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Social learning in dogs: the effect of a human demonstrator on the performance of dogs in a detour task

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We recorded the behaviour of dogs in detour tests, in which an object (a favourite toy) or food was placed behind a V-shaped fence. Dogs were able to master this task; however, they did it more easily when they started from within the fence with the object placed outside it. Repeated detours starting from within the fence did not help the dogs to obtain the object more quickly if in a subsequent trial they started outside the fence with the object placed inside it. While six trials were not enough for the dogs to show significant improvement on their own in detouring the fence from outside, demonstration of this action by humans significantly improved the dogs' performance within two–three trials. Owners and strangers were equally effective as demonstrators. Our experiments show that dogs are able to rely on information provided by human action when confronted with a new task. While they did not copy the exact path of the human demonstrator, they easily adopted the detour behaviour shown by humans to reach their goal.

Social learning is likely to be particularly effective among animals living in groups. While in many cases competition between individuals prevents social learning (Fritz & Kotrschal 1999), different techniques to obtain food can spread by individuals observing more experienced members of the group (great tits, *Parus major*: Hinde & Fischer 1951; Japanese monkeys, *Macaca fuscata*: Kawai 1965). For example, social attraction and group cohesion allow guppies, *Poecilia reticulata*, to learn new routes by following their groupmates (Laland & Williams 1998). As laboratory studies show (e.g. Palametta & Lefebvre 1995), social learning in nature does not usually involve the exact copying of the demonstrator's behaviour. Naïve observers usually want to obtain the same target as the demonstrator and develop their own method to get it. Their solution is usually similar to the demonstrator's method.

Although traditionally a manipulation task has been used to test social learning, in some cases observers had to learn about the motor components of an action shown by the demonstrator. Without the manipulation of tools, one can more easily avoid the confusing effects of different manipulative skills in different species. Moore (1992) described an African parrot, *Psittacus erithacus,* that imitated certain human behavioural actions, and Tayler & Saayman (1973) reported a dolphin, *Tursiops aduncus,* copying behaviour patterns of a seal. More recently, imitation of the movements of human gestures has also been described in a dolphin (Bauer & Johnston 1994). Hayes & Hayes (1952) have shown that a young chimpanzee, *Pan troglodytes*, was able to imitate human gestures (Do as I do! technique), a finding confirmed later under more rigorous experimental conditions (Custance et al. 1995).

However, in animals with less flexible motor abilities learning by observation is more difficult to show. Since there is little possibility for new motor actions to emerge (or it is difficult to prove at a satisfactory level), one might argue (Heyes 1994) that social learning can be involved if the existing motor actions (e.g. walking) of the animal are executed in a topographically new manner. Although the novelty of an action is regarded as crucial by researchers trying to establish cases of motor (or true) imitation, it is of less concern if only the presence of social learning is at stake. Since for some species true imitation might be difficult to show experimentally (but not impossible, see Voekl & Huber 2000), the contribution of social learning to the adoption of behaviour patterns might still be of interest.

Domestic dogs, *Canis familiaris,* have coexisted with modern humans for the last 100 000 years (Vilá et al. 1997) and form a strong attachment with their owner (Topál et al. 1998). Context-specific signals (Bekoff 1977)

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and metacommunication (Fox 1978; Bekoff 1995) play a significant role in the communication of both wolves and dogs. Dogs can rely on visual signs of humans (Miklósi et al. 1998; Soproni et al. 2001) and make use of human visual or acoustic (McConnell & Baylis 1985) signs in cooperative actions with humans. Furthermore, the dog–owner relationship (the extent of social dependency of the dog on its owner) seems to influence their success in problem-solving tasks (Topál et al. 1997). These features have made the dog a useful companion of humans in many respects (McConnell & Baylis 1985), but have also contributed to its adaptation to human social groups (McBride 1995; Paxton 2000).

Social learning among dogs has rarely been investigated. There is evidence that naïve puppies may learn via observation from an experienced puppy to solve a simple food manipulation task (Adler & Adler 1977), and Slabbert & Rasa (1997) reported that early experience of observing their trained mother can enhance puppies' drug-locating and retrieving behaviour. In contrast, with the exception of some observational reports (e.g. Frank 1980), the ability of dogs to learn from human demonstrators in a new task has not been investigated.

We used a classical detour task to see whether dogs can learn to solve a task by observing a human demonstrator. Although there has been little systematic work on this subject (but see Buytendijk 1933), dogs are thought to perform badly in such situations compared with members of other species (e.g. golden hamsters, *Mesocricetus auratus*; spiders: genus *Phiddipus*) that live in complex environments with many obstacles and paths requiring detours (e.g. Hill 1979; Etienne et al. 1986).

Buytendijk & Fischel (1932) showed that the performance of dogs in a detour task could be improved after several trials, where the dog apparently learned this method by trial-and-error. We wanted to give dogs a relatively difficult task, a detour around a V-shaped fence that, however, was not impossible to solve. We hypothesized that demonstration of a detour by a human would enhance the performance of the observer dogs resulting in a decrease in the time needed to make the detour. In the first experiment we investigated how dogs learn this detour without demonstration and if the topographic set-up (i.e. detours from inside or from outside the fence) had any effect on the dogs' performance. In the second experiment we investigated how demonstration by a human could alter the performance of the dogs in making a detour, and whether the owner and an unfamiliar experimenter differed in effectiveness as a demonstrator.

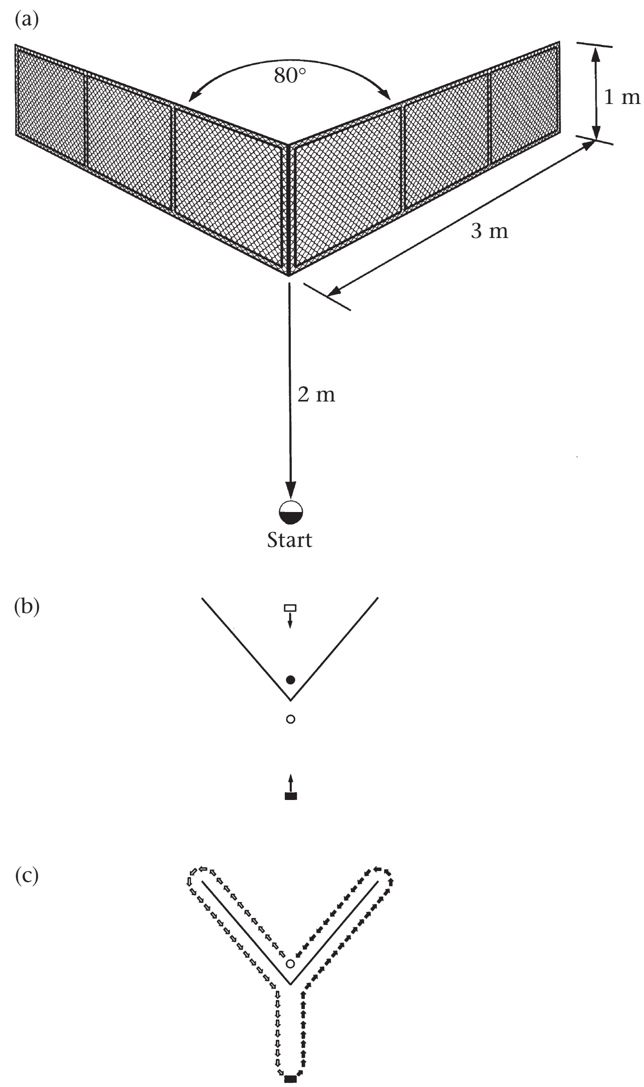

Figure 1. (a) Drawing of the V-shaped experimental fence. The steel-framed wire-mesh fence was fixed into the soil by its protruding pegs. The starting point for the Inward Detour group is indicated. (b) Sketch from above of the position of the starting point (□, ■) and the position of the target (○, ●). ■, ●: Inward Detour group; □, ○: Outward Detour group. (c) A sketch from above of a possible demonstration route in experiment 2. The other demonstration route is the reverse of the one presented. The human demonstrator carried the object to the inside intersecting angle of the fence (➡) put it down and left the fence (⇨).

GENERAL METHODS

Subjects

Our study was done in Hungary. We recruited dogs (N=82) and their owners from among participants of a dog training school and competitions for dogs. Participation in the tests was voluntary. Owners were asked to fill in a questionnaire and they were instructed how to behave and what to do (and not to do) during the test. We included dogs only where the owner acted in line with our instructions. We filled the experimental groups in a parallel manner and dogs were assigned randomly to them. Each dog was tested in only one condition, but owners could participate with more than one dog.

Only dogs older than 1 year were tested ($\bar{X} \pm SD$= 3.34 ± 2.04 years) and dogs from various breeds were included (see Appendix). There were 38 male and 44 female dogs and 25 male and 57 female owners.

Procedure

We did the tests outdoors in the spring and early and late summer of 2000. For the tests, we used a V-shaped fence (Fig. 1a) 1 m high, with sides 3 m long subtending at an angle of 80°. The fence was made of wire mesh, with a hole diameter of 20 mm, set on to a steel frame. The fence was set up by pushing the pegs protruding from the frame into the ground. The frame of the fence prevented the dogs digging under it. To dissipate any scent marks, before the experimental trials the experimenter made tracks in the grass along both sides of the fence (including the inner side) 10 times, in both directions.

A starting line was defined at 2 m from the intersecting angle of the fence (Fig. 1b), where both the dog and the owner had to stand at the start of the trial. The task of the dogs was to get to a piece of food or their favourite toy (target objects) by detouring along the fence. Before the test we asked the owner which target object would be more appropriate for motivating the dog, and if both a toy and food were suggested, we chose the toy.

The test consisted of a series of 1-min detour trials that were started one after the other with short (1–3 min) between-trial intervals. Besides the owner, the experimenter and an assistant were present who videotaped the whole test. During the trials the owner was asked to encourage the dog to reach the target object but she/he had to stay on the starting line and was asked not to command the dog to go round verbally, or via gestures given by hand or other body parts. The specific conditions of the experimental groups are described below.

Data Collection and Analysis

We measured the dog's latency to obtain the target. Latency was defined as the time elapsed between the owner releasing the dog from the leash and the dog taking the target in its mouth. To analyse latency we used single, repeated measures or mixed ANOVAs and Student–Newman–Keuls post hoc tests. Correlation between the latencies of different trials was analysed by Spearman rank correlation.

We also noted the direction of the dogs' detours. We analysed the concordance of the dogs' detours in relation to the direction of their first successful trial with Wilcoxon two-sample tests. Similarly, Wilcoxon tests were applied to analyse whether the direction of detour by the demonstrator had any influence on the dog's subsequent performance (experiment 2). In these cases we used the number of subsequent trials in which concordance occurred either with the direction of the dog's first successful detour or with the direction of the demonstrator.

In addition, we measured the frequency of three further variables during the trials: (1) the number of encouraging utterances (both single words and sentences) by the owner; (2) the number of backward glances to the owner by the dog; (3) the number of alternations (going from one side of the fence to the other before reaching the target) made by the dog. We analysed these data with repeated measures ANOVA, or unpaired *t* tests.

EXPERIMENT 1

In this experiment we tested the ability of dogs to make a detour around a fence. We assumed that on the first trial the majority of dogs would eventually reach the target but the question was whether they could learn from this experience. Pilot studies established that dogs can solve this problem within 1 min. Furthermore, we wanted to know whether the geometrical arrangement of the fence with regard to the position of the dog affected performance, since the solution of one problem might be transferred to a new situation, that is finding the way outward or inward in this situation (see Fig. 1). We tested this hypothesis by giving experienced dogs a reverse trial, that is, dogs were presented with an outward detour problem after six inward detour trials or vice versa.

Method

We divided 30 dogs between two groups ($N=15$ per group) that differed in the direction of detour necessary for reaching the target.

Inward Detour group

For the Inward Detour group the experimenter placed the target behind the V-shaped fence near to the inner side of the intersecting angle (Fig. 1b), while the owner remained with the dog at the starting point and covered the dog's eyes with her/his hands preventing it from seeing the experimenter's actions. When the experimenter returned to the starting point, the owner led the dog on the leash to the outer side of the intersecting angle of the fence and showed it the target through the wire mesh. After returning to the starting point, the owner unleashed the dog, starting the trial. If the dog obtained the target, the owner praised it verbally, played with it, or allowed it to eat the food. If the dog was not able to obtain the target within 1 min, the trial was terminated, and a new trial was started.

After six such trials the positions of the target and the dog were reversed (outward detour). In this seventh trial the owner and the dog were positioned inside the fence 0.5 m from the intersecting angle. While the owner covered the dog's eyes, the experimenter placed the target at the outer side of the intersecting angle. After the experimenter's return to the starting position for an outward trial, the owner showed the target to the dog on the leash, allowing it to approach the intersecting angle from inside. After the owner had returned with the dog to the starting position, the trial started when the owner unleashed the dog. The owner encouraged the dog from inside the fence.

Outward Detour group

Dogs in this group were exposed to the same test procedure as described above but in reverse order. There were six consecutive outward detour trials followed by a single inward detour test as trial 7.

Results and Discussion

The effect of the position of the starting point (i.e. outside or inside the fence) and the overall effect of

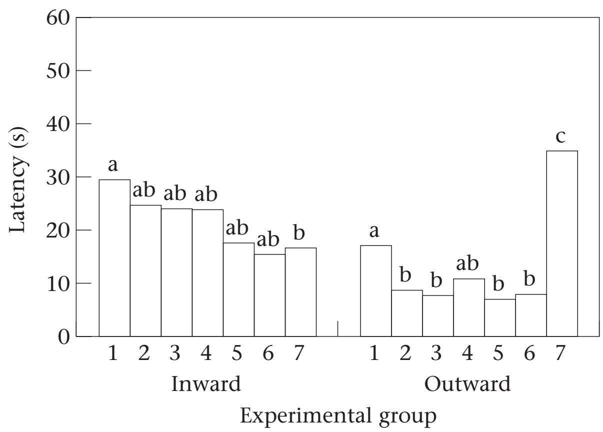

Figure 2. The latencies to make the detour for dogs in the Inward and Outward Detour groups for seven consecutive trials. The first six trials were performed from one direction and the seventh from the other (reverse) side of the fence (see Fig. 1 and text). The trials with significantly differing latencies are indicated with different letters; Student–Newman–Keuls post hoc test: $P<0.05$.

repetition (first six trials) on the latency of detours was analysed by a mixed ANOVA with repeated measures for the trials as within-subject factor. Both position (between-subject factor; $F_{1,28}=8.24$, $P<0.01$) and trials ($F_{5,140}=3.85$, $P<0.01$) had a significant effect, and there was no significant interaction between the two variables ($F_{5,140}=0.55$, $P=0.74$). In the first six consecutive trials the latency of the detours did not change significantly in the Inward Detour group (repeated measures ANOVA: $F_{5,70}=1.83$, $P=0.12$; Fig. 2). In the reverse trial (outward detour) the dogs' performance did not change compared to the last inward detour (paired t test: $t_{14}=0.48$, $P=0.64$); however, they reached the target significantly quicker than in trial 1 when they first encountered the inward detour task ($t_{14}=2.24$, $P<0.05$).

In the Outward Detour group the latencies varied significantly (repeated measures ANOVA: $F_{5,70}=3.41$, $P<0.001$). Student–Newman–Keuls post hoc tests showed that the latency in trial 1 was significantly longer ($P<0.05$) than in trials 2, 3, 5 and 6 (Fig. 2). The latencies in trials 1 and 6 were significantly shorter than in trial 7 (paired t test: $t_{14}=3.69$, $P<0.01$; $t_{14}=4.53$, $P<0.001$, respectively).

We analysed the correlation between the latency data of trials 1 and 6, 1 and 7 and 6 and 7 within both groups. The purpose of this analysis was to see whether the dogs varied in speed. Spearman rank correlation proved to be significant in all cases: Inward Detour group: trials 1 and 6: $r_s=+0.70$, $N=15$, $P<0.01$; trials 1 and 7: $r_s=+0.67$, $N=15$, $P<0.01$; trials 6 and 7: $r_s=+0.89$, $N=15$, $P<0.001$; Outward Detour group: trials 1 and 6: $r_s=+0.57$, $N=15$, $P<0.05$; trials 1 and 7: $r_s=+0.82$, $N=15$, $P<0.001$; trials 6 and 7: $r_s=+0.62$, $N=15$, $P<0.001$.

Concordance in the direction of detours was analysed only for dogs that reached the target within the time limit in the first trial. We used the number of subsequent trials in which concordance occurred in relation to the direction of the first trial. In the Inward Detour group a Wilcoxon two-sample test revealed that dogs did not walk on the same side of the fence on repeated trials (concordance by chance would be 2.5 during the five trials; $T=47$, $N=13$, $P=0.11$). In contrast, dogs in the Outward Detour group were loyal to their direction of detour chosen in the first successful trial ($T=69$, $N=14$, $P<0.05$).

We analysed the frequencies of the utterance count of owners, alternations before success (going from one side to the other before detouring the fence) and the backward glances by the dogs to find out whether the dogs in the different groups were equally encouraged and motivated to solve the detour task. The first trials of the Inward and Outward Detour groups did not differ in any of these measures (unpaired t test for the utterance count: $t_{28}=0.61$, $P=0.55$; alternation: $t_{28}=0.68$, $P=0.50$; backward glance: $t_{28}=0.10$, $P=0.92$). We also compared the seventh (reverse) trials of the two groups. We did not find significant differences for any parameters (utterance count: $t_{28}=0.74$, $P=0.47$; alternation: $t_{28}=1.05$, $P=0.30$; backward glance: $t_{28}=0.99$, $P=0.33$).

In addition we analysed the frequencies of utterance count, alternations and backward glances for the possible within-group differences by repeated measures ANOVA. The repetition of trials 1–6 did not cause any significant differences in the Inward or the Outward detour groups (Inward Detour group: utterance count: $F_{5,70}=1.02$, $P=0.42$; alternations: $F_{5,70}=2.19$, $P=0.07$; backward glances: $F_{5,70}=0.81$, $P=0.55$; Outward Detour group: utterance count: $F_{5,70}=0.97$, $P=0.44$; alternations: $F_{5,70}=0.90$, $P=0.48$; backward glances: $F_{5,70}=1.22$, $P=0.31$).

The results showed that the dogs performed differently depending on their position with regard to the fence. In spite of the several consecutive trials, dogs in the Inward Detour group did not show significant improvement in latency. Learning the detour thus seemed to be a difficult problem. In contrast, dogs in the Outward Detour group mastered this task much more easily; latencies were significantly shorter after the first trial, suggesting that under these circumstances there was no room for improvement. A possible explanation for this asymmetry could be that dogs might more often encounter situations in which they had to get out from somewhere (e.g. from a garden), rather than get in. Furthermore, in the outward detour there is less ambiguity, that is, any exit could be successful. An additional explanation could be that dogs in the Outward group had to walk mainly tangentially to the target, but the Inward detour needed a long walk away from the target at first. One could also argue that the Inward detour situation might generate higher levels of neophobia in the dogs than the Outward detour task. However, the fence was an equally strange obstacle for the dogs in both situations. Furthermore, dogs in the Inward Detour group tried strongly to obtain the target, barking at it and sometimes trying to dig under the fence. As our data show, their motivational status, and the owners' encouraging behaviour, was identical to that of the Outward group. The strong positive correlation between the latency data of the same dogs in different trials shows that the subjects took different times to make the detours. These individual differences remained stable during the consecutive trials, as dogs improved only their own level of performance, suggesting differential experience with fences.

Although owners encouraged their dogs with equal frequency, the performance of dogs differed significantly in the two groups. Since the groups did not differ in frequency of backward glances, a possible sign of hesitation, we can conclude that the dogs were equally motivated to solve the detour tasks. During the consecutive trials the encouraging behaviour of the owners did not change in either group. Similarly, dogs altered sides and glanced backwards to the owner with equal frequency in trial after trial, which could indicate either the difficulty of the task in the Inward Detour group, or its simplicity in the Outward Detour group.

The direction of the detours along the fence in the Outward Detour group showed strong concordance with the direction of the first successful detour. The lack of such a concordance in the Inward Detour group may indicate the difficulty of this task for the dogs; these dogs might have got behind the fence by chance during the first trial, which made it more difficult for them to remember the direction in which they started. The dogs seemed unable to translate their experiences from outward detours to the inward direction. After six successful outward trials they needed considerable time to solve the reverse task, which also shows that experience with a fence is not important in itself. This lack of immediate ability for such cognitive transformation of a spatial relationship might indicate a species-specific trait present only to a limited level in dogs, in contrast with animals such as pigeons, *Columba livia* (Zentall & Hogan 1978; Piscatera et al. 1984), or ants (*Solenopsis*: Wilson 1971). However, the experiments were performed in a relatively small area around the fence and the dog had little time during the trials to learn about the structure of the surrounding environment.

EXPERIMENT 2

Experiment 1 showed that six trials were not enough for the dogs to reach significant improvement on their own in detouring the fence from outside. Dogs are well known to show interest in human activity, so we hypothesized that observing a human making a detour might enhance learning in naïve dogs.

Methods

The set-up used in this experiment was the same as in experiment 1. All dogs were naïve with regard to this test and were tested in the inward detour situation only. The first trial was the same for all groups, as described above for the Inward Detour group. We tested the dogs' ability to make a detour because we wanted to exclude dogs that were already proficient in this task. Therefore dogs that performed the detour within 10 s in the first trial were excluded from the main analysis. The results of the previous experiment also showed that a single exposure to the fence had no significant effect on the performance of naïve dogs in subsequent trials. Also, the data of dogs whose first trial was unsuccessful were analysed separately, because these dogs did not experience detouring before the demonstration.

Experimenter Demonstration group

This group consisted of 16 dogs. From this, three dogs had to be excluded because of their short latency in trial 1, and six dogs were not able to master the first trial.

In both trials 2 and 3 the owner stayed with the dog at the starting point, but she/he did not cover the eyes of the dog. Instead, both the owner and the experimenter encouraged the dog to watch the experimenter continuously as he/she carried the target object behind the fence. The experimenter made a detour near to one side of the fence, put down the object conspicuously, showed his/her empty hands, and, finally, went outside the fence, walking along the other side (Fig. 1c). The trial started after the experimenter returned to the starting point, and the owner unleashed the dog and encouraged it to obtain the target. The directions in demonstration of the detours were counterbalanced between trials and dogs.

Owner Demonstration group

This group consisted of 15 dogs. Four dogs had to be excluded because of their short latency in trial 1, and four other dogs had no successful first trials. In this group the owner demonstrated the detour. Before the trials the experimenter explained to the owner what to do and how to do it, and the owners were asked to make one detour by their own before the experiment when their dog was not watching. In this group the experimenter remained with the dog at the starting point during the demonstration by the owner.

No Demonstration group

This group consisted of 21 dogs. Four dogs had to be excluded because of their short latency in trial 1, and six other dogs did not succeed in trial 1. Dogs in this group received three consecutive inward detour trials as described in experiment 1.

Results and Discussion

We first analysed the results of the dogs who performed a successful detour during their first trial (Experimenter Demonstration, N=7; Owner Demonstration, N=7; No Demonstration, N=11).

The effect of consecutive trials (within-subject factor) and the experimental group (between-subject factor) was analysed with mixed ANOVA for repeated measures to the within-subject factor. Consecutive trials had a strong significant effect on the latency ($F_{2,44}$=12.82, P<0.001). There were no significant differences between groups ($F_{2,22}$=3.04, P=0.07), and no significant interaction between the two parameters ($F_{4,44}$=2.32, P=0.07).

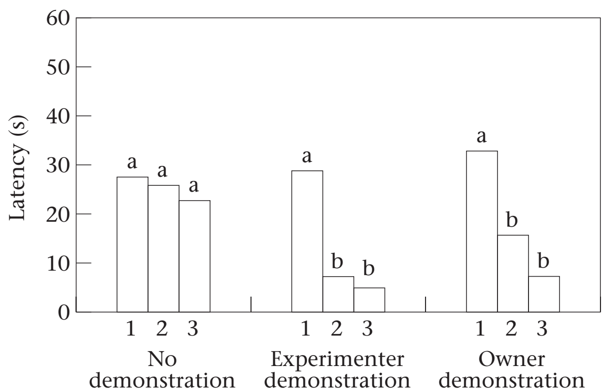

Figure 3. The latencies to make the detour of dogs in the No Demonstration, Experimenter Demonstration and Owner Demonstration groups in three consecutive trials. Significantly differing groups are indicated with different letters; Student–Newman–Keuls post hoc test: $P<0.05$.

Latencies without demonstration did not show a significant effect of repetition (repeated measures ANOVA: $F_{2,20}=0.36$, $P=0.70$) but there was a significant effect of repetition in both the Experimenter ($F_{2,12}=10.90$, $P<0.01$) and the Owner ($F_{2,12}=6.59$, $P<0.05$) demonstration groups. A Student–Newman–Keuls post hoc test showed (Fig. 3) that in both groups with human demonstration latencies were significantly lower in trials 2 and 3 than in trial 1 (Experimenter Demonstration group; $P<0.01$; Owner Demonstration group: $P<0.05$).

As expected there were no group differences for the latencies of trial 1 (one-way ANOVA: $F_{2,22}=0.30$, $P=0.74$) but the effect of different demonstrations proved to be significant for the latencies in trial 2 (one-way ANOVA: $F_{2,22}=4.88$, $P<0.05$) and trial 3 (one-way ANOVA: $F_{2,22}=5.26$, $P<0.05$). A Student–Newman–Keuls post hoc test revealed that dogs in the Experimenter and Owner demonstration groups made the detour with significantly shorter latencies ($P<0.05$) in both trials 2 and 3 than the dogs with No Demonstration.

Since the two kinds of demonstrators had similar effects, we pooled the data of these groups for the analysis of the detour direction. In total, 17 dogs made successful attempts in both trials 2 and 3. We analysed the concordance between the direction of the demonstrator's detour and the subsequent detours of the dogs. We used the number of concordant trials for the analysis. A Wilcoxon two-sample test revealed that these dogs did not choose the demonstrator's direction in subsequent trials ($Z=0.53$, $N=17$, $P=0.99$; the level of choosing the direction by chance would be 1.0). However, the 14 dogs that had also succeeded in the first trial followed the direction of their first successful attempt in subsequent trials (2 and 3; $T=63$, $N=14$, $P<0.05$; the level of choosing the direction by chance would be 1.0).

We used the pooled data from the two demonstration groups for the analysis of the frequencies of the utterance count of owners, alternations and backward glances to the owner. There was no significant difference between observers and nonobservers in any of the three parameters during trial 1 (unpaired t test: utterance count: $t_{23}=0.79$, $P=0.44$; alternations: $t_{23}=0.41$, $P=0.68$; backward glances: $t_{23}=1.75$, $P=0.09$). Repeated measures ANOVA showed that the consecutive trials did not affect utterance count and alternations in any of the groups (No Demonstration group: utterance count: $F_{2,20}=0.66$, $P=0.53$; alternation: $F_{2,20}=1.40$, $P=0.27$; Demonstration group: utterance count: $F_{2,26}=0.09$, $P=0.92$; alternation: $F_{2,26}=2.48$, $P=0.10$). Backward glances at the owner did not change over the trials for the No Demonstration group ($F_{2,20}=3.31$, $P=0.06$), but decreased over repeated trials for the Demonstration group ($F_{2,26}=5.13$, $P<0.05$). A Student–Newman–Keuls post hoc test showed that dogs looked back at their owners significantly more often in trial 1 than in trial 3 ($P<0.05$). The dogs did not glance backward in trial 3.

Sixteen dogs did not obtain the target within the time limit in trial 1 (No Demonstration, $N=6$; Owner Demonstration, $N=4$; Experimenter Demonstration, $N=6$). We wanted to know if these unsuccessful dogs also benefited from observing a human demonstrator, or if they were less skilful at both making a detour and learning from humans. Therefore we first compared the results of unsuccessful dogs with and without demonstration. The dogs from the two groups with demonstration were pooled for further analysis. One-way ANOVA revealed that in consecutive trials latency dropped significantly in the Demonstration group ($F_{2,27}=6.50$, $P<0.01$). A Student–Newman–Keuls post hoc test showed that the latencies of trials 2 and 3 were significantly shorter than the latency of the first (unsuccessful) trial. The No Demonstration group showed no significant shortening of latency during the consecutive trials ($F_{2,15}=3.31$, $P=0.06$), although the smaller sample size and reduced statistical power in the No Demonstration group might account for this difference between these groups.

We also wanted to know if there was a difference between the performance during trials 2 and 3 of initially unsuccessful dogs and those dogs that succeeded in trial 1. A difference might indicate that unsuccessful dogs were less able to master a detour task. We compared the initially unsuccessful dogs, both with ($N=10$) and without ($N=6$) demonstration, with the successful No Demonstration dogs ($N=11$) and the pooled, successful Demonstration dogs ($N=14$). One-way ANOVA proved to be significant for the latency of all trials (trial 1: $F_{3,37}=23.21$, $P<0.001$; trial 2: $F_{3,37}=4.42$, $P<0.01$; trial 3: $F_{3,37}=5.58$, $P<0.01$). A Student–Newman–Keuls post hoc comparison showed that the dogs from the Demonstration groups that succeeded in the first trial had significantly shorter latencies than the unsuccessful ones not only in the first trial but also in trials 2 and 3 ($P<0.05$). The latencies of the unsuccessful dogs did not differ from those of the No Demonstration dogs with successful first trials (Fig. 4).

Without demonstration dogs did not show significant improvement in making a detour within three consecutive trials. However, just one demonstration shortened significantly the time for a detour in dogs of both Demonstration groups. Dominowski & Dallob (1994) distinguished between learning and problem solving via stereotypy, stating that learning requires merely that a

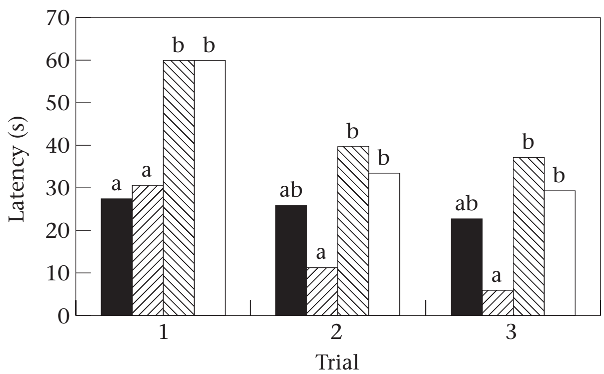

Figure 4. Comparison of the successful Control (■) and Demonstration (▨) groups with the unsuccessful Control (▧) and Demonstration (□) groups. The dogs from the latter groups did not perform the first trial within 60 s. Both Demonstration groups were formed by pooling appropriate data from Experimenter Demonstration and Owner Demonstration groups. Significant differences between the groups are indicated with different letters; Student–Newman–Keuls post hoc test: $P<0.05$.

response be acquired by repetition, but a problem-solving task requires a subject to discover the correct response. Discovery of a detour as a quick solution to get inside the fence occurred only to those dogs that were watching human demonstration. The dog's own experience of a successful trial had less effect than the observation of a detour. Such a finding has also been observed in a related study where dogs learnt about manipulating a handle to get a ball reward (E. Kubinyi, J. Topál, Á. Miklósi & V. Csányi, unpublished data).

Dogs might be in some sense predisposed to copy human behaviour. The fact that the owner and the strange experimenter demonstrated with equal efficiency also indicates a general tendency in dogs to observe and obtain information from human behaviour. Although the owners were always present, and therefore could influence the dog's behaviour, nevertheless this was also true for the No Demonstration group, and we were not able to find differences in the general behaviour of both owners and dogs that could have been attributed to this kind of social situation. Furthermore, it is likely that the exclusion of the owner from the experimental situation might have had a deleterious effect on the performance of all dogs (see also Topál et al. 1997). At the same time the decrease in the frequency of backward glances in dogs that had been observing the demonstration might indicate the growing efficiency and waning hesitation in performing detours. The latencies to reach the target object might also have become too short for the dog to have time to glance backward.

It is also clear that those dogs that were unable to solve the detour problem during the first trial showed some improvement if they were given the opportunity to observe a human demonstrator (in contrast to dogs in the No Demonstration group). The difference between dogs in their initial performance (i.e. unsuccessful and successful first trials) might point to different experience or individual variation. At the same time our results underline the fact that even dogs without personal experience of a correct detour could benefit from observing humans.

The direction of demonstration did not affect the direction in which dogs performed the detours but the direction of the dog's own first successful trial did. The direction of the detour and the ability to make a detour seemed to be manifested at different organizational levels of behaviour, and only the second was affected by observation of the demonstrator.

Finally, olfactory cues did not appear to play any significant role in this experiment. With the reservation that the role of olfactory cues could be ruled out only with a specific control group (for example, the demonstrator makes the detour while the dog's eyes are covered), it should be pointed out that many dogs assigned to different groups were tested in the same place on a given day, therefore many overlapping odour trails from both humans and dogs were laid during the demonstration and the detours. If dogs used odours as cues they should have followed the path of the demonstrator, which was clearly not the case. Neither were dogs following their own (or other conspecifics') odour path since in this case No Demonstration dogs should have reached the target inside the fence with similar latencies as observers in trials 2 and 3.

GENERAL DISCUSSION

Our experiments showed that (1) dogs could solve a detour task of their own accord, but (2) they did it more easily starting from inside the V-shaped fence than when outside it. (3) Even after several consecutive trials they could not improve significantly if they started from outside the fence. (4) Dogs were apparently unable to transfer their experience of mastering the task from inside the fence to a reverse detour. (5) Human demonstration improved the dogs' performance in detouring, but (6) we did not find a difference in the effectiveness of owners and strangers. (7) Although dogs executed the task quicker after observing the demonstrator, they did not copy the demonstrator's actual route. Furthermore, they clung to the direction of their own first successful trial. (8) Those dogs that succeeded by their own in the first trial performed better as a result of subsequently observing the demonstrator than dogs that were unsuccessful in the first trial.

For solving a problem like a detour task, at least two conditions must be fulfilled. First, the animal has to be motivated to obtain the reward from the other side of the fence. In our case, based on their vigorous attempts to get through the fence, all dogs could be regarded as well motivated by the targets. Second, the animal has to have the mental ability to make a detour that involves a temporary distancing from the target. Without demonstration, such a detour proved to be difficult for the majority of the dogs. While trial-and-error learning improved the performance slowly, observation of a human demonstrator led to immediate improvement in detouring behaviour.

The field of social learning is overwhelmed with categories and definitions, many of them derived from a few experiments or observations on a limited number of species. In addition, some of these categories overlap to a considerable degree, mainly because there is no agreement on common labels (see and compare for example, Galef 1988; Whiten & Ham 1991; Heyes 1994; Byrne & Russon 1998). We also feel that given the present turbulent state of this field, our case is difficult to fit into many of these categories. Nevertheless, based on past experience and some recent developments, below we try to account for the learning process that might have taken place.

To begin with, the presence or action of the demonstrator might affect the motivational state of the observer that eventually leads to better performance. This effect is usually called 'social facilitation' (Zajonc 1965). Thus the mere presence and action of the human demonstrator might have contributed to the enhanced performance of the dogs in the Demonstration group. For example, these dogs could have been better motivated only because they were allowed to follow a human behind the novel fence. However, the dogs did not show any sign of fear or anxiety about going inside the fence during the first trial. All dogs aimed for the target immediately and when they made the detour (turning around the far corner) they obtained it without hesitation (by retrieving the toy to the owner, or eating the food). Furthermore, the frequency of alternations between the two sides of the fence did not differ between the Control and the Demonstration dogs indicating all dogs were similarly motivated to surmount the fence, but only the Demonstration dogs mastered the detours easily. Therefore the role of social facilitation appears to be of little significance here.

Stimulus enhancement is said to occur if the action of the demonstrator draws the attention of the observer to particular objects in the environment; the actual action of the observer is acquired on the basis of trial-and-error. For example, in our case the movements of the human demonstrator could direct the attention of the dog to (1) the path he was walking, (2) to the corner of the fence where he turned back or (3) to the object that was carried behind the fence. Although the present experiment does not exclude these possibilities, if stimulus enhancement had occurred the dogs would have been more likely to follow the actual path of the human, especially as the fence was relatively large and the dogs could clearly see the human walking at a particular place with regard to the fence. However, we have shown that the dogs did not follow the path of the human; they relied on their own previous experience which to some extent contradicts the predictions of stimulus enhancement. A further possibility is to describe the observed effect as a form of observational conditioning (Heyes 1994) where the localization of the goal was associated with the behaviour of the demonstrator. However, since learning apparently took place after one trial it is tempting to suggest that the dogs copied the detouring behaviour in a general sense, but not taking into account its actual topographical features. Therefore, response facilitation (Byrne & Russon 1998) could also be a mechanism involved. In this latter case we consider making a detour as a behaviour pattern that is already in the dogs' repertoire. Observing human demonstrators making a detour might subsequently facilitate the dog to perform similar actions. In conclusion, our present evidence cannot exclude alternative explanations, and further experiments would be helpful, where we could separate the route-demonstrating and object-manipulating roles of the demonstrator.

Dogs have been bred for many reasons from temperament to fetalization of facial features (Scott & Fuller 1965), but one can assume that there has been a long and largely unplanned selection that has adapted the dog to human groups (Paxton 2000). As social learning often increases the chances of survival in a relatively stable environment, selection for the greater ability to learn from groupmates or relatives becomes an advantageous trait (Avital & Jablonka 1994). Dogs have been selected for docility and trainability (Fox 1971; Frank 1980); nevertheless heterospecific social learning in dogs might have enhanced their chances of survival in the human environment.

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Appendix

Breeds of the participating dogs

Inward Detour Group: Husky (3), German Shepherd (2), German Pointer (2), Pumi (2), Tervueren (1), Golden Retriever (1), Giant Schnauzer (1), Hungarian Vizsla (1), Border Collie (1), Kuvasz (1).

Outward Detour Group: Husky (3), Collie (2), Malamute (2), Tervueren (2), Border Collie (2), Samojede, (1), Airdale Terrier (1), Dachshund (1), Mixed-breed (1).

Experimenter Demonstration Group: Tervueren (3), Mudi (2), Mixed-breed (2), Giant Schnauzer (2), German Pointer (1), Kuvasz (1), Pumi (1), Boxer (1), Poodle (1), Pointer (1), German Shepherd (1).

Owner Demonstration Group: Tervueren (2), Boxer (2), Hungarian Vizsla (2), Mixed-breed (2), Border Collie, (1), Weimar Pointer (1), Great Dane (1), Spaniel (1), Beagle (1), Poodle (1), Kuvasz (1).

No Demonstration Group: Husky (3), Mudi (2), Pumi (2), German Shepherd (2), Border Collie (2), Tervueren (2), Mixed-breed (2), Golden Retriever (1), Giant Schnauzer (1), German Pointer (1), Hungarian Vizsla (1), Kuvasz (1), Shar Pei (1).