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Dog as a model for studying conspecific and heterospecific social learning

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Abstract In human communities social learning (i.e., learning by the observation of knowledgeable individuals) plays an important role; it shapes cultures, traditions, and cognition. Dogs seem to be an ideal system for modeling human cognition from the social learning aspect. The present review offers a short overview on the relevant general theories of social learning, discusses the adaptive value of social learning, introduces dog as a model system, presents evidence for different forms of social learning in dogs and argues for practical implications that social learning might have in this species.

Social learning: A general overview

Social learning takes place when some aspects of the behavioral similarity between 2 individuals are due to learning and not only to social influencing or nonsocial processes (Whiten and Ham, 1992). Other definitions place more emphasis on the fact that exposure to the behavior of the demonstrator enhances the probability of behavioral conformity on the part of the observer by drawing its attention to a particular place or stimulus/object, a behavioral action or 'goal of an action,' and that the observer should be able to execute the action in the absence of the demonstrator (Galef, 1988; Whiten and Ham, 1992; Heyes, 1993; Byrne and Russon, 1998; Miklósi, 1999; Zentall, 2006). However, it should be mentioned that the definitions and even some parts of the terminology are under permanent debate and reshaping.

According to the above definition, similarity of behavior of the demonstrator and observer is a precondition for social learning to take place, however, there are many different ways for the emergence of such congruence. To illustrate the problems associated with the social learning phenomenon we suggest that the reader imagines the following simple scenario. There is a box on the ground that contains a ball. The ball can roll out through a little hole on the back wall of the box if a protruding lever at the front is pushed either to the left or to the right (Kubinyi et al., 2003a). Dogs can learn through trial and error that in addition to touching and shaking the box, the pushing of the lever with the mouth or the paw is also an effective action to obtain the ball. In another case a trained demonstrator dog always pushes the lever to the right using his left paw and obtains the ball. Thus the observer dog has an advantage in obtaining the ball because he could witness the effective action. In many such cases we find that observers outwit non-observers in getting the ball when tested later. Thus the question emerges: What has been learned in this situation by observing the skillful demonstrator? Students of social learning go a long way to find out the nature of information that was obtained by the naïve observer. It turns out that the interpretation of such situations is far from being straightforward.

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Behavioral conformity without learning: Social influence

In the following paragraphs we will use the terminology of Whiten and Ham (1992). First there is a possibility that no social learning takes place. If the mere presence of the demonstrator increases the chance that the observer gets interested in the box we might describe the situation as social influence. It is assumed that the presence of a conspecific might simply change the motivation of the observer and its behavior in relation to the object/problem and plays no role in the enhanced performance shown by the observer. Such cases were referred to by Zajonc (1965) as social facilitation.

Various forms of social influence might play an important role to synchronize ongoing activity in animals. There are some experimental observations that this might affect synchronization of behavior in dogs. Vogel et al. (1950) and Scott and McCray (1967) found that dogs run for a food reward significantly faster in pairs than in singles. Similarly, puppies eat much more food when fed in a group compared to being fed alone (Ross and Ross, 1949). Others distinguish situations in which the motor component of the action is more obvious. Accordingly, yawning in response to yawning of a group mate (in humans) or barking on hearing others bark (in dogs) is often considered to be social influence (contagious behavior: Whiten and Ham, 1992).

Mechanisms of social learning

If our observer dog showed better performance (faster acquisition of the effective behavior) only if it had seen the demonstrator interacting with the box, and it displays this behavior also in the absence of the demonstrator, we could assume that some form of learning had taken place. Generally, there are 3 different aspects of the demonstrator's behavior that could have a facilitating effect on the behavior of the observer. Through his behavior the demonstrator can direct the observer's attention (1) to the location or object of the action, (2) to the problem-situation and "solvability," and (3) to the particular form of action needed.

Students of social learning attempt to separate these situations because they think there are differences in the underlying cognitive mechanisms. However, as it will become clear, this separation is often quite arbitrary and depends more on the theoretic approach preferred by the researcher than on the behavioral situation under investigation. In many cases it is also difficult to set up experimentally clear cases for study.

Forms of enhancement

According to Spence (1937), who was the first to use the term, *stimulus enhancement* occurs when observation of an action leads the observer to increase the frequency of its behavior directed toward the location or object of the demonstrator's activity. The demonstrator's action increases the probability that the observer will contact the same contingencies and thereby facilitates acquisition of the same response. *Local enhancement* (Roberts, 1941) refers to cases in which an animal is attracted to a site or object by the current presence of a conspecific at the site or by residues of the demonstrator's activity at the site (e.g., odor cues). Thus one distinguishes local from stimulus enhancement in terms of whether the observer is attracted only to a particular location or object contacted by the demonstrator (local enhancement) or to all objects with the similar physical appearance (stimulus enhancement). If the observer dog is attracted only to the particular handle mounted on the box (see above) through olfactory stimuli or if he is seeing the demonstrator acting nearby, then local enhancement might be an explanation. However, if he will be attracted indiscriminately to similar boxes or handles, stimulus enhancement might be at work.

Some researchers assume that the demonstrator's action could facilitate directly certain motor patterns in the observer. Recently, Byrne (1999, 2002) and Byrne and Russon (1998) have introduced the term of *response facilitation* for the case when the observer is exposed to a novel relationship between a familiar action (i.e., it has been carried out by the observer before) and some part of the environment (see contextual learning by observation, Janik and Slater, 2000; Byrne, 2002). In our example, the way of action of the demonstrator could facilitate ("prime") the emergence of a similar pattern of behavior in the observer. For example, response facilitation is at work if the observer dog's way of action on the handle is the function of the demonstrator's action. In this case watching a dog pushing the handle either with his paw or mouth would make the observer display the congruent pattern of action. This kind of 'blind' re-enacting ("copying") of familiar behavior action is called by some authors 'mimicry' (Tomasello and Call, 1997).

(Goal) Emulation

The actions of the demonstrator can direct the attention of the observer to a particular problem to be solved. Researchers refer to *goal or social emulation* if the observer copies the goals or outcomes of another animal's behavior but without necessarily copying the form of the action (Tomasello and Call, 1997). In our example, the actions of the demonstrator could make the observer dog realize that the demonstrator's goal was to obtain the ball from the box. Thus in case of emulation the observer is aware of the outcome of the demonstrator's action but uses his own idiosyncratic way of action to reach the same goal, i.e., instead of using a paw or mouth the dog could simply flip the box to the side. Importantly, in the case of emulation, observers can realize the nature of the problem and try to invent their own solution if they see the self-propelled automatic movement of the handle without a demonstrator that also results in the emergence of a ball (so-called ghost condition).

Imitation

According to the concise definition of Thorndike (1898), imitation is "learning to do an act from seeing it done," whereas Heyes (1993) added that learning something particular about the form of behavior should also be included in the definition of imitation. Although most researchers agree that imitation involves learning about a novel motor aspect of behavior, there are many practical and theoretic problems in distinguishing imitation from other forms of social learning. For example, to be able to fulfill this definition of imitation the box experiment should be designed in a way that the observer has a chance to learn a novel way of manipulating the handle. Given the limited motor abilities of dogs (and many other animals) this might be a difficult task, although using the more "generous" definition of Heyes, one could argue that copying minor details of pushing (e.g., pushing the handle to the same side) should be taken as evidence for imitation (Bugnyar and Huber, 1997). There have been arguments that it is not the novel aspect of a particular action but the organization of action sequences that should provide some evidence for imitation (Byrne, 1994; Whiten, 1998; Nguyen et al., 2005).

The adaptive role of social learning

Functional approaches are very important in the understanding of the evolution and ecologic role of any behavioral trait (Krebs and Davies, 1997), that is, explaining how certain aspects of the behavioral phenotype contribute to the survival of the species. In a given context and situation, freely behaving individuals (both animals and humans) are rather more conservative, i.e., they are more likely to perform their species-specific or idiosyncratic behavior pattern (repetitive and stereotypic) that is explained easily by the relatively stable everyday environment and the accumulating individual experience. To assess the significance of social learning as a contributor to survival, one must be able to show that it has the potential to replace and counteract individual experience. In other words, that information gained by social learning processes is qualitatively similar to information obtained by individual learning. For example, Galef and Whiskin (2001) showed that if rats are given the possibility to sample their environment continuously, socially acquired behavior diminishes faster, i.e., socially acquired taste preference became less pronounced if they were allowed to eat another type of food. This means that in certain cases, there may be a competition between individually and socially acquired preferences.

Authors seem to agree on that under certain environmental conditions social learning abilities may prove to be useful in addition to genetically predisposed behavior and individual learning. Learning by observing the experienced individuals offers more flexibility than species-typical behavior and it may avoid the negative consequences of trial and error learning (Zentall, 2006). In addition, at the group level social learning is one aspect of behavioral synchronization that facilitates the interaction of companions (Csányi, 2000).

Although relying on knowledgeable individuals could reduce the acquisition costs, it can also be misinformative or out of date in certain cases (for example, if the environment has changed). Moreover, if the proportion of social learners increases, the value of copying declines, as the frequency of asocial learners who sample the environment for accurate information decreases. In equilibrium, social and asocial learners should have equal fitness (Barnard and Sibly, 1981).

Thus copying others indiscriminately is not an adaptive strategy in itself. Laland (2004) and Galef and Laland (2005) present specific strategies for allocating effort between socially acquired and individually acquired information. They suppose that there are favorable conditions in nature that facilitate the emergence of copying and individuals whom it might be worthy to learn through observation from. Accordingly, social learning is advantageous when: (1) the established behavior is unproductive (for example, if the execution of an individually learned strategy is blocked) (Pongrácz et al., 2003a); (2) asocial learning is costly (e.g., in the case of herbivores eating some plants that could be poisonous) (Bilkó et al., 1994); and (3) when there is a low predictability of certain environmental changes (as in the human environment for dogs). In other circumstances unlearned or asocial learning are preferred.

Coussi-Korbel and Fragaszy (2005) suggested that social rank, gender, age, and the particular social relationship between observer and demonstrator is also an important factor that determines whether social learning takes place or not. For example, learning from kin could be advantageous because demonstrator and observer experience the same environment. Additionally, if the information transmission is costly, individuals may have more to gain by providing reliable information to kin than to non-kin, because of their shared genes (Laland, 2004). In case of dogs it is known that puppies are able to learn from their mother (Slabbert et al., 1997) and experimental data suggests that hierarchical relationship affects dogs' social learning performance (Pongrácz et al., 2007).

A new species in the study of social learning: The dog

Recent studies on social learning were interested mainly in imitation, because it is considered as an important manifestation of intelligence. As a result, experiments were conducted mostly on such species in which foraging behavior requires refined and meticulous skills to manipulate small objects, like boxes or locking devices (e.g., keas: Gajdon et al., 2004; capuchin monkeys: Caldwell and Whiten, 2004; chimpanzees: Custance et al., 2001). However, if we change our attitude and focus on the adaptive advantages of social learning, it may be convincing that the dog has the potential to become an important subject. In recent years researchers emphasized that social interactions between dogs and humans have an unique character such as, for example, communication (Miklósi and Soproni, 2006) or attachment (Gácsi et al., 2001; Topál et al., 2005b) (for an extensive review see Miklósi, 2007). Accordingly, selection for living in a human niche changed the behavior of the dog, and this resulted in behavioral parallels between dogs and humans. Therefore dogs have the potential to model specific features of social interactions, including social learning, which was present during early human evolution before the emergence of language. The successful application of the dog as a behavioral model is based on 3 key features: (1) selection of the wild ancestors (e.g., wolves) for highly social behavior and for living in various environments; (2) selection for living in the human environment (domestication); (3) naturalistic socialization to humans during ontogeny.

Canid social behavior

In a review, Nel (1999) pinpoints that in canids, social learning could have been an adaptation to local environmental conditions. As an example, Nel (1999) refers to the avoidance of poisoned bait that is thought to be transferred socially among group members. In the laboratory it was found that mates and cubs of experienced jackals learned to avoid the common cyanide gun that suggests acquisition through social learning (Brand and Nel, 1997).

Dogs' closest relative, the wolf, lives in family-based packs that consist of an unrelated pair and their offspring of various ages. Packs maintain a hierarchical social structure based on leadership (Packard, 2003). Resident wolf packs are territorial and aggressively defend their home range areas against other wolves. Wolf cubs are cared for by both parents and other group members and most of them leave the pack at the age of 3 years or even before that age. In principle such a social (family) environment could favor the acquisition of certain skills through social learning that can be used, for example, in communicative interactions and hunting.

Effect of domestication on social learning abilities in dogs

Frank and Frank (1985) noted that, when compared to dogs, captive wolves show enhanced skills in "insight" because they are able to recognize mean-ends relationships. In a similar vein, he argued that social learning abilities should also be inferior in dogs. Although comparative studies conducted by this research team did find behavioral and performance differences between dogs and wolves, the particular notion about social learning was "supported" only by anecdotal observations. According to this report wolves locked in a kennel, which was fitted with a complicated gate mechanism, were able to escape after watching a human operating it only once, whereas dogs did not. Obviously such remarks, although interesting, cannot provide much support for the theory, partly because motivational differences can also explain the described species differences.

Unfortunately, subsequent studies (Miklósi et al., 2003; Kubinyi et al., 2007) failed to compare dogs and wolves with respect to their ability to learn through observation, nevertheless, the assumption that dogs have been selected for living in human social groups (see above) would not necessarily predict decreased social learning abilities. On the contrary, we would expect that dogs are able to learn through observation both from conspecifics and humans.

Naturalistic socialization to humans

The life of a family dog can be divided into 2 parts. Most often the puppy spends its first 8–10 weeks with the mother and the litter mates before it is moved to a human group. This case is special from 2 aspects. First, conspecific parental care is shorter in dogs than in the wild relatives, and second, humans often interfere with parental care from the beginning and then become the most significant social partner later in their life. In this mixed group, humans usually obtain a leading role and are more experienced with regard to the physical and social environment. According to Coussi-Korbel and Fragaszy (1995) and Laland (2004) this would predict that dogs should be more inclined to learn from humans in comparison to learning from conspecifics. Even if this hypothesis is correct, the actual performance of the dogs might however be hindered by species-specific abilities in perception and/or motor skills.

Social learning in dogs: Experimental evidence

In the study of social learning, experimental approaches are unavoidable. By comparing the performance of observers with non-observers (i.e., individuals that are not exposed to a demonstrator) one can establish whether observation of others' behavior is really critical in the emergence of an improved performance. Further, to differentiate between social learning and social influence, one has to show that observers also can use these skills in the absence of the demonstrator. Experimental approaches are also favored because they offer a detailed analysis of behavior (motor pattern of the action), which could be useful when the researcher is interested in the nature of information that has been acquired. Carefully designed experimental groups that are tested under different conditions could help to disentangle differences in the cognitive machinery that control social learning.

From a more practical point of view it is crucial that the observer is exposed to a novel situation that it did not encounter before. This offers the possibility for learning to take place and the assumption is that the observation of a demonstrator who has learned the problem earlier leads to faster learning of the observer in comparison to non-observers. Naturally, novelty can relate to the stimulus, the object or the location, to the problem itself or the way of action that needs to be implemented. However, as it has been pointed out earlier, novelty is a relative concept (Whiten and Custance, 1996; Miklósi, 1999). Thus in the case of each design, the experimenter has to establish how "novel" the particular problem is for any given population of animals. Even family dogs might gain different experience, which depends, for example, on whether they live in flats or gardens. The performance of animals tested without demonstrators is not only important for establishing a "baseline," but also to see whether the problem can be solved by trial and error. If the problem is too easy there will be little room for social learning to be more effective than individual learning. However, if the problem is very difficult then it is unlikely that the observer can accomplish it by means of a short exposure to skillful demonstrators as it is usually done in such investigations. Looking at the behavior of non-observers (when the process is controlled by trial and error learning) is also important to find out the preferred way of action that is probably based on species-specific behavior (e.g., in certain situations dogs might prefer to use the paw or the mouth/head). This could be important in cases where researchers aim to collect evidence that the observation affects directly the utilization of an action by the observer, as for instance in the case of response facilitation or imitation.

In comparison to apes, for example, the possibilities for designing social learning tests in dogs are more limited. Partly due to their evolutionary history most canids display rather rigid motor patterns. They are constrained in fine motor movements that could be reflected in their perceptual capacities and ways of cognitive processing. Thus one cannot expect dogs to show skillful performance in situations that involve manipulation of sophisticated mechanical devices (Osthaus et al., 2005).

A further complicating factor is the species of the demonstrator. In the case of other species, demonstrators are conspecifics, whereas in the case of dogs both humans and dogs can play this role. Humans are often the preferred choice because they do not need to be trained and dogs quickly develop a social relationship with unfamiliar humans. However, use of a human demonstrator leads to problems of interpretation of the underlying mechanisms because of the differences in the species-specific aspects of behavior. Thus it seems to be optimal to test dogs in the same context both with conspecific and human demonstrators. Dogs might learn different aspects of the same situation depending on the species of the demonstrator (Pongrácz et al., 2007).

Early studies of social learning produced mostly negative results. Using conspecific demonstrators, Brogden (1942), found that naïve dogs exposed to a demonstrator dog, which had been conditioned to flex the forelimb to a sound stimulus by electric shock, did not learn a similar behavior more rapidly. Similarly, Thorndike (1898) reported that dogs could not learn to manipulate a latch after observing a human.

In contrast, Dachshund puppies learned faster to pull a cart by a means of a string after observing their trained litter mates (Adler and Adler, 1977), and German shepherd puppies were more skillful in drug search work if they participated in the training exercises of their mother (Slabbert et al., 1997).

Although this later experiment is often cited as evidence for social learning in dogs, the experimental design leaves many questions unanswered with regard to the target and nature of the learning process. For example, was the behavior of the mother the important factor (as a demonstrator's action), or rather the exposure to the drug-sachets? If the mother's actions played the most important role, what exactly did the puppies learn from her? What aspect of the mother's behavior was important: the retrieval, or simply the manipulation of the target? These questions can be answered only by designing a more sophisticated experimental design.

Conspecific social learning

Food preference

Acquired food-preference is often achieved through social learning (Galef and Whiskin, 2001). Lupfer-Johnson and Ross (2007) were the first who applied this method to dogs. They tested whether dogs would acquire a preference for basil or thyme flavoring that was transmitted by the smell of the conspecific's breath during a 10-min interaction. They found that exposed dogs preferred the flavored diet consumed by the demonstrator.

Learning a detour by observation

Species differ to a large degree in their capacity to rapidly solve detour tasks that reflects partly their adaptation to a specific niche. Obviously, such skills could be learned through individual experience but younger animals might improve also from observing skillful individuals. Whereas looking at such effects under natural circumstances is nearly impossible, experimental models could provide some help. Buytendijk and Fischel (1932) Dogs can improve their performance in consecutive trials through trial and error learning when navigating around barriers (Buytendijk and Fischel, 1932; Scott and Fuller, 1965).

More recently a series of experiments were staged to test whether detouring behavior can be improved by social learning. In these tasks dogs had to go around a V-shaped transparent wire mesh fence to obtain the reward (their favorite toy or food) (Pongrácz et al., 2001).

At first we wanted to establish how the task is solved by trial and error learning, thus dogs were tested without demonstrations. We found that there is no significant difference between the latencies of the first 5 trials; only the latency of the sixth detour was significantly shorter than the first. Thus dogs improved the speed of their detours relatively slowly when they had to rely on their own experiences (Pongrácz et al., 2001). The performance in this task seems to be uninfluenced by the breed (Pongrácz et al., 2005) and the social status in the home pack of dogs (Pongrácz et al., 2007). The relative slow acquisition of this task by family dogs (approximately 16% of the subjects were able to detour the fence under 30 s in the first trial) suggests that social learning might improve the development of skillful behavior.

A series of experiments established that either dog or human demonstration has a facilitating effect on the acquisition of detouring (Pongrácz et al., 2001; Pongrácz et al., 2003a); as the latency was then significantly shorter by the second trial. Owners and unfamiliar people were equally effective as demonstrators (Pongrácz et al., 2001).

Interestingly, the social rank of the observer (having a dominant or a subordinate status in the native family in relation to other dogs) has an influence on social learning performance. We found that independently from social status, observer dogs learned equally well from a human demonstrator whilst subordinate dogs were superior in comparison to dogs of higher status if the demonstrator was an unfamiliar dog (Pongrácz et al., 2007).

Present observations provide input for a range of processes that influence social learning. The indiscriminate learning from demonstrators, whether con- or heterospecifics, suggest that the demonstrator's behavior serves to direct the attention of the observer to certain parts or aspects of the physical environment (e.g., end points of the fence). Such cases are usually categorized as stimulus or local enhancement (see above).

Object manipulation

Object manipulation tests are usually about obtaining a reward from a box, which requires specific handling techniques of a locking device (e.g., budgerigars: Heyes and Saggerson, 2002). Although the detour tests were useful for showing the existence of interspecific and intraspecific social learning in dogs, including the role of context of demonstration, experience etc., they relied on a very simple action pattern. Learning about manipulating an object could give a more specific insight into what is indeed learned.

Adler and Adler (1977) investigated the ability of young Dachshund puppies to learn from one of their litter mates, who was trained to solve a simple food-obtaining task (food was attached to a little tray, which could be pulled into the cage by grabbing a little handle on the tray). Beyond the fact that 7- and 9-week-old puppies solved the task faster after watching the demonstrator, the authors concluded that the younger puppies' poorer performance was caused by the immaturity of their motor and visual capacities.

In a recent experiment (Range et al., 2007) dogs showed some flexibility in choosing an action depending on the demonstrators' possibilities to execute the actions needed to solve the problem. Naïve dogs were exposed to a demonstrator dog that opened a food container by using its paw. Although without demonstration naïve dogs preferred to use their mouth, observers showed preference for copying the demonstrated way of action: they also used their paw. However, this matching did not take place if the demonstrator dog had a ball in its mouth while using her paw for opening the container. In this case a constraint (occupied mouth) could explain the demonstrator's otherwise nonpreferred choice. This is similar to the behavior of young human infants. Children—without relying on language—imitate a nonpreferred action only if the demonstrator has no good reason to do so (Gergely et al., 2002). Although the selective, interpretative competence was thought to be human-specific, the results show an analog capacity, inferential selective imitation in the dog.

Heterospecific social learning

Social anticipation

Predicting an action in a sequence allows the dog to start either similar or complementary action as a response, which contributes to behavioral synchronization and cooperative processes between dog and owner.

We tested if dogs would follow a novel human action, if it represents a deviation from the daily routine without any obvious necessity. Dog owners were asked to add a new part to the walking route shortly before they arrived at home. This new path was short, but most importantly, "illogically" superfluous because it's direction was away from the house or flat door. Dog owners carried out this new routine repeatedly for 180 occasions during a 3–6 months period.

The results showed that dogs were able to learn a new habit without any extrinsic reward or social feedback. This process required a long incubation period was not equally present in all dogs (large individual variation). At first, dogs stayed at the door or followed their owners on the new route, and only some of them showed signs of anticipation later—these dogs would run forward toward the additional section (Kubinyi et al., 2003b). The observed phenomenon was described as social anticipation that manifests when an animal learns the proper sequence of an act carried out by others, which triggers similar or complementary actions of his part. This ability could facilitate group synchrony.

Learning a detour by observation

In the detour experiments (see above) we found that the familiarity of the demonstrator does not play a significant role, that is, dogs learn equally fast after observing either an unfamiliar experimenter or their owner (Pongrácz et al., 2001).

We tested different experimental groups to look at the effects of a demonstrator's behavior on the performance of dogs in the detour task (Pongrácz et al., 2004). Results suggested that in the case of a human demonstrator, maintaining the dog's attention is the most important factor. Interestingly, such an effect does not seem to be present in the case of a conspecific demonstrator. This could be explained by assuming that the behavior of the demonstrator dog exposes the observer to a more natural pattern of action, or in the case of human demonstration, dogs have learned to attend human action only in certain situations, e.g., when the demonstration is accompanied by communicative cues, or human communicative cues (eye contact, pointing), which became more attractive for the dog as the result of domestication and acquired the potential to direct focus of attention (Bräuer et al., 2006; Erdőhegyi et al., 2007).

Object manipulation

Kubinyi et al. (2003b) tested dogs for preference of the demonstrated method of obtaining a ball from a box over their own idiosyncratic way of action. Pushing a protruding lever of the box to the right or left let the ball roll out from the box. Without demonstration dogs pushed the lever only accidentally, instead they preferred to shake and scratch the whole box to obtain the ball. After the owner of the dog showed pushing of the lever 10 times, these observer dogs showed a clear preference to use the lever. Interestingly, dogs learned to use the lever even if no ball emerged from the box during the demonstrations. It shows that human actions can be important for the dogs without the presence of obvious reward at the same time. In other experimental models social learning does not take place if there is no obvious reinforcement (but these models do not use humans as demonstrator) (Akins et al., 1998).

Although in the one-action tests observer dogs are required to reproduce a similar action to that shown by the demonstrator, this method does not have the potential to separate learning processes that rely on some sort of "enhancement" or are more specifically tied to the observed behavioral action. Thus most researchers agree that the so-called two-action test should be favored because contextually the demonstrators expose all observers to the same situation but the only significant difference is the actual motor action observed by different groups of observers (Zentall, 2001; Heyes and Saggerson, 2002). Recently, we have applied a two-action test in dogs to see whether dogs assigned to different demonstrators match their motor action to that of the model (Pongrácz et al., 2008). We used a horizontally suspended tube as a two-action device. If the tube was tilted then a ball rolled out. Tilting of the tube was possible (1) by pulling one of the two ropes, which were hanging from both ends of the tube; or (2) by pushing down any end of the tube directly. Naïve dogs preferred pushing the tube, however, observer dogs used the demonstrated action significantly more often in both experimental groups (i.e., either the pulling of the rope or pushing down the tube).

Importantly, it is still debated whether significant increase in the frequency of using the demonstrated action is an evidence for imitation or should be interpreted as response facilitation (see below). In any case, our results suggest that dogs are able to find a functionally similar action in their own repertoire that matches to the demonstrator's way of acting to solve the problem.

Matching behavior to human's action sequences

Recently Topál et al. (2006) obtained some evidence that dogs could be capable of using a human behavior action as a cue for displaying a functionally similar behavior. To test this ability, they adopted a matching-to-sample paradigm ("Do as I do" task) from studies in apes (Custance et al., 1995; Call, 2001) and dolphins (Herman, 2002). The procedure consists of 2 phases. First, the subject is trained to carry out an action that is matched to that of a demonstrator after a simple command (Do it!). In the second phase the animal is tested with novel actions. A 4-year-old male Belgian shepherd assistance dog (Philip) learned to carry out 9 different actions after the presentation of the human demonstrator in weekly 20-min training sessions for 10 weeks (191 trials in total, 17–28 trials with each action). It should be noted that because of anatomic differences, human and dog actions were only partially equivalent in motor terms, but were functionally similar. For example, the matching action to the human demonstrator jumping into the air with 2 feet was standing on 2 hind legs in the dog. Other trained actions included turning around the body axis, bowing, lying down, barking, jumping over a horizontal rod, putting objects into a container, carrying an object to the owner, and pushing a rod from a chair to the floor. In further tests when novel sequences of actions were demonstrated, Philip displayed a considerable ability to generalize his understanding of copying, and was able to learn to use different forms of human behavior as a sample, against which to match his own, on the basis of resemblance to the demonstrated action.

In the second phase the dog was tested with complex novel action sequences. Three identical plastic bottles were put on 6 predetermined places on the floor. The owner picked up 1 bottle from one place and transferred it to one of the 5 other places. After the 'Do it!' command, the dog was able to duplicate the entire sequence of moving a bottle from one particular place to another more often than expected by chance. Thus it seems that the dog understood the action sequence on the basis of spontaneous observation alone in terms of the initial state, the means, and the goal.

Interaction between information acquired through individual and social learning

In a series of experiments, we manipulated the experience of the dogs before they were exposed to the human demonstrator. In one study using the fence of the detour task, the dogs were allowed once to obtain the target through an opening at the near corner of the fence (Pongrácz et al., 2003a). Next, dogs were divided into 2 experimental groups, one with and one without witnessing a detouring demonstrator. Only dogs exposed to a demonstrator were able to surmount the detour task within the time limit set for the observation when the opening at the near corner of the fence was no longer available.

In another study, dogs that witnessed a human demonstrator walking along one side of the fence (unambiguous detour) surmounted the problem mainly by using the same side of the fence. In contrast, dogs that had either the previous experience of detouring the fence or witnessed a demonstrator walking along both sides of the fence (ambiguous detour), did not show such preference (Pongrácz et al., 2003b). This was true for dogs that were unsuccessful in the first trial and accomplished the demonstration in the second and third trials, and for those that accomplished the demonstration before the first trial.

In a third study, we tested the willingness of a dog to follow a demonstrated action if a not demonstrated, although more straightforward, solution was available. Most dogs continued to detour the fence even when the easier, direct access through a door opening at the tip of the fence was presented to them. However, dogs that were given only a single demonstration of detour, abandoned detouring sooner and chose to get to the target through the doors (Pongrácz et al., 2003a).

In general, dogs attempt to solve a problem in their own idiosyncratic way; however, at the same time they are keen to learn by observation that may improve their performance in cases when their experience fails. Dogs with little or no experience of detour were more likely to copy the human demonstrator's action, especially if it provided unambiguous information.

Possible use of learning by observation of others in some training tasks

There is strong evidence that dogs are able to learn by observation both from con- and heterospecific demonstrators. It is clear that this trait could support synchronization of dog–human interaction, especially in collaborative situations. On this basis, however, one could also envisage ways by which this ability can be deliberately used to enhance behavioral and cognitive skills in dogs.

Early social learning and skill acquisition

There are some behavioral observations that teaching might be present among wild canids. For example, Macdonald (1980) described observing a red fox *(Vulpes vulpes)* cub repeatedly using a 'mouse jump' (the forequarters rise high and the forefeet and nose descend vertically on the prey) to catch earthworms without success. Suddenly its mother caught an earthworm. She did not pull it out completely from its burrow but let her cub grab at it. Thereafter the cub started to use the vixen's technique: moving slowly with frequent pausing and then rapidly plunging the snout into the grass and grasping the prey. Similarly, dingos (*Canis lupus dingo*) provide their pups with rabbits and create the opportunity for pups to approach them closely. One female even coached the pups during stalking (Corbett, 1995).

These observations and present experimental evidences offer new perspectives in training methods. However, this idea is not entirely new, because overland men have used such processes in training naïve juvenile dogs. There are at least 2 possible situations in which one can enhance the capabilities of juveniles through social learning. First, in contrast to the traditional view that puppies should be separated from their mother at the age of 6–8 weeks, data suggest that working dogs can probably acquire several tasks from their trained mother (Slabbert et al., 1997). These results led to the decision at the South African Police Service Dog Breeding Centre in 1990 to leave pups with the mother until the age of 12 weeks (Slabbert and Odendaal, 1999). According to the experiences of the Breeding Centre, keeping the litter together with the mother for an extended period is a suggested method for commercial dog breeders too, for reducing separation stress, which could cause a higher rate of disease susceptibility (Slabbert and Rasa, 1997).

The second perspective is in the conservation of wild canids. For example, captive-reared wild dogs gradually starved after reintroduction into Etosha National Park, as they were not able to defend their own kills from other predators (Scheepers and Venzke, 1995). It is not clear that the lack of knowledgeable adults or the insufficient asocial experience produced this outcome. The rate of successful reintroductions could be enhanced by adding experienced conspecifics to the captive-reared group before release.

New training methods

Owners spontaneously use their dog's social learning ability in everyday life. For example, when one wants the dog to touch an object he/she usually touches it during the training. However, there is now evidence that this method ("rival training") can be used as a form of training (McKinley and Young, 2003). The idea is based on the assumption that social animals are able to learn by evaluating a complex social interaction (Pepperberg, 1991). The subject does not receive any reinforcement; he/she is the passive observer of the demonstrators' interaction. In Pepperberg's experiments (1999), a human partner plays the role of the 'Model,' who presents and names a new object and gives it to the other person, called the 'Rival' (i.e., the rival of the subject, because the subject never gets the object even if it wants to). The Rival observes the object, utters the name, and gives it back to the Model. This event is repeated several times, depending on the interest of the subject. This "rival training" was very effective in a grey parrot (Pepperberg, 1999). McKinley and Young (2003) observed that dogs perform equally when trained by operant conditioning or rival training. However, Cracknell et al. (2008) found that dog's learning the name of a new object is quicker when interactions during training are kept simpler than training them by the model-rival method. In any case this method could facilitate learning about the environment in dogs through the guidance of humans.

Studies have shown that the "Do as I do" task can also be very useful in making dogs understand that human behavior can be a sample to learn from. Dogs that acquired the rules of the task will learn rapidly to use certain actions in a novel situation after human demonstration (Topál et al., 2006).

How to facilitate the emergence of social learning?

Dogs are usually discouraged from spontaneous behavior that inhibits learning from others by observation. Therefore, if one would like to enjoy the advantages of owning a good "social learner" dog, he/she has to facilitate early sensitivity to ostensive-communication cues from puppy age. The owner has to be responsive to the gaze orientation of the puppy and reward it with his/her own appropriate behavior. As a consequence, the dog learns to orient its gaze at the owner for long enough to attend complex actions shown by the human. In parallel, dogs should be given specific experience in situations in which the human acts as a demonstrator and encourages the dog to copy the action. To prevent uncontrolled proliferation of this tendency in the dog, one can use specific situation-setting signals (Do it!). Social learning is a natural part of the dog's social skills, thus giving them an opportunity to use this will certainly increase their life enrichment.

Conclusion

We conclude that dogs are able to obtain information of varying complexity by observing either a human or dog demonstration, including cases in which the goal or the result of the action is not clear. Behavioral conformity may enhance the efficiency of interactions among group members and dogs probably have been selected for a willingness to attend to the behavioral actions of both humans and conspecifics.

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