue was found as there was no interaction between choice and starting cue, (cooperative trials: $F_{(4,42)}=1.322$; $p=0.277$, competitive trials: $F_{(4,42)}=1.646$; $p=0.181$) and no main effect of starting cue, (cooperative trials: $F_{(2,21)}=0.124$; $p=0.884$, competitive trials: $F_{(2,21)}=0.463$; $p=0.636$).

The dogs did not choose differently depending on experimenter as no main effect of experimenter was found, ($F_{(1,22)}=1.271$; $p=0.272$) and there was no interaction between the experimenter and cue, ($F_{(5,110)}=0.884$; $p=0.494$).

8.2 First day data

Although not statistically significant, there was a slight indication of a carryover effect between the conditions in the data. Therefore we also analyzed the first day data for each dog and these results are shown in Fig 9. Looking at first day data only i.e. a between subjects design with N12 for each condition, a 2x3 repeated measures ANOVA comparing correct choice for the cues and context showed that the dogs chose differently in the cooperative and competitive context. There was a main effect of context, $F_{(1,22)}=5.098$; $p=0.034$. There was no interaction between context and cue, $F_{(2,44)}=1.052$; $p=0.358$ or main effect of cue, $F_{(2,44)}=0.536$; $p=0.589$. The context averages indicated that the dogs choose more correct in the cooperative context, cooperative average 64.4% correct, competitive average 53.4% correct.

With N12 for each condition the dogs still choose above chance in the cooperative point: $t_{(11)}=3.071$; $p=0.011$, average 67% and in the cooperative stop, $t_{(11)}=3.386$; $p=0.006$, average 69%. They were not above chance in any other cue/context combination, Cooperative approach: $t_{(11)}=1.164$; $p>0.05$, average 57%, competitive point: $t_{(11)}=1.296$; $p>0.05$, average 57% competitive approach, $t_{(11)}=0.5$; $p>0.05$, average 54%, competitive stop, $t_{(11)}=0.179$; $p>0.05$, average 49%.

Fig. 9. Average percentage correct choices + SEM of the averages on the dogs' first day. What is seen is first day data only, N12 cooperative trials and N12 competitive trials. * indicates significant difference from chance.

8.3 First trial data

I also looked at first trial data for each condition, all cues combined. 75% of the dogs chose the baited cup in the cooperative context and 42% of the dogs chose the baited cup in the competitive context. This was not significantly different from 50%; binomial test cooperative: $p = 0.146$, competitive $p = 0.774$. A chi squared test found no significant difference between the contexts (N12, 12), $\chi^2_{(1)}: 2.74$; $p = 0.098$

9. Discussion

As in the first study the dogs were successful in using the cooperative cues. The dogs did not use any of the competitive cues above chance. Looking at the first day data there was a significant difference between the two contexts. No difference was found between the contexts when looking at all data, but since there was an indication of a carryover effect between the contexts this might have affected the overall averages. The difference between the contexts is also reflected in the first trial data although not significant, but that might be due to a small sample size. As in the first study the dogs hesitated more before they made their choice in the competitive context. Thus it can be concluded that the dogs followed the cooperative cues but not the competitive cues as was the hypothesis of the first study. The results of the second study also support the hypothesis that the dogs could use the stop gesture as well as the pointing gesture in the cooperative context. The two gestures seem to have been perceived as similar in the competitive context as well.

The fact that the dogs were successful in the cooperative condition is in accordance with most other studies investigating dogs' use of human communication (e.g. Miklosi et al, 1998, Soproni et al, 2001, Soproni et al, 2002, Miklosi and Soproni, 2006).

The dogs choose fairly randomly between the cups in the competitive conditions and that indicates that they were confused by the situation rather than only obeying the command. If the reason for their behaviour had been obedience, they would have shown a preference for the empty cup. As in the first study, the fact that the dogs hesitated longer before they made their choice also indicates that they were more confused in the competitive context. This could mean, as is discussed in study 1, that the dogs either saw the competitive cue as

contradictive or did not pay attention to it. The approach cue did not have the interpretative confusion. There it was very clear that the command was being spoken directly to the cup and the dogs still chose randomly. However, this cue required the dogs to stay attentive for quite a long time and also to remember for that time period what had happened at both sides. It was easy for the dogs to get distracted or loose interest during this cue and when looking at the first day data only the dogs do not utilize the cooperative approach cue as well as the other cooperative cues, which indicate some methodological issue.

Gasci et al, 2009, stresses the importance of alternative strategies as explanations for the dogs' random choice behavior in object choice tasks. Three test dogs⁶ had what is called side biases, i.e. they consistently only chose one side and thus received half of the rewards. In the data this looks like a random choice when it really is not. However these dogs were side biased in the cooperative context as well and it thus seems like their data did not bias the overall mean towards a 50% choice. The first trial data also reflects the main findings, the dogs' reactions to the competitive context was truly close to what would be expected by chance and the dogs were able to use the cooperative cues to find the food. Thus the results that the dogs succeeded in the cooperative context, but did not understand the competitive context is probably reliable.

10. General Discussion

In my study the dogs used cooperative cues but did not understand the competitive contexts. Herrmann and Tomasello, (2006), showed that apes can be successful in communicative contexts with humans if the human motive is competitive. Dogs seem to be the opposite of that. Given the socio-ecological differences between the species these results are not so surprising. Apes lives are shaped by competitive contexts (Hare, 2001). Dogs on the other hand are receivers of altruistic, cooperative, acts from humans all the time and are conversely very seldom in direct competition with humans, especially over food. Other studies have confirmed social cognitive differences between dogs and apes, where dogs were able to use social communicative cues and apes were not as skillful (Hare et al, 2002, Bräuer et al, 2006, Miklosi et al, 1998). My study adds to this by showing that dogs on the other hand are not as skillful as apes in understanding competitive human communication, but seem to be specialized on cooperative cues.

The dogs' result in this study is similar to the results of the 24 month old children in the study conducted by Herrmann and Tomsello, (2006). They too were successful only in the cooperative communicative context whereas the 18 month old children were successful only in the competitive context of the object choice task. Herrmann and Tomasello, (2006), states that the older children probably did understand where the food was hidden in the competitive situation, but that they were too intimidated by the forbiddance to actually take it. The fact that the younger children were successful in the competitive context supports this theory. Thus there are both similarities and differences between the dogs and the children. The fact that both dogs and humans seem to have a cooperative communicative understanding raises the question of similar cognitive mechanisms in the older children and dogs.

Tomasello (2006), suggest that in order to utilize a pointing gesture in a communicative situation the subject must have some sort of context understanding. A pointing gesture communicates nothing if the emitter and receiver of the communication do not share a

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⁶ One further dog also had a sidebias in only the competitive context and one further dog had a sidebias only in the cooperative context. So in total 4 dogs had sidebiases in each condition.

common knowledge about the underlying reason for the communication. Tomasello (2006) calls this shared knowledge based on a “joint attentional frame”. That a joint attentional frame is necessary to understand pointing as communicating information is further supported by the fact that apes, who do not utilize human cooperative pointing gestures in communicative object choice tasks, have no problem following human gazes and points as directions in space (Tomasello, 2006). Thus it can be argued that in order to be successful in the cooperative communicative situation in our study, the dogs must be able to understand the experimenters’ cooperative motive to inform them about the location of the food and understand the meaning of the food finding game. In other words dogs would share a joint attentional frame with the human experimenter to find the food and in order to do this the dog must have a sense of the experimenters’ communicative motive. Dogs have been shown to understand human communication as referential, i.e. referring to an object (Soproni et al, 2001). This indicates that dogs can base their choice on more than behavior reading and discriminative aspects (e.g. at what side a person is looking) of a human given cue (Miklosi, 2007). If the theory proposed by Tomasello, 2006 is applicable to dogs and dogs see the pointing gesture as referring to the food, my results suggest that the dogs’ ability to understand humans’ communicative intentions would be limited to cooperative situations.

Liskowski et al (2004) showed that 12 month old children point declaratively for adults with the motive to share attention in an object. 12 month old children also point informatively for adults to help them find lost objects (Liskowski et al, 2006) and they point out the location of hidden objects more frequently for adults that do not know where they are hidden than for adults that do (Liskowski et al, 2008). These findings indicate that children realize that adults have own minds and mental states, that these young children know what information is new to others and use communication to help others. Similar studies with dogs have found that dogs do show humans where food and toys are hidden, with a higher frequency if the human is unaware of the objects location (Miklosi et al, 2000). They are however not as skillful at this as children (Viranyi et al, 2006). Viranyi et al, (2006) compared dogs and children in a task that required the subject to not only show the location of hidden food, but to also show the experimenter where a tool was hidden that was needed to access the food. The dogs had difficulties with this whereas the children did it readily. Also dogs do not indicate where objects are hidden unless the objects are interesting to the dog (pers.comm. Juliane Kaminski, MPI). However dogs might have an understanding of what is known to others. They discriminated between information given from a knowledgeable dog and an ignorant dog when trying to find hidden food (Cooper et al, 2003). It has also been shown that they are well aware of what humans are attending to and they understand about human visual access (Call et al, 2003, Bräuer et al, 2004). Thus the evidence concerning dogs social cognitive abilities are not as clear as those concerning human infants but there are still indications that dogs have the ability of realizing that others minds are different from their own.

On the other hand Southgate et al, (2007) argues for a different interpretation of infants’ social cognition and offers a second view on the meaning of pointing gestures. They mean that young infants point not to inform adults, but to encourage adults to repeat actions that the infant can learn from and that the point therefore is not helpfully informative but selfishly imperative. Southgate et al, 2007, also point out that the communicative context switches on this learning mechanism in the infants. Cisbira and Gergely (2006) argue that teaching and learning has evolved in humans as a way of coping with our complex cultural environment and they call this special form of communication pedagogy. Pedagogy consists of different parts, one of which is ostension (Cisbira and Gergely, 2006). Ostension is the way the teacher shows that the communication is aimed at the pupil. This is done using ostensive cues such as

a high pitched voice, raised eyebrows, name calling and eye contact (Gergely et al, 2007). In my study with the dogs, we used these ostensive cues together with the referential cues and the results indicate the possibility that dogs have the same on switch for learning mechanisms as do children according to this theory. In that case it seems that particularly the high pitched voice is important for the dogs as this was the main difference between the cooperative and competitive condition. Other studies on dogs have shown the importance of ostensive cues in dog-human communication. Kaminski et al, (submitted) have shown that dogs do not follow gestures like pointing or gazing when the ostensive cues given indicate that the experimenter is talking to another person. However when the dogs name is used the dogs follow the communicative referential cue, even without eye contact when the experimenter has her back towards the dog. Also dogs do not follow cues that look similar to pointing and gaze cues in the absence of ostensive cues and thus without a communicative context (Kaminski et al, (submitted). Indeed this theory also explain the dogs confusion in the competitive condition of my study since the low pitched voice and prohibiting command used in connection with calling the dogs name and eye contact would be a mixed signal. Importantly pedagogy theory does not require that the dog have any understanding of the state of mind in the emitter of the communication, only that the dog is sensitive to the pedagogy and that the ostensive cues make them able to take in information they otherwise would not listen to (Cisbra and Gergely, 2006). Both the theory proposed by Tomasello (2006) and the pedagogical theory could explain the dogs' behavior in my study. The pedagogical theory is seen as more "low-level" and therefore more parsimonious.

No matter how much dogs understand about human communication, this ability is probably present in the dogs due to several different factors (Cooper et al, 2003, Gomez, 2005). First the dogs have evolved from a social species, the wolf (Vila et al, 1997). Therefore dogs may have phylogenetic predispositions for social learning and interactions (Cooper et al, 2003). Secondly the dog has been domesticated by humans at least 15.000 years ago and may have lived in connection to humans for over 100 000 years (Vila et al, 1997). It is very likely that this connection has affected dogs' social cognition both by direct and indirect selection (Hare et al, 2002, Hare and Tomasello, 2005). Thirdly pet dogs associate with humans from the moment they are born and especially early ontogeny is likely to play a part in their understanding of human communication (Riedel et al, 2008, Gascsi et al, 2009). Viranyi et al, (2008), have shown that intensive socialization can lead to increased usage of the human pointing gesture in wolves.

The pointing gesture and other forms of human social communication may very well have a different meaning for dogs and young children. That dogs are sensitive to learning mechanisms such as those proposed by pedagogical theory is not surprising, since trainability must have been a major selection pressure during human controlled domestication. The fact that dogs are especially attentive to the human face is also indicative of this (Gacsi, et al, 2004). Dogs' ability to follow human social communication was probably strengthened artificially by humans, selecting for attentiveness and trainability. Dogs were perhaps more receptive of such selection due to the cognitive windows opened by early domestication processes (Hare and Tomasello, 2005). The fact that the dogs in my study had no understanding of the competitive motive supports this theory and the hypothesis that dogs do not have an understanding of human communicative motives in general.

11. Conclusion

In conclusion the dogs in my studies followed the cooperative cues but did not understand the competitive context. In both studies they had a significantly longer latency before choice in

the competitive condition and that indicates that this condition confused them. In study 2 they chose the correct cup significantly more often in the cooperative condition than in the competitive condition. Thus it is clear that dogs do not have the ability to draw conclusions from competitive contexts or from forbiddance.

The dogs' inability to follow the competitive cues and success in using the cooperative cues can be interpreted in different ways. If dogs understand the referentiality of the human gestures, it could mean that they might have the ability to interpret cooperative intentions. This might be due to them having evolved from a social species and due to indirect selection during domestication. If dogs however follow the gestures only when encouraged, it would indicate that ostensive cues might be of importance for the dogs, in a way similar to the ideas proposed by pedagogical theory (Cisbra and Gregerly, 2005). This would mean that dogs do not need to understand the communicative motive in order to be successful in the object choice task.

In order to know exactly how dogs understand communication the issue about how the pointing gesture is perceived must be resolved. The function and importance of ostensive cues in dog-human communication should also be further investigated. The answers to these two issues are necessary, before we can fully interpret the dogs' success in the object choice task.

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