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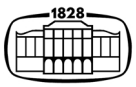

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OBEYING SOCIAL RULES: A COMPARATIVE STUDY ON DOGS AND HUMANS*

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Abstract. Here we suggest that subjects' performance in a traditional object permanence paradigm could be based on the contribution of different cognitive capacities such as (1) the ability to represent an object mentally in case of invisible displacements; (2) the ability to use appropriate deductive inferences; (3) the ability to use associative learning and local rules or cues; and (4) the presence of appropriate motivation to solve the task. In addition to these, there is another factor that may contribute to the performance, at least in some social species: (5) the ability to identify and use social rules that are formed by the interaction with the experimenter during the consecutive object hiding and search tasks. Experiment 1 was designed to demonstrate that such social rules may have an independent influence on the performance of both human and dog subjects during consecutive object hiding and search tasks. The behaviours of adult and preschool humans and adult pet dogs were compared in a modified version of the successive invisible displacements task (no object condition) and in a similar task in which, however, the location of the target object was well known by the subjects (game condition).

During the no object condition most of the humans and dogs performed a full and systematic search of all potential hiding places. However, results in game condition indicate that Piagetian object permanence tests may be interpreted by both dogs and humans not only as object hiding and finding tasks, but, alternatively, as social-behavioural games of different sorts that may contribute to the systematic search performance. It seems that successful performance on such tasks should not be interpreted exclusively as indicating a representational understanding of object permanence and an ability for deductive inferences.

A second experiment was directly designed to demonstrate the influential effect of social rules in the object hiding and finding tasks. Results show that the functional 'opacity' of the HIDER's behaviour (i.e., performing both functionally relevant and irrelevant actions upon hiding) enhanced the emergence of 'obeying social rules' (i.e., dogs tended to perform search behaviour, although they knew the location of the target object). We suggest that during their domestication dogs may have been selected for certain human-like capacities such as recognising and following social rules in the context of interacting with humans.

Keywords: dog, cognition, obeying rules, social behaviour

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INTRODUCTION

In humans rule-following behaviour is one of the mechanisms for synchronisation of group behaviour and at the simplest level it can be considered as a behavioural tool for minimising conflicts. There is a hierarchy of rules from very simple behavioural rules to more complex cultural rules in our species, and various forms of rules are tied to our linguistic communication system, i.e., they can be formalised in language. Following a rule is closely connected to the rank order of the group. Forming and keeping a rank-order is transformed into a new organizational level by obeying a depersonalized dominance. The dominant individual is substituted by a socially accepted rule (CSÁNYI 2000). DE WAAL (1996) suggested that the context of rule learning is either agonistic, when obeying the rules minimize the negative consequences in social interactions or collaborative (play, cooperation, communication), which leads to maintaining social interaction.

A social rule is a mental construction which can be formed by the observation of the behaviour of others and this mental-constructional skill might be an important factor for the development of moral systems (FLACK and DE WAAL 2000a, b).

In non-human animals, however, the term "social rule" has a different meaning. Social rules can be mastered by two means: (I) Prescriptive rules are upheld by reward and punishment, as it was shown, for instance, in cases where dominant-submissive interactions are controlled by social rules (see e.g., "respect of possession" studies on macaques – KUMMER and CORDS 1991; and on baboons – SIGG and FALETT 1985). These rules are in most cases enforced and they do not apply equally to all members of the community (i.e., they are not reciprocal). (II) Descriptive rules, however, are formed without an exterior constraint, such as when females defend their offspring from conspecifics in aggressive situations (DE WAAL 1991). Descriptive rules describe a typical response to a specific social situation, while the statistical regularities of prescriptive rules are perceived, complied with and/or enforced by the individuals (FLACK et al. 2005). In highly social species following social rules could lead to more flexible and complex group-hunting, sharing resources and picking up behavioural traditions.

There are three main factors in nonhuman (social) species that are supposed to have an enhancing effect on the emergence of social rules: (I) flexible motor patterns (trainability), (II) dependence on social mimesis, (III) ability of role reversal (e.g., in play or in cooperation) and (IV) acceptance of division of resources (e.g., food sharing). In line with this approach, DE WAAL (1996) suggested that dogs are an ideal subject for social rule investigations. "Canids have an excellent sense of social rules, which allows for order within the hunting pack and explains their trainability for human purposes..." (DE WAAL 1996, p. 94).

Moreover many assume that over the course of domestication dogs acquired behavioural and cognitive traits that enabled them to adapt to human social life (MIKLÓSI et al. 2004; TOPÁL et al. 2005). Human social living is challenging for dogs by virtue of its complex social nature and linguistic communication system, and this environment might represent a selection pressure (see SCHLEIDT 1998; PAXTON 2000) for the so-called social understanding involving the propensity for recognising and following social rules in the context of interacting with humans. Recent observations suggest that dogs show sophistication in situations where they acquire information from humans.

It has been reported, for instance, that although dogs were not able to learn how to solve a detour task around a V-shaped fence by trial and error learning (even after 6 repeats), they were able to master this task after a single human demonstration (PONGRÁCZ et al. 2001). Dogs tended to follow the learned solution of this task even if a simpler way, a shortcut through the fence was opened for them (PONGRÁCZ et al. 2003) and were also able to rely on information provided by a demonstrator dog going around the fence.

Dogs can also learn effectively from human demonstrators in manipulative tasks (KUBINYI et al. 2003b) and via observation of their human master they also show evidence of establishing a habit like a detour having no obvious goal (KUBINYI et al. 2003a). Namely, when dogs could witness a causeless detouring behaviour of their owner after their usual daily walks, they gradually started to develop a similar habit, although the owner neither rewarded nor encouraged the dog's behaviour. This phenomenon was interpreted as a form of social mimetic processes that might contribute to the synchronisation of group activities and to the manifestation of cooperative actions between dog and owner. The aforementioned cases of social learning suggest that dogs are not only skilful in forming associations between human behavioural cues and some motor responses, but also show an ability to understand the constituents of the problem situation in the form of recognizing social-behavioural rules.

The experiments of the present paper are based on object permanence tests that were originally designed to study human infant cognitive development (PIAGET 1937). Within the Piagetian tradition, UZGIRIS and HUNT (1975) elaborated a stepwise procedure using object hiding and search tasks for the assessment of the development of mental representational capacity for object permanence. GAGNON and DORÉ (1992, 1993, 1994), following the initial work of TRIANA and PASNAK (1981) and PASNAK et al. (1988), have shown that dogs, like apes, can also solve the invisible displacements task. Although these findings have been questioned recently (GÓMEZ 2005), it is still debated whether in these tasks dogs are guided by simple associative rules rather than the mental representation of the object's past trajectory (COLLIER-BAKER et al. 2004). In our view, when solving an object permanence task subjects' performance could be based on a number of different cognitive capacities

such as the ability (1) to represent an object mentally at least during the duration of the test; (2) to use appropriate deductive inferences; (3) and to use associative learning and local rules or cues. The presence of appropriate motivation to solve the task (4) could also be an important factor in the successful solution of the problem. In addition to the above, in this paper we focus on an additional factor that may play an important role in determining subjects' performance – the ability to identify and use social rules which are formed by the interaction with the experimenter during the testing procedure. In the object permanence paradigm subjects are presented with a number of trials during which the experimenter hides an object behind one of the screens in more or less complicated ways. At the beginning of the hide-and-search trials subjects (children or animals) are ignorant of the specific goals of the situation (i.e., they should focus on the hiding procedure in order to get relevant information on the baited location). Many assume that repeated trials lead to subjects' gradual learning to use relevant 'local rules' or cues when searching for the hidden bait (GAGNON and DORÉ 1993).

However, if a subject considers the consecutive trials as a social situation, which involves a more or less complex game regulated by a social rule-system (e.g., 'he hides, I search'), then not only the represented location of the object, but also the observed behaviour of the experimenter and the subject's tendency to form expectations about the social rules of the task may significantly influence the observed performance. In other words, the search behaviour may not only be guided by the subject's mental representations but may also be influenced by its ability to recognize and obey social rules.

The present study was therefore designed to demonstrate that social rules identified by dog/human subjects during the consecutive trials of an object permanence test may have an independent influence on their performance in case of both humans and dogs. In the first experiment we applied a modified version of the Stage 6 successive invisible displacements tasks. The standard procedure for this is that an object is first hidden in a container in front of the subject, then the container is successively moved behind several screens under one of which the object is surreptitiously released. Finally, the empty container is shown to the subject who can then proceed to search for the object under the screens. Successful Stage 6 performance is scored when the subject exhibits "systematic search" which involves looking under all and only those hiding places where the object could have been deposited. In the following trial, similarly to the second experiment, we investigated whether dogs show evidence of understanding and following social-behavioural rules in interaction with humans.

EXPERIMENT I[1]

Methods

Subjects

Since active and volunteer participation in trials was essential, some subjects were previously excluded because of insufficient motivation or attention. Six children and 11 dogs proved to be resistant: they refused to search or retrieve the object during the introductory shaping trials. After their exclusion, our three groups of subjects consisted of 24 adult students (16 females and 8 males between 18–27 years of age; mean age ±SD: 21.7 ± 2.2), 24 preschoolers (14 girls and 10 boys between 4–6 years of age; mean age ±SD: 5.4 ± 0.6) and 19 dogs (8 females and 11 males between 1.5–7 years of age; mean age ±SD: 3.2 ± 1.5; 11 Belgian shepherds, 3 Labradors, 4 Golden retrievers, 1 Doberman pincher).

Experimental arrangement

The different conditions of the experiment were carried out in environments moderately familiar to the subjects: students were tested in a room at the Eötvös Loránd University, children were observed in a room of their nursery school, while the dog subjects were tested in an enclosure at the training school that they attend at weekends together with their owners.

The experimental arrangement is shown in *Figure 1*. Three green plastic screens (frontal side: 40 × 60 cm) were placed along a semicircle and a plastic non-transparent flower-pot (20 cm deep, 15 cm in diameter) was used as a container. An experimenter, a cameraman, an assistant and the subject were in the room during the trials. The assistant was the owner of the dogs and a nurse familiar to the children.

Procedure

Both dogs and humans were treated identically, so neither the preschoolers nor the adult students received any specific instructions about the nature of the task before the trials of the experiment began. "We shall perform an experiment, please act as you feel appropriate!" – they were told. After entering the room, the subjects were

[1] Some of the dogs' and children's data presented here (Shaping and No object conditions) have been published in WATSON et al. (2001).

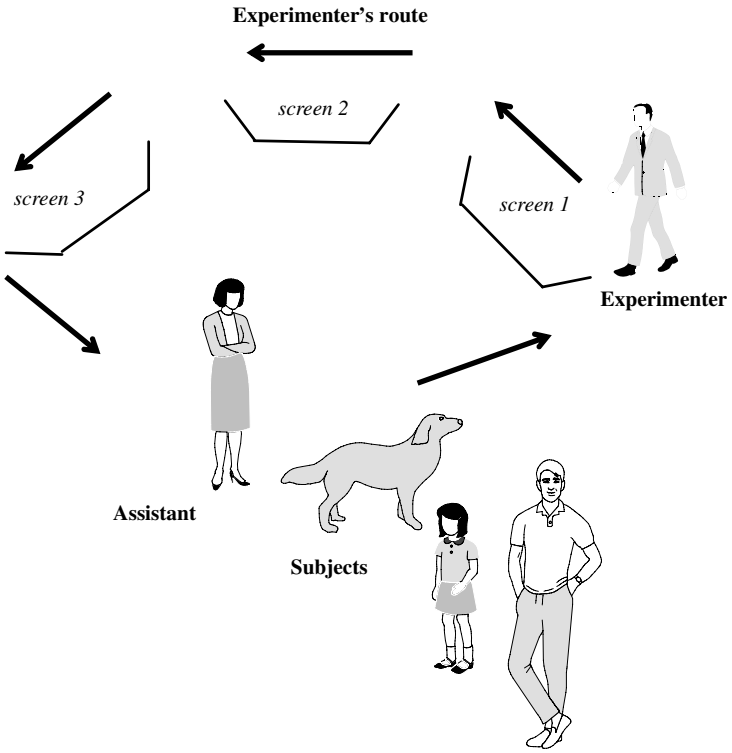

Figure 1. Schematic representation of the experimental arrangement

allowed to explore the environment for a minute. The assistant showed several different objects to the subject, trying to arouse interest in them. The target object to be used was either a small rubber bear, a plastic dog, a plastic baby doll or a small ball depending on which one of these the subject showed most interest in. Then the assistant got the subject to sit down in the middle of a circle. The experimenter caught the subject's attention with the target object in hand and then proceeded to place the object into the container. The experiment consisted of three phases: shaping, no object condition and game condition.

Shaping

During the introductory shaping trials six successive visible displacements were administered. The experimenter went behind the first screen, came out, went behind the second one, came out again, then behind the third one and out again with the object made visible between screens, provided it was still in the container. Care was taken to make sure that the subject was clearly attending to and following each step of manipulation. In half of these trials (during the second, fourth, and sixth trials) the

experimenter visited all the three screens sequentially but the object remained in the container throughout. In the other half of the trials (i.e., during the first, third and fifth trials), while walking behind screens 1, 2, 3 in consecutive order, the experimenter randomly left the object behind one of them. When the experimenter returned, he placed the container in front of the subject for inspection and then the assistant called upon the subject to search for and retrieve the toy. If the object was retrieved, the subject was praised by the assistant.

No object condition

The shaping trials were followed by a modified version of the standard successive invisible displacements task. This was similar to the shaping trials in which all the three screens were visited, except that now the displacements of the target object were invisible, i.e., the content of the container was *not* revealed between visiting the screens. In fact, the target object was not left under any of the screens as the experimenter, while he was hiding the container behind one of the three screens, placed the toy surreptitiously in his pocket. Therefore, at the end of this trial not only was the container presented, but also all of the three hiding screens were empty. When the experimenter returned, the empty container was shown to the subject, and the assistant allowed the subject to move freely without, however, giving any specific instructions to search for or retrieve the object. So the subject was allowed to search some or all of the containers freely for a minute or, in fact, to engage in any other type of behaviour, while performance was videotaped. After a minute the hidden toy was presented to the subject by the experimenter. It was taken visibly from his pocket, so the subject could realize that it was fooled.

Game condition

This was identical to the no object condition, except for the fact that before the trial began, the experimenter gave the object clearly visibly to the assistant, who first caught the subject's attention with it, and then put it in his/her pocket. So, during this condition the real location of the object was obvious and known to the subject throughout the whole procedure. Then the experimenter went on to perform the same series of acts of hiding behind the screens as in the no object condition, this time, however, with an empty container in hand. This control condition was designed to determine, whether the experimental procedure was interpreted by the subjects as an object-oriented task with the aim of finding and getting the object the target toy, or as a game regulated by social rules that the subject needs to follow *(Table 1)*. The behaviour of the subjects in each condition was videorecorded for later analysis.

Table 1. Proportion of subjects (%) following the different hypothetical rules during the game condition

Rule I: 'get the object' – behaviour: no inspection.
Rule II: 'follow the experimenter's route' – behaviour: 'forward', sequential searching.
Rule III: 'produce searching behaviour' – behaviour: scattered exploration.

	Rule I	Rule II	Rule III
Dogs (N = 19)	25	21	54
Children (N = 24)	50	29	21
Adults (N = 24)	54	41	5

Behavioural variables

In the Shaping, No object and Game conditions different aspects of subjects' behaviour were recorded and analysed.

Shaping trials:
Only the *"Number of errors"* was recorded (i.e., if the first choice was an empty screen) and compared.

No object condition:
The subjects' *"First choice"* (i.e., the location of the screen inspected firstly) and the *"Order of visited screens"* were recorded. Subjects were scored on the basis of whether they show systematic/sequential search behind all the three screens (score: 1) or a non-systematic search (score 0).

Game condition:
The *"Number of subjects performing a search"* was recorded. Moreover, in case of dogs the *"Time spent with examining the screens"* (i.e., the time spent with exploring the ground behind the screens – sec.) and the *"Number of glances at the Owner"* (i.e., number of direct head orientations towards the owner) were also recorded.

Results and discussion

Shaping
During the successive visible displacements, a trial was considered correct if the subject's first choice was the screen containing the object or the container when the object remained in it (2nd, 4th and 6th trials). Although dogs chose the screen containing the target object more frequently than it was expected by chance (frequency of correct choices: 0.49 vs. 0.33 chi^2 (1) = 5.7, $p < 0.017$), they made more mistakes during the shaping trials than children (Mann–Whitney U-test: $Z = 2.96$, $p = 0.003$)

and students. The preschoolers also made significantly more errors than did the adult students (Mann–Whitney U-test: $Z = 3.77$, $p < 0.001$).

No object condition

Since the subject has no information as to which one of the three screens may be hiding the target object, he/she/it should consider each screen as an equally probable hiding location and so would be expected to sequentially search behind each of them.

Accordingly, a representational hypothesis predicts that a subject who has a fully developed object permanence capacity should search systematically behind all the three screens during this condition. Indeed, in accordance with this prediction, most of the preschoolers and adult students and the majority of the dogs performed a full and systematic search of all three screens. The percentage of systematically inspector subjects in the three experimental groups did not differ significantly (dogs: 68%, children: 91%, adults: 91%; maximum likelihood comparisons: chi^2 (2) = 5.7, p = NS).

Note that since the probability of each screen being the actual hiding place for the object is equal, the representational model provides no reason to prefer any one of them. But both dogs and humans exhibited clear screen preference as their first choice for inspection. Most of the dogs (12/19) first inspected the screen that was visited last; as if they followed the local rule of 'go to the screen last manipulated by the experimenter'. The preschoolers searched systematically either in a backward direction (13/24, i.e., similarly to dogs, starting from the last visited screen and proceeding backwards) or in a forward direction (10/24), starting from the first screen visited by the experimenter, as if they acted according to the local rule of 'follow the experimenter's route'. In contrast, the dominant search strategy of adult students was a systematic forward search (22/24), starting from the first screen visited by the experimenter.

Game condition

Since in this condition no object was hidden into the container when visiting the screens, based on the representational hypothesis no search behaviour behind the screens was expected. This should be so as long as the task is interpreted as being solely about finding the hidden object and assuming that the subjects are able to remember by the end of the trial where the object was last seen (i.e., in the owner/assistant's pocket). Nevertheless, a considerable number of adult students (11/24; 45.8%), preschoolers (12/24; 50%) and dogs (14/19; 73.7%) performed a search behind the screens despite the fact that earlier they had witnessed the placing of the object into the pocket of the assistant.

However, there were important differences between certain aspects of the search behaviour elicited in the No object condition versus the Game condition, respective-

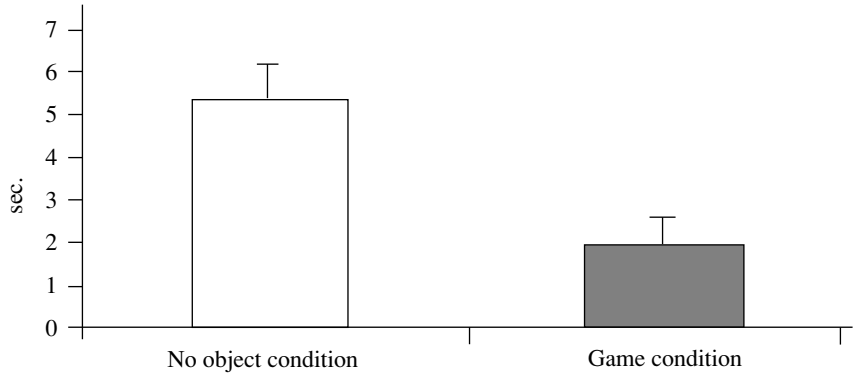

Figure 2. Time spent with the examination of the screens (mean±SE) in the dogs during the No object and Game conditions

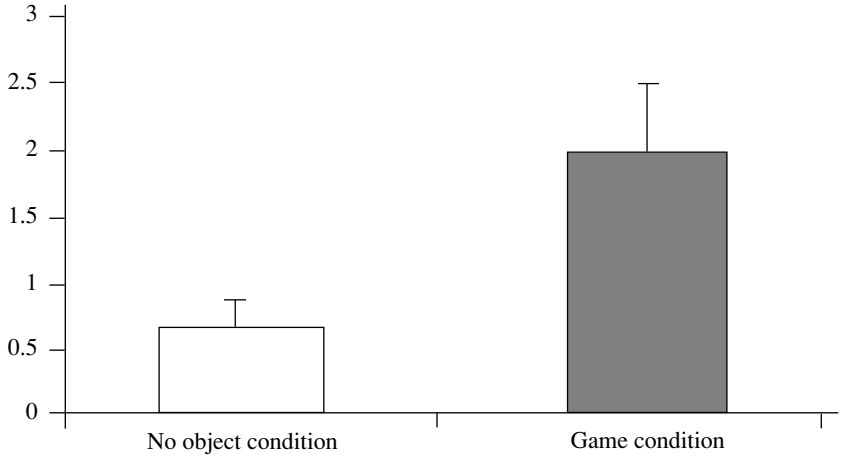

Figure 3. Number of glances at the owner (mean±SE) by the dogs during the No object and Game conditions

ly. Thus, during the Game condition both dogs and humans of different age inspected the screens systematically less frequently than during the No object condition [WILCOXON matched pairs test: $Z(19) = -3$, $p = 0.0027$ for dogs; $Z(24) = -3.05$, $p = 0.0023$ for children; $Z(24) = -4.58$, $p < 0.0001$ for adults – *Figure 2*].

Following the Game condition the adult students as well as the preschoolers were asked about the real location of the object which they could correctly recall in all cases. This indicates that the search behaviour observed in such cases was *not* aimed at getting the target object. More importantly, a comparison of the dogs' behaviour during the No object and Game conditions, respectively, suggests that they were also aware of the location of the target object. *Figure 3* shows that, compared to the No object condition, during game condition searching dogs spent significantly less time with examining the screens (two sample *t*-test: $t(26) = 4.05$, $p < 0.001$) and during search they glanced more frequently at their owner (two sample *t*-test: $t(26) = 3.32$, $p = 0.0026$) in whose pocket the object really was. Therefore it seems that the behaviour of both dog and human subjects in the game condition was the result of identifying and following a social rule of a game rather than the consequence of lacking appropriate representational capacity.

What kind of social rule determined the subjects' search behaviour in the game condition? Based on their search behaviour subjects could be categorized into 3 main groups. In the Game condition some of the subjects seem to have assumed that the task was about finding and retrieving the target object. These subjects (21–41% of all subjects – see *Table 1*) *did not* search behind the screens during the Game condition, as they probably knew well that the target object was at a quite different location, but instead they stayed close to the ball orientating towards the owner/assistant. In contrast, the other subjects did search the screens; some of them in fact exhibited a systematic sequential search behind all three screens starting from the first screen visited by the experimenter, while others showed a more diffuse search pattern *(Table 1)*. These latter subjects searched not only behind some of the screens, but other places in the room as well, irrespective of the real location of the target object. It seems that in the Game condition dog/human subjects' search behaviour was guided by different hypothetical rules in comparison to the No object condition. During the Game condition none of the subjects produced the kind of systematic search that started at the last screen manipulated by the experimenter, even though such a search pattern was observed quite frequently both in dogs and preschoolers during the No object condition (i.e., when they believed that the object was indeed hidden under one of the screens).

This finding suggests that the "forward sequential search" pattern observed in the Game condition was not driven by the aim to find the target object, but rather, it was generated by the social rule to "follow the experimenter's route".

EXPERIMENT II

In the first experiment we found that dogs (similarly to human subjects) tended to show searching even when the ball was obviously not hidden behind the screens. This behaviour, a "habit" having no obvious goal, has probably been developed as a result of the experimenter's behaviour demonstrations (i.e., performing the same behaviour sequence repeatedly upon shaping trials). The question, however, why a large proportion of dogs in the above experiment decided to choose an "aimless" search between/behind the screens instead of showing a goal oriented behaviour (i.e., trying to get the ball from its well-known place) needs for further clarification. The "social rule" hypothesis described in the first experiment leads to specific predictions with respect to the dogs' behaviour.

First, a basic precondition for the development of any "social-behavioural" rule in a hide-and-search task is that the dog should focus not only on the movement of the object behind the screens upon hiding but on the *behaviour* of the human demonstrator, too. That is, eliminating the social nature of the hide-and-search task (i.e., when no human is involved in the hiding process) dogs should not show search behaviour in a situation where the reward is not hidden (Game condition).

Moreover, in a social "version" of the hide-and-search task the emergence of "rule following behaviour" in the dog (i.e., willingness to search in a situation where no reward is hidden) can be facilitated by the repeated and stereotypic nature of the demonstrated hide-and-search tasks and by the increase of non-relevant elements in the demonstrated action sequence (i.e., intricate behaviours upon hiding the ball).

In the following experiment we aimed to study the aforementioned predictions, and experimental groups were also designed to exclude the possibility that the emergence of search behaviour when there is no hidden reward is due to the dogs' limitations in working memory.

Subjects

Fifty-four adult pet dogs participated in this experiment. The dogs and their owners were recruited on a voluntary basis in dog training schools. The only criterion for selection was that the dogs had to be highly motivated to play with a tennis ball, therefore prior to the experiment the owner was asked to perform 3–4 retrieval task with his/her dog.

Experimental arrangement

Three screens (frontal side: 40×25 cm, green plastic) were staged in line, 1 m distance in between. There was a stool 3 m behind the middle screen. Dog, owner and

experimenter stood at a distance of 5 m in front of the middle screen. A Panasonic DV camera stood on a tripod 5 m behind the first screen.

Procedure

The experimental procedure consisted of two phases: Shaping trials (6) and Game trial (1). Groups were designed to analyse the effect of different conditions (Shaping trials) on the dogs' willingness to show "social-rule following" in the subsequent Game trial. The following 5 experimental groups were tested:

Simple route, pretended hiding without ball (Simple – No Ball)
(N = 11, 7 males, 4 females, age = 2.5 ± 1.0, 5 Belgian shepherds, 3 Mongrels, 1–1 German shepherd, Airedale terrier, Dachshund).

Shaping
During the first shaping trial the experimenter drew the attention of the dog to the ball, and went to the first screen while the ball was constantly visible in her right hand. Then she crouched behind the screen, put the ball down, and returned, showing that her hand is empty. The owner said: "Bring it to me!" ("Hozd!" in Hungarian) only once. After the dog retrieved the ball the owner gave it back to the experimenter. Then the experimenter hid the ball behind the second screen and finally the same sequence of actions was repeated for the third screen. The whole procedure was repeated (altogether 6 trials).

Game trial
The experimenter caught the dog's attention with the ball in her hand and then slowly placed it into the owner's palm, who put it behind his/her back. Then the experimenter went to the first screen, constantly showing her empty hands, and crouched behind the screen, but did not put down her hands so the dog could always see them. After it she went back to the dog and the owner let the dog free while saying: "You can go!" ("Mehetsz!" in Hungarian). The dog was allowed to move freely for 30 sec while the owner remained at his/her predetermined position and did not give any gestural or verbal signal to the dog.

Intricate route, pretended hiding without ball (Intricate – No Ball)
(N = 11, 6 males, 5 females, age = 2.3 ± 1.1, 5 Belgian shepherds, 2 Mongrels, 1–1 German shepherd, Great schnauzer, Leonberger, Golden retriever).

Shaping
During the first shaping trial the experimenter drew the attention of the dog to the ball, and before putting down the ball behind the first screen, she first walked round the stool behind the screens, while the ball was constantly visible in her middle-held right hand. Then she crouched behind the screen, put the ball down, and returned, showing that her hand was empty. The owner said: "Bring it to me!" ("Hozd!" in Hungarian) only once. After the dog retrieved the ball, the owner gave it back to the experimenter. The experimenter repeated the process with screens 2 and 3. Six such shaping trials have been performed.

Game trial
The procedure was identical to that used in "Simple – No Ball" group.

Intricate route, pretended hiding with ball (Intricate – Ball)
(N = 11, 9 males, 2 females, age = 2.9 ± 2.1, breeds: 4 Belgian shepherds, 3 German shepherds, 1–1 Collie, English setter, Labrador and Boxer).

Shaping
The procedure was identical to that of described in "Intricate – No Ball" group.

Game trial
The procedure was identical to that described for "Intricate – No Ball" group, except that the experimenter took the route *with* the ball in her hand and gave it to the owner only *after* visiting the screens.

Intricate route, pretended hiding with ball, 25 sec delay (Intricate – Ball – Delayed)
(N = 10, 3 males, 7 females, age = 2.4 ± 2.4, breeds: 3 mongrels, 2 Belgian shepherds, 1–1 Sheltie, Airedale terrier, Hungarian vizsla, Cocker spaniel, Mudi).

Shaping
The procedure was identical to that described in "Intricate – No Ball" group.

Game trial
The procedure was identical to that described in "Intricate – Ball" group, except that the owner did not release the dog when the experimenter returned, only after 25 sec elapsed (that was the mean time of walking the path by the experimenter).

Throwing the ball
(N = 11, 6 males, 5 females, age = 2.6 ± 1.6, breeds: 5 Belgian shepherds, 2 German shepherds, 1–1 Hungarian vizsla, Pumi, Mudi, Mongrel).

Shaping
An adult man sat on a stool during the experiment. The experimenter threw the ball to the man, who rolled it behind the first screen. The owner said: "Bring it to me!" ("Hozd!" in Hungarian) only once. After the dog retrieved the ball the owner gave it back to the experimenter. Then the ball was hidden behind the second screen in the same way and finally the same sequence of actions was repeated for the third screen. The whole procedure was repeated (altogether 6 trials).

Game trial
The experimenter threw the ball to the man sitting on the stool who threw it back to the experimenter. Then she caught the dog's attention with the ball in her hand and slowly placed it into the owner's palm, who put it behind his/her back. After it the experimenter commanded the dog: "You can go!" ("Mehetsz!" in Hungarian).
According to the aforementioned predictions we expect that those dogs should show the highest tendency to perform search behaviour in the test trial (i.e., when the ball is not hidden) who witness an ***f0intricate*** hiding route and the pretended hiding is demonstrated *without ball* ("Intricate route, pretended hiding without ball" group). In comparison to these subjects, when the hiding route is more goal-directed ("Simple route, pretended hiding without ball" group) or the pretended hiding is shown by the experimenter with the ball in her hand ("Intricate route, pretended hiding with ball" group), dogs should show a weaker tendency to perform search behaviour in the test trial (Game condition).

Moreover, in an 'asocial' version of the hide and search task, that is, when no human is involved in the repeated hidings, dogs should not show search behaviour in the situation where the reward is not hidden ("Throwing the ball" group).

RESULTS AND DISCUSSION

Shaping trials
We analysed the latency of getting the ball in the repeated trials (within subject factor) and the experimental group (between subject factor) with mixed ANOVA for repeated measures of the within subject factor. Further, we used Student-Newman–Keuls post hoc tests (between groups comparisons). The groups showed significant differences (dogs in the 'Throwing' group get the ball sooner than the others; $F_{4,49} = 5.864$, $p = 0.001$), but neither the repeating nor the interaction proved to be significant ($F_{5,49} = 1.53$, $p = 0.181$ and $F_{5,49} = 0.282$, $p = 0.888$ respectively).

Regarding the number of erroneous choices (an error was recorded if the dog visited a non-baited screen or the stool before the baited screen) we found significant differences between groups. Dogs in the "Throwing the ball" group made signifi-

cantly less errors than subjects in the "Simple – No Ball" and "Intricate – No Ball" groups (Kruskal Wallis test with DUNN's post hoc test: $chi^2 = 21.165$, $p = 0.0003$) It seems that dogs could focus on the visible displacement task better when the ball was thrown between the target locations instead of transferring it by a human.

Game trial

The focal question regarding subjects' behaviour in the Game trials was whether dogs leave their owner (who holds the ball) and perform search behaviour around the experimental area or remain in the close vicinity of the owner. Subjects leaving the vicinity of the owner (< 1 m) within 5 seconds after the command ("You can go!") and starting the search were categorized as "Searchers".

We should note that in the 6th shaping trial each dog (in all groups) was categorized as "Searcher" (i.e., left the owner and retrieved the ball). In the Game trial, the majority of dogs (64%) in the "Intricate – No Ball" group were categorized as "Searcher". In this case the number of "Searcher" individuals in the Game trial did not differ significantly from the frequency of searchers in the 6th shaping trial (McNemar test, $p = 0.125$).

The same comparisons show, however, that subjects' behaviour significantly changed in all of the other groups as the majority of them did not leave the owner (i.e., the ball).

That is, when the hiding route of the human demonstrator was goal-directed ("Simple – No Ball" group), only 27% of the subjects were categorized as "Searcher" in the Game trial (comparison with the last shaping trial: McNemar test: $p = 0.008$). Similarly, when the pretended hiding in the Game trial was demonstrated with the ball in hand ("Intricate – Ball" group), only one third of the dogs (36%) performed searching behaviour in the Game trial (McNemar test: $p = 0.016$) and this ratio was only 10% when the dog had to wait 25 seconds after the demonstration ("Intricate – Ball – Delayed" group; comparison with the last shaping trial – McNemar test: $p = 0.004$). This latter observation suggests that dogs could keep the location of the ball in their working memory. Moreover, when the hiding process was asocial ("Throwing the ball" group) none of subjects searched in the Game trial (i.e., all dogs stayed next to the owner – McNemar test: $p = 0.001$)

All of these suggest that dogs left the owner (and the ball) more frequently when previously they had been trained for a hide-and-search task using a more sophisticated way of object hiding, provided that the experimenter accomplished the test trial without the ball in her hand. It seems that the ball in the hand during the test trial (pretended hiding) maintained the dogs' attention on the ball and therefore dogs preferred the "get the object" strategy (waiting for the ball near the owner orientating to her/his) when they were allowed to choose. Searching when the reward is not hidden behind the screens was not due to working memory problem as dogs could recall

where the reward had been seen even after 25 sec (i.e., 90% of the dogs in the "Intricate – Ball – Delayed" group did not leave the owner in the test trial).

As predicted, when the social-behavioural component of the hide-and-search task was removed (Throwing the ball group), dogs seemingly favoured the "get the object" strategy versus "social-behavioural" rule following (i.e., search behaviour) in the game condition.

GENERAL DISCUSSION

Stage 6 object permanence, as one of the major achievements of early cognitive development, has been assessed by a variety of experimental methods (PIAGET 1937) and performance on such tasks has been measured on a standardized scale (UZGIRIS and HUNT 1975). Success in the Stage 6 invisible displacements tasks by two-year-old infants and older human subjects has typically been interpreted as indicating a mature mental capacity to represent the permanent and independent existence of objects and an ability to use deductive inference to mentally reconstruct the invisible changes in a displaced object's spatial position.

However, as PIAGET himself repeatedly pointed out, solving the invisible displacements task does not necessarily imply the use of a mental representational model generated by deductive inference (PIAGET 1937). In fact, as recent studies using different nonhuman species demonstrate, the Stage 6 object permanence problem can be successfully solved by non-representational means as well, such as associative learning and the reliance on local rules or cues (e.g., NATALE et al. 1986; TOMASELLO and CALL 1997; WATSON et al. 2001; COLLIER-BAKER et al. 2004; GÓMEZ 2005).

In this paper we have hypothesized that successful performance on such tasks may also be influenced by an additional factor, namely, the subjects' propensity to obey social rules of a task that is interpreted as a behavioural game. According to this view, the subsequent trials of different hiding procedures can be construed by the subjects as a social game regulated by a behavioural rule system that they infer from the experimenter's actions. The present study was designed to demonstrate the effect of such social rules on the performance of dogs as well as humans in an object permanence task.

The paradigmatic element of our experiments is that we used a shaping procedure involving a series of visible object displacements (i.e., hide-and-search tasks) to familiarize our subjects (both dogs and humans) with the experimental situation. In accordance with former studies (e.g., WOOD et al. 1980; GAGNON and DORÉ 1992) we found that not only humans of different ages but also dogs fulfilled the standard criteria for successive visible displacements tasks (Stage 5 object permanence),

showing results significantly above chance performance in the shaping trials. However, as the findings in the Game condition indicate, systematic sequential search is not a sufficient criterion for demonstrating representational understanding of object permanence, as such a search pattern ('forward' sequential search – see *Table 1*) has also been observed in a significant number of subjects even when no object was hidden under the screens and the subjects were demonstrably aware of the actual location of the target object. That is, in the Game condition only a minority of subjects seemed to perform a goal-directed behaviour (i.e., the "find and retrieve the target object" rule) while the others' behaviour can be described on the basis of either "perform search behaviour similar to that of the experimenter" or "perform aimless search behaviour" rules. We suggest, therefore, that systematic search in the game condition can be seen as subjects' susceptibility to interpret the hide-and-search tasks as a situation involving rules of a social game.

The observed differences in the behaviour shown in the No object and Game conditions (Exp. I) give further support for the assumption that dogs and human subjects are sensitive to the "game-like" nature of the situation. While even dogs have shown some degree of representational understanding of object permanence in the No object trial, they performed less goal-directed behaviour in the Game condition ("aimless" search despite the fact that the location of the reward is well known).

Experiment I has shown that both humans and dogs created and followed some sort of a social rule in the context of the object permanence test. However, this experiment did not reveal the underlying mechanisms. Human subjects could give follow-up comments on their own behaviour, but these explanations did not point out exactly what kind of factors urged them to produce search behaviour. Usually all they said was that they thought they should search because of the behaviour of the demonstrator... The "forward sequential search pattern" observed in the Game condition suggests that the *way of hiding* behaviour (in the Shaping trials) is probably the key-component for the emergence of the "aimless" search behaviour (i.e., obeying social rule) in the subsequent Game trial.

Unlike human subjects dogs of course could not give verbal explanation for their behaviour, therefore we decided to reproduce the findings using a simplified shaping procedure, where we could systematically manipulate and observe the effect of the special hiding methods. According to this, and in line with the approach proposed by DE WAAL (1991) for studying the nature of social rules, the plausibility of the "social rule" hypothesis in dogs can be studied through the direct analysis of its specific predictions.

One of these is that the elimination of the social component should lead to at least two consequences regarding the dogs' behaviour performance. First, dogs should perform better in the ball-retrieving task, because they do not divide their attention between the (intricate) behaviour of the human demonstrator and the actual position

of the ball. Second, in the Game condition, there is no reason to perform search behaviour around the screens, provided that the dog can recall that the ball is in the hand of its owner. Our findings supported these assumptions: dogs did not visit the non-baited screens during the shaping trials and did not leave the owner in the Game trial if the human demonstrator was not involved in the hiding procedure (i.e., she has thrown the ball to the screens instead of performing a hiding ritual).

Furthermore, Experiment I has raised another issue. Namely, the human demonstrator performed several salient but functionally not relevant behaviours during the shaping period. She visited *each screen* in the same sequence no matter which one was baited actually and in the Game condition, she performed a complete hiding ritual *without* the ball in her hand. This could lead to the prediction that the functionally non-relevant behaviours of the human demonstrator (in shaping and pretended hiding trials) could be a further important factor for the emergence of rule following behaviour in dogs.

Results of the second experiment support the aforementioned predictions. The tendency to perform "aimless" search behaviour was highest among those groups which could see a more intricate hiding route during the shaping trials and "hiding with empty hands" in the subsequent trial. One may assume that this was due to the dogs' limitations in working memory; however, results (with the "delayed" group) do not support this possibility. These findings coincide with our earlier observations (KUBINYI et al. 2003a), where after seeing a systematically recurring exposition of a functionally non-relevant, aimless but stereotype detour by the owner, dogs tended to take over the habit. Dogs seem to be sensitised to the recurring, but cognitively and causally "opaque" behaviour of humans.

This skill can be seen as a behavioural adaptation to a complex human environment which might contribute to the emergence of a close relationship with a different species. The willingness to follow social rules in dogs could serve as the scaffolding on which many forms of complex social behaviour between dogs and humans can develop.

In sum: it seems that the sequential visible and invisible displacement tasks that were originally designed to demonstrate a representational understanding of object permanence may be interpreted by subjects not only as object hiding and finding tasks, but, alternatively, as social-behavioural games of different sorts that may contribute to the subjects' systematic search performance. Therefore, successful performance on such tasks may be based on qualitatively rather different underlying mediating mechanisms, and so it should not be interpreted exclusively as indicating a representational understanding of object permanence and an ability to make deductive inferences.

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