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Dogs' understanding of human pointing gestures

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Nyckelord/Keyword:

Animals, behaviour, communication, dogs, human gestural cues, human pointing gesture, two-way object choice test.

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1. Abstract

To investigate the ability for animals to understand human communication signals and the communication between animals and humans, scientists often investigate the understanding of human gestural cues. Dogs (*Canis lupus familiaris*) which have a long history of co-evolution with humans have been shown to make good use of human gestural cues. In the present study I investigated whether dogs in general understand a human pointing gesture and if there are differences between sex, age or breeds. In total 46 dogs of different breeds participated in the study. The study was carried out in a dog center in Linköping, Hundens och djurens beteendecenter. To test if dogs understand human pointing gestures, a two-way object choice test were used, where an experimenter pointed at a baited bowl at a distance of three meter from the dog. The results showed that dogs in general can understand human pointing gestures. However, no significant differences were found for sex, age or breeds. As a conclusion, I found that dogs in general can understand human pointing gestures, but sex, age or breed did not affect the ability.

2. Introduction

Investigation of animals' ability to understand other species' communication signals can help us to understand other cognitive aspects of their behaviour (Gácsi et al. 2009a). Investigation of the understanding of human gestural cues, such as pointing, is assumed to show communication abilities of animals with humans (Gácsi et al. 2009a). Animals with a long domesticated history may have developed an improved understanding of human gestural cues, compared to animals with a shorter domesticated history (Miklosi and Soproni 2006). Hare et al (2005) showed that foxes (*Vulpes vulpes*) that for many generations had been selected for tameness performed better than non-selected foxes in the understanding of human communicative signals. Dogs (*Canis lupus familiaris*) use human gestural cues (Miklosi et al. 1998), even better than humans' closest relatives like chimpanzees (*Pan troglodytes*) (Hare and Tomasello 2005). Dogs may understand human gestural cues better than chimpanzees due to the domestication process of dogs (Miklosi et al. 1998). The domestication hypothesis states that dogs' ability to use human gestural cues may be influenced by selection pressures during domestication (Kaminski and Nitzschner 2013). When comparing dogs to its ancestor, the wolf (*Canis lupus*), in the understanding of human gestural cues, Miklosi et al. (2003) found that dogs were more successful than wolves. This finding supports the domestication hypothesis. There are two main hypotheses about how the domestication may have had an influence on the dogs' higher understanding of human gestural cues; the first is the by-product hypothesis (Kaminski and Nitzschner 2013). The

by-product hypothesis states that human selection on dogs' for one trait, e.g. tameness, which may also have result in an improved understanding of human gestural cues (Kaminski and Nitzschner 2013). The second hypothesis is the adaptation hypothesis, which states that humans actively selected for understanding in human gestural cues in dogs (Kaminski and Nitzschner 2013).

Gácsi et al. (2009a), showed that neither the sex, age nor the breed of the dog have an impact on the understanding of human gestural cues. Although, no sex differences were found by Gácsi et al. (2009a), there is a hormone called oxytocin which is known to be of higher levels in females (Kis et al. 2014). Oxytocin is known to affect the sociality in both women and men, although it may affect them differently (Kis et al. 2014). Oxytocin has also been shown to influence dogs' social behaviours towards humans (Kis et al. 2014). Since the dogs social behaviours towards humans' are influenced by the oxytocin their communication ability with humans might be affected as well. Because the hormone oxytocin might affect females and males in different ways it might be differences between sexes in dogs in their communication ability with humans. In a study by Dorey et al. (2010) the age of the dogs was found to have an impact on their understanding of human gestural cues. The authors found no evidence for puppies younger than 21-weeks can understand human gestural cues (Dorey et al. 2010). They also found that the puppies improved with age in their use of human gestural cues (Dorey et al. 2010).

In addition to sex and age, breeds may differ in their use of human provided cues. Even though not all breeds differ in the understanding of human gestural cues, Gacsi et al. (2009b) found that there are differences between breed groups that are selected for different characteristics. Gacsi et al. (2009b) found that cooperative working dogs were better at understanding human gestural cues than both the independent working dogs and the mongrels, which are crossbred dogs. Cooperative working dogs work with continuous visual contact with their human partner (e.g. herding dogs and gundogs) and independent working dogs work with no human visual contact (e.g. hounds and livestock guarding dogs) (Gácsi et al. 2009b). Gacsi et al. (2009b), also found that brachycephalic ("shortnosed") dog breeds performed better than the dolichocephalic ("long-nosed") dog breeds in a two-way object choice test. McGreevy et al. (2004) detected a difference in the distribution of retinal ganglion cells between brachycephalic and dolichocephalic dog breeds. These differences may affect the brachycephalic dog breeds so that they might respond most to stimuli in the central field (i.e., when looking forward)

unlike the dolichocephalic dog breeds (McGreevy et al. 2004). These differences between the different working dog breeds and between the brachycephalic and dolichocephalic dog breeds might affect their use of human provided cues.

Because of earlier studies' result, dogs were overall expected to understand human pointing gestures and the method used was also expected to be a suitable way to investigate this. In the present study I investigated whether there is any sex, age and breed group differences in the understanding of human gestural cues. The age groups used are young (up to two years old) and adult (three years and older) dogs. Although, no sex differences have been found in earlier studies, oxytocin might affect females and males differently (Kis et al. 2014). Because of this I predicted there to be a difference between the sexes. Dorey et al. (2010) found differences between ages in young puppies. In my study, the age span between young and adult dogs will not be so large, therefore no differences between young and adults was expected. Since different breeds are bred for different purposes the expectation is that there will be differences between the breed groups. The brachycephalic and dolichocephalic dog breeds were grouped according to McGreevy et al. (2013) cephalic index to do a comparison of their use of human pointing gestures. The cooperative and independent working dog breeds were grouped according to Gacsi et al (2009b) table of independent and cooperative working dog breeds. The breeds that were not grouped into one of the working dog groups were considered as non-working dogs.

3. Material & method

3.1 Method and subjects

The study was performed in a dog center in Linköping named Hundens och djurens beteendecenter, during days and evenings. All of the tests were video recorded and the behaviours were scored from the videos. Before the test owners were given a questionnaire to fill in some background information about the dog such as sex, age (in full years) and breed of the dog. The dog was considered young if they were two years or younger and adult if they were three years or older. They also gave a written consent that they were willing to be videotaped.

In total there were 50 dogs participating in the study from 24 different breeds and some. Of these dogs, 19 were females and 27 were males. Four dogs were excluded from the study. They were excluded because it took too long time for them to respond in the test set up (see below).

3.2 Motivation test and treats

The experiment started with a motivation test where the dogs were encouraged to eat from a bowl (6x12cm), which all the dogs passed. This was done to investigate if the dogs were motivated to take a treat in a bowl. The motivation test was performed three times per dog. The treats that were used through the study were frolic and liverwurst. After the motivation test the dogs started the actual test.

3.3 Test procedure

For this study a so called two-way object choice test was used where the arrangement of two bowls, the experimenter and the owner were similar to a comparative study of Gácsi et al. (2009a, Fig.1) and so was also the procedure.



Figure 1. A two-way object choice test for dogs. The arrangement of the bowls, the experimenter, the owner and the dog.

Two plastic bowls were used and both were scented with liverwurst before the start, to reduce that the dogs smelled the treat in the baited bowl.

When the test started, the experimenter, who always was a female, shifted the bowls in front of her chest so the dog could not see in which bowl the experimenter laid the treat. Which bowl the treat was laid in was semi-randomized, so no bowl could have the treat more than two times in a row. The bowls were then placed two meters from each other, the right bowl was always placed first (seen from the experimenter). The experimenter stood 0.5 meters behind the bowls in the middle and the dog sat, hold by its owner, three meters in front of the experimenter (Fig.1). When the bowls were placed by the experimenter, the experimenter stood

in her position and had the arms bent in front of her chest and established visual contact with the dog prior to signaling with a squeaking sound. When the experimenter had the dog's attention she did a pointing gesture towards the baited bowl with her outstretched arm. The pointing gesture was held for less than two seconds, after which the experimenter put her arm back to her chest. The owner then released the dog to make a choice of which bowl to go to. The owner stood still during the whole trial. A choice indicated by the dog when it had crossed an imaginary middle line between the bowls. Immediately after a dog had reached a bowl both bowls were picked up from the floor by the experimenter. Hence, the dog was not allowed to investigate the other bowl.

The test session included ten trials for each dog. If a dog did not take visual contact with the experimenter in 60 seconds after the experimenter had made a signal, the dog was excluded from the study. If a dog after the pointing gesture did not move towards a bowl, a new pointing gesture was performed. The new pointing gesture was presented after five seconds at maximum three times, before the dog was excluded from the study.

3.4 Statistics

Three variables were recorded from the videotapes, these were: number of correct choices from the ten trials performed by each dog (i.e. 1-10), the latency in seconds for the dog to attend to the experimenter (called latency to attention) and the latency in seconds for the dogs from that they had been released until they had made their choice of which bowl to go to (called latency to choice). The latency for the dogs to attend to the experimenter was the time from when the experimenter was ready to do the pointing gesture until the pointing gesture was completed. If no difference was found in any of the categories with all dogs included the same thing was tested with dogs that only did unilateral choice excluded. By exclude them, only the dogs that did active choices was included. This eliminated dogs biased by which bowl was put down first or last.

3.4.1 One sample Wilcoxon signed rank test

The numbers of correct choices were calculated in percentage from the ten trials for each individual and then a non-parametric test, one sample Wilcoxon signed rank test, was performed on the groups (e.g. sex or age) to compare the dogs' performance against chance performance (50%). One sample Wilcoxon signed rank test was performed on data from all dogs.

3.4.2 Independent sampled Mann-Whitney U test

A non-parametric test, a Mann-Whitney U test, were performed to investigate if there were significant differences between female and males, young and adults, previously trained with human gestures and not previously trained, between brachycephalic and dolichocephalic dogs, between working dogs and non-working dogs and between cooperative working dogs and non-working dogs.

3.4.3 Independent samples Kruskal-Wallis test

A non parametric Kruskal-Wallis test was done to investigate if there were any significant differences between breed groups which were divided into the 10-groups system configured by FCI (Fédération Cynologique Internationale) (Svenska kennelklubben, 2014). Groups that included five individuals or more were tested, i.e., group 1 (Sheepdogs and Cattle Dogs), group 2 (Pinscher and Schnauzer, Molosser and mountain dogs and sennen dogs), group 3 (terriers), group 8 (Offensive dogs, retrieving dogs and water dogs) and group 9 (pet dogs). A Kruskal-Wallis test was also used to test if there were any significant differences between independent working dogs, cooperative working dogs and non-working dogs.

3.4.4 Spearman's rho

A non-parametric correlation test (Spearman), was done to investigate if there were any correlations between number of correct choices and latency to choice to see if the latency to choice affected the dogs performance. Spearman's rho was also used to investigate if there were any correlation between number of correct choices and latency until attention.

4. Results

4.1 Number of correct choices

Dogs in the current study performed more correct choices than what is expected by chance (N: 46, \bar{X} : 62.83, SE: 18.70, $W=446$, $P<0.001$). It was also shown that males, young dogs and adult dogs can understand human pointing gestures (Fig. 2A, B), while female dogs have a tendency to chose correctly (Fig. 2A). Dogs that previously have been trained with human pointing gestures and those that have not, were both shown to choose correctly (Fig. 2C).

Brachycephalic individuals understand human pointing gestures (Fig. 2D). Dolichocephalic dogs were found to have a tendency to understand human pointing gestures (Fig. 2D).

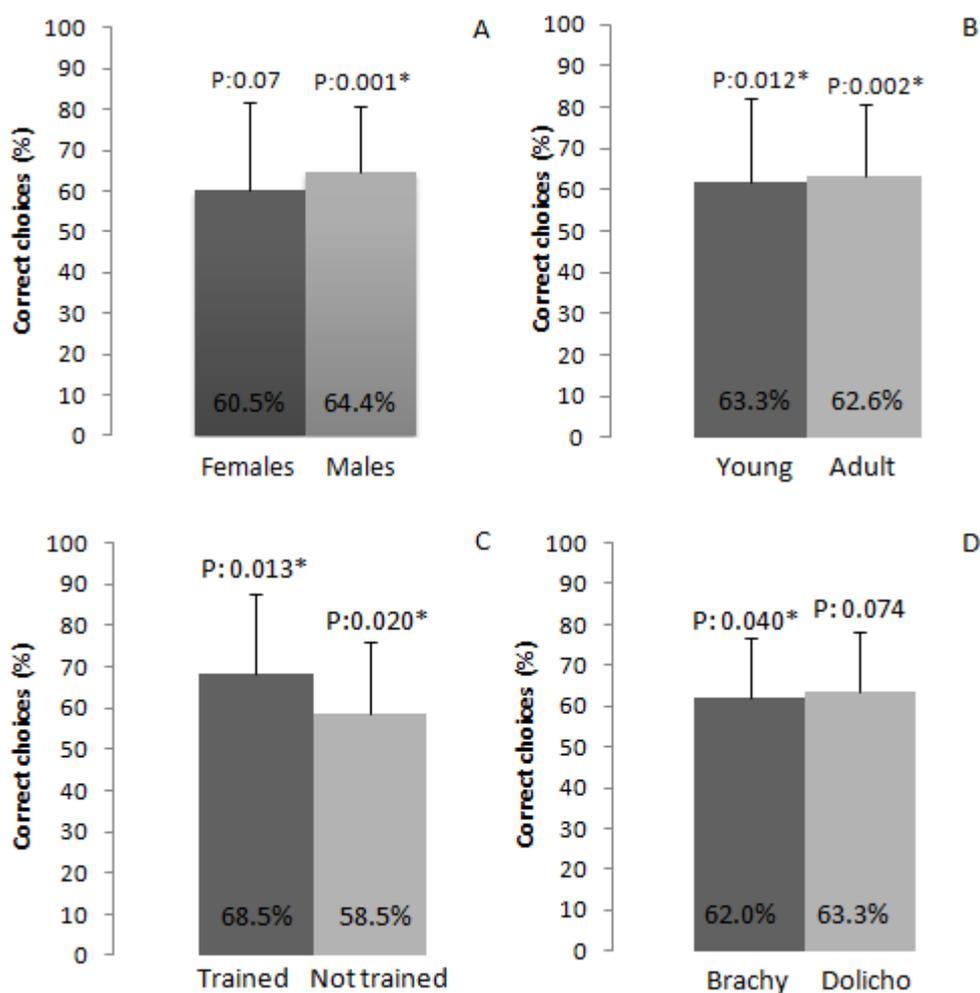


Figure 2. Mean % correct choices for the dogs of which bowl to go to, compared to if choices were made by chance (50%) in a two-way object choice test. A: For females (N= 19, \bar{X} = 60.5, SE= 21.2, W= 71, P= 0.07) and males (N= 27, \bar{X} = 64.4, SE= 17.0, W= 163, P= 0.001) B: For young (N= 22, \bar{X} = 63.3, SE= 21.3, W= 102, P= 0.012) and adults dogs (N= 24, \bar{X} = 62.6, SE= 17.7, W= 116, P= 0.002). C: For previously trained (N= 14, \bar{X} = 68.5, SE= 19.0 W= 51.5, P= 0.013) and not previously trained dogs (N= 13, \bar{X} = 58.5, SE= 17.6, W= 34.5, P= 0.020). D: For brachycephalic (N= 10, \bar{X} = 62.0, SE= 14.8, W= 26, P= 0.04) and dolichocephalic dogs (N= 6, \bar{X} = 63.3, SE= 15.1, W= 14, P= 0.07) dog breeds. Asterisk (*) indicate significant differences (≤ 0.05) from chance level.

No differences were found between sex, age or the brachycephalic and dolichocephalic dogs (Table 1). Dogs that had previously been trained with human pointing gestures had a tendency to perform better than those dogs that had not been trained (Table 1). When testing for breed differences no significance was found (Table 2). No significant difference was found between independent-, cooperative working dogs and non-working dogs (Table 2).

Thirteen dogs made unilateral choices and seven dogs choose the bowl that was put down first (the right seen from the experimenter) and six dogs only to the bowl that were put down last (the left seen from the experimenter).

Table 1. Differences between sex, age, exposure to previous training with human gestures and between brachycephalic and dolichocephalic breeds of dogs, in correct choice in the two-way object choice test.

Categories	Groups	N	\bar{X}	SE	U	P
Sex	Female	19	60.5	21.2	295	0.373
	Males	27	64.4	17.0		
Age	Young	15	63.3	21.3	224	0.848
	Adult	31	62.6	17.7		
Trained/not trained	Trained	20	68.5	19.0	345	0.054
	Not trained	26	58.5	17.6		
Brachy/dolicho	Brachy	10	62.0	14.8	31	1
	Dolicho	6	63.3	15.1		

Table 2. Differences between breed groups and between cooperative, independent and non-working dog breeds, in correct choice in the two-way object choice test.

Categories	Groups	N	\bar{X}	SE	K	P
Breed groups	Group 1	11	54.5	20.7	3.49	0.445
	Group 2	5	62.0	21.7		
	Group 3	5	60.0	15.8		
	Group 8	11	67.3	19.0		
	Group 9	6	63.3	15.1		
Cooperative/independent/non-working	Cooperative	28	62.5	19.0	0.146	0.930
	Independent	5	60.0	20.0		
	Non-working	13	64.6	19.0		

4.2 Latency until attention

Percentage of right choices and latency for the dog to attend to the experimenter, when all dogs were included, was negatively correlated (Fig. 3B).

4.3 Latency from release to choice

Percentage of correct choices and latency from that the dog was released until it had made its choice, when all dogs were included, had no correlation (N= 46, $r_s = -0.160$, $P = 0.287$).

Percentage of correct choices and latency from that the dog was released until it had made its choice, when dogs that only did unilateral choice (only chose the bowl on one side) were excluded, was negatively correlated (Fig. 3A).

No significant difference was found between the different breed groups in latency from release to choice (N= 38, $K = 1.976$, $P = 0.408$). It tended to take shorter time for cooperative dog breeds from release until choice, than for non-working dog breeds (Fig. 4).

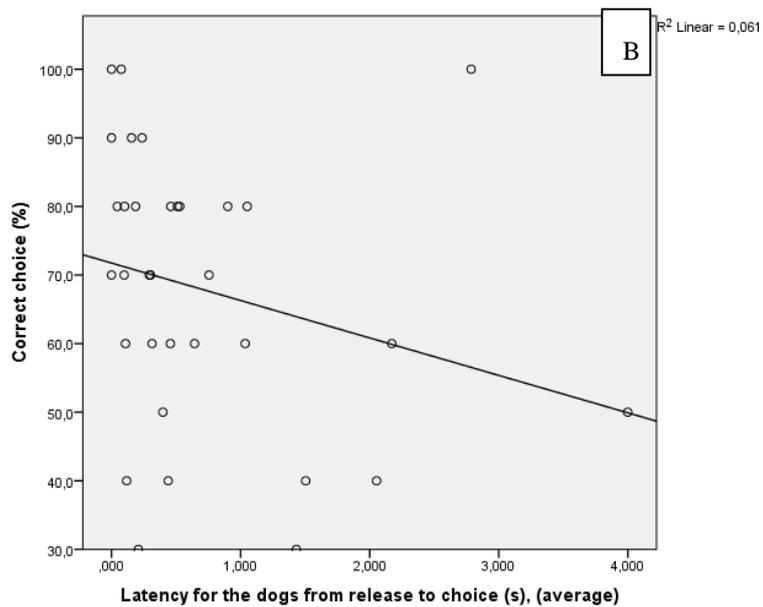
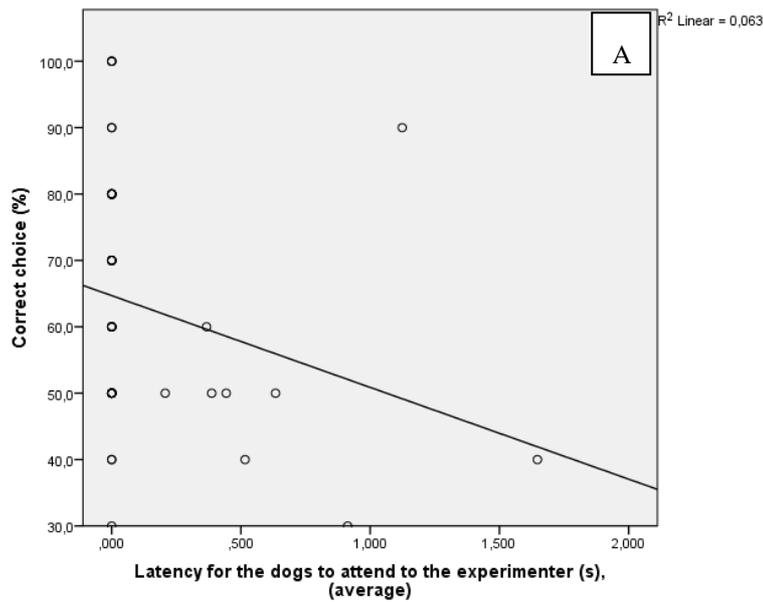


Figure 3A: Relationship between behavioural variables in a two-way object choice test. Correlation between percentage of correct choices for the dogs of which bowl to go to and latency for the dogs to attend to the experimenter (N: 46, r_s : -0.331, P: 0.025), when all dogs were included. B: Correlation between percentage of correct choices for the dogs of which bowl to go to and latency for the dogs from release until it has made its choice (N: 33, r_s : -0.363, P: 0.038), when dogs that only did unilateral choice was excluded. Significance at ≤ 0.05 .

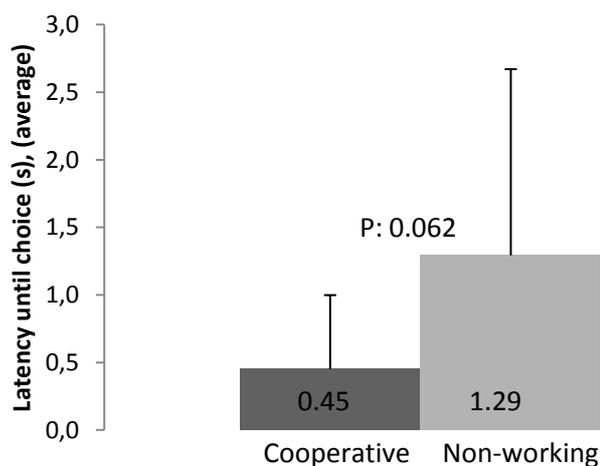


Figure 4. Differences between cooperative and non-working dog breeds in the latency for the dog from release until it have made its choice of which bowl to go to in a two-way object choice test (Cooperative breeds: N= 20, \bar{X} = 0.45, SE= 0.55, Non-working breeds: N= 9, \bar{X} = 1.29, SE= 1.38, Test statistics: U= 130, P= 0.062). Dogs with unilateral choice were excluded. Significance at ≤ 0.05 .

5. Discussion

The results from the present study indicate that dogs can understand human pointing gestures. No differences were found between sex, age or breed groups which is supporting previous findings by Gácsi et al. (2009a). When testing females and males separately against chance level, females were found to have a tendency to understand human pointing gestures. Males were found to understand human pointing gestures. That males were shown to understand human pointing gestures while females only had a tendency may be due to small sample sizes, since the difference in the mean of correct choices for males and females are very small. Even though no results have shown that sex have an impact on the understanding of human gestural cues, the hormone oxytocin may in some way affect the dogs communication ability with humans (Kis et al. 2014). In humans, females have a higher level of oxytocin and this may also be the case in dogs (Kis et al. 2014). Therefore it would be interesting to do further studies to investigate if oxytocin affects dog females and males differently in their communication with humans.

The result that age does not have an impact on dogs understanding of human pointing gestures also supports Gácsi et al. (2009a) and Hare et al (2002). Both Gácsi et al. (2009a) and Hare et al. (2002) did not find any affect of age to choose correctly in a two-way object choice test. On the other hand, Dorey et al. (2010), found that the understanding of human pointing gestures in dogs increased with age. However, they tested puppies that were 9- 24 weeks old. In the present study the dogs were considered young if they were two years or younger and adult if they

were three years or older. At two years old a dog has learned a lot in comparison with a nine or 24 week old puppy. The youngest dog in the present study was ten weeks, but it was the only dog that was that young. The ten week old dog had 50 % correct choices and only made unilateral choices. The next youngest dog was ten months and it had 70% correct choices. Since 50% is seen several times among the adult dogs this support the results that there are no difference between ages. The age span in the present study for the young dogs is so wide in comparison to the study of Dorey et al. (2010) and this may have affected the results. It may be so that already at age 10-24 weeks a dog starts to understand human pointing gestures, but this warrant further investigations.

Like the findings of Gácsi et al. (2009a) no differences was found between breed groups. However, in another study by Gácsi et al. (2009b) they found that cooperative working dogs were better at understanding human gestural cues than both the independent working dogs and the non-working dogs. In the present study no differences between any of the working dogs and the non-working dogs for percentage of correct choices were found. However, a tendency was found that it took a shorter time for the cooperative dogs until choice than the non-working dogs. Cooperative dog breeds take visual contact when they work with humans, which might affect the use of human cues in comparison to the non-working dog breeds. This would be interesting to do further research on to investigate if the cooperative dog breeds visual contact when working with humans affect their performance in the two-way object choice test.

Gácsi et al. (2009b) found that brachycephalic dog breeds performed better than the dolichocephalic dog breeds. I did not find differences in performance between brachycephalic and dolichocephalic dogs. The reason why my results differ from Gácsi et al. (2009b) might depend on sample sizes. For both the brachycephalic and dolichocephalic the sample sizes were small. I did not find any differences between those two groups but when testing them on their own against chance brachycephalic dog breeds were found to understand human pointing gestures, while dolichocephalic dog breeds was found to have a tendency to understand human pointing gestures. To clarify the relationship further investigation would be of interest.

In the questionnaire the owners had to fill in if the dog previously had been trained with human pointing gestures. I thought it could be interesting to study if there were any differences in the results for dogs that had been trained and those that had not. I did find a tendency that dogs that previously had been trained with human pointing chose more

correctly than those who had not been trained. This result is what I would have expected since the dogs that had been trained should understand human pointing gestures better than those who have not been trained. With further investigations and larger sample size this relationship could be clarified.

In the present study a correlation was found between percentages of correct choices against latency until choice, when dogs that made unilateral choice were excluded. This may indicate that the more confident a dog is in its choice of a bowl the more quickly it makes the choice. The more quickly a dog makes a choice of which bowl to go to it seems that the probability of making the correct choice gets higher. A correlation was also found between the percentages of correct choices and the latency until attention, when all dogs were included. This suggests that, the shorter time it takes for the dog to attend to the experimenter the higher probability that it chooses the correct bowl. Since both of these correlations are about the time it takes for the dog to do something, the time that a dog can stay concentrated might affect these. Dogs that have a hard time to stay concentrated took longer time to make a choice in the test. This may be interesting to do further research on, to more thoroughly investigate if the time a dog can stay focused affect the performance in the two-way object choice test.

The two-way object choice test that was used in this study is a common used method for these kinds of research (Dorey et al. 2010). Almost all the dogs in the current study looked intensely at the experimenter when the bowls were put down. The dogs did also follow the pointing gesture, but still some dogs chose the wrong bowl. This might be because the dogs were affected by the order of which the bowls were put down. I think that when the dogs were able to see in which order the experimenter put down the bowls it affected them in their choice of which bowl to choose. Therefore, to improve the method one should aim to prevent the dogs from seeing the experimenter putting down the bowls. Then they have to rely on the pointing and you can eliminate the possibility that the dogs get affected in which order the bowls were put down. Another way to improve the method is to decide if the experimenter should stand or sit down when making the pointing gesture. If the experimenter sits down, even the small dogs have a better chance to see the pointing gesture. Then the pointing gesture will be seen in the small dogs' field of view.

6. Social and ethical aspects

The dogs have a major role in today's society; they help a lot of people by for example lead blind people and just being a good friend. Dogs are also an important partner for many police men in their daily work to example find drugs and lost people. This study increases our understanding of how to communicate with dogs and how good dogs are in the use human gestures and by that increase the cooperation between humans and dogs.

Most dogs used in the present study were family dogs and were only behaviourally tested. Therefore, there were no ethical aspects that needed to be considered other than it might have been a novel and therefore stressful environment for the dogs.

7. Conclusion

The conclusion of the study is that dogs in general understand human pointing gestures and there are no differences between sex, age or breeds in dogs' ability to do so. However, more research is needed with larger and more even sample sizes to clarify some of the patterns found here. More research might make it possible to explain why some dogs are especially talented in the use of human pointing gestures. Also, the method could be improved to avoid other factors than the pointing gestures affect the dog to choose which bowl to go to. Further investigations would also bring the research of dogs understanding of human gestures forward and it might also increase the cooperation between humans and dogs.

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