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# Dogs' attention towards humans depends on their relationship, not only on social familiarity

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## Abstract

Both in humans and non-human animals it has been shown that individuals attend more to those they have previously interacted with and/or that they are more closely associated with than to unfamiliar individuals. Whether this preference is mediated by mere social familiarity based on exposure or by the specific relationship between the two individuals, however, remains unclear. The domestic dog is an interesting subject in this line of research as it lives in the human environment and regularly interacts with numerous humans, yet it often has a particularly close relationship with its owner. Therefore, we investigated how long dogs (*Canis familiaris*) would attend to the actions of two familiar humans and one unfamiliar experimenter, while varying whether dogs had a close relationship with only one or both familiar humans. Our data provide evidence that social familiarity by itself cannot account for dogs' increased attention towards their owners since they only attended more to those familiar humans with whom they also had a close relationship.

### Keywords

domestic dogs; social attention; social familiarity; dog-human relationship

## Introduction

In recent years, evidence has accumulated both in humans and non-human animals that information does not flow uniformly within social groups (Rendell et al. 2011). In a series of comparative experiments that used the same experimental set up for various species it has been shown that ravens (Scheid et al. 2007), marmosets (Range & Huber 2007) and human children (Range et al. 2009) attend more to the actions of individuals with whom they are more familiar and have a closer affiliation. Further, guppies (Swaney et al. 2001) as well as ravens (Schwab et al. 2008) have been found to learn more frequently by observing the behaviour of closely associated individuals than by observing less familiar individuals. Additionally, human children have been found to rely more strongly on and to more

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frequently endorse the information provided by a person they had previously interacted with than the information provided by an unfamiliar individual (Corriveau & Harris 2009). The mechanism mediating this preference to attend to, learn socially from and rely on some individuals from one's social group rather than others, however, remains unclear.

Several studies in non-human animals have found that a relatively short exposure to another animal is sufficient to create social familiarity (e.g. guppies: 12 days, Griffiths & Magurran 1997; sheep: 72 hours, Keller et al. 2011), which then elicits a preference for this specific individual compared to unfamiliar individuals. This social preference has been argued to lead to more proximity to the familiar individuals and consequently to a stronger propensity to acquire information from these individuals (Swaney et al. 2001). Others, however, suggest that the relationship between two individuals goes beyond mere social familiarity and is specified by the nature of their past interactions. Future social interactions are thus dependent on the specific characteristics of the relationship. Strong evidence for the latter claim comes from studies with children showing that insecurely attached children do not rely on information provided by their mother any more than that provided by an unfamiliar experimenter (Corriveau et al. 2009). This cannot be due to a lack of social familiarity – since those children interact daily with their mothers – but must result from their specific relationship. Nonetheless, in most studies to date it is hard to disentangle the effects of mere social familiarity based on exposure and of the specific relationship between two individuals, since those two effects are usually strongly confounded.

The domestic dog is an interesting subject in this line of research as it lives in the human environment and regularly interacts with numerous humans, yet it often has a particularly close relationship with its owner (Topál et al. 1998). Range and colleagues (2009) found that dogs paid significantly more attention to food-related actions of humans than to those of a conspecific. Beyond that, dogs have been found to pay more attention to their owners than to an unfamiliar experimenter when observing them walking through a room (Mongillo et al. 2010). However – due to the reasons elaborated above – in dogs as in other species the mechanism for this preference is not well understood.

Therefore, the aim of this study was to investigate whether dogs' attention towards humans was affected by social familiarity or by the specific relationship. Accordingly, we investigated how long dogs would attend to the actions of three different models: two familiar humans living together in one household with the dog, and one unfamiliar experimenter. Additionally, we varied whether dogs had a close relationship – characterized by many joint activities and frequent feeding – with only one or both of the familiar humans. To investigate whether the behaviour of the model had an influence on dogs' attention, each model performed three different actions differing in the intensity of interaction with the target object. In a second phase we additionally investigated whether dogs would preferentially approach a location where a specific action had been performed.

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## Materials and methods

### Participants

Twenty-four dogs from various pure or mixed breeds participated in this experiment with two humans living together with them in one household. Both familiar humans provided information about who was responsible for the dog (i.e. dog training, pet care, vet visits). Additionally, all participants (except one) provided information about three factors likely to influence their relationship with the dog (i.e. duration in the same household, joint activities, frequency of feeding; see Table 1 for detailed information about the participants). We used the owners' reports about joint activities and feeding occasions to assign the dogs to two groups. Dogs for which the average difference between the two familiar humans in those two values was greater than a third of the total (i.e. one of the owners was interacting with the dog more than twice as much as the other), were assigned to the "Responsibility not shared" group ($N$=13; 7M/6F; *mean age* ± *SD*=4.8±2.50 years). For those dogs, the human participating in more joint activities and feeding them more often was considered the main caregiver. The other person interacted with the dog on a daily basis but less than half of the time of the main caregiver. For the other dogs the average difference between the two familiar humans was a third or less of the total of joint activities and feeding occasions and the two humans were considered to share the responsibility for the dog ("Responsibility shared" group: $N$=11; 6M/5F; *mean age* ± *SD*=4.2±3.38 years). In the one case where one owner did not provide information about joint activities and feeding, the dog was assigned according to both owners' statement that they shared the responsibility. All participating humans (14M/34F) were at least 14 years old (*mean age* ± *SD*=35.9±15.30 years) and had been living together with the dog for a minimum of 10 months.

In the "Responsibility shared" group one pair of familiar humans had been living together with the dog for an unequal length of time (difference Fam1-Fam2: 2 months). In the group "Responsibility not shared" this was the case for four pairs of familiar humans (difference Fam1-Fam2: 12 months, 18 months, 22 months, 28 months). The two groups differed significantly in the absolute difference of joint activities (relative to the total number of joint activities per dog) between the two familiar humans (Mann-Whitney U test, $N$=23, $U$=104.0, $P$=0.015). There was less difference in joint activities with the dog in the "Responsibility shared" group (*median (IQR)*=0.30 (0.225)) than in the "Responsibility not shared" group (*median (IQR)*=0.58 (0.425)). Further, the two groups differed significantly in the absolute difference in feeding occasions (relative to the total number of occasions per dog; Mann-Whitney U test, $N$=23, $U$=107.5, $P$=0.006) with less difference in frequency of feeding in the "Responsibility shared" group (*median (IQR)*=0.14 (0.468)) than in the "Responsibility not shared" group (*median (IQR)*=0.86 (0.530)).

### Experimental set up

Testing took place in a quiet experimental room (6m × 5m) at the Clever Dog Lab (Nussgasse 4, 1090 Vienna). Three sets of three boxes were used as targets for the actions of the human models in this experiment. To counteract any decrease in dogs' interest in the experimental set up across the sessions, the three sets differed in colour and material but all boxes were filled with shredded newspaper. In each session, three boxes were positioned in

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a semi circle at equal distances from the observation position of the dog (Figure 1a). At the observation position the dog was gently restrained by one of the familiar human participants with a short lead while the other human was standing next to the dog passively (Figure 1b). The experimental room was equipped with one camera showing a close-up of the dog and three additional wide-angle cameras. All cameras were connected to monitoring and recording equipment in the adjacent room.

## Procedure

The experiment started with a familiarization phase. In this phase the experimenter, the two familiar humans and the dog entered the experimental room and the dog could explore the room and the three sets of boxes freely for one minute. During this time the experimenter verified that the dog did not show a preference to approach or investigate one particular set of boxes. After this phase each dog received three experimental sessions with the three human models: a) first familiar human, b) second familiar human, and c) unfamiliar female experimenter. All three sessions were carried out on one day with short breaks between the sessions. The sequence of the experimental sessions was counterbalanced across dogs. All three humans were present in the room throughout the experiment.

Each experimental session consisted of a sequence of two phases: an attention phase followed directly by a choice phase. During the attention phase, the dog could observe a human model performing actions at the three boxes for 30 seconds, timed by a ticking clock on the wall. To see whether the type of action influenced the attention of the dog, we used three different actions: a) crouching down and looking inside the box without touching it, b) crouching down while looking into and touching the box, and c) crouching down and searching the box noisily (Figure 2). The model always started with the box positioned in location 1, continued to the box in the middle and then ended with the box in location 3, performing a different action at each box. The sequence of the three actions was semi-randomized between models with the restriction that an action never occurred at the same location across the three models. During the attention phase, the model never called the dog's attention and refrained from establishing eye contact. The two humans next to the dog at the observation position did not look at the dog or at the actions of the human model. Instead they looked at the small screen of a camera mounted on the opposite side, which allowed them to indirectly observe the behaviour of the dog.

After the model returned to the observation position, the choice phase followed immediately. The dog was released by the human holding the lead with one command to run free and/or search (e.g. "Run!", "It's yours!"). During this phase the humans remained in their position and did not look at the actions of the dog. After one minute, the dog was called back by one of the familiar humans and everybody left the room together with the dog. The next session started after 5 minutes during which the experimenter prepared a new set of boxes.

### Data analysis

Experimental sessions were videotaped for later behavioural coding with Solomon Coder beta (©2006-2009 András Péter). Statistical analyses were carried out with SPSS Statistics 17.0.0 (©2008 SPSS Inc.).

In the attention phase, we coded the "duration of looking at each action (s)" from the video showing the close-up of the dog, defined as the dog directing its eyes at the model, from the instant when the model started performing the action for a duration of 30 seconds. Those three durations were summed up as the "total duration of looking at the three performed actions (s)" of each human model. A second coder blind to aim and conditions of the experiment coded 20% of the videos and Spearman's correlation coefficient was greater than $r$=0.9 for both behavioural variables. In the choice phase we coded whether the dog approached any of the boxes (i.e. whether the dog's muzzle was closer than 10 cm to a box; yes/no), which of the boxes where the different actions had been performed was approached first (actions approached: crouch, touch, search), and which of the locations was approached first (locations approached: location 1, location 2, location 3).

We calculated a linear mixed model (LMM) with the response variable "total duration of looking at the three performed actions (s)", the fixed factors "sequence of sessions" (first session, second session, third session), "responsibility" (shared, not shared), and "identity of the model" (1st familiar human, 2nd familiar human, unfamiliar experimenter), and the random factor "dog". We ran a separate LMM with only the trials where the two familiar humans acted as models with the fixed factors "responsibility" (shared, not shared) and "identity of the model" (1st familiar human, 2nd familiar human), and the random factor "dog". We additionally calculated two LMMs for the two groups of dogs (responsibility shared, responsibility not shared) with the response variable "duration of looking at each action (s)", the fixed factors "type of action" (crouching, touching, searching), "sequence of actions" (first action, second action, third action), and "identity of the model" (1st familiar human, 2nd familiar human, unfamiliar experimenter) and the random factor "dog". In all cases the models comprising the main effects and all possible interactions yielded the lowest AIC and were therefore selected. Analyses of the residuals of the LMMs with the Shapiro-Wilk test confirmed normal distribution for all variables.

We calculated a generalized linear model (GzLM) with the binary response variable "approach" (yes, no), the fixed factors "responsibility" (shared, not shared) and "identity of the model" (1st familiar human, 2nd familiar human, unfamiliar experimenter), the interaction of those two factors and the covariate "total duration of looking at the three performed actions (s)"

## Results

During the attention phase we found that dogs overall attended for unequal amounts of time to the different human models ($LMM_{Sequ*Resp*Mod}$, $N$=24, $F_{2,54}$=6.351, $P$=0.003), while responsibility ($F_{1,54}$=0.320, $P$=0.574) and sequence ($F_{2,54}$=2.083, P=0.135) had no main effect on how long dogs observed the model. Additionally, the model yielded a non-significant trend for an interactive effect of the identity of the model and whether the

responsibility was shared or not ($F_{2,54}$=2.983, P=0.059). Since the effect was very close to reaching significance and we expected the two groups to differ mainly in their attention towards the familiar humans and not towards the unfamiliar experimenter, we calculated a separate model taking into account only the dogs' attention towards the familiar humans. In this model, the interaction between the identity of the model and the responsibility was significant ($F_{1,36}$=5.361, $P$=0.026), indicating that the dogs' attention towards the familiar models differed depending on whether they belonged to the "Responsibility shared" or to the "Responsibility not shared" group (Figure 3). To investigate how the dogs in the two groups responded to the familiar humans in comparison to the unfamiliar experimenter, we split the data. We found that in the "Responsibility shared" group dogs paid different amounts of attention to the three models (one-way ANOVA, $N$=11, $df$=2, $F$=3.836, $P$=0.033). While there was no difference between the two familiar humans (post-hoc test (LSD), $P$=0.356), dogs looked for a significantly longer time at the second familiar human than at the unfamiliar experimenter (post-hoc test (LSD), $P$=0.028) and there was also a non-significant trend that they looked longer at the first familiar human (post-hoc test (LSD), $P$=0.084). In the "Responsibility not shared" group the identity of the model also had an influence on how long the dogs paid attention (one-way ANOVA, $N$=13, $df$=2, $F$=5.718, $P$=0.007). In contrast to the other group, however, the dogs with only one main caregiver looked at this person significantly longer than at either the other familiar human (post-hoc test (LSD), $P$=0.010) or the unfamiliar experimenter (post-hoc test (LSD), $P$=0.004). Furthermore, there was no difference in the attention paid to the unfamiliar experimenter and to the human who was familiar but not responsible (post-hoc test (LSD), $P$=0.694).

Since the two groups of dogs differed in their patterns of overall attention, we calculated two separate models for the duration that dogs looked at each action. In the "Responsibility shared" group, we found a significant interaction between the type of action, the sequence of the actions and the identity of the model ($LMM_{ActType*ActSequ*Mod}$, $N$=11, $F_{8,72}$=2.243, $P$=0.034). When we split the data into the three types of actions, we found that when the performed action was "touch", the dogs looked longer at the first performed action than at either the second or the last performed action of each model ($LMM_{Mod*ActSequ}$, $N$=11, $F_{2,24}$=7.085, $P$=0.004; post hoc test (LSD): $P_{Act1,Act2}$=0.004, $P_{Act1,Act3}$=0.002). No other effects and interactions were significant. In the "Responsibility not shared" group, the dogs looked at each action of their main caregiver more than at the actions of either the second familiar human or the unfamiliar experimenter ($LMM_{ActType*ActSequ*Mod}$, $N$=13, $F_{2,90}$=9.515, $P$≤0.001; post hoc test (LSD): $P_{Fam1,Fam2}$=0.002, $P_{Fam1,Unfam}$=0.001), while there was no difference between the second familiar human and the unfamiliar experimenter (post hoc test (LSD), $P_{Fam2,Unfam}$=0.845). Those dogs also paid less attention to the last action compared to the first action performed by all models ($F_{2,90}$=5.774, $P$=0.004; post hoc test (LSD): $P_{Act1,Act3}$=0.008), but did not look for different amounts of time at the three types of actions ($F_{2,90}$=0.521, $P$=0.596).

In the choice phase, dogs did not base their choice of which box to approach first on where a specific action had been performed in the preceding attention phase (actions approached: crouch, $N$=17; touch, $N$=17; search, $N$=15). The dogs approached the first and the last box where they had seen an action performed more often than the middle box (location

approached: location 1, $N$=19; location 2, $N$=7; location 3, $N$=23). However, in 32% of the trials the dogs did not approach any of the boxes during the choice phase. There was only a non-significant trend of an influence of the identity of the model on whether the dogs approached any of the boxes or not for both groups ($GzLM_{Respo*Mod+LookingTime}$, $N$=24, Wald $X^2_2$=5.853, $P$=0.054). When the model was the first familiar human, the dogs approached the boxes in 79% of the trials and when it was the second familiar human in 75% of the trials. However, when the unfamiliar experimenter acted as the model, the dogs approached the boxes in only 50% of the trials (Table 2). The time that the dogs spent looking at the model during the preceding attention phase had no influence on whether they approached the boxes or not (Wald $X^2_1$=2.310, $P$=0.129).

## Discussion

In contrast to previous studies investigating dogs' attention towards humans (Mongillo et al. 2010; Range et al. 2009) our data allowed us to distinguish between social familiarity – resulting from exposure to a person – and the quality of the relationship with a person as the basis for attention. We found that the dogs attended significantly more to a familiar human from their household than to an unfamiliar experimenter only when the person had a close relationship with the dog, characterized by many joint activities and frequent feeding. When the human was familiar to the dog as a result of an equally long exposure period, but spent less active time with the dog than the main caregiver, dogs only paid as much attention to them as to the completely unfamiliar experimenter. Therefore, social familiarity by itself cannot account for dogs' increased attention towards their owners compared to an unfamiliar experimenter found in previous experiments (Mongillo et al. 2010; Range et al. 2009). If this effect was due merely to a lower degree of familiarity with the second human from the household – because dogs spent more time per day with their main owner – then the amount of attention paid to this person would have still been expected to be substantially higher than the attention towards the completely unfamiliar experimenter. However, the attention towards the second person that was familiar but did not have an equally close relationship with the dog was not significantly different from the attention paid to the experimenter.

Corollary support for our findings comes from an earlier study investigating dogs' behaviour in a problem-solving task (Topál et al. 1997). The authors found that dogs that were classified as having a close companion relationship with their owner (i.e. living in the house as a family member) looked at their owners significantly more during the task than dogs having a less close relationship (i.e. being kept outside for guarding or other purposes). In our study all dogs were kept in the household as pets. Although in the "Responsibility not shared" group the familiar humans, who were not responsible for the dog, interacted with the dog less than the main caregiver, they nevertheless participated in joint activities with the dog for some hours per week, and most also occasionally fed the dog. Therefore, it is possible that a small amount of joint activities with a human is not sufficient to influence dogs' attention but that many positive interactions with a specific human are needed to raise their attention towards this person above that towards an unfamiliar human. Moreover, the owners only provided very basic and general information about their daily interactions with the dog (e.g. a sum of the time spent walking, playing, training, and working) by filling in a questionnaire. It is possible that with more detailed questions on the specific interactions

and/or more objective measurements the specific factors influencing dogs' attention could be pinpointed more precisely in future research. Also, unlike Mongillo and colleagues (2010), we did not investigate dogs' selective attention when presenting them with several models at the same time. When having to choose whom of the three models to observe, the patterns of attention might have been different from the ones found in the current study.

When looking separately at dogs' attention towards the different performed actions we found that for none of the human models did the dogs show different amounts of attention to the different actions. Furthermore, in the choice phase the dogs did not preferentially approach any of the boxes where a specific action had been performed. This is surprising, given the fact that dogs have been shown to be able to learn from a human demonstrator through observation (e.g. Kubinyi et al. 2003; Pongrácz et al. 2001) and can even be trained to observe and copy minute body movements of a human model (i.e. "Do-as-I-do" task: Huber et al. 2009; Topál et al. 2006). However, it is possible that in our experiment – since dogs did not see the outcome of the model's actions – they did not perceive any of the actions as more salient or relevant than the others. Additionally, this might have been the reason why in a third of the trials the dogs did not approach any of the boxes at all. Interestingly, the dogs approached the boxes more often after observing either familiar human than after observing the unfamiliar experimenter – independently of whether the responsibility was shared or not. Therefore, it seems that the choice to approach the boxes is – unlike the attention paid to them – influenced more by the familiarity with the model than by the relationship.

In summary, this study indicates that in dogs, the nature of past interactions with a human specify their relationship beyond the effect of mere social familiarity, and that this relationship in turn has the potential to influence their future social interactions. Similar effects of individual relationships have been described in several other species. In primates (Fraser et al. 2010) and ravens (Fraser & Bugnyar 2010) for example the "quality of the relationship" between two individuals influences the likeliness of reconciliation after agonistic interactions. The same mechanism has also been proposed for interactions between dogs housed in big social groups without human owners (Cools et al. 2008). However, to date it is not known whether the same mechanisms are also relevant for dog-human relationships. It is however conceivable that the relationship that a dog has with a person could affect not only their attention towards this individual but also other social interactions, like, for example, the ability to learn socially from that person. Accordingly, the current study has important implications for cognitive research in domestic dogs, since dogs' limited social skills in experiments using an unfamiliar human as a model could be due to a lack of attention rather than their cognitive abilities. However, it is important to note that in our study the models never used any attention-getting cues (e.g. calling the dog's name) while performing the actions. Several recent studies have shown that dogs are very sensitive to ostensive-communicative cues (i.e. speaking in a high-pitched voice, establishing eye contact), which adult humans normally use to address infants and children in teaching contexts (Csibra & Gergely 2009). For example, Téglás and colleagues (2012) found that dogs only followed a human's gaze to an indicated location when they were previously addressed with ostensive-communicative cues. The same cues have also been found to influence dogs in the A-not-B search task, leading the dogs to continue to search for a

reward in the previously indicated A location, even when a reward is later hidden in the novel B location (Topál et al. 2009). Therefore, it is possible that also in our task such communicative cues could have attenuated the differences between the owners and the unfamiliar experimenter. Finally, the results of this study also have important practical implications for dog training. They show that building a close relationship with the dog based on many joint activities could be the basis for a stronger orientation towards the caregiver and subsequently a greater success rate in training.

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## References

Cools AKA, Van Hout AJM, Nelissen MHJ. Canine reconciliation and third party initiated postconflict affiliation: do peacemaking social mechanisms in dogs rival those of higher primates? Ethology. 2008; 114:53–63. doi:10.1111/j.1439-0310.2007.01443.x.

Corriveau K, Harris PL. Choosing your informant: weighing familiarity and recent accuracy. Dev Sci. 2009; 12:426–437. doi:10.1111/j.1467-7687.2008.00792.x. [PubMed: 19371367]

Corriveau KH, Harris PL, Meins E, Fernyhough C, Arnott B, Elliott L, Liddle B, Hearn A, Vittorini L, de Rosnay M. Young children's trust in their mother's claims: longitudinal links with attachment security in infancy. Child Dev. 2009; 80:750–761. doi:10.1111/j.1467-8624.2009.01295.x. [PubMed: 19489901]

Csibra G, Gergely G. Natural pedagogy. Trends Cogn Sci. 2009; 13:148–153. doi:10.1016/j.tics.2009.01.005. [PubMed: 19285912]

Fraser ON, Bugnyar T. Ravens reconcile after aggressive conflicts with valuable partners. PLoS ONE. 2011; 6:e18118. doi:10.1371/journal.pone.0018118. [PubMed: 21464962]

Fraser ON, Stahl D, Aureli F. The function and determinants of reconciliation in *Pan troglodytes*. Int J Primatol. 2010; 31:39–57.

Griffiths SW, Magurran AE. Familiarity in schooling fish: how long does it take to acquire? Anim Behav. 1997; 53:945–949. doi:10.1006/anbe.1996.0315.

Huber L, Range F, Voelkl B, Szucsich A, Virányi Z, Miklosi A. The evolution of imitation: what do the capacities of non-human animals tell us about the mechanisms of imitation? Philos T Roy Soc B. 2009; 364:2299–2309. doi:10.1098/rstb.2009.0060.

Keller M, Cornilleau F, Archer E, Lévy F. Development of social familiarity in ewes. Physiol Behav. 2011; 104:392–397. doi:10.1016/j.physbeh.2011.04.030. [PubMed: 21557959]

Kubinyi E, Topál J, Miklósi Á , Csányi V. Dogs (*Canis familiaris*) learn from their owners via observation in a manipulation task. J Comp Psychol. 2003; 117:156–165. doi: 10.1037/0735-7036.117.2.156. [PubMed: 12856786]

Mongillo P, Bono G, Regolin L, Marinelli L. Selective attention to humans in companion dogs, *Canis familiaris*. Anim Behav. 2010; 80:1057–1063. doi:10.1016/j.anbehav.2010.09.014.

Pongrácz P, Miklósi Á , Kubinyi E, Gurobi K, Topál J, Csányi V. Social learning in dogs: the effect of a human demonstrator on the performance of dogs in a detour task. Anim Behav. 2001; 62:1109–1117. doi:10.1006/anbe.2001.1866.

Range F, Horn L, Bugnyar T, Gajdon GK, Huber L. Social attention in keas, dogs, and human children. Anim Cogn. 2009; 12:181–192. doi:10.1007/s10071-008-0181-0. [PubMed: 18716802]

Range F, Huber L. Attention in common marmosets: implications for social-learning experiments. Anim Behav. 2007; 73:1033–1041. doi:10.1016/j.anbehav.2006.07.015.

Rendell L, Fogarty L, Hoppitt WJE, Morgan TJH, Webster MM, Laland KN. Cognitive culture: theoretical and empirical insights into social learning strategies. Trends Cogn Sci. 2011; 15:68–76. doi:10.1016/j.tics.2010.12.002. [PubMed: 21215677]

Scheid C, Range F, Bugnyar T. When, what, and whom to watch? Quantifying attention in ravens (*Corvus corax*) and jackdaws (*Corvus monedula*). J Comp Psychol. 2007; 121:380–386. doi: 10.1037/0735-7036.121.4.380. [PubMed: 18085921]

Schwab C, Bugnyar T, Schloegl C, Kotrschal K. Enhanced social learning between siblings in common ravens, *Corvus corax*. Anim Behav. 2008; 75:501–508. doi:10.1016/j.anbehav.2007.06.006.

Swaney W, Kendal J, Capon H, Brown C, Laland KN. Familiarity facilitates social learning of foraging behaviour in the guppy. Anim Behav. 2001; 62:591–598. doi:10.1006/anbe.2001.1788.

Téglás E, Gergely A, Kupán K, Miklósi Á , Topál J. Dogs' gaze following is tuned to human communicative signals. Curr Biol. 2012; 22:209–213. doi:10.1016/j.cub.2011.12.018. [PubMed: 22226744]

Topál J, Byrne RW, Miklósi Á , Csányi V. Reproducing human actions and action sequences: "Do as I Do!" in a dog. Anim Cogn. 2006; 9:355–367. doi:10.1007/s10071-006-0051-6. [PubMed: 17024511]

Topál J, Gergely G, Erdőhegyi Á , Csibra G, Miklósi Á . Differential sensitivity to human communication in dogs, wolves, and human infants. Science. 2009; 325:1269–1272. doi: 10.1126/science.1176960. [PubMed: 19729660]

Topál J, Miklósi Á , Csányi V. Dog-human relationship affects problem-solving behavior in the dog. Anthrozoös. 1997; 10:214–224. doi:10.2752/089279397787000987.

Topál J, Miklósi Á , Csányi V, Dóka A. Attachment behavior in dogs (*Canis familiaris*): A new application of Ainsworth's (1969) strange situation test. J Comp Psychol. 1998; 112:219–229. doi: 10.1037/0735-7036.112.3.219. [PubMed: 9770312]

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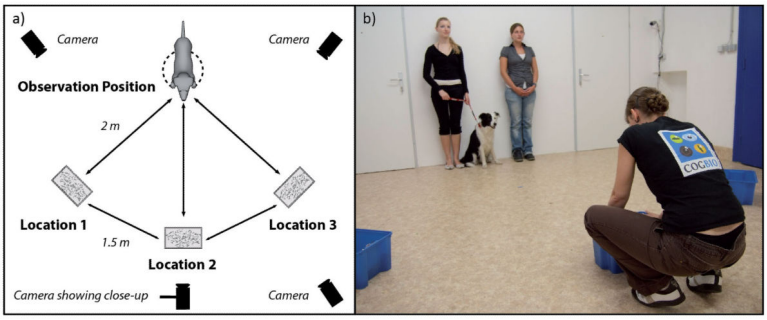


**Figure 1.**

a) Schematic bird's eye view of the experimental set up and the positions of the four cameras. b) Photograph showing the positions of the dog and the humans during the demonstration phase (Photo by A. Gaigg).



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**Figure 2.**
Photograph of the experimenter displaying the three actions carried out during the attention phase: a) crouching, b) touching, and c) searching (Photo by A. Gaigg).



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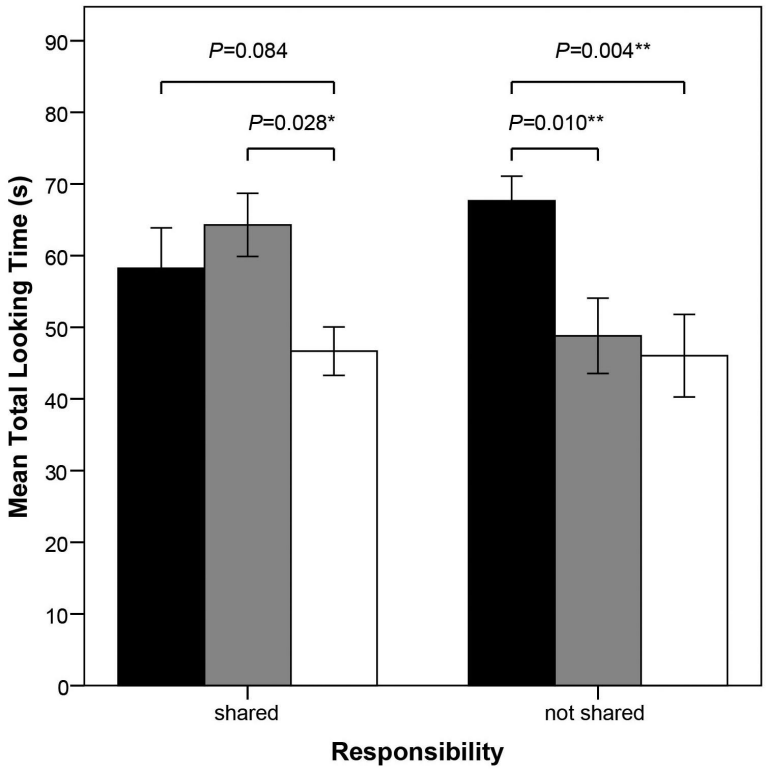


**Figure 3.**

Mean total duration (±SEM) of looking at the actions of each model, grouped by responsibility of the familiar humans. Black bars, 1st familiar human; grey bars 2nd familiar human; white bars, unfamiliar experimenter.

## Table 1

List of dog and human participants, indicating the sex and breed of the dogs, and the gender, time spent together in the same household with the dog ("Exposure", months), joint activities (i.e. sum of walking, playing, training, and working; "Activity", hours per week), and frequency of feeding ("Feeding", average occasions per week) for the two familiar humans. Familiar human 1 was the person having on average a greater relative frequency of joint activities and feeding occasions than the other person.

| | **Dog:** | | | **Familiar Humans:** | | | | |
|---|---|---|---|---|---|---|---|---|
| | **Name** | **Sex** | **Breed** | **Identity** | **Gender** | **Exposure (mths)** | **Activity (hs/wk)** | **Feeding (occ/wk)** |
| **Responsibility shared** | Akina | F | Akita Inu | Fam1: | female | 10 | 21 | 4 |
| | | | | Fam2: | male | 10 | 10 | 3 |
| | Bonnie[a] | F | White Swiss Shepherd Dog | Fam1: | female | **42** | 22 | 4.5 |
| | | | | Fam2: | female | **40** | 16 | 2.5 |
| | Cleo | F | Border Collie | Fam1: | female | 13 | 22 | 7 |
| | | | | Fam2: | female | 13 | 18 | 7 |
| | Dewey | M | mixed breed | Fam1: | female | 76 | 25 | 3.5 |
| | | | | Fam2: | female | 76 | 17 | 3.5 |
| | Flori | F | Pomeranian | Fam1: | female | 21 | 14 | 7 |
| | | | | Fam2: | male | 21 | 8 | 5 |
| | Gina | F | Poodle | Fam1: | male | 129 | 6 | 1 |
| | | | | Fam2: | female | 129 | 12 | 0 |
| | Luis | M | Shetland Sheepdog | Fam1: | female | 12 | **n/a** | **n/a** |
| | | | | Fam2: | female | 12 | 10 | 4 |
| | Nash | M | Siberian Husky | Fam1: | male | 108 | 3.5 | 7 |
| | | | | Fam2: | female | 108 | 1.3 | 7 |
| | Robin | M | mixed breed | Fam1: | male | 17 | 16.3 | 7 |
| | | | | Fam2: | female | 17 | 38 | 0 |
| | Sanji | M | Continental Toy Spaniel | Fam1: | female | 54 | 12.5 | 4.5 |
| | | | | Fam2: | female | 54 | 9 | 3.5 |
| | Viktor | M | Havanese | Fam1: | female | 19 | 18 | 3 |
| | | | | Fam2: | female | 19 | 8 | 4 |
| **Responsibility not shared** | Amy[a] | F | Siberian Husky | Fam1: | female | **53** | 10 | 6 |
| | | | | Fam2: | male | **35** | 6 | 1 |
| | Benji | M | White Swiss Shepherd Dog | Fam1: | female | 110 | 3.5 | 14 |
| | | | | Fam2: | male | 110 | 0 | 0 |
| | Bobby[a] | M | French Bulldog | Fam1: | female | **60** | 5 | 6.5 |
| | | | | Fam2: | female | **48** | 2 | 3 |
| | Cash[a] | M | Australian Shepherd | Fam1: | female | **40** | 15.5 | 13 |
| | | | | Fam2: | male | **18** | 3.5 | 1 |
| | Cheyenne | F | Australian Shepherd | Fam1: | female | 46 | 13 | 14 |

| Dog: | | | Familiar Humans: | | | | |
|---|---|---|---|---|---|---|---|
| **Name** | **Sex** | **Breed** | **Identity** | **Gender** | **Exposure (mths)** | **Activity (hs/wk)** | **Feeding (occ/wk)** |
| | | | Fam2: | male | 46 | 4 | 0 |
| Filon | M | Australian Shepherd | Fam1: | female | 15 | 28 | 7 |
| | | | Fam2: | female | 15 | 1.5 | 0 |
| Kim | F | Poodle | Fam1: | female | 44 | 10 | 13 |
| | | | Fam2: | female | 44 | 9 | 1 |
| Lucy | F | mixed breed | Fam1: | female | 75 | 43 | 13 |
| | | | Fam2: | male | 75 | 6 | 0.5 |
| Mika | F | Poodle | Fam1: | female | 114 | 12 | 1 |
| | | | Fam2: | male | 114 | 5 | 0 |
| Monti | M | mixed breed | Fam1: | male | 24 | 8 | 13 |
| | | | Fam2: | female | 24 | 7 | 0.5 |
| Napoleon[a] | M | mixed breed | Fam1: | female | **48** | 7 | 11 |
| | | | Fam2: | male | **20** | 1 | 3 |
| Palmira | F | Belgian Sheepdog | Fam1: | female | 46 | 9.5 | 9 |
| | | | Fam2: | male | 46 | 2.5 | 5 |
| Ted | M | mixed breed | Fam1: | female | 12 | 14 | 9.5 |
| | | | Fam2: | female | 12 | 2.3 | 4.5 |

[a]Dogs, which had been living together with familiar humans for an unequal length of time.

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**Table 2**

Total number of trials in which the dogs either approached or did not approach the boxes, grouped by model identity and responsibility.

| Model | Approach | Responsibility shared | Responsibility not shared | Total |
|---|---|---|---|---|
| 1st familiar human | yes | 7 | 12 | 19 |
| | no | 4 | 1 | 5 |
| 2nd familiar human | yes | 9 | 9 | 18 |
| | no | 2 | 4 | 6 |
| Unfamiliar experimenter | yes | 6 | 6 | 12 |
| | no | 5 | 7 | 12 |