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Dogs, *Canis familiaris*, find hidden food by observing and interacting with a conspecific

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Social learning is an important process in the development of behaviour in many species. It is involved in information transfer concerning food that leads, in some species, to food preferences. In our experiment an adult dog (the observer) was allowed to observe another adult dog (the demonstrator) while the latter was disappearing behind one of four projecting blinds. In one trial the demonstrator dog found food behind the projecting blind, but not in the other. After the demonstrator had inspected the potential food location, it returned to the observer dog and they were allowed to interact and to have snout contact. Afterwards, the observer dog was allowed to inspect the potential food locations, while no olfactory cues from the food were given. The observer dogs were able to adjust their search behaviour depending on the knowledge gained by observing and interacting with a conspecific. Food availability to the demonstrator dog during the demonstration phase increased the willingness of observer dogs to have snout contact with their demonstrators and increased their motivation to search for food. In contrast to snout contact, however, food availability to the demonstrator dog had no influence on the decision to go to a particular food location. Furthermore, our results suggest that dogs use snout contact as a source of information to decide whether to go to a potential food location or not.

Learning by observing and interacting with a conspecific is an important process in the development of behaviour in many species (Galef & Laland 2005). Social learning is involved in information transfer concerning food that leads, in some species, including humans, rodents and birds, to food preferences (Lupfer-Johnson & Ross 2007). Galef & Wigmore (1983) investigated the transfer of information regarding distant foods in rats, *Rattus norvegicus*. If an observer rat had to choose between two novel diets, this rat preferred the diet that was previously eaten by a demonstrator conspecific with whom the observer had interacted before. The authors concluded that olfactory cues passing from demonstrator to observer provided enough information about the diets for the observer to make its choice. In some species information transfer concerning food leads to food preferences in pups. Rabbit, *Oryctolagus cuniculus*, pups raised by mothers fed different diets during pregnancy and lactation showed a clear preference for the diet of their mothers at weaning (Bilkó et al. 1994). Three equally effective means of information transmission in rabbits were found: the faeces deposited by the mother in the nest, prenatal experiences, and contact with the mother during nursing (Bilkó et al. 1994). Galef & Giraldeau (2001) concluded in their review that food odours detected on the breath of a conspecific allowed its identification, and cause food preferences in rats, mice, *Mus domesticus*, Mongolian gerbils, *Meriones unguiculatus*, and spiny mice, *Acomys cahirinus*. Dogs also show a preference for the flavoured diet detected on a conspecific's breath (Lupfer-Johnson & Ross 2007). Tonkean macaques, *Macaca tonkeana*, are able to use the information gained by smelling the mouth of a companion to adapt their searching behaviour to the quality of food artificially deposited in the field (Chauvin & Thierry 2005). The tested individuals adjusted their foraging speed according to the value of the expected reward to be found.

Social foraging by vertebrates often depends not on specialized signals, but on information-bearing cues (Galef & Giraldeau 2001). Hearing the sound produced by a conspecific while eating may attract a companion that has learned the meaning of this particular sound. This phenomenon is observed in agoutis, *Dasyprocta punctata*, which are attracted by the rasping sound a conspecific makes when gnawing on a nut (Galef & Giraldeau 2001). Visual cues are used by some birds that are attracted by other birds feeding at a particular location (Avery 1994). Furthermore, some animals use specific vocalizations as food calls. Male domestic chickens, *Gallus gallus domesticus*, for example, produce food calls that communicate information about food quality to a hen (Marler et al. 1986a). The roosters modulate these calls by social context: the calling is

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enhanced in the presence of a hen, and inhibited in the presence of another cock (Marler et al. 1986b). Food calls are also known from nonhuman primates (e.g. *Macaca mulatta* and *Macaca sinica*); their food calls contain information on the location, quantity and quality of the food (Chauvin & Thierry 2005). Chimpanzees, *Pan troglodytes*, informed about a food location succeeded in leading others to the reward by drawing attention to themselves through actions such as tapping others on the shoulders or repeatedly glancing at them while heading in the direction of the food (Menzel 1974). In competitive situations, however, where a chimpanzee could observe a human experimenter baiting a food container in an outdoor enclosure and a second individual observed the observer, but was not able to observe the experimenter, the two chimpanzees developed tactics and countertactics to get the food on their own (Hirata & Matsuzawa 2001). An additional foraging tactic is to observe a food-storing conspecific, and to locate and raid the caches later. This strategy has been demonstrated for several food-caching corvids, including ravens, *Corvus corax* (Heinrich & Pepper 1998; Bugnyar & Kotrschal 2002) and a variety of jays (e.g. Bednekoff & Balda 1996a, b; Watanabe & Clayton 2007).

Socializing when searching for food is advantageous for dogs: young puppies can learn by observing how others obtain food (Adler & Adler 1977) and adult dogs are able to imitate a conspecific in an inferential, selective manner to get food out of a box (Range et al. 2007). Cooper et al. (2003) tested the ability of dogs to use a conspecific as an information source to find a baited target, but their dogs seemed to be more interested in positive social interaction than locating food, as they always followed another dog, but did not discriminate between apparently informed and uninformed dogs. Locating hidden food by using conspecific signals was investigated by Hare & Tomasello (1999). In their study they used an informant dog gazing at one of two barriers. Some of the observing dogs were able to use the conspecific cue to locate the hidden food. All these studies indicate that social interaction might be important in the development of foraging strategies in dogs. Nevertheless, the influence of intraspecific social interactions, such as snout contact, on finding food has been little investigated.

In our study we investigated the influence of observation and interaction in a food-finding experiment. We tested pairs of adult dogs. One dog, the observer, observed a conspecific, the demonstrator, disappearing and reappearing behind one of four projecting blinds. We investigated whether dogs are able to adjust their searching behaviour for food depending on whether the demonstrator dog had found food behind one of the projecting blinds or not. We predicted that dogs would be inquisitive and inspect the corner behind which their conspecifics had disappeared. Second, we investigated whether an interaction between the two dogs, that is, snout contact, influences the searching behaviour of an observer dog. We predicted that the smell of the food on the demonstrator's breath would motivate the observer to go faster to the presented food location, which no longer contained food or its odour.

METHODS

Thirty-seven (male/female: 16/21) domestic dogs of different breeds and mongrels participated in this experiment. Twenty-four (male/female: 11/13) dogs were tested as observer dogs, whereas the other 13 were demonstrator dogs. All dogs were between 2 and 13 years of age and lived with private owners (Table 1).

The experiment took place outdoors in a quiet enclosure at the University of Zurich-Irchel. The enclosure was surrounded by concrete walls on three sides and on the remaining side there was another empty enclosure separated by a high fence covered with a bamboo screen. The entrance for the dogs was a metal latticed door covered with a plastic sheet; the exit from the building and the observation cabin, slightly above the experimental space and built into the wall of the building, were made of glass. Inside the enclosure an inner section was built with nontransparent plastic sheets, the effective test area (Fig. 1). A plastic box was placed in each corner of the inner room behind a projecting blind. All of these four plastic boxes, of equal size, served as potential food locations. To avoid food-related olfactory cues, there was no food inside any of the four boxes throughout the experiments. In addition, four small, plastic boxes, of equal size, were affixed with a string from the roof of the enclosure 2.3 m above these four potential food locations. It was possible to lower these four small boxes from the observation cabin. There was food inside these boxes throughout the experiment to mask the small of the food rewards. After the experiment, the dog owners gave this food to their dogs, once it was lowered by the experimenter in the observation cabin.

Experimental Set-up

In each trial an 'observer dog' and a 'demonstrator dog' participated. The observer dogs were divided into two groups with different levels of experience. The 12 in the experienced group had participated in other food-finding experiments in the same enclosure between 2 weeks and 3 months before. During these experiments the dogs observed, three to seven times, a human that hid food in one of four boxes under different conditions. The 12 dogs in the inexperienced group had never participated in an experiment before. Most of the tested dog pairs were from the same household, but in six pairs the dogs were from different households although they regularly spent time together. Two dogs were tested first as observer dogs and then used as demonstrator dogs. The dominance ranks of the dogs in each dyad were defined by answers of the dog owners to specific questions: which dog starts to eat first or eats the other dog's food, if the dogs get food at the same time and at the same place; which dog is normally able to monopolize a desired and limited resource; and which dog shows submissive (definition was given) behaviour in a resource (food, toy, human) competition situation.

Food presentation phase

The demonstrator dog was led into the test area by the experimenter in the absence of its owner and the observer dog. In one of the four corners two dog biscuits (Frolic, Mars Switzerland Inc., Zug, Switzerland) were placed on top of the plastic box, while the demonstrator dog observed this action. This corner was determined at random before the experiment began. Afterwards, the demonstrator dog left the test area for 30 s. Following this, there were two different treatments: in half of the trials with the experienced and with the inexperienced observer dogs, the food was taken away in the absence of the demonstrator dogs (trial: 'no food') whereas in the other trials, the food remained at the food location (trial: 'food').

Demonstration phase

In both trial treatments the demonstrator and the observer dogs entered the test area together with the owner of the demonstrator dog and the experimenter. If the two dogs were not from the same household, the owner of the observer dog waited outside the enclosure and returned to his/her dog after the interaction phase. They went to the middle of the test area and the humans looked in the direction of the observation cabin (Fig. 1), whereas the dogs did not have to look in a specific direction. The demonstrator dog was then released from the leash by the experimenter. Both owner and observer dog were now allowed to look in any direction, but had to remain in the middle of the test area together with the experimenter. All of the demonstrator dogs went immediately to the

Table 1
Name, breed, age, gender, experience level, and role of the participating subjects

Subject	Breed	Age (years)	Gender	Experience level	Role
Ajenga	Medium poodle	7	F	Inexperienced	Observer
Arwen	Standard poodle	5	F	Experienced	Observer
Baci	Dachshund	7	M	Inexperienced	Observer
Baja	Standard poodle	2	F	Experienced	Observer
Barni	Labrador retriever	5	M	Inexperienced	Observer
Ben	Border collie	3	M	Inexperienced	Demonstrator
Biggi	Mongrel	13	F	Inexperienced	Demonstrator
Camilla	Scottish terrier	2	F	Experienced	Demonstrator
Caroline	German shepherd	10	F	Inexperienced	Observer
Chessy	Airedale terrier	6	F	Inexperienced	Demonstrator
Chilly	Irish terrier	7	F	Experienced	Observer, then Demonstrator
Dexter	Irish terrier	7	M	Experienced	Demonstrator
Enja	German pinscher	6	F	Experienced	Demonstrator
Even	Border collie	3	M	Experienced	Observer
Fighter	Border collie	3	M	Inexperienced	Observer
Flash	Scottish terrier	4	M	Experienced	Observer
Gibsy	Dachshund	5	M	Experienced	Demonstrator
Jara	Irish terrier	4	F	Experienced	Observer
Jaschico	Border collie	10	M	Inexperienced	Observer
Jesse	Mongrel	5	M	Experienced	Observer, then Demonstrator
Kangoo	Irish terrier	5	F	Experienced	Observer
Kimana	Border collie	2.5	F	Experienced	Demonstrator
Kira	Mongrel	7	F	Inexperienced	Observer
Luna 1	Mountain dog-mix	3	F	Inexperienced	Observer
Luna 2	Standard poodle	8	F	Experienced	Demonstrator
Macho	German shepherd	3.5	M	Experienced	Demonstrator
Mila	Mongrel	6	F	Experienced	Observer
Nalani	Border collie	3	F	Experienced	Demonstrator
Nelson	Airedale terrier	7	M	Experienced	Demonstrator
Nubia	Bouviers de Flandre	3	F	Experienced	Demonstrator
Piro	Mongrel	7.5	M	Inexperienced	Observer
Pongo	Weimaraner	6	M	Inexperienced	Observer
Ronja	Mountain dog-mix	5	F	Inexperienced	Observer
Scuba	Flat-coated retriever	4	M	Experienced	Observer
Scully	Scottish terrier	8	F	Inexperienced	Observer
Smily	Chihuahua	4	M	Experienced	Observer
Zora	Mongrel	2	F	Experienced	Observer

F = female; M = male.

corner where the food was previously presented. There the demonstrator dogs found and ate the food in food trials or they found no food in no-food trials. The observer dog was only able to observe the demonstrator dog disappearing behind one of the corners and returning, but it was not possible for them to see what the demonstrator dog did behind the corner blind.

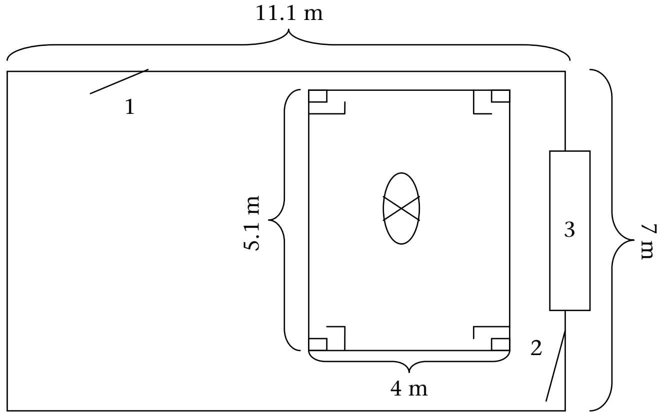

Figure 1. Outline of the outdoor enclosure and test area. The potential food locations in the corners are marked with a rectangle. The circle with the cross in the middle marks the start point of the dogs in the experiments. 1: Door through which the test animals entered the enclosure. 2: Exit from the building. 3: The position of the elevated observation cabin inside the building.

Interaction phase

When the demonstrator dogs came out from behind the projecting blind or at the latest after 15 s, the owners called them back. Afterwards, the observer dog was allowed to interact with the demonstrator, and had the opportunity to have snout contact with it. The experimenter observed the behaviour of the two dogs and noted whether they had snout contact or not. After that, the demonstrator dog was taken on its leash and guided out of the enclosure by the experimenter.

Test phase

The observer dogs and their owners stayed in the room, and, without changing location, rotated three full circles and the dogs were released from their leash in a predetermined direction. This direction was determined at random before the experiment started. The owner was asked to remain motionless in the middle of the test area and to look in a predetermined direction. This direction was also determined at random before the experiment started. While the observer dog was allowed to inspect the corners, there was no food on the ground at any of them, but there was food in all four small boxes hanging 2.3 m above the corners. In trials where the demonstrator dogs had found food, the experimenter who observed and filmed the experiment from the observation cabin gave a sign to the owners, if the observer dogs stayed for 5 s in the corner where the demonstrators had previously found food. Then the owners went to their dogs, the small box above the corner was lowered and the owners rewarded their dogs with a treat (Frolic) out of this small box. If an observer dog just went behind the demonstrated corner and returned immediately to inspect the next corner, the owner got no signal to reward the dog, but the time was noted. This was to minimize the influence of the dog owner, to avoid any early movements that might influence a dog's decision and to render the result of this trial comparable with the trial where the demonstrator dog did not find food. In this other trial, where the demonstrator dogs had not found food, the observer dogs were not rewarded in any corner and the experiment was stopped after 90 s. However, the time was noted when they went to the box where the demonstrator dogs were during the presentation. The owners of the observer dogs were not informed about the trial treatment (whether the demonstrator had found food or not).

Each observer dog participated in four experimental trials (see above): two trials where the demonstrator dog found food and two where it did not. Between the separate trials there was always a waiting period of 15 min during which the dogs and their owners went for a walk in the adjacent park. A trial where the demonstrator dog had found food was followed by a trial where it did not find food and vice versa (i.e. food, no food, food, no food; or: no food, food, no food, food). Furthermore, the food location was always at a different corner. The trial orders and the food locations were randomized and counterbalanced between and within the groups.

We measured with a stopwatch the time the observer dogs needed to go to the food location visited by the demonstrator and noted the order of the potential food locations the dogs visited. Furthermore, we noted whether the observer dogs had snout contact (sniffing, licking or touching the partner's snout) with the demonstrator dogs after the food presentation. All tests were filmed with a digital video camera (Panasonic NV-DX1E) to check and supplement the observations of an experimental trial. To prevent direct eye contact between the dogs and their owners, to reduce communicative cues during the experiment, the owners wore sunglasses.

Statistical Analysis

We calculated a generalized mixed model using the binomial distribution to investigate the influence of age, gender, dominance rank, stage (first or second time with or without food), experience level and food availability (demonstrator dog) on the observer dog's willingness to have snout contact. The individual was involved in the model as a random factor. Furthermore, the time the observer dogs needed to go to the potential food location that was indicated by a conspecific was analysed with a linear mixed-effect model. In this model the influences of age, dominance rank, stage (first or second time with or without food), gender, experience level, food availability (demonstrator dog) and snout contact were analysed, whereas the individual was involved in the model as random factor. Our data were not normally distributed, because an experimental trial lasted at most 90 s. Therefore, we calculated the latency of a dog to go to the presented corner as a ratio of the maximum possible latency. This enabled us to transform the data (latency) with a logit transformation. A linear mixed-effect model (LME) was calculated to investigate the influence of snout contact and food availability on the latency to when the dogs chose a first potential food location. The individual was included in the model as a random factor. We also calculated a generalized mixed model using the binomial distribution to investigate the influence of food availability (demonstrator dog) and snout contact on the observer dog's choice of corner during an experimental trial. The individual was involved in the model as a random factor. The models were calculated with the program R 2.5.1 (R Development Core Team, Vienna, Austria).

RESULTS

An influence of food availability (GLM: $T_{69} = -3.727$, $P < 0.001$) and an interaction between gender and stage (GLM: $T_{69} = -2.592$, $P = 0.012$) was found for the willingness to have snout contact, but not an influence of dominance rank (GLM: $T_{19} = 0.69$, $P = 0.50$), age (GLM: $T_{19} = -0.67$, $P = 0.51$) or experience level (GLM: $T_{19} = -0.37$, $P = 0.71$). Snout contact and no snout contact occurred in similar proportions if the demonstrator dogs had found food. However, if the demonstrator dogs had not found food a smaller percentage of observer dogs had snout contact than those with no snout contact (Fig. 2). Male and female observer dogs showed differences in their behaviour on having snout contact. Snout contact and no snout contact occurred in similar proportions in female dogs and they showed no difference in this pattern between the first and second stage of a trial (with or without food). However, male dogs in general had snout contact less often than no snout contact and during their second stage of a trial they had snout contact less often than during their first stage (Fig. 3).

The latency of an observer dog to go to the presented potential food location was influenced by snout contact (LME: $F_{1,69} = 7.929$, $P = 0.006$), whereas age (LME: $F_{1,19} = 0.12$, $P = 0.73$), dominance rank (LME: $F_{1,19} = 0.11$, $P = 0.74$), stage (first or second time with or without food; LME: $F_{1,67} = 0.85$, $P = 0.36$), gender (LME: $F_{1,19} = 0.14$, $P = 0.71$) and experience level (LME: $F_{1,19} = 0.90$, $P = 0.35$) had no influence. A nonsignificant tendency was found for food availability to the demonstrator dogs during the demonstration phase to influence the latency (LME: $F_{1,69} = 3.25$, $P = 0.08$). Additionally, there was a significant interaction between food availability and snout contact (LME: $F_{1,69} = 7.454$, $P = 0.008$); therefore, the influence of snout contact was different according to the demonstrators' success at finding food. Snout contact only had an influence if the demonstrators had found food (Fig. 4a). Furthermore, observer dogs that had snout contact with their conspecifics went faster to the presented potential food location in trials where the demonstrator dogs found food than where they did not (LME: $F_{1,20} = 29.075$, $P < 0.001$), whereas observer dogs that had no snout contact showed no difference in the time they needed to go to the presented food location between the two trials (LME: $F_{1,35} = 2.52$, $P = 0.12$).

The latency to when the observer dogs went to inspect their first corner was influenced by the food availability to the demonstrator dogs (LME: $F_{1,70} = 7.688$, $P = 0.007$); they went faster to the first corner if the demonstrator dogs had found food before. However,

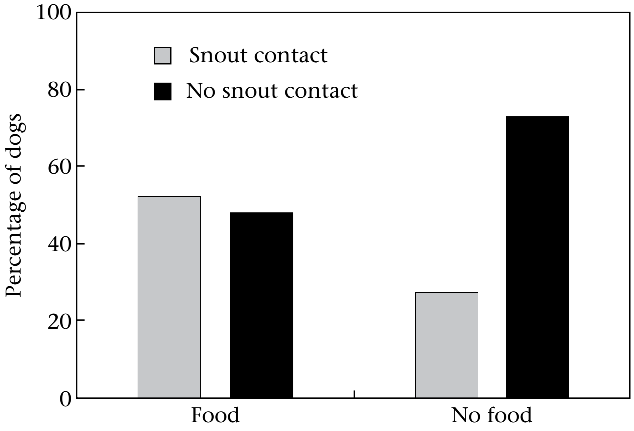

Figure 2. Influence of food availability during the demonstration phase on the willingness of observer dogs to have snout contact.

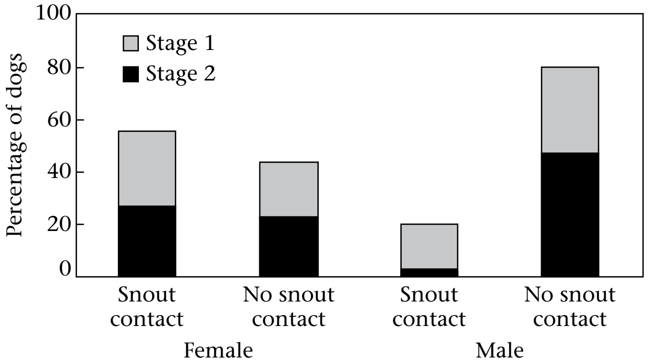

Figure 3. Influence of an observer dog's gender on the willingness to have snout contact.

no influence of having snout contact could be found (LME: $F_{1,70} = 0.01$, $P = 0.93$; Fig. 4b).

The number of potential food locations (including the presented one) an observer dog visited until it went to the presented one, as well as the number of observers that did not choose or did not go to the presented corner, differed between the trials and the dogs that did or did not have snout contact. In trials where the demonstrator dog had found food, 56.5% of the observer dogs that had no snout contact went to the presented location on their first choice and 26% never went to this corner. If the observer dogs had snout contact during this trial, 84% went to the presented corner on their first choice and 4% did not go to the presented corner. In trials where the demonstrator dogs had not found food, 15.4% of the dogs that had snout contact went to the presented corner on their first choice and 54% did not go to this corner during this trial. If the observer dogs had no snout contact during the trial 'no food', 31.5% of the dogs went to the presented corner on their first choice and 43% of the observer dogs did not go to this corner (Fig. 5).

Whether an observer dog chose to go to the presented food location during an experimental trial was influenced by snout contact (GLM: $T_{69} = 2.078$, $P = 0.042$), whereas food availability to the demonstrator dog had no influence on the dogs' choice (GLM: $T_{69} = -1.53$, $P = 0.13$). However, there was a significant interaction between food availability (demonstrator dog) and snout contact (GLM: $T_{69} = -2.237$, $P = 0.029$); therefore, the influence of snout contact was different according to the demonstrators' success at finding food (Fig. 6).

DISCUSSION

Dogs ('observers') that were allowed to observe a conspecific ('demonstrators') inspecting a potential food location apparently gained information during this observation and the following interaction with their conspecifics, enabling them to find the presented potential food location after the demonstrator had left the test area. The ability to follow a conspecific to a food location has been shown in various animals, for example in pigs, *Sus scrofa* (Held et al. 2000), rats (Galef et al. 1987), chimpanzees (Hirata & Matsuzawa 2001) and great tits, *Parus major* (Marchetti & Drent 2000).

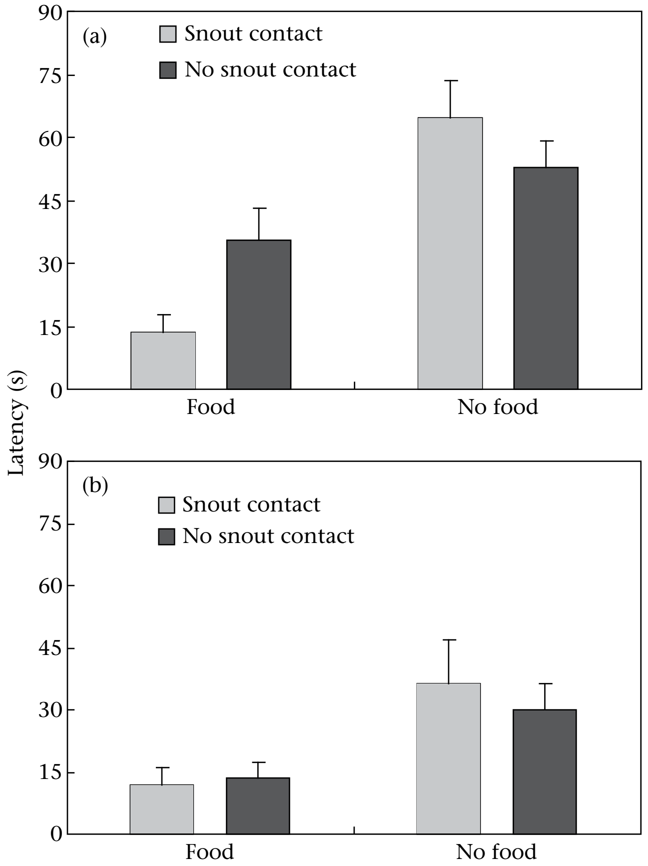

Figure 4. (a) Influence of snout contact on the latency to go to the presented potential food location. (b) Latency of the observer dogs to go to inspect their first potential food location. Values presented are mean + 1SE.

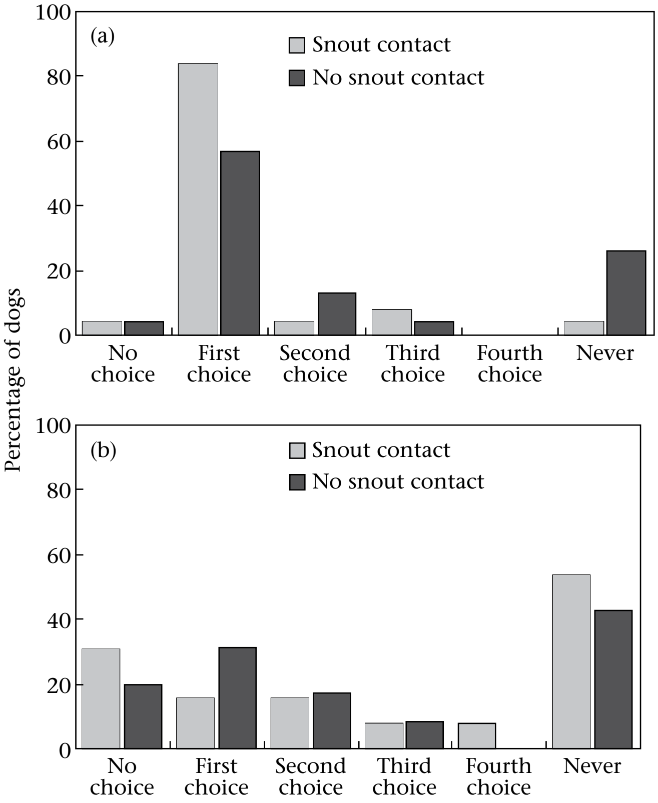

Figure 5. Percentage of dogs that either went during their first, second, third or fourth choice to the presented potential food location, did not choose one of the four corners or visited other corners but not the presented one. (a) Behaviour of the observer dogs that observed a demonstrator that had found food behind one of the four corners. (b) Behaviour of the observer dogs that observed a demonstrator that had not found food behind one of the four corners.

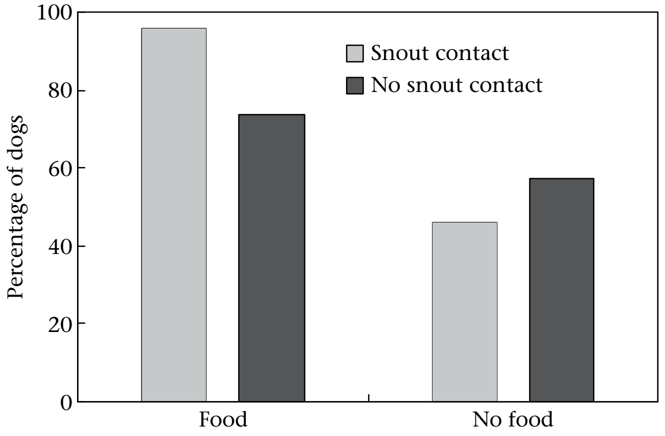

Figure 6. Percentage of dogs that went to the presented box during the experiment.

Dogs can also follow a conspecific to a baited target (Cooper et al. 2003). In the present study, observer dogs that had snout contact with their conspecifics were able to distinguish between the situations where the demonstrator dogs had found food and where they had not. These observer dogs went faster to the presented potential food location in trials where the demonstrator dogs had found food than in trials where they did not. The lack of success of demonstrator dogs in finding food seemed to be a reason for the observers that had snout contact with their conspecifics to avoid this corner, or not to go there very fast to search for food. Dumas & Pagé (2006) found that dogs are able to show strategy planning: when their dogs had to choose between three target locations equidistant from the starting point, they chose locations randomly. However, when the distances were different, the dogs relied on the 'least distance rule' and most of the errors were directed to the closest target. Dumas & Pagé's (2006) study supports our result that dogs are not motivated to search immediately in the originally presented corner if they are aware of its emptiness.

Our results indicate that snout contact is an important source of information for observer dogs to find a potential food location where a conspecific was successful before. However, the willingness of observer dogs to have snout contact was different in male and female observer dogs and depended on the food availability to the demonstrator dogs during the demonstration phase. Female observer dogs had snout contact equally often as no snout contact whereas male dogs had no snout contact with their demonstrator conspecifics in more trials. Furthermore, in contrast to male observer dogs, female dogs had snout contact equally often during the two stages (first or second time the demonstrator dogs had found food or not). Male dogs had snout contact less often during their second stage than during their first stage. Little is known about gender differences in dog behaviour. A few studies have investigated gender differences, for example concerning dominance over the owner, aggression to conspecifics, general activity, playfulness, obedience training and other similar traits (Hart & Hart 1985; Hart 1995) or concerning differences in play behaviour between and within same-sex dyads and mixed-sex dyads (Ward et al. 2008). However, these studies do not help to explain the gender difference in our study. It is conceivable that the low willingness of male dogs to have snout contact is associated with dominance rank and the fact that most of the tested dyads were mixed-sex dyads. It is also conceivable that dominant male observer dogs that were tested with a female conspecific were less focused on the task than other observer dogs because of the more or less unfamiliar surroundings of the test area and their interest in guarding their females. Only male observer dogs that were tested with a dominant conspecific had snout contact in more than one trial. However, the sample size needs to be increased to investigate these gender effects.

We found an influence of food availability to the demonstrator dogs during the demonstration phase on the willingness of observer dogs to have snout contact. Additionally, the influence of snout contact on the latency and on the decision of an observer dog to go to the presented potential food location was found mainly in trials where the demonstrator dogs had found food. Nevertheless, we found no influence of food availability during the demonstration phase on the decision of an observer dog to go or not to go to the presented potential food location. These findings point out that there were cues that indicate the presence of food during the demonstration phases of 'food' trials. The obvious use of these cues by the observer dogs raises the question of how important snout contact is relative to the other food cues. The influence of food availability (for demonstrator dogs) on the willingness to have snout contact and the lack of an influence of snout contact in trials where the demonstrator dogs did not find food may indicate that snout contact affects only the present motivation of a dog to search for food. However, if this were true, then the observer dogs that had snout contact should inspect a first potential food location faster than dogs without snout contact. This was not the case: we found no difference between dogs that had snout contact and dogs that had no snout contact in the time they needed to go to inspect their first potential food location. Nevertheless, food availability had an influence on this latency. This indicates that snout contact does not reflect the motivation of an observer dog to search for food, and it implies that food availability during the demonstration phase motivates the dogs to search for food. The findings that snout contact does not reflect the motivation of a dog to search for food, that food availability (for the demonstrator dog) does not influence the decision of an observer dog to go to the presented food location, and that only observer dogs that had snout contact with their conspecifics were able to distinguish between the trials indicate that snout contact is used as an important source of information. The possibility of information transfer via snout contact in dogs is supported by the work of Lupfer-Johnson & Ross (2007). The use of information gained by smelling the mouth of a companion has been shown in Tonkean macaques as well. These animals were able to adapt their searching behaviour to the quality of food deposited in the field after they had smelled the mouth of a conspecific (Chauvin & Thierry 2005). It is conceivable that in social animals such information transfer could be important. In feral dogs it might be important for unsuccessful foraging dogs to get information about food locations by interacting with successful conspecifics. This benefit is known from other animals. For example, cliff swallows, *Petrochelidon pyrrhonota*, that have been unsuccessful on a foraging trip return to the colony, locate a successful conspecific, and follow that individual later to a food source (Brown 1986). Nonbreeding common ravens quickly assemble at carcasses, and in communal roosts. Marzluff et al. (1996) showed that such ravens made knowledgeable of food sources joined roosts and led roost mates to that food location.

Observer dogs were using cues that indicated the presence of food during the presentation phase of the 'food' trials. Such cues may include visual, olfactory and auditory stimuli. During the observation phase the observers were only able to see how a conspecific disappeared behind a projecting blind and how it returned to the middle of the test area. Therefore, the observer dogs were not able to see what the demonstrator did behind the projecting blind, but it is conceivable that the latter showed some behaviour, for example, licking its mouth while returning, which might indicate to the observer dogs that the demonstrator had found food. Furthermore, during the demonstration phase there were possible auditory cues from the demonstrator dog's eating that could be used as a cue. The use of sounds made during eating as a cue to a food location has been shown in agoutis (Galef & Giraldeau 2001). During the food presentation phase there might also have been olfactory cues. During the trials where the demonstrator dogs found food, the food was located behind the projecting blind and there was a high probability that the observer dogs smelled the food. The constant food smell in the whole test area, from the same food inside the four small boxes hanging above all four corners, probably reduced but did not exclude this influence. Therefore, we suggest that olfactory cues coming from the additional food in one of the four corners and visual and auditory cues may have motivated the observer dogs to have snout contact and to search faster for food in 'food' trials.

In conclusion, dogs are able to adjust their search behaviour depending on the knowledge gained by observing and interacting with a conspecific. Our results suggest that snout contact is used as a source of information and that it has an influence on the decision of a dog to go to a presented potential food location or not. Furthermore, food availability to the demonstrator dog during the demonstration phase increased both the willingness of observer dogs to have snout contact with their demonstrators and their motivation to search for food, but food availability to the demonstrator dog had no influence on the decision to go to a particular food location.

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