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When rank counts — dominant dogs learn better from a human demonstrator in a two-action test

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Abstract

Dogs can learn effectively from a human demonstrator in detour tests as well as in different kinds of manipulative tasks. In this experiment we used a novel two-action device from which the target object (a ball) was obtained by tilting a tube either by pulling a rope attached to the end of the tube, or by directly pushing the end of the tube. Tube tilting was relatively easy for naïve companion dogs; therefore, the effect of the human demonstration aimed to alter or increase the dogs' initial preference for tube pushing (according to the behaviour shown by naïve dogs in the absence of a human demonstrator). Our results have shown that subjects preferred the demonstrated action in the two-action test. After having witnessed the tube pushing demonstration, dogs performed significantly more tube pushing than the dogs in the rope pulling demonstration group. In contrast, dogs that observed the rope pulling demonstration, performed significantly more similar actions than the subjects of the other demonstration group. The ratio of rope pulling was significantly higher in the rope pulling demonstration group, than in the No Demo (control) group. The overall success of solving the task was also influenced by the social rank of the dog among its conspecific companions at home. Independently of the type of demonstration, dominant dogs solved the task significantly more often than the subordinate dogs did. There was no such difference in the No Demo group.

This experiment has shown that a simple two-action device that does not require excessive pre-training, can be suitable for testing social learning in dogs. However, effects of social rank should be taken into account when social learning in dogs is being studied and tested, because dominant and subordinate dogs perform differently after observing a demonstrator.

Keywords

social learning, dog, human, two-action test, dominant, subordinate.

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1. Introduction

Our knowledge of the context and extent to that dogs follow and/or copy the actions of a demonstrator in different settings of social learning is expanding (for a review, see Kubinyi et al., 2009). Dogs have been shown to learn socially both in intra- and inter-specific contexts. Both dogs (e.g., Adler & Adler, 1977; Slabbert & Rasa, 1997; Range et al., 2007), and humans (e.g., Pongrácz et al., 2001, 2003a,b, 2008; Kubinyi et al., 2003a,b) can be effective demonstrators.

Coussi-Korbel & Fragaszy (1995) and Laland (2004), proposed that not only the sociability of a species affects its capacity for social learning, but the actual social relationship among group members, that is, the quality of the dyadic interactions are equally important. Therefore, the social hierarchy may have a special fundamental influence on the transfer of knowledge. Position in the social network may predict which individual will likely be effective as a demonstrator and which one will mostly be an observer. For example, according to Coussi-Korbel & Fragaszy (1995), social learning is more likely to occur if there is a stronger bond among particular individuals, and/or if individuals live in a well defined dominance relationship (i.e., between a dominant and a subordinate individual). However, the social rank of a particular individual can also have an effect on the performance of the given animal in different kinds of learning tasks. What was mostly found earlier is that dominant individuals are more successful in problem solving tasks (as in chimpanzees: Chalmeau & Gallo, 1993; and in brown lemurs: Anderson et al., 1992). In house mice, Barnard & Luo (2002) showed that recently gained dominant status can enhance a mouse's performance in a maze. Nicol & Pope (1999) found that dominant domestic hens not only learn better than lower ranked hens from a conspecific, but dominant individuals are also more salient demonstrators as well. We should also mention that in other studies dominant individuals underperformed their low ranking group members in particular learning tasks (as in crab eating macaques, Bunnell & Perkins, 1980).

As dogs have been cohabitating with humans in various forms of social groups for quite some time (Miklósi, 2007), we predicted that dogs should be inclined to learn from humans at least as well, and perhaps even better than they do from conspecifics, provided that they are not hindered in performing the task by motor or perceptual differences. Earlier we demonstrated that the rank of dogs from multi-dog households had a strong effect on their efficacy in learning a detour task by observing an unfamiliar dog or human demonstrator (Pongrácz et al., 2008). Interestingly, dominant dogs did not learn after observing another dog making the detour, nevertheless their learning performance slightly exceeded the subordinate dogs' performance, if a human acted as demonstrator. These results indicated that even when tested in isolation from their group mates, the inclination for learning socially in dogs is strongly influenced by the social relationships of their group and dominance rankings. Interestingly, this factor has been rarely taken into consideration in tests on social learning in dogs using conspecific demonstrators (e.g., Range et al., 2007; Tennie et al., 2009).

As with the effect of dominance status, the combination of the observed behaviour of the dogs' own preferred solutions in social learning tasks has been investigated only sporadically. We found earlier that dogs readily consolidate their directional preferences in a detour task with the faster detouring learned from a demonstrator (Pongrácz et al., 2001). However, detouring a V-shaped fence gives only limited opportunity to test the subjects preference for a particular solution — there is no alternative way (in terms of behaviour pattern) to solve the task, and demonstrators' detouring makes the directional or side choices ambiguous ('going towards' and 'coming back' from the fence can involve both sides of the device).

In recent years the two-action paradigm became one of the main tools to investigate social learning. In this task a naïve observer is exposed to a demonstrator responding to a manipulandum in one of two ways (e.g., pushing left or right), or that performs one of two possible actions with the same manipulandum (e.g., pushing it in or pulling it out). Two-action tests were successfully applied to various species, such as starlings (Campbell et al., 1999), budgerigars (Heyes & Saggerson, 2002) and pigeons (Dorrance & Zentall, 2002).

Dogs were tested also in a few experiments with different variants of the two-action paradigm. Range and colleagues (2011) trained pet dogs to use their mouth or paw to operate a sliding door on a box. In subsequent discrimination training, dogs were given the opportunity to either copy or 'counter-copy' the action of their owner on the box. Dogs learned faster to copy the demonstrated action than to execute the opposite action. The authors concluded that dogs are inclined to follow 'automatically' the humans' action. In another study Range and colleagues (2007) used a dog demonstrator that operated a food-dispenser by the means of a pull-down rod. The demonstrator used his paw to pull down the rod. Half of the subjects saw the demonstrator doing this with a ball in his mouth and the other half saw him demonstrating it without the ball. The subjects preferred to pull the rod with their mouth, but those who observed the demonstrator performing the action without the ball in his mouth, copied the demonstrator's paw action. Range et al. (2007) interpreted these observations as 'selective imitation', however, there are other existing explanations in the literature also, see, for example, Kaminski et al. (2011), who explained the original findings with much simpler mechanisms of social learning.

In this study we tested dogs in a new version of a two-action task. The procedure we used controls for socially mediated effects (the mere presence of a demonstrator) and stimulus enhancement (attention drawn to a manipulandum by its movement), and it has the added advantage of being symmetrical (the two different actions require the same or at least a very similar motor movement). This task was easy enough to be solved spontaneously by the dogs without the need for any preparatory training. Thus, in contrast to other studies, we did not pre-train our subjects to manipulate successfully the experimental device (e.g., Miller et al., 2009; Range et al., 2011). Therefore, by involving a human demonstrator who displayed an unlikely solution of the problem, we could test to what degree dogs maintain their own natural preferences in this context. Based on earlier results (e.g., Pongrácz et al., 2003a; Range et al., 2011), we expected that dogs will show a tendency to copy the demonstrated action.

Additionally, we analyzed the possible differences between the learning performance of the dominant and subordinate dogs. Based on our earlier work (Pongrácz et al., 2008), we expected a stronger effect of demonstration on dominant dogs than on those that are subordinate. In that paper the detour paradigm was used and the performances of dominant and subordinate dogs were compared either when trying to get around by their own or after observing a human demonstrator performing the detour. While dogs in both groups showed equally low performances in the trial-and-error condition, dominant dogs negotiated the fence faster than the subordinate ones after witnessing the demonstration. As the new task we provided to our subjects in this article was much easier for the dogs to master in comparison to detouring around a fence, we wondered whether the position in the conspecific social network at home would affect the success rate and/or the preferred method of action. While the effect of the demonstration was quantitative in the detour test (e.g., faster detour), in the present experiment both qualitative (e.g., switching between alternative behaviours for solving the task) and quantitative effects (e.g., more successful trials) could be expected.

2. Material and methods

2.1. Subjects

Adult ($N = 57$; mean age = 4.2 years, range 1–9 years) medium sized companion dogs from various breeds participated in the experiments. The sex of the subjects was balanced in the overall sample and in the experimental groups. All dogs participated together with their owners in our tests. Two owners each participated with two dogs in the tests, in these cases the dogs of the same owner were sorted to different experimental groups. Dogs and owners were recruited from various dog schools. Each dog was tested only once, in one of the three groups (see the list of the subjects in the Appendix).

As a prerequisite for participating in the test, we checked whether the subject was motivated to play with a ball. We asked the dog's owner to play a retrieval game with the dog. Only those dogs were included in the testing that ran readily after a ball thrown at least 10 m distance for three times consecutively. We did not require strict retrieval procedure as in obedience training (i.e., the dog retrieves the ball directly to the hand of the owner), but high motivation of chasing and fetching a ball was necessary for our test (i.e., retrieval or at least grabbing and playing intensively with the ball).

We categorized each dog according to the number of dogs in the household and their social rank (subordinate, dominant), in case of multi-dog households. The social rank of the dog was determined by the same questionnaire used by Pongrácz et al. (2008). Owners were asked to fill in the questionnaire before the test. There were three possible answers (the subject dog, some of my other dogs, I don't know) for each of the following questions:

(1) When a stranger comes to the house, which dog starts to bark first (or if they start to bark together, which dog barks more or longer)?

(2) Which dog licks more often the other dog's mouth?

(3) If the dogs get food at the same time and at the same spot, which dog starts to eat first or eats the other dog's food?

(4) If the dogs start to fight, which dog wins usually?

We considered a dog dominant if the owner answered ‘the subject dog’ to at least three questions, and additionally if he or she did not answer ‘some of my other dogs’ to the fourth question. Similarly, we considered a dog ‘subordinate’ if the owner answered ‘some of my other dogs’ to at least three questions, and additionally he or she did not answer ‘the subject dog’ to the fourth question.

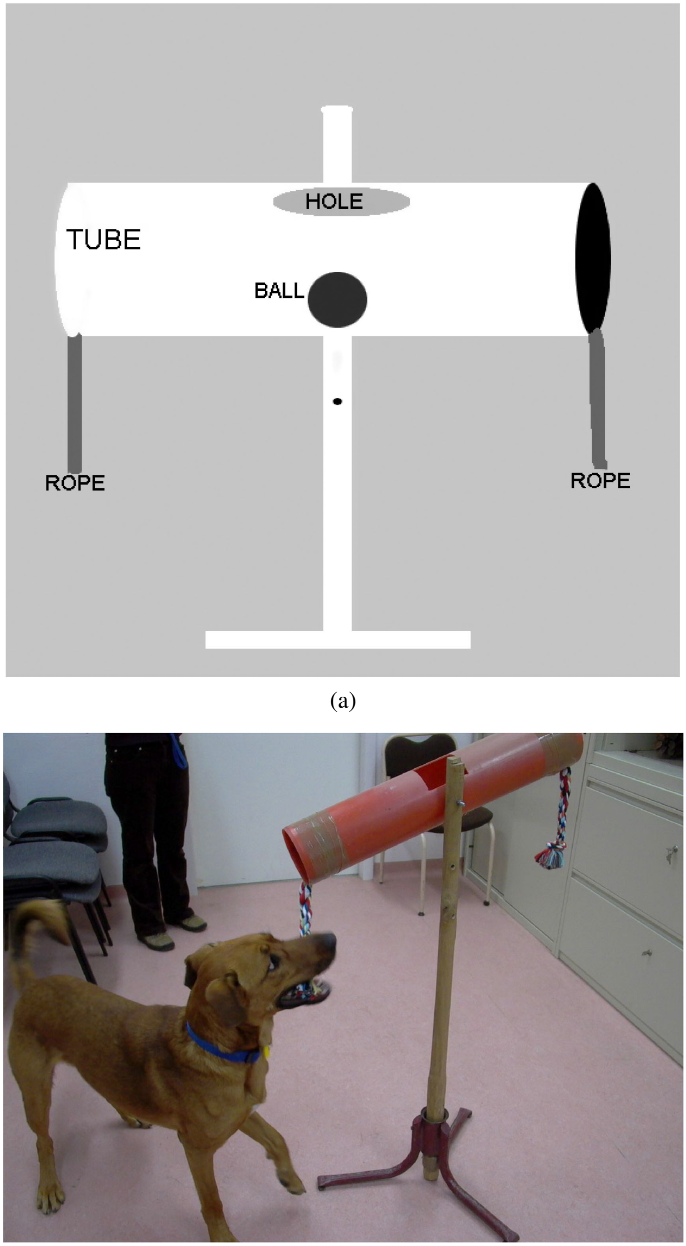
2.2. Procedure

Approximately half of the tests were conducted at the Department of Ethology in Budapest, in an empty experimental room (3 × 5 m). The equipment was placed in the middle of the room so the dog could approach it from either side easily. The other half of the subjects was tested outdoors in a summer camp for dog owners. Here the equipment was situated in a secluded area where other dogs and humans would not disturb the subjects. In each experimental group half of the subjects were tested indoors and the other half in outdoor conditions.

2.3. Equipment

The same equipment was used for each experimental group (Figure 1). A hollow plastic, non-transparent tube was fixed to a wooden pole with a screw (63 cm long by 12 cm diameter). The tube could swivel around the screw, but it was balanced well enough to stay horizontal when not being touched. A 27-cm-long, thick rope was attached on each end of the tube. A small opening was cut on the top side of the tube at equal distance from both ends. The opening was big enough to place a tennis ball through it into the centre of the tube. To retain the tennis ball in the middle of the tube, two strings were fixed through the inner side of the tube, right under the opening. These strings were positioned as low thresholds, preventing the ball from rolling out of the tube if it was tilted only slightly. Any tilting that exceeded a 20° angle from horizontal, caused the ball to roll over one of the strings and fall out of the tube.

The wooden pole had three holes for the screw, so the position of the tube was vertically adjustable, according to the height at the withers of the dogs. The three holes were at 80, 90 and 100 cm from ground level, respectively. We adjusted the position of the tube in such a way, that the dog could just grab the lower end of the ropes with its mouth in a normal standing position.



(a)

(b)

Figure 1. (a) Schematic drawing of the experimental device, (b) a picture of a dog performing tube tilting and (c) a picture of a dog performing pulling of the rope.

(c)

Figure 1. (Continued.) Exact measurements are given in text. The vertical placement of the tube was adjustable to one of three positions, depending on the height of the actual subject. The tube is made of non-transparent plastic; therefore, the ball is not visible as is depicted in panel a. This figure is published in colour in the online edition of this journal, which can be accessed via http://www.brill.nl/beh

2.4. Familiarization with the equipment

The aim of the familiarization was to introduce each dog to the experimental room (or alternatively to the outdoor site) and equipment, and to show them that the ball can come out of the tube if it was tilted. Each dog was assigned to one of the three experimental groups (see below) before the familiarization. Before the dog and its owner (O) entered the experimental site, the experimenter (E, a 23 year old woman at the indoor tests and a 40 year old man at the outdoor tests) set the tube to the height of the dog. While E was doing this, she/he touched the equipment all around, including the ropes, to provide an even coverage of her/his odour on the equipment. After it, E tilted the tube to an approximately 45° slanted position and asked O to come in with the dog. O encouraged the dog to look around in the room or the experimental site, and played with it for about 1 min, to familiarize the dog to the new place. Next, E stepped behind the equipment, then O with dog, faced E from a distance of 2 m from the equipment at the start point.

Each dog was also exposed to the functioning of the apparatus. E called the dog's attention, then put the tennis ball into the tube on the upper end, and let it roll through the tube and fall down to the floor. O encouraged the dog to get the ball. After this O called the dog back to the start point, and while O turned the dog away from the equipment, E quickly tilted the tube in the other direction. They repeated the procedure, but the ball rolled out the opposite end of the tube. At the end of the pre-training, O again turned the dog away from the apparatus (preventing it from watching E's actions) while E adjusted the tube to the horizontal position.

2.5. Testing

The familiarization was followed, without any break, by three experimental trials that differed according to the tested groups. The three experimental groups are as follows:

2.5.1. No Demo

No Demo ($N = 18$ dogs; 5 dominant, 8 subordinate, 5 only dog at home). Additional video material of this test can be seen at http://www.cmdbase.org/web/guest/play/-/videoplayer/45

E stood behind the horizontally positioned tube in the middle. O held the dog by its collar at the start point. E called the dog's attention, waited until the dog made eye contact with E and then slowly placed the ball into the tube through the opening in the middle. Next E moved three steps backward, and O, who remained at the start point throughout the test, encouraged the dog to obtain the ball. We asked O to use only such encouraging phrases (e.g., 'Come on!', 'Go!', 'Fetch the ball!') that did not involve specific instructions on how to solve the task. O was not allowed to command the dog, to touch or pull the ropes that were attached to the tube.

Each dog participated in three similar trials. One trial lasted for 1 minute (if the dog obtained the ball earlier, we started the next trial). If the dog successfully obtained the ball, then O allowed a short play session. Next O took the ball from the dog and gave it back to E.

If the dog did not obtain the ball after 1 minute, O was asked to call the dog back and cover the dogs eyes with their palms. E took the ball out of the tube through the opening on the top of the tube. After this O uncovered the eyes of the dog and E repeated the insertion of the ball as described above.

2.5.2. Push Down Demo

Push Down Demo (PushD) group ($N = 19$ dogs; 7 dominant, 7 subordinate, 5 only dog at home). Additional video material of this test can be seen at http://www.cmdbase.org/web/guest/play/-/videoplayer/46

E called the dogs' attention, and then placed the ball into the tube as in the No Demo group. Then E stepped to the end of the tube and crouched down while calling the dog's attention. Next E put their right hand on the top of the tube, and pushed it slowly down. E caught the ball as it fell out and showed it to the dog. After it O covered the eyes of the dog for a short moment, while E tilted the tube back to the horizontal position. Then O removed their palm from their dog's eyes, and then E placed the ball back into the tube. Finally, E moved back three steps, and O let the dog free and encouraged it to obtain the ball.

Each dog participated in three such trials. For each subject dog, E demonstrated the tilting of the tube always on the same side. For nine dogs the demonstration was done at the right end of the tube, the remaining ten dogs observed a demonstration on the left end. A trial lasted until the dog obtained the ball or for a maximum of 1 min.

2.5.3. Pull Down Demo

Pull Down Demo (PullD) group ($N = 20$; 7 dominant, 8 subordinate, 5 only dog at home). Additional video material of this test can be seen at http://www.cmdbase.org/web/guest/play/-/videoplayer/47

The procedure was handled just as it was in the PushD group (see above), but in this case E demonstrated the tilting of the tube by grabbing one of the ropes with their right hand, and pulling it down until the ball rolled out from the tube. Each dog participated in three trials. Half of the subjects observed the demonstration on the right end of the tube, the other half of the dogs observed the demonstration on the left end. A trial lasted until the dog obtained the ball or for a maximum of 1 min.

2.6. Data collection and analysis

All experimental trials were videotaped. We recorded whether the dogs obtained the ball (yes/no) during each trial, and the method they used (push/pull):

Pulling: The dog pulls down the rope by grabbing it with their mouth.

Pushing: The dog pushed down the tube with their nose or paw, while rearing on their hind legs.

A trial was considered as successful if the ball rolled out from the tube as a result of some kind of manipulation by the dog within 1 min. Besides the above-described action types (pull on the rope, push on the tube), no other variants of successful actions were observed (e.g., knocking over the whole device).

In order to establish the dogs' side preference, we also noted which end (right or left) of the tube was manipulated by the dog. The data of side choice did not follow Gaussian distribution (Kolmogorov–Smirnov test for normality); thus, we used Wilcoxon Signed Rank test for analyzing the faithfulness of dogs to the previously chosen, or to the demonstrated side.

For comparing the ratio of chosen methods (push or pull) among the experimental groups, at first we calculated the frequency of individual rope pulling for each dog by dividing the number of rope pulling with the number of successful trials (there were only two solutions available — push or pull —, the reciprocity frequency of rope pulling was suitable to analyze the ratio of solutions in both demonstration groups). The frequency of individual rope pulling was compared with a Kruskal–Wallis test among the three groups.

In order to establish the preference (pushing or pulling) for manipulating the tube without any former experience, we used the medians of the frequencies of pushing the tube and pulling the rope obtained from the dogs in the No Demo group as a basis of reference. Frequencies were calculated similarly to those mentioned above (the number of a particular solution divided by the number of successful trials). The medians of the relative tube pushing and the rope pulling, served as expected choice levels for the analysis of action preference in the PushD and PullD groups (Wilcoxon test).

Finally, we compared the number of successful trials between the dominant and subordinate dogs in the two demonstration groups by a two-factorial (rank $\times$ type of demonstration) GLM (Generalized Linear Model) analysis.

3. Results

3.1. Overall success in the three groups

We compared the number of successful trials among the three groups with Kruskal–Wallis test, and we did not find a significant difference ($K_3^2 = 0.74$; $p = 0.69$). This means that the task was easy enough for the dogs to solve, even without demonstration. Table 1 shows the number of successful trials in each experimental group.

3.2. No Demo group

Thirteen dogs obtained the ball successfully in Trial 1 (72%), four dogs were unsuccessful in all three trials. For calculating the individual frequencies of rope pulling, we included only those dogs that had at least one successful trial (out of three possible opportunities). The median of individual rope pulling was 0.17. This value served as the hypothetical median for the groups with demonstrations.

The successful dogs ($N = 13$) did not show side preference during the first trial (five manipulated the right end and eight manipulated the left end; binomial test $p = 0.58$).

Three dogs obtained the ball only once, while ten dogs obtained the ball in all three trials. The data from these ten dogs we analyzed further with a Wilcoxon Signed Rank test whether they were faithful to the method (push or pull) or the side (right or left) they chose in the first trial. The expected value was 1, because dogs had two additional trials (the second and the third) to follow or not, their choice in Trial 1. The results show that the dogs did not maintain their preference in Trial 1 in the subsequent two trials, either with regard to the method ($W_7 = 12.00$; $p = 0.38$) or the choice for the side ($W_6 = 7.00$; $p = 0.56$).

Table 1.
Number of successful trials in the three experimental groups.

	Trial 1	Trial 2	Trial 3
No Demo ($N = 18$)	13	11	10
Push Demo ($N = 19$)	15	13	13
Pull Demo ($N = 20$)	15	14	16

3.3. PushD and PullD groups

At first we compared the frequencies of the rope pulling among the three experimental groups. Kruskal–Wallis tests found significant difference ($K_3^2 = 7.13$; $p < 0.05$) among the groups, and Dunn's post hoc tests revealed that the frequency of rope pulling was significantly higher in the PullD group than in the PushD group. Dogs did either pulling or pushing; thus, the frequency of tube pushing was also significantly higher in the PushD group than in the PullD group (Figure 2).

In the next step we compared the frequency of rope pulling of the PullD group and the tube pushing of the PushD group to the hypothetical median values derived from the No Demo group. The Wilcoxon test found significant difference in the case of the PullD group (hypothetical median $= 0.17$, $W_{16} = 96.0$; $p < 0.05$). This means that in the PullD group, dogs used rope pulling significantly more often than in the No Demo group. However, in the PushD group we did not find significant effect (hypothetical median $= 0.83$, $W_{16} = 44.0$; $p = 0.27$). Considering that the dogs had a strong preference for the tube pushing in the No Demo group, it is not surprising that the frequency of tube pushing did not differ significantly from this value in the PushD group (Figure 2).

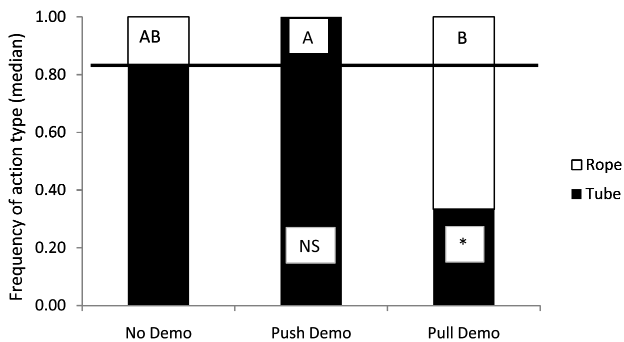


Figure 2. The frequency of pulling the rope and pushing the tube in the three experimental groups. Individual frequencies were calculated by dividing the number of rope pulling or tube pushing with the number of the successful trials for each dog. The observed ratio in the No Demo group served as the hypothetical median (horizontal line) for the two demonstration groups. There was a significant difference in the Pull Demo group from the hypothetical value (Wilcoxon Signed Rank test), and the two demonstration groups differed from each other as well (Kruskal–Wallis test with Dunn's post hoc test). Different letters show significant differences between the groups. An asterisk shows significant difference from the hypothetical median. NS, not significant; $^*p < 0.05$.

The results of the three time successful dogs were pooled from the two demo groups (12 from the PushD and 14 from the PullD group, respectively), for the analysis of the faithfulness to the side where E manipulated the tube. We found that dogs did not prefer the end of the tube that was manipulated by E (Wilcoxon test, $W_{26} = 15.00$; $p = 0.86$, the hypothetical median was 1.5). We analyzed also whether the three time successful dogs were faithful to the side of the tube they had chosen in their first trial. With 1 as the hypothetical median, we found that dogs did not follow their first choice for the side either (Wilcoxon Signed Rank test, $W = 76.00$; $p = 0.10$).

3.4. The effect of the social rank

Dominance rank did not have a significant effect on the success of ball obtaining in the No Demo group (Mann–Whitney U-test: $U = 14.00$; $p = 0.41$). We tested the effect of dominance rank and the type of demonstration in the two groups with demonstration, with a two factorial GLM (fixed factors: rank (dominant, subordinate); experiment (pull, push)). In this analysis the three times unsuccessful dogs were included also, and we included only the dominant and subordinate dogs based on the answers provided in the questionnaire ($N = 14$ and $N = 15$, respectively).

Dominant dogs were more successful than subordinate dogs in both demonstration groups (Generalized Linear Model, $K_2^2 = 10.46$; $p < 0.001$). The experimental conditions however (Generalized Linear Model, $K_2^2 = 0.37$; $p = 0.54$) did not have a significant effect (Figure 3).

4. Discussion

Summarizing our results, we found that (1) without demonstration, dogs show clear preference for the pushing action over the pulling action, in this type of two-action test; (2) dogs prefer to follow the demonstrated method, but not the demonstrated side, after seeing a human demonstrator; (3) dominant dogs were more successful than subordinate dogs in the case of demonstration.

There is an obvious difference between the present observations and the results of the detour experiments with dogs (e.g., Pongrácz et al., 2001, 2008; Mersmann et al., 2011). Mastering of the detour around a V-shaped or a straight fence was a hard task for the subjects, so the effect of demonstration was clearly measurable on the improvement of the success rate, or the latency

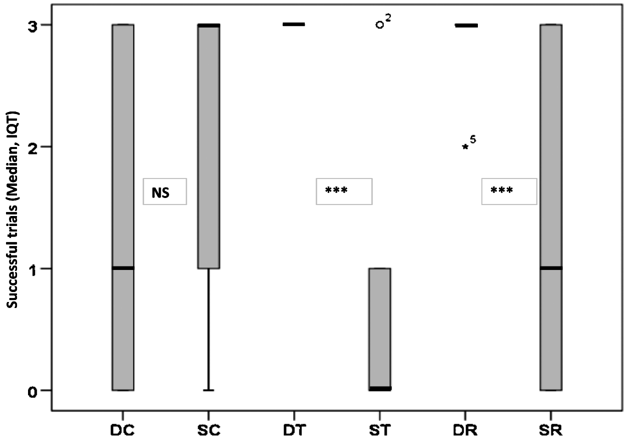


Figure 3. The median of successful trials (± interquartiles) in the No Demo and the two demonstration groups. Success of obtaining the ball was compared between the dominant and subordinate dogs as well as among demonstration types. There was no difference between the dominant and subordinate dogs in the No Demo trials (Mann–Whitney U-test). Rank had a significant effect: dominant dogs perform better if they see human demonstration (Generalized Linear Model). $N = 5, 8, 7, 7, 7$ and 8, respectively. NS, not significant; $^{***}p < 0.001$; Abbreviations of the test groups on the x-axis: DC, dominant, no demo; SC, subordinate, no demo; DT, dominant, tube pushing demo; ST, subordinate, tube pushing demo; DR, dominant, rope pulling demo; SR, subordinate, rope pulling demo.

in the experimental groups. However, in our tube test, dogs in the control group were comparably successful to dogs that watched a demonstration. Thus, the effect of demonstration prevailed itself in the way (push or pull) the dogs solved the task. Similar tendency was found by Range et al. (2011), who tested dogs' social learning skills by using a box with a sliding door in which dogs used their mouth or their paw to move the door according to the human demonstration. However, the dogs were instrumentally trained before the test to be able to perform both actions on the manipulandum on command. In our experiment, dogs did not require pre-training because the majority of them could solve the task easily. From this aspect the results are interesting because in the present case dogs gave up their habitual behaviour and matched their action to that shown by the human demonstrator. This was especially obvious in the case of the less preferred type of action (rope pulling).

Our findings contradict the results of detour experiments in which dogs were usually faithful to their first direction of detour (Pongrácz et al., 2001). In those experiments the dogs followed the demonstrator's exact route behind the fence (left or right side) only if two specific conditions were present: the dog did not solve the detour problem earlier, and the demonstrator walked along the same side of the fence in each trial for going behind and coming back (Pongrácz et al., 2003b). The present experiment gives an interesting new aspect of dogs' problem solving behaviour in a different task. Although dogs obtained the ball from the tube with relative ease even without demonstration, they did not show side preference across the repeated trials (or faithfulness to their own solution in the No Demo group). This may indicate that dogs have an enhanced willingness to behave in an idiosyncratic manner if the task is simpler or they have a generally greater ambiguity of consistency in a non-detour problem.

Obtaining data about the subjects' initial or spontaneous behavioural preferences for the possible solutions of the two-action test is very important (see for example in marmosets: Voelkl & Huber, 1999; dogs: Range et al., 2007). In the latter study, dogs had to operate the testing apparatus either by pulling a rod with their mouth or with their paw, and showed a strong preference (circa 83%) for using their mouth in the control group. This level of preference is comparable to our value that suggests that dogs show strong context-dependent action preferences. In our case, human demonstration increased the percentage of the successful trials involving rope pulling by more than 100%, and the percentages of tube pushers were also higher in the corresponding demonstration group. However, this is also a limitation because a plateau effect (for the preferred behaviour) may restrict the demonstration of learning for both alternate actions.

Dogs have a keen sense of smell, so dogs may prefer to manipulate objects that were touched by a human and are marked by human scent patches on the surface. Scent of a demonstrator proved to be important in rats when they were learning to push a stick lever from a demonstrator rat (for example, Heyes & Dawson, 1990; Mitchell et al., 1999). We prevented this from being an issue by having our experimenters touch all parts of the equipment, including the tube and the ropes prior to the test, similar to the efforts of Miller et al. (2009), who also carefully applied odour cues from the human and dog demonstrators onto their test apparatus. In addition, our observations provide little scope for the utilization of odour cues because we did not find any effect of the demonstrated side on the lateral preference of the dogs. Therefore, it is unlikely that dogs were attracted by the scent of the demonstrator in this task when they chose between the sides of the equipment (see also Szetei et al., 2003; Pongrácz et al., 2004).

It was found earlier that dominant group members of several nonhuman animal species perform better than the subordinate ones in problem solving tasks. In chimpanzees for example dominant individuals may monopolize the food dispenser device; therefore, they prevent subordinate ones from learning how to operate it (Chalmeau & Gallo, 1993). In house sparrows dominant birds will more likely take the role of the scrounger over the subordinate sparrows, which act as 'producers' in a food searching task (Barta & Giraldeau, 1998). These examples show that dominant animals may benefit from their social position (and physical strength) in a competitive situation. In our problem solving task dominant dogs generally performed better than subordinate ones, but only in the two experimental groups in which they observed the human demonstrator's action. No such difference was observed in the No Demo condition. This result is in accordance with the outcome of the study by Pongrácz and colleagues (2008) who reported that dominant dogs were slightly better than the subordinate dogs in learning the detour from a human demonstrator by observation (while the subordinate dogs learned much better from a dog demonstrator). Thus, results from both studies suggest that social rank affects performance in social learning situations, which is in accordance with earlier predictions (see Coussi-Korbel & Fragaszy, 1995), specifically, that in social groups with clear hierarchy, dominant individuals will be the more influential demonstrators and the knowledge transfer will, therefore, be rather unidirectional. If dog-human groups are regarded as social units with some type of internal hierarchy, humans are usually considered as the leaders in this hierarchy. In this scenario, the human will be the most influential demonstrator for the dominant dog. The subordinate dogs will probably learn better from the dominant dog that is next in the hierarchy. The previously outlined scenario would fit well also to the system found in domestic hens (Nicol & Pope, 1999). However, rank relationships are normally effective within a well defined group of individuals, like for example in different primate species (Bunnell & Perkins, 1980; Chalmeau & Gallo, 1993). In our case the human demonstrator was unfamiliar to the subjects, that is, not a member of the social group of the dog. Our results, thus, provide an interesting extension of the theory of Coussi-Korbel and Fragaszy (1995) to dogs, because these animals may generalize their in-group social experiences to other interactions with unfamiliar individuals, that is, dogs may regard all humans as knowledgeable leaders.

In general, the tube test proved to be successful in testing dogs with a human demonstrator in a two-action test. Regarding the possible social learning mechanisms involved, simple local or stimulus enhancement is not likely to be the key factor because the dogs did not show preference for the side where the demonstrator manipulated the device. Response facilitation, or any form of imitation, is also unlikely because (i) the human demonstrator used her/his hand to operate the device, while dogs usually manipulated the tube or the rope with their mouth, or sometimes with their paw and (ii) pulling a rope or pushing a tube is not in the usual behavioural repertoire of most companion dogs.

It is more likely that dogs relied on a generalized stimulus enhancement, combined with some kind of an emulation mechanism (for a review, see Hopper, 2010). Generalized stimulus enhancement means that dogs were able to realize the similarity between the left and the right side of the tube, so their choice for the target to be manipulated was independent from the actual target touched by the demonstrator. Next they configured their action in a way that moved the tube in the expected position. Emulation, as it was described in children (Wood, 1989), is a mechanism whereby the observer reaches the same result as the demonstrator did, but it was achieved by utilizing a somewhat different solution. Emulation is often divided to sub-categories that differ in finer details of what was exactly learned. In our experiment dogs may have understood that the demonstrator's action led to the emergence of the ball ('goal emulation', e.g., Tomasello, 1998). Obviously they did not follow the exact method of the human, as they did not restrict their manipulations to the same end of the device the demonstrator used. The other two sub-categories of emulation ('affordance learning': Byrne, 1998; and 'object movement re-enactment': Custance et al., 1999) both describe learning about physical properties of the environment (they can be touched and/or moved), the relationship among objects (they can move each other), and the possible trajectories of movement (objects can be moved to particular directions). In our case dogs may have also understood that the rope or the tube respectively are 'worthy' to be touched and they can be moved downwards subsequently.

We should consider that the reward was always present in these tests — the ball rolled out from the tube during the demonstration. Kubinyi et al. (2003b) found that dogs copied the action of the humans also if they could not witness that the demonstrated action leads to a particular outcome (no ball is rolling out from an opaque box after the manipulation of the handle).

Additionally, we also found earlier that dogs can solve the detour task after a demonstration by a human who did not carry the reward behind the fence, but kept on communicating ostensively to the dog (Pongrácz et al., 2004). Therefore, it is also possible that dogs would have solved the tube test if the demonstration had not caused the ball to roll out.

Several social learning experiments involve the so-called 'ghost control method' (Fawcettet al., 2002) to separate goal emulation from imitation. Ghost control consists of 'demonstrations' that show the experimental device working without the apparent touch of the demonstrator. It is argued that if observers learn to master the task in the ghost condition, then it is unlikely that they imitate the demonstrator's action. In the tube test, both actions of the demonstrator tilted the tube downward and the only difference was the part of the tube being manipulated (the rope or the tube itself), and the manner of the movement was also slightly different (pushing or pulling). Thus, in our case the ghost control (i.e., the tube tilts and the ball rolls out without an actual touch on the device) would not have separated pushing or pulling.

To summarize the results of this experiment, we have shown that naïve (untrained) dogs are ready to display a matching behaviour to a human demonstrator's action in a two-action test. They switch preference to the observed solution of the task, even if there is no obvious advantage compared to their own preferred solution. A possible explanation for the dogs' willingness to follow human demonstration could be that in the past dogs have experienced that following a human has beneficial outcomes. Thus, in a novel context and as a result of ostensive communicative cues displayed by the demonstrator (Pongrácz et al., 2004; Topál et al., 2009), dogs are more tempted to learn socially, than they are to solving a problem in their own way. This result extends the earlier results found with the detour paradigm (Pongrácz et al., 2003a). Finally, we have successfully confirmed findings of our previous work (Pongrácz et al., 2008), that dominant dogs copy a human demonstrator more effectively than subordinate dogs do. As this phenomenon was detected by using a very different method, it seems plausible that position in the hierarchy may have a wide-spread influence on a multitude of social interactions between dogs and humans.

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Appendix

Participants of the experiments

No Demo group

'Only dog' — Border collie, Labrador retriever, Mixed breed, Mudi, Rottweiler

'Dominant' — American bulldog, German shepherd dog, Husky, Mixed breed, Mudi

'Subordinate' — Border collie, German pointer, German shepherd dog (2), Golden retriever (2), Labrador retriever, Staffordshire terrier

Push Demo group

'Only dog' — Border collie, Hungarian vizsla, Mudi, Mixed breed, Rhodesian ridgeback

'Dominant' — Belgian malinois, Border collie (2), German shepherd dog (2), Golden retriever, Labrador retriever

'Subordinate' — Belgian groenendael, Cairn terrier, German shepherd dog, Hungarian vizsla, Kelpie, Medium poodle, Mixed breed

Pull Demo group

'Only dog' — Australian shepherd, English dwarf spaniel, Mixed breed (2), Belgian tervueren

'Dominant' — Border collie, Jagdterrier, Belgian tervueren, German shepherd dog, Mixed breed (3)

'Subordinate' — Border collie (2), Cocker spaniel, Belgian tervueren, Hungarian vizsla, Labrador retriever, Mudi, Rottweiler