Available online at www.sciencedirect.com
SCIENCE DIRECT®
ELSEVIER
Applied Animal Behaviour Science xxx (2005) xxx–xxx
APPLIED ANIMAL BEHAVIOUR SCIENCE
www.elsevier.com/locate/applanim

A friend or an enemy? Dogs' reaction to an unfamiliar person showing behavioural cues of threat and friendliness at different times

Judit Vas [b,*], József Topál [a], Márta Gácsi [a], Ádám Miklósi [a], Vilmos Csányi [a]

[a] *Comparative Ethology Research Group, Hungarian Academy of Sciences, Hungary*
[b] *Department of Ethology, Eötvös University, H-1117, Budapest, Pázmány P.s. 1/c., Hungary*

Accepted 10 February 2005

Abstract

Responsiveness of adult pet dogs (*Canis familiaris*) to an unfamiliar human was observed in two studies. Subjects were faced with an approaching woman (Stranger) who showed definite signs of friendliness and threat during alternate approaches. Observations consisted of two episodes: the Stranger either approached the dog in normal speed of walk while talking to it and finally petted it gently (Friendly approach episode) or she moved slowly and haltingly and looked steadily into the eyes of the dog without any verbal communication (Threatening approach episode).

In the first study 30 dogs of 19 different breeds were tested in the two episodes in a balanced sequential order. The dogs acted appropriately according to the different human behaviour cues. The order of the Friendly/Threatening approaches had no significant effect on the dogs' responsivity.

In the second experiment 60 dogs of three breed groups (20 Belgian shepherds, 20 retrievers and 20 sled dogs) were first 'greeted friendly' and then approached 'threateningly' by the same Stranger. Results show significant breed specific differences in the responsivity when dogs faced an apparent switch of the human behaviour cues. Compared to retrievers and sled dogs, Belgian shepherds more frequently changed their response, showing passive or active avoidance or sign of aggression when approached threateningly.

While sex differences were not found, breed comparisons suggest that selective breeding (i.e. for hunting or shepherd work) influenced the dogs' sensitivity to human social cues in different ways.

* Corresponding author. Tel.: +36 1 381 21 79; fax: +36 1 381 21 80.
E-mail address: turbolya@freemail.hu (J. Vas).

0168-1591/$ – see front matter
doi:10.1016/j.applanim.2005.02.001

Results also support the hypothesis that human influence (domestication) has led to extreme flexibility of the dogs' situation-relevant behaviour while interacting with an unfamiliar human.

Keywords: Dog; Dog–human interaction; Social cues; Breed differences; Aggression

1. Introduction

The ethological analysis of human–animal interaction is of great importance for understanding the evolution and function of behaviour in domestic species. Recent investigations have shown that studying dog–human interaction is important for understanding the evolutionary process (i.e. domestication) in general and the evolution of social communicative abilities in particular (see Miklósi et al., 2004 for review).

Domestic dog (*Canis familiaris*) is a socially skillful species as it is extremely sensitive to human bodily visual communication cues (body position, gestures, head orientation) and is able to utilize these cues in choice tasks (see Miklósi and Soproni, in press for review). Further, it has been shown that visual attention has special relevance to dog-human communication. Dogs are not only able to exceed chimpanzees in recognising the subtle changes of human attention in food choice tasks (Soproni et al., 2001; Povinelli et al., 1999) but are able to discriminate the focus of their human partner's attention when instructed verbally in a training situation (Virányi et al., 2004) or in retrieval tasks (Gácsi et al., 2004).

It seems that gaze cues have multiple function in dog–human relation and are used not only for the expression of dominance but also in other communicative situations as attention getting signals or indicating the focus of attention. For example, staring is often used in dominance related situations where subordinates break eye contact earlier than dominant ones (Bradshaw and Nott, 1995) and similar behaviour can also be observed in play situations when groupmates initiate playful interactions (Bekoff, 1995). The dogs are responding to social cues of another species, for example in some cases when they interact with humans (Miklósi et al., 1998).

Moreover, it seems that different cues (e.g. body posture, position of tail and ears, orientation of head, etc.) shown simultaneously by the interactants constitute a meaningful pattern and therefore a single cue involved in the pattern cannot be interpreted in themselves. The pattern as a whole can exhibit willingness to play, aggression, superiority, submission, etc. Among dogs for example, upright body position accompanied with staring, tail up and ears erected expresses dominance and threat while opposite changes in behaviour show inferiority (Schenkel, 1967).

Human and dog are similar in their communicatory systems in the sense that both place considerable emphasis upon visual signals of the body and face. For example, the human smile is remarkably similar to the grin of the dog when it greets another individual, and both could serve as appeasement gestures. Despite the fact that dog trainers routinely utilize social cues in the course of training, the problem of how these stimuli are functioning in dog–human interactions has received relatively little attention.

When the role of social cues in dog–human interaction is studied, we should consider that present dogs are the result of a special behavioural evolutionary process called

domestication. Compared to their wild ancestors, the wolf, different types of changes in the behaviour have accumulated. While some of the behaviour units have disappeared from the repertoire (e.g. incomplete ethogram of aggressive behaviour in many breeds, Goodwin et al., 1997), others have became less context-specific and facilitated by environmental effects (e.g. variable forms of barking in many different situations, Feddersen-Petersen, 1998; Bradshaw and Nott, 1995). In some cases, domestication may have led to the emergence of novel behavioural traits (e.g. situation-specific eye contact with humans, Miklósi et al., 2003).

Generally, it seems that compared to wolves, dogs social interest towards humans is accompanied by relatively greater sensitivity to human behavioural cues (Hare et al., 2002; Frank and Frank, 1982). Wolf–dog comparisons led some to suppose that domestication relaxed the selectional pressure on the highly organized behavioural repertoire programmes and resulted in the emergence of an unprecedented flexibility of the behavioural system in the dog (Frank and Frank, 1987).

Accordingly, we can hypothesize that this plasticity made it possible for the dog to live in the close proximity to humans. Dogs should show high responsiveness to a broad range of social stimuli from humans and should react very flexibly to the sudden changes of human behaviour. Despite little experimental work many assume that there are breed-specific differences in their responsiveness to human cues. For example, analysing the behaviour of four breeds (basenji, Shetland sheepdog, fox terrier, beagle) Freedman (1958) found that the manner of social interaction with humans had differential effect in a subsequent test (social inhibition of eating).

In this study we investigate how dogs are able to modify their own behavioural actions in response to the behavioural changes of a human partner.

The first experiment is aimed at the questions whether dogs show corresponding changes in their reactions to an approaching human who shows apparent changes in her behaviour (friendly/threatening). The second experiment is designed to study whether dogs show breed specific differences in their reactions towards an unfamiliar person whose friendly behaviour cues are switched suddenly to threatening signals.

2. Study I

2.1. Methods

2.1.1. Subjects

Thirty pet dogs from 19 different breeds were involved in the present study on the basis of their owners' volunteer participation. All subjects were adults (aged between 11 month and 10 years) and half of them were females. For the observations dogs were divided in two groups.

First-Greeted group: 15 individuals (5 males, 10 females; 2-2-2 German shepherds, Hungarian vizslas, Belgian shepherds, a miniature poodle, a cocker spaniel, a beagle, a border collie, a briard, a German hunting terrier, a Welsh terrier, a fox terrier, a mongrel; mean age: 3.5 ± 3.1 years) were tested first in the Friendly approach episode. *First-Threatened group*: 15 individuals (10 males, 5 females; 1-1 German shepherd, miniature

poodle, cocker spaniel, Airdale terrier, boxer, Belgian shepherd, hovawart, great Dane, pumi, rottweiler, shar-pei and four mongrels; mean age: 2 ± 1.3 years) started with the Threatening approach episode.

2.1.2. Procedure

The experiment was carried out in 2002 and 2003 at the Top Mancs dog training school (Budapest, Hungary). Behavioural observations were made at a visually separated location in a park near the training school, which was familiar to the dogs. Subjects were tested individually when no other dogs were nearby.

Three participants, the dog, the owner and a young unfamiliar woman (Judit Vas – 'Stranger') took part in the observations. The behaviour of the dog was recorded from the side by an other person (cameraman) from a greater distance (10 m). The owner was asked to tether his/her dog with a 1.5 m long leash to an isolated tree and to make it sit or lay down (depending on the dogs controllability) orienting towards the Stranger who stood motionless 5 m from the dog. Then the owner stepped back to a predetermined point (about half a meter behind the dog) and stayed there without moving or speaking.

The test consisted of two subsequent episodes (Friendly approach and Threatening approach). The dogs were observed first in either of the episodes (for the sequential order see Section 2). At the end of the first episode the Stranger returned to her starting position (5 m away from the dog). The owner got the dog to its initial position (sit/lay down) stepped back again and the second episode started immediately.

2.1.2.1. Friendly approach. The Stranger stood 5 m away from the dog and called it by its name. When the dog gazed at her face, she started to approach it in normal speed of walk while she spoke in a friendly manner to the animal and tried to keep continuous eye contact with it. If the dog showed explicit signs of fear or aggression (passive or active avoidance, attack, vocalization—in detail see below) she stopped and the trial was terminated. If the dog did not show any of these behaviours she approached the dog and petted it gently (Fig. 1a–c).

2.1.2.2. Threatening approach. The unfamiliar woman stood motionless and silently 5 m from the dog. At the moment when the animal looked at her face, she began to approach it. She was moving slowly and haltingly (one step in every 4 s) with slightly bent upper body and she was looking steadily into the eyes of the dog without any verbal communication (Fig. 1d).

The behaviour of the Stranger was determined and standardized across subjects according to the following 'If . . .then. . .' rules (a–d):

(a) If the dog kept looking at her, then she continued to approach the dog and finally petted it.
(b) If the dog interrupted the eye contact with her (moving away and/or turning head away), she stopped and waited motionless for about 4 s and then she tried to attract the dogs attention: she made some noise (had a slight cought or scratched the ground with her foot). If the dog continued to avert his gaze the Stranger attempted to call the dog's attention two more times (with 2 s in between attempts). Whenever the dog looked

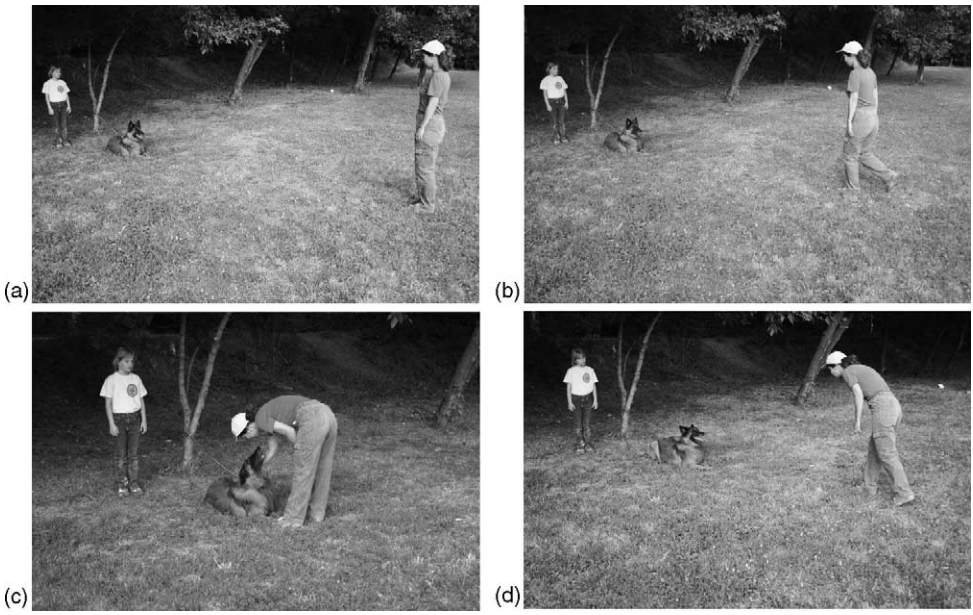

Fig. 1. Experimental arrangement: (a) initial position of Friendly and Threatening approach; (b) Friendly approach: the Stranger is approaching the dog with an upright body position, in normal speed of walk, speeking in a friendly manner to the animal; (c) the Stranger is petting the dog; (d) Threatening approach: the Stranger approaches the dog with a slightly bent upper body, moving haltingly, without any verbal communication.

again at her, the Stranger continued the approach. If, however, the dog did not look at her after the third attempt, the Threatening approach was terminated.

(c) If the dog showed active avoidance, that is, it moved away to the back of the owner from the approaching Stranger while keeping eye contact, she stopped and Threatening approach was terminated.

(d) If the dog showed definite signs of aggression, e.g. barked repeatedly or growled continously (more than 4 s) and/or tried to attack the Stranger (moving ahead and stretching the leash), Threatening approach was terminated.

If the subject did not show any form of fear or aggression mentioned even when the unfamiliar woman reached it, she touched the dog's head and gently petted it.

Comparing the two episodes its important to note that the Stranger attempted to obtain continuous eye contact in both of them. In contrast to the Friendly approach verbal communication cues were absent in the Threatening approach (except for attention getting signals). The speed of approach of the Stranger was normal speed of walk in the case of the Friendly and slow in the Threatening episode. The body position of the Stranger was erected in the Friendly and slightly bent in the Threatening approach.

2.1.3. Scoring of behavioural variables

The behaviour of the dogs was scored separately in both episodes by using the following definitions:

- 'Moving off'
  Score 0: The dog does not move away from the approaching Stranger while gazing at her.
  Score 1: The dog moves away from the approaching Stranger while gazing at her, but it does not move behind the owner.
  Score 2: The dog moves behind the owner while gazing at the Stranger.
- 'Avert gaze'
  Score 0: The dog is continuously looking at the face of the Stranger or if eye contact is interrupted, the subject re-establishes it again within 4 s.
  Score 1: The dog averts its gaze from the Stranger for more than 4 s (i.e. 'warning noise' made by the Stranger is needed to re-establish eye contact).
  Score 2: The dog averts its gaze from the Stranger and does not look back even after the third 'warning noise' made by the Stranger.
- 'Vocalization'
  Score 0: The dog neither barks nor growls.
  Score 1: Barking and growling last not longer than 4 s.
  Score 2: The dog barks repeatedly or growls continously (more than 4 s).
- 'Attack'
  Score 0: The dog does not make any sudden movement towards the Stranger associated with growling or barking or trying to bite.
  Score 1: The dog initializes some sudden movements towards the Stranger associated with a short growling or barking response (0–4 s) while still on loose leash.
  Score 2: The dog makes some sudden movements towards the Stranger associated with continuous growling or barking (more than 4 s) or attempts to bite while stretching the leash.
- 'Contact seeking'
  Score 0: The Stranger cannot pet the dog because the trial is terminated before she could reach the dog (for the rules of termination see Section 2.1.2).
  Score 1: The trial is terminated by petting the dog, but when the Stranger reaches out her hand to pet the dog, it does not move towards her or moves towards her without tail wagging.
  Score 2: The trial is terminated by petting the dog, and when the Stranger reaches out her hand to pet the dog, it moves towards her while wagging its tail.

Interobserver agreements for all of the five behaviour categories were assessed by means of parallel coding of the total sample by two observers and relatively high values were calculated in all cases (Index of concordance and Kappa coefficient, respectively, are 0.93 and 0.76 for 'moving off', 0.9 and 0.75 for 'avert gaze', 0.95 and 0.84 for 'vocalization', 0.97 and 0.81 for 'attack', 0.93 and 0.84 for 'contact seeking').

2.1.4. Data analysis

For data analysis we used nonparametric statistical methods (SPSS, version 9.0). Mann–Whitney *U* test was used to compare the scores of the five behaviour variables between experimental groups (*First-Greeted* versus *First-Threatened*), sexes (males versus females) and between the two age groups (1-year-old dogs versus more than 3-years-old

dogs). Comparisons between the two episodes (Friendly approach versus Threatening approach) were analysed by Wilcoxon matched-pairs signed rank test. Chi-square test of homogeneity and Fisher's exact test were applied when the distribution of the dogs in the main response categories were analysed.

2.2. Results and discussion

2.2.1. Order effect of the Friendly/Threatening approach

Comparisons of the behaviour variables of the two groups (*First-Greeted* and *First-Threatened*) did not show any significant differences in the Friendly approach episode ($U = 105$, $P > 0.05$ for 'moving off' 'vocalization' and 'attack'; $U = 112.5$, $P > 0.05$ for 'avert gaze' and $U = 106$, $P > 0.05$ for 'contact seeking'). When the Stranger approached in a friendly manner, none of the dogs have averted their gaze and only 1-1 dog from both groups showed 'moving off' or 'vocalization' or 'attack' towards the human. In contrast, most dogs in both groups displayed high levels of 'contact seeking' (only 1-1 dogs did not show any contact seeking while seven and six individuals in the two groups received the maximum score for contact seeking).

Results were similar when the behaviours observed in the Threatening approach episode were compared (*First-Greeted* versus *First-Threatened groups*). The only difference between the two groups was that dogs in the *First-Threatened group* tended to avert their gaze more during the Threatening approach in comparison with those who met the friendly behaving Stranger first ($U = 59.5$, $P < 0.05$). None of the other behaviours 'moving off' ($U = 126$, $P > 0.05$) and 'vocalization' ($U = 92.5$, $P > 0.05$), nor 'attack' ($U = 112.5$, $P > 0.05$) and 'contact seeking' ($U = 106$, $P > 0.05$) have shown significant differences.

When the Stranger approached the dog she adapted her behaviour to the dog's reaction: the Friendly/Threatening approach was interrupted and the trial was terminated when the dog either averted its gaze continuously, or moved off actively or showed signs of aggression. Otherwise she fully approached the dog and petted it. As Table 1 shows this differentiation provides an opportunity to categorize the dogs' responses on the basis of their behaviour for the further analysis.

All dogs in both experimental groups were classified into one of the '*passive*', '*friendly*', '*passive avoidant*', '*active avoidant*' or '*threatening*' categories (Table 2). In the Friendly approach episode almost all dogs in both groups (14-14 out of the 15) showed '*friendly*' or '*passive*' behaviours, however, when the Stranger approached them threateningly, more than half of them (eight and nine, respectively) avoided the interaction with the Stranger (performed either '*passive/active avoidance*' or '*threatening*' behaviour).

Considering the small sample (less than five individuals) in 13 out of the 20 cells (see Table 2) we could only compare the distribution of the dogs among the main categories (*Seeking for/tolerating* versus *Avoiding*, see Table 1). This analysis, however, showed no significant differences either in Friendly approach or in Threatening approach episode. *First-Greeted group* versus *First-Threatened group* in Friendly approach episode: $\chi^2 = 0.13$, d.f. = 1, $P > 0.05$ and in Threatening approach episode $P > 0.05$ (in this latter case with Fisher's exact test).

It seems that the sequential order of the two episodes (i.e. the fact whether Threatening approach was preceded or followed by a Friendly approach of the Stranger) had only minor

Table 1
Categorizing the dogs' response to the Stranger

How was the trial terminated?	Full approach: Stranger petted the dog		Interrupted approach: Stranger did not pet the dog		
The dog's reaction at the end of the trial	Did not move tail waggingly towards the outstreched hand	Moved tail waggingly towards the outstreched hand	Averted its gaze continously	Moved towards the owner or behind the owner while gazing at the Stranger (and/or vocalizing)	Made sudden movement towards the Stranger associated with vocalization (stretching the leash)
Response categorization	'*Passive*'	'*Friendly*'	'*Passive avoidant*'	'*Active avoidant*'	'*Threatening*'
	Seeking for/tolerating the interaction with the Stranger		*Avoiding the interaction with the Stranger*		

Table 2
Number of individuals (females, males) showing different responsivity to the Stranger in the two episodes

Episodes	Categories				
	Seeking for/tolerating the interaction with the Stranger		*Avoiding the interaction with the Stranger*		
	'*Passive*'	'*Friendly*'	'*Passive avoidant*'	'*Active avoidant*'	'*Threatening*'
First-Greeted group ($N = 15$)					
Friendly approach I	8 (6, 2)	6 (3, 3)	0	1 (1, 0)	0
Threatening approach II	5 (4, 1)	2 (1, 1)	4 (2, 2)	2 (2, 0)	2 (1, 1)
First-Threatened group ($N = 15$)					
Threatening approach I	3 (0, 3)	3 (2, 1)	2 (0, 2)	5 (2, 3)	2 (1, 1)
Friendly approach II	7 (2, 5)	7 (3, 4)	0	0	1 (0, 1)

effect on the behaviour of the dogs. Therefore, the two groups were merged for further analysis in order to study how the dogs adapted to the changes in the behaviour of the Stranger.

2.2.2. Situation-relevant changes in the dogs' behaviour

The question whether the dogs altered their behaviour in accordance with the switch in the Stranger's way of approach was first studied by paired comparisons of the five behaviour variables between Friendly approach and Threatening approach episodes. This analysis shows significant differences for all but one recorded behaviours ($T_- = -28$, $P < 0.05$ for 'moving off'; $T_- = -153$, $P < 0.001$ for 'avert gaze'; $T_- = -55$, $P < 0.05$ for 'vocalization'; $T_- = -6$, $P > 0.05$ for 'attack' and $T_+ = 246$, $P < 0.001$ for 'contact seeking'). Dogs tended to move off, avert their gaze and vocalize more in the Threatening approach episode and performed less contact seeking compared to the episode when Stranger approached them friendly.

Changes in the dogs' reactions due to the modifications in the Stranger's behaviour can be further analysed by comparing the individuals' distribution among the five response-categories ('*passive*', '*friendly*', '*passive avoidant*', '*active avoidant*' and '*threatening*') in the two episodes. This analysis showed a highly significant difference ($\chi^2 = 18.6$, d.f. = 4, $P = 0.001$). Namely, when the Stranger greeted them in a friendly manner almost all individuals were scored as '*friendly*' (13/30) or '*passive*' (15/30) in contrast to the Threatening approach episode when only the minority of dogs responded '*friendly*' (4/30) or '*passively*' (9/30) and many of them (17/30) were categorized as *Avoiding the interaction with the Stranger* (Table 2).

Analysing the behaviour of the dogs in its continuity across the two episodes (Friendly approach and Threatening approach) individuals could have been assigned to the following four main categories:

(I) Two subjects were categorized as Consistently avoiding since their behaviour was described in both episodes (Friendly approach and Threatening approach) as *Avoiding the interaction with the Stranger.*

(II) Thirteen dogs were categorized as Consistently seeking for/tolerating because their behaviour were characterized in both episodes by *Seeking for/tolerating the interaction with the Stranger.*
(III) Fifteen subjects were classified as Relevantly alternating because their behavioural response changed or complemented the behaviour of Stranger (i.e. Avoiding in Threatening approach and Seeking for/tolerating in Friendly approach episodes).
(IV) None of the dogs performed a behaviour opposite of the behaviour of the Stranger (i.e. *Avoiding* in the Friendly approach and *Seeking for/tolerating* in the Threatening approach episodes), therefore none of them were regarded as Irrelevantly alternating.

Moreover, we found that irrespective of whether the Threatening approach preceded or followed the Friendly approach, the majority of the dogs in both *First-Greeted* and *First-Threatened groups* showed either Consistently seeking for/tolerating behaviour towards the Stranger (seven and six individuals, respectively) or Relevantly alternating response (seven and eight individuals, respectively) and there was only 1-1 dogs who showed Consistently avoiding behaviour.

2.2.3. The effect of gender and age on dogs' reaction to the Stranger

Since there are many examples in the literature suggesting that male dogs are more aggressive than females (e.g. Wright and Nesselrote, 1987) and sex differences may also be significant in aggression towards human (e.g. Podberscek and Serpell, 1997; Wright, 1991) we may assume that males and females react differently to the Stranger in our test situation as well. The analysis of the sex differences, however, showed no significant effect in Friendly approach episode ($U = 105$, $P > 0.05$ for 'moving off', 'vocalization', 'attack' and 'contact seeking' and $U = 112.5$, $P > 0.05$ for 'avert gaze') nor in Threatening approach episode ($U = 94.5$, $P > 0.05$ for 'moving off', $U = 104$, $P > 0.05$ for 'vocalization', $U = 112.5$, $P > 0.05$ for 'attack', $U = 102.5$, $P > 0.05$ for 'avert gaze' and $U = 106$, $P > 0.05$ for 'contact seeking'). In accordance with this, we found that the two sexes were evenly distributed among the two main response categories (*Seeking for/tolerating* and *Avoiding*) in both episodes ($P > 0.05$ with Fisher's exact test).

Further, someone may assume, that the dogs' responsiveness towards the different behaviours of the Stranger is influenced by age. We can hypothesize that older (experienced) individuals react more sensitively to the changes in the Stranger's behaviour. Therefore, dogs were divided into two distinct age categories: *Adolescent dogs* were 11–13-months old (6-6 individuals from both the *First-Greeted* and *First-Threatened groups*); *Adult dogs* were more than 3-years old (six dogs from the *First-Greeted* and four dogs from the *First-Threatened group*).

Results show that dogs of different ages behaved similarly in the Friendly approach episode: all but one individual in the *Adolescent dog* group showed '*passive/friendly*' behaviour towards the Stranger and all dogs in the *Adult dog* group did the same. Regarding the five different behaviour variables scored by the observer, we found that all but one dog showed 'contact seeking' towards the friendly Stranger and the two age groups performed similar levels of 'contact seeking' ($U = 54$, $P > 0.05$). The analysis did not show significant differences in the Threatening approach episode in any of the behaviour

variables ($U = 46.5$, $P > 0.05$ for 'moving off', $U = 55$, $P > 0.05$ for 'vocalization', $U = 51$, $P > 0.05$ for 'attack', $U = 52.5$, $P > 0.05$ for 'avert gaze' and $U = 48$, $P > 0.05$ for 'contact seeking'). Moreover, we found that dogs of different ages are evenly distributed among the two main response-categories (*Seeking for/tolerating* and *Avoiding*) when approached threateningly by the Stranger ($P > 0.05$ with Fisher's exact test).

It seems that when approached by an unfamiliar human, dogs react in two different ways: half of them modified their reactions flexibly relying upon the changes in the human's behavioural cues while the others seemingly ignored these changes, and gave consistent (mostly friendly) response. Results suggest that in dogs at least from adolescent age this different responsivity cannot be attributed to sex and may be not influenced by age.

The question, however, that why some dogs showed consistent friendly behaviour while others tended to show sensitive and relevant change in their response to an unfamiliar human remained unanswered and called for further investigation.

3. Study II

To test whether the breed can influence the reaction to friendly and threateningly approaching human we observed the behaviour of dogs from three breeds, which had originally different functions for the humans. The dog breeds are partially inbred, genetically isolated strains (Ostrander et al., 2000), and the gene flow is today restricted by breeders. Therefore, it seem reasonable to suppose that breed-specific differences have a genetic basis.

3.1. Methods

3.1.1. Subjects

Sixty adult pet dogs (aged between 1 and 12 years) were involved in the present study on the basis of their owners' volunteer participation. On the basis of their breed subjects were divided into three groups ($N = 20$ dogs in each). All groups were balanced for sex ratio (10 males, 10 females):

- 'Sled dog' group (mean age: 3.6 ± 1.6 years) consisted of huskies (6) and malamutes (14).
- 'Retriever' group (mean age: 3.1 ± 2.2 years) involved golden retrievers (12) and Labrador retrievers (8).
- 'Belgian shepherd' group (mean age: 3.8 ± 3.4 years) consisted of Tervuerens (9) and Groenendaels (11).

All breed groups represented the same age category (comparing mean ages: $F(2, 57) = 0.43$, $P > 0.05$).

3.1.2. Procedure

The observations were carried out in 2003 at the Top Mancs dog training school (Budapest, Hungary), at a sled race in Dunaharaszti (Hungary) and at a retriever dog

training school (Budapest, Hungary). The experimental arrangement and the exact procedure of the test was identical to that of described in Section 2 with the only exception, that all subjects are observed first in the Friendly approach episode, which was followed by the Threatening approach by the Stranger. Importantly, those dogs who showed any sign of avoidance or aggressive behaviours towards the friendly Stranger in the first episode were excluded from further analysis (three Belgian shepherds).

3.1.3. Behaviour variables and data analysis

The behaviour of the dogs was scored by using the same five variables than that of used in Section 2. Breed groups were compared with nonparametric methods (Kruskal Wallis tests with Dunn's post hoc tests). Mann–Whitney U test was used in order to compare the scores of the five behaviour variables between sexes.

3.2. Results and discussion

3.2.1. Friendly approach episode

Dogs in all breed groups performed similar behaviour; 12 individuals of each group were scored as '*passive*' and eight as '*friendly*' when greeted by the Stranger. All breed groups were characterized by high 'contact seeking' scores (mean scores = 1.4 for all groups and no differences between groups were found: KW = 0, $P > 0.05$).

3.2.2. Threatening approach episode

Comparisons of the five behaviour variables between breed-groups showed significant differences for 'moving off' (KW = 10.71, $P < 0.01$), 'vocalization' (KW = 11.48, $P < 0.01$) and 'contact seeking' (KW = 10.95, $P < 0.01$) but not for 'avert gaze' (KW = 2.1 $P > 0.05$) and 'attack' (KW = 3.49, $P > 0.05$). Compared to sled dogs and retrievers, Belgian shepherds tended to move back towards their owners more frequently when the Stranger approached them threateningly (Dunn's multiple comparison post-test: $P < 0.05$). Moreover, Belgian shepherds vocalized more often and for longer periods and obtained lower scores of 'contact seeking' towards the Stranger than retrievers or sled dogs (Dunn's multiple comparison post-tests: $P < 0.05$).

Further, breed specific differences were found when dogs were classified into the five response-categories (Table 3, Fig. 2).

Table 3
Number of individuals (females, males) showing different responsivity to the Stranger in the Threatening approach episode

Groups	Categories				
	Seeking for/tolerating the interaction with the Stranger		*Avoiding the interaction with the Stranger*		
	'*Passive*'	'*Friendly*'	'*Passive avoidant*'	'*Active avoidant*'	'*Threatening*'
Sled dogs	3 (0, 3)	4 (2, 2)	8 (5, 3)	0	5 (3, 2)
Retrievers	4 (1, 3)	5 (2, 3)	6 (3, 3)	0	5 (4, 1)
Belgian shepherds	0	0	5 (2, 3)	5 (3, 2)	10 (5, 5)

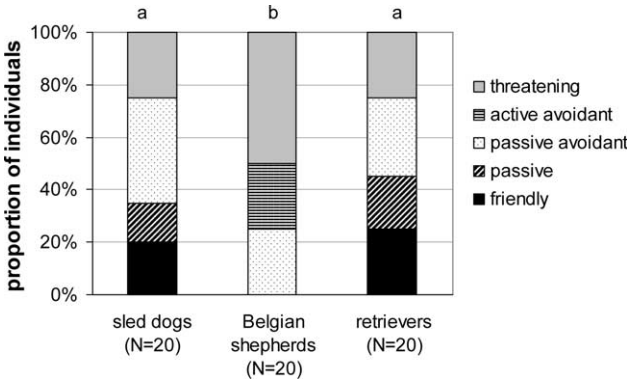

Fig. 2. Distribution of individuals in the three breed groups based on the five behaviour categories showed in the Threatening approach episode (different letters indicate significant differences between groups, $P < 0.05$).

While a number of individuals responded '*passively*' or '*friendly*' to the threatening behaviour cues of the Stranger among sled dogs (7 out of 20) and retrievers (9 out of 20), none of the Belgian shepherds did (Table 3). Instead, all of them avoided the interaction with the Stranger showing '*passive/active avoidance*' (5-5 subjects) or '*threatening*' behaviours (10 subjects). Comparing the distribution of the dogs' response in the three groups we found highly significant breed specific differences ($\chi^2 = 11.42$, d.f. = 2, $P < 0.01$), that is retrievers and sled dogs were less likely to avoid the Stranger.

Finally, in line with the results obtained in Section 2, dogs failed to show any sex related differences in their responsiveness in all three groups (sled dogs: 'moving off' $U = 44.5$, $P > 0.05$; 'avert gaze' $U = 44$, $P > 0.05$; 'vocalization' $U = 45.5$, $P > 0.05$; 'attack' $U = 45$, $P > 0.05$; 'contact seeking' $U = 38$, $P > 0.05$, in Belgian shepherds: 'moving off' $U = 44.5$, $P > 0.05$; 'avert gaze' $U = 44$, $P > 0.05$; 'vocalization' $U = 48.5$, $P > 0.05$; 'attack' $U = 43$, $P > 0.05$; 'contact seeking' $P > 0.05$) and in retrievers: 'moving off' $U = 50$, $P > 0.05$; 'avert gaze' $U = 41$, $P > 0.05$; 'vocalization' $U = 34.5$, $P > 0.05$; 'attack' $U = 45.5$, $P > 0.05$; 'contact seeking' $U = 36.5$, $P > 0.05$).

4. General discussion

The aim of this paper was to study the response of adult pet dogs to an unfamiliar woman (Stranger) who expressed social behaviour cues of friendliness and threat sequentially. The first study showed that dogs (of various breeds) often show clearly distinguishable reactions towards the Stranger depending on her way of approaching and irrespective of whether friendly encounter preceded or followed the threatening interaction. The majority of dogs showed cues of tolerant, friendly behaviours upon Friendly approach by the Stranger, many of them gave various signs of avoidance or aggressiveness when the Stranger approached them threateningly.

We suppose that gazing cues (of the Stranger) have an important role in eliciting the dogs' response. Earlier observations suggest that direct eye-contact is a typical component

of the dominant displays among dogs (Bradshaw and Nott, 1995), and they show this behaviour in dominance-related situations (Borchelt, 1983). Wolves also often use gaze to force others into subordination and maintain their position in the group (Schenkel, 1947). Others found that human gazing may also function as social cue in dog–human interactions as gazing by the owner can trigger aggression in dogs who have dominance-related problems with their owner (Line and Voith, 1986). It seems that extended duration of gazing is often regarded as a form of ritualized aggression. In dogs, similar to other social mammalian species averting the gaze indicates subordination by avoiding the gaze of the dominant.

However, our results suggest that although human gazing may indeed function as a 'social cue' for dogs, the approaching human's attempt to keep eye contact does not evoke unconditional fear or aggression, because in both way of approaching (friendly and threatening) the continuous eye-contact between the dog and the human was aimed. Instead, it seems that not the gazing alone but other cues of human behaviour pattern, like body posture (straight/crouched), way of movement (continuous walking/halting) and verbal cues (friendly calling/speechless) have an influence on dogs' response. Human gaze is often regarded as the most important means of species specific visual communication (Tomasello, 1995), therefore it seems that in the course of domestication dogs were selected for the ability to utilize this channel of communication along with other visual cues of human behaviour. Many recent experimental observations led to the assumption that dogs' skills in communicating with humans are the result of domestication (in the form of genetic pre-adaptation) and that dogs prefer to use the communication channel of gazing, similar to humans (see Miklósi et al., 2004 for a review of these studies).

We suggest that in behaviour interaction with humans dogs perceive not single cues of human behaviour but the pattern of human behaviour as a group of simultaneously perceived cues. This interpretation is in agreement with some earlier observations which have suggested that dogs have a sophisticated ability for taking into account different aspects of human behaviour. Similarly to gazing, the so called stand-over position when the owner or other person reaches for the dog, or wants to embrace the animal is also supposed to function as a dominance signal (Borchelt, 1983; Line and Voith, 1986). Further, Millot (1994) found that dogs were able to discriminate between affiliative and agonistic body postures of children-like dummies, and provided evidence for the importance of visual and olfactory communication between human and dog. Regarding the sophisticated human-recognition ability in dogs, Lore and Eisenberg (1986) reported that male dogs showed an initial wariness to unfamiliar men in contrast to women in a human reaction test, when the human sat motionless and quietly and looked directly at the dog. It seems that gazing combined with signs of body posture (bent upper body), movement and olfactory signals as specific stimulus configuration may evoke fear/avoidance or aggression towards human.

We should note, however, that in Section 2 dogs' could be classified in two distinct categories. Only half of the subjects proved to be '*responsive*' and they performed a flexible, relevant change in response to the altering cues of the Stranger (i.e. seeked for contact when greeted friendly and avoided contact when approached threateningly). In contrast, the other half of the dogs can be regarded as '*non-responsive*' as they showed consistent (predominantly friendly, tolerant) response and seemingly ignored the changes in Stranger's behaviour.

This variability in the behaviour of dogs can be explained in different ways. First, although differences in early social experiences may result in differences in interaction with human (Fox and Stelzner, 1966), we suppose, that responsive/non-responsive dichotomy cannot be explained merely by major differences in our dogs' socialization prehistory or differences in their individual experiences with human. Our subjects represented a relatively homogeneous group from this respect. All dogs were kept as pets and they were recruited from dog training schools, where they regularly met unfamiliar dogs and people. Second, results failed to show a significant effect of age on the observed behaviour of the dogs. We should note however, that the nonsignificant effect of age is not conclusive in the sense that this study does not exclude the possible age-related differences in responsiveness between juvenile dogs and adults.

Regarding the dogs' reaction to the Stranger one of the more self-evident assumption is that the two main response categories (i.e. relevant and flexible response to the Stranger or consistent friendly, tolerating reaction) are attributed to breed specific differences. Many assume that some breeds can differ from each other in many situations, as it was reported e.g. for emotionality, aggression or hunting abilities (Plutchnik, 1971; Wright, 1991; Wright and Nesselrote, 1987; Christiansen et al., 2001). The second study addressed this hypothesis and aimed to evaluate whether breeds that had been selected for distinctly different purposes tended to show different reactions to a human whose behaviour suddenly switched from friendly to threatening.

The comparison of breed groups (sled dogs, shepherds and retrievers) has shown important differences and similarities among breeds. The behaviour of sled dogs and retrievers did not differ significantly from each other and many of them (35% and 45%, respectively) continued to show friendly, tolerant behaviour even when the Stranger displayed threatening behaviour. The relatively large number of '*non-responsive*' sled dogs and retrievers is in accordance with the widely accepted view, that sled dogs (malamutes and huskies) were originally working in cooperation with packmembers and following the human leader's vocal instructions (and therefore a lower sensitivity to human behaviour is expected) while retrievers (golden and Labrador retrievers) were bred for fetching the prey during hunt (so low aggression, low predatory motivation and readiness to retrieve could be advantageous).

In contrast, Belgian shepherds differed from the other two breed groups in the way, that all of them proved to be '*responsive*', and a significant proportion of them (50%) performed aggressive/threatening behaviour towards the threatening human. Aggression against humans is often believed to be influenced by environmental factors such as socialization and individual experiences (Podberscek and Serpell, 1997), this result however suggests the role of breed related differences. Many assume that shepherd dogs had herding and watching functions and therefore a sensitive reaction to changes in others' behaviour and some degree of aggression against unfamiliar humans are expected.

It is important to note, that both retrievers and shepherds participating in our study are kept as companions and are not used to perform their original hunting/herding function. In contrast, the majority of malamutes and huskies are housed by their owners as typical sled-dogs (they are living in packs and often participate in sled-races).

In conclusion, the results support the role of breed-specific genetic makeup in the response to human behaviour cues and confirm the hypothesis that in the course of the

selection process during which different breeds have emerged, dogs of certain breeds have been selected against some traits while other traits have become more expressed.

The flexible nature of dog behaviour is the result of an evolutionary process during which dogs adapted to various degree of association with humans. In line with this consideration our results show that the role of environmental factors (socialization, training, etc.) in the behavioural plasticity of dogs in relation with the genetic pre-adaptation to learn flexibly about human behaviour and communicative signs need further investigation.

Acknowledgements

We are grateful to all participating dog owners. This study was supported by the Hungarian Academy of Sciences (F01031) and an OTKA grant (T043763).

References

Bekoff, M., 1995. Play signals as punctuation: the structure of social play in Canids. Behaviour 132, 419–429.

Borchelt, P.L., 1983. Aggressive behavior of dogs kept as companion animals: classification and influence of sex, reproductive status and breed. Appl. Anim. Ethol. 10, 45–61.

Bradshaw, J.W.S., Nott, H.M.R., 1995. Social and communication behaviour of companion dogs. In: Serpell, J. (Ed.), The domestic dog: its evolution, behaviour and interactions with people. Cambridge University Press, Cambridge, pp. 115–130.

Christiansen, F.O., Bakken, M., Braastad, B.O., 2001. Behavioural differences between three breed groups of hunting dogs confronted with domestic sheep. Appl. Anim. Behav. Sci. 72, 115–129.

Feddersen-Petersen, D.U., 1998. Die kommunikative Bedeutung des "Lautsystems Bellen". Kleintier Konkret 6, 2–15.

Fox, M.W., Stelzner, D., 1966. Approach/withdrawal variables in the development of social behaviour in the dog. Anim. Behav. 14, 362–366.

Frank, H., Frank, M.G., 1982. On the effects of domestication on canine social development and behaviour. Appl. Anim. Ethol. 8, 507–525.

Frank, H., Frank, M.G., 1987. The University of Michigan Canine information-processing project (1979–1981). In: Frank, H. (Ed.), Man and Wolf. Dr. W. Junk Publishers, Dordrecht, The Netherlands, pp. 143–167.

Freedman, D.G., 1958. Constitutional and environmental interaction in rearing of four breeds of dogs. Science 127, 585–586.

Gácsi, M., Miklósi, Á., Varga, O., Topál, J., Csányi, V., 2004. Dogs show situation-dependent recognition of human's attention. Anim. Cogn. 7, 144–153.

Goodwin, D., Bradshaw, J.W.S., Wickens, S.M., 1997. Paedomorphosis affects visual signals of domestic dogs. Anim. Behav. 53, 297–304.

Hare, B., Brown, M., Williamson, C., Tomasello, M., 2002. The domestication of social cognition in dogs. Science 298, 1634–1636.

Line, S., Voith, V.L., 1986. Dominance aggression of dogs towards people: behavior profile and response to treatment. Appl. Anim. Behav. Sci. 16, 77–83.

Lore, R.K., Eisenberg, F.B., 1986. Avoidance reactions of domestic dogs to unfamiliar male and female humans in a kennel setting. Appl. Anim. Behav. Sci. 15, 261–266.

Miklósi, Á., Kubinyi, E., Topál, J., Gácsi, M., Virányi, Zs., Csányi, V., 2003. A simple reason for a big difference: wolves do not look back at humans but dogs do. Curr. Biol. 13 (9), 763–767.

Miklósi, Á., Polgárdi, R., Topál, J., Csányi, V., 1998. Use of experimental-given cues in dogs. Anim. Cogn. 1, 113–121.

Miklósi, Á., Soproni, K., in press. A comparative analysis of the animals' understanding of the human pointing gesture. Anim. Cogn.
Miklósi, Á., Topál, J., Csányi, V., 2004. Comparative social cognition: what can dogs teach us? Anim. Behav. 67, 995–1004.
Millot, J.L., 1994. Olfactory and visual cues in the interaction systems between dogs and children. Behav. Process. 33, 177–188.
Ostrander, E.A., Galibert, F., Patterson, D.F., 2000. Canine genetics comes of age. Trends Genet. 16, 117–124.
Plutchnik, R., 1971. Individual and breed differences in approach and withdrawal in dogs. Behaviour 40, 302–311.
Podberscek, A.L., Serpell, J.A., 1997. Environmental influences on the expression of aggressive behaviour in English Cocker spaniels. Appl. Anim. Behav. Sci. 52, 215–227.
Povinelli, D.J., Bierschwale, D.T., Cech, C.G., 1999. Comprehension of seeing as a referential act in young children, but not juvenile chimpanzees. Br. J. Dev. Psychol. 17, 37–60.
Schenkel, R., 1947. Ausdrucksstudien an Wölfen. Behaviour 1, 81–129.
Schenkel, R., 1967. Submission: Its features and function in the wolf and dog. Am. Zool. 7, 319–329.
Soproni, K., Miklósi, Á., Topál, J., Csányi, V., 2001. Comprehension of human communicative signs in pet dogs. J. Comp. Psychol. 115, 122–126.
Tomasello, M., 1995. Joint attention as social cognition. In: Moore, C., Dunham, P. (Eds.), Joint Attention: Its Origins and Role in Development. LEA, Hillsdale, NJ, pp. 85–101.
Virányi, Zs., Topál, J., Gácsi, M., Miklósi, Á., Csányi, V., 2004. Dogs respond appropriately to cues of human's attentional focus. Behav. Process. 66, 161–172.
Wright, J.C., 1991. Canine aggression toward people: bite scenarios and prevention. Vet. Clin. N. Am. 21, 299–314.
Wright, J.C., Nesselrote, M.S., 1987. Classification of behaviour problems in dogs: distributions of age, breed, sex and reproductive status. Appl. Anim. Behav. Sci. 19, 169–178.