

BRIEF COMMUNICATIONS

Attachment Behavior of Adult Dogs (*Canis familiaris*) Living at Rescue Centers: Forming New Bonds

Márta Gácsi and József Topál
Hungarian Academy of Sciences

Ádám Miklósi, Antal Dóka, and Vilmos Csányi
Eötvös Loránd University

In this study, 60 shelter dogs (*Canis familiaris*) were observed in the modified version of the Strange Situation Test, which has proved to be a useful method for studying dogs' attachment behavior toward humans (J. Topál, Á. Miklósi, V. Csányi, & A. Dóka, 1998). Before testing, 40 dogs were handled 3 times for 10 min. In the test, handled dogs encountered 2 persons: the handler in the role of the "owner" (OW) and an unfamiliar person (UP), whereas the 20 nonhandled dogs encountered unfamiliar persons in both roles. Dogs in the handled group exhibited more contact seeking with the entering OW, less physical contact with the UP, less frequent following of the leaving UP, and less standing by the door in the presence of the OW. The specific response of the handled dogs toward the handler fulfilled the operational criteria of attachment. In shelter conditions, the remarkable demand for social contact with humans may result in rather fast forming of attachment even in adult dogs.

On the basis of human behavioral observations, Bowlby (1958) described *social attachment* as an asymmetrical social relationship that presumes the dependency of the attached individual on the object of attachment, who can be used as a secure base. The adaptational significance of social attachment may be supplying offspring with resources for survival and with defense against predators by ensuring that offspring remain in the vicinity of the parent (Bowlby, 1969). Attachment is claimed to be the basic organizational factor for any species's social structure leading to group formation. The dependency of the attached individual manifests itself in behavioral preferences indicated by special behavior patterns in choice situations (Wickler, 1976).

Up to now, only a few researchers have investigated in experimental studies the animal-to-human attachment. Most of them described attachment as the result of imprinting-like processes in a sensitive period, which manifest in proximity seeking and prox-

imity maintenance toward a human handler (see, e.g., birds, Heinrich, 1910; rabbits, Pongrácz & Altbacker, 1999; rhesus monkeys, Sackett, Porter, & Holmes, 1964; lambs, Scott, 1945). Proximity seeking and proximity maintenance are the major behavioral indicators of parent-infant attachment in humans as well, though the spatial distance to the object of attachment is not as important for the attached individual as is its availability or accessibility (Bowlby, 1972). More complex operational criteria of attachment have been developed by other researchers, who claim that attachment presumes (a) an ability to discriminate and respond differentially to the object of attachment (secure-base effect), (b) preference for the attachment figure (proximity and contact seeking), and (c) response to separation from and reunion with the attachment figure that is distinct from responses to others (Cmic, Reite, & Shucard, 1982; Gubernick, 1981; Rajecki, Lamb, & Obmascher, 1978). In this article, we use the term *attachment* according to these operational criteria.

The Strange Situation Test (SST), developed by Ainsworth and Wittig (1969), is one of the laboratory procedures that is based on these operational criteria for manifestation of attachment, as during the test situation, attachment behavior is activated by separation from and reunion with the attachment figure. This procedure proved to be a reliable methodological approach for the assessment of not only human parent-infant attachment but animal to human attachment as well. As several authors have discovered (Bard, 1983, 1991; Miller, Bard, Juno, & Nadler, 1990), young chimpanzees react similarly to the ways children do during separation and reunion with conspecifics and also with human caretakers. Re-

Márta Gácsi and József Topál, Comparative Ethology Research Group, Hungarian Academy of Sciences, Budapest, Hungary; Ádám Miklósi, Antal Dóka, and Vilmos Csányi, Department of Ethology, Eötvös Loránd University, Budapest, Hungary.

This study was supported by Grant F-226/98 from the Hungarian Academy of Sciences and Grant T029705 from Országos Tudományos Kutatási Alapprogram (the Hungarian Scientific Research Fund). We wish to thank the staff of the two rescue centers for their help, especially Henriette Merza and Frigyes Fischl. We are very grateful to Judit Gervai who commented on an earlier version of this article and to Andrea Lantos and Orsolya Varga for their assistance. This research complies with the current Hungarian laws on animal protection.

Correspondence concerning this article should be addressed to Márta Gácsi, Department of Ethology, Comparative Ethology Research Group, Hungarian Academy of Sciences, Pázmány Péter sétány 1/c. VI., Budapest, H-1117 Hungary. Electronic mail may be sent to gm.art@axelero.hu.

We use the phrase *strange situation* just to emphasize the continuity of the studies using the well-known method (SST); however, the term *strange* is widely criticized (see Rheingold & Eckerman, 1973).

cently, a modified version of the SST was applied to activate dogs' attachment behavior in regard to their owner and to observe the features of the dog-human bond under experimental circumstances (Topál, Miklósi, Csányi, & Dóka, 1998).

The dog's ability to form attachment with humans is one of the most widely accepted consequences of domestication. It can be assumed that dogs have been selected for tens of thousands of years (Vilá et al., 1997) for dependency on and attachment to humans (Millot, 1994). The long-lasting selection for conflict-minimizing behavior in human communities may have resulted in a coevolutionary process of the two species (Paxton, 2000; Schleidt, 1998). During the period of domestication, some important components of the "human behavior complex" (see Csányi, 2000) as special attributes of social behaviors may have emerged in the dog. Social attachment between dog and owner is one of the behavior traits that has comparable equivalents in human behavior. The forms and manifestation of the dog-human relationship seem to be analogous to the parent-child relationship (Collis, 1995; Topál et al., 1998). Dogs have an unfolding pattern of socialization and some sensitive periods during development that are very similar to the same phenomena recognized in the human infant (Fox, 1971). Moreover, under certain conditions such as the loss of the attachment figure (parent or owner), both dog and child may develop similar behavior disorders ranging from psychogenic epilepsy to asthma-like conditions, ulcerative colitis, anorexia nervosa, and so on (Fox, 1968).

It is claimed that during an early sensitive period, puppies are ready to form close social relationships not only with their mothers but also with members of other species, for example with rabbits (Cairns & Werboff, 1967) or most commonly with humans (Scott & Fuller, 1965). Dogs seem to show innate responsiveness to humans that is not influenced by feeding (Brodbeck, 1954), and even punishment does not extinguish the proximity seeking of pups to a handler (Fisher, 1955). Moreover, puppies show social attraction to humans even if they were exclusively strictly disciplined during handling (Freedman, 1958). Pettijohn, Wont, Ebert, and Scott (1977) found that separation distress in 4- to 8-week-old puppies was reduced most successfully by humans, not by conspecifics. Dogs socialized in human families seem to form more significant social bonds to their owners than to their conspecifics. Tuber, Hennessey, Sanders, and Miller (1996) found that in a novel environment, dogs showed increased responses of stress both when they were alone and when they were together with a familiar conspecific. The presence of a familiar human caretaker, however, significantly reduced the responses of stress in dogs. The effective security-providing role of humans for dogs is presumably the result of domestication that led to the acceptance of humans as conspecifics (Kretschmer & Fox, 1975). This view is supported by the fact that the behavior patterns dogs show in their interactions with humans were found to be basically similar to those displayed to their parents or to the conspecifics (Scott, Stewart, & DeGhett, 1973).

An adult dog's attachment to a given person has been assessed so far mainly by the means of questionnaires (Bonas, McNicholas, & Collis, 1996; Serpell, 1996; Wilson, Netting, & New, 1985). Finding measurable indicators of attachment, however, is of great importance, as the ethological approach emphasizes that this phenomenon can be studied through its manifestation in different behavior patterns (Sears, Whiting, Novlis, & Sears, 1953). In a

recent experimental study, Topál et al. (1998) demonstrated that adult dogs show specific patterns of attachment behavior toward their owners. The significant changes in dogs' behavior in the presence of their owner and a stranger and the dogs' specific reaction to the separation from and reunion with the owner fulfilled the operational criteria of attachment (Rajecki et al., 1978). So adult dogs seem to be particularly suitable subjects for investigating the phenomenon of animal-to-human attachment. We know, however, very little about the conditions of the development of attachment in adult dogs, because all the experiments on the development of social relationships between dogs and humans have focused on infantile behavior in a sensitive period. Thus, the aim of this experiment was to study the effect of three short interactions with an unfamiliar human on the development of attachment behavior of dogs living in rescue centers. The dogs' behavior was observed in the modified SST.

We hypothesized that dogs' demand for social contact with humans increases in those dogs living without the possibility of forming such relationships for a longer period of time, and therefore even a short duration of human handling may evoke attachment behavior in these dogs. Furthermore, we asked whether handled dogs would show characteristic features of attachment behavior that would fulfill the operational criteria of attachment (i.e., secure-base effect, proximity and contact seeking, and specific response to separation).

Method

Subjects

In this experiment, 60 dogs (*Canis familiaris*; 30 females and 30 males) took part. They were from two rescue centers: Szent Ferenc Animal Shelter in Ócsa, Hungary, and Vasadi Dog Shelter in Vasad, Hungary. The maintenance and housing conditions were the same in both rescue centers; the dogs were kept in big packs in very large yards (1,000 to 1,600 m²). There were 30 to 100 dogs in each yard living together without any possibility to make contact with people, except for their caretaker, who gave them food and cleaned the yard once a day. Most of the dogs were mongrels; only a few seemed to be purebred, but none of them had an official pedigree. Almost nothing about the history of the dogs was documented at the shelters. The ages of the dogs in this study ranged from 1 to 8 years, estimated by the veterinarians at the centers. The dogs were chosen from the register of the centers on the basis of their gender, size, and length of time at the shelter (only dogs that had already spent more than 2 months in the center were chosen). Six of the chosen dogs could not be caught in 2 min. In these cases, we included the next dog from our list.

We grouped the dogs according to their gender and size (small dogs < 60 cm; large dogs > 60 cm), and members of the handled and control groups were chosen at random from these groups (see Table 1). We formed counterbalanced samples for the two handlers as well. Both handlers were women (23 and 34 years old) who had not previously met the dogs.

Procedure

In both centers, 20 dogs were handled and then tested, and another 10 nonhandled dogs were tested as controls. The purpose of the handling was to familiarize the dog with one of the handlers, who later in the SST played the role of the "owner" (OW); the other person acted as the unfamiliar person (UP). For the nonhandled dogs, the two experimenters played the role of the OW in turns. They caught these dogs and fed them to the test kennel together. The nonhandled dogs had been observed in the SST before

Table 1
Distribution of the Gender and Size of the Dogs From the Two Shelters in the Handled and Nonhandled Samples

Shelter	Handled				Nonhandled			
	Male (<i>n</i> = 20)		Female (<i>n</i> = 20)		Male (<i>n</i> = 10)		Female (<i>n</i> = 10)	
	S	L	S	L	S	L	S	L
Vasadi	4	6	4	6	2	3	1	4
Szent Ferenc	2	8	2	8	1	4	3	2

Note. In the handled group, there were 6 small (S) and 14 large (L) dogs in each of the male and female subgroups. In the nonhandled male group, there were 3 small and 7 large dogs; in the nonhandled female group, there were 4 small and 6 large dogs. Small dogs < 60 cm; large dogs > 60 cm.

the handling of the other group starteri. This was necessary to avoid the spontaneous familiarization of the nonhandled dogs with the handlers when they interacted with the handled dogs.

Handling

The handling took place about 50 m from the dog yards at an open area visually hidden from the other dogs where the handler and the dog could be alone. Dogs were caught and taken from the yards by the respective handler. The handling was carried out on leash and consisted of talking to the dog, petting, doing very simple exercises such as matring them sit down, walking together, or playing and fetching) depending on the willingness of the dog.

At both centers, 20 dogs per day were handled on 3 consecutive days. Two different persons performed the handling, and each person handled 10 dogs at both places. Each handling lasted for 10 min, and the test was carried out immediately after the handling of each subject.

Attachment Test

The experimental petting and the protocol of the tests were similar to the one used for dogs by Topál et al. (1998). The tests were carried out 60 m from the yards in an environment that was unfamiliar to all dogs. A newly built 5.5 X 3.5 m kennel with opaque walls (2 m high) was used as the testing facility. The OW and the UP entered and left the kennel through a 90 cm x 2 m door. There were two chairs facing each other in the middle of the kennel (one for the OW and one for the UP), played 1.5 m from each other. There were also some toys in the otherwise empty space.

The test procedure consisted of seven episodes, each lasting 2 min. Human participants had to follow a detailed protocol that determined the form and timing of their behavior. The behavior of the dogs was videotaped and analyzed later.

In the handled group, the handler of the dog acted as the OW and an unfamiliar experimenter acted as the UP. In the nonhandled group, both the OW and the UP were unfamiliar to the dogs. Each experimenter played the role of the OW for half of these dogs and played the role of the UP for the other half.

Experimental Episodes

Episode 1 (OW and dog). The OW entered the kennel together with the dog, sat down, and starteri to read. After 1 min, she starteri playing with or petting the dog, depending on its willingness. (She stopperi playing or petting when the UP entered.)

Episode 2 (OW, UP, and dog). The UP entered, greeted the OW, stopperi for a maximum of 5 s to allow the dog to respond, and then sat down. After 30 s, she initiated conversation with the OW. Another 30 s

later, the UP starteri playing with or petting the dog, depending on its willingness. At the end of the episode, the OW left as unobtrusively as possible, leaving the leash on her chair.

Episode 3 (UP and dog). In this first separation episode, the UP tried to play with the dog or offer petting. After 1 min, she sat down and petted the dog if it was close enough.

Episode 4 (OW and dog). In this first reunion episode, the OW called the dog while she was approaching the closed door. After entering, she stopperi for a maximum of 5 s to allow the dog to respond and then went to the chairs. Then the UP left. The OW starteri playing with or petting the dog, depending on its willingness, for 1 min and then sat down and petted the dog if it was close enough. At the end of the episode, she said to the dog, "I must go, you should stay here;" and left.

Episode 5 (dog alone). This was the second separation episode. Dogs were closed in the kennel for 2 min.

Episode 6 (UP and dog). The UP entered and stopperi for a maximum of 5 s to allow the dog to respond, then starteri playing with or petting the dog, depending on its willingness. After 1 min, she sat down and petted the dog if it was close enough. She stopperi playing and petting when the OW entered.

Episode 7 (OW and dog). In the second reunion episode, the OW called the dog while she was approaching the closed door. After entering, she stopperi for a maximum of 5 s to allow the dog to respond and then went to the chairs. Then the UP left. The OW starteri playing with or petting the dog, depending on its willingness, for 1 min and then sat down and petted the dog if it was close enough.

Behavior Categories

Two trained observers analyzed the behavior of the dogs during the sessions using nine behavior categories. Each behavior category listed was coded both in the presence of the OW and in the presence of the UP (e.g., exploration in the presence of the OW = EXPO, and in the presence of the UP = EXPS). For describing the behavior of the dogs during the episodes, we used four nonoverlapping categories: exploration (EXP), passive behavior (PAS), playing (PLY), stand by the door (SBY); and one overlapping category: physical contact (CON). The greeting behavior of the dogs toward the entering person was described by three variables: contact seeking (COS), delay of contact seeking (DEL), and the duration of physical contact while greeting (DCON). The ninth category aimed to describe the dogs' following behavior of the departing person (FOL).

Interobserver agreement was assessed by parallel evaluation of the behavior of 10 dogs by two experienced observers (see Martín & Bateson, 1986). Detailed descriptions of the behavioral categories are presented in the Appendix.

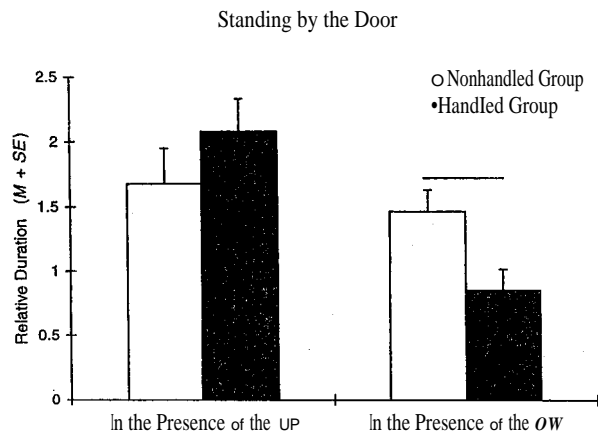


Figure 1. Relative duration of standing by the door in the presence of the unfamiliar person (UP) and of the "owner" (OW) in the nonhandled ($n = 20$) versus the handled group ($n = 39$). $*p < .05$.

Analysis of Data

The behavior of the dogs was recorded continuously during the observations. As the duration of the episodes slightly varied, we calculated the relative percentage of the time spent in each behavior category.

To analyze whether there was any general change in the behavior of the handled dogs, we compared the handled and nonhandled groups using the sum of the corresponding variables for the OW and the UP (e.g., EXPO + EXPS) in each behavioral category for both groups.

As the raw data did not always correspond to a normal distribution (Kolmogorov-Smirnov analysis), in four cases (PLYO, PLYS, SBYO, SBYS) square-root transformations were performed to achieve normality. Six variables (COSO, COSS, DELO, DELS, FOLO, FOLS) could not be transformed, so these were analyzed by nonparametric statistical methods.

We analyzed the behavior of the dogs by using two-sample t tests for the variables with normal distribution and by using Mann-Whitney U tests for variables that did not have a normal distribution. We should note, however, that merely by increasing the number of the tests performed, the probability of detecting effects that do not exist in reality has also increased. Therefore, when we analyzed several types of behavior using the same samples, the Bonferroni procedure (Holm, 1979) was applied to correct p values. (The test results of one handled dog could not be analyzed because of technical problems with the videotape, so it was omitted from the total sample.)

Results

Effect of Gender, Size, and Rescue Center

Gender and size did not have significant effect on the behavioral variables in the test situation. Two differences were found in the behavior of the dogs living in the two different rescue centers: Dogs at Vasadi showed increased delay in approaching the entering UP: DELS, $U(57) = 294.00$, $p < .05$; and they also spent more time in physical contact with the entering UP: DCONS, $t(57) = -2.42$, $p < .05$. Because we had a well-balanced sample for all variables (see Table 1), these effects did not alter the effect of handling.

Effect of Handling

General effects. When comparing the behavior of the handled and nonhandled dogs in the SST, as a first step we compared the

two groups using the sum of the corresponding variables related to the OW and the UP (e.g., EXPO + EXPS; PASO + PASS, etc.) in both groups. No significant differences were found between the handled and nonhandled groups in any of the nine behavior categories: EXP, $t(57) = -1.03$; PAS, $t(57) = 0.99$; PLY, $t(57) = 0.05$; SBY, $t(57) = -0.02$; CON, $t(57) = 1.94$; BCON, $t(57) = -0.74$; COS, $U(57) = 386.5$; DEL, $U(57) = 382.0$; FOL, $U(57) = 309.5$; $ps = ns$ in all cases. So the fact that the handled dogs were taken out of their home yards and handled three times did not have significant effect on their overall behavior in the test situation.

Specific effects in the presence of the OW and the UP. However, separating the behavioral variables according to their display in the presence of the OW or the UP revealed marked differences between the handled and nonhandled groups. Dogs in the handled group stood by the door less in the presence of the OW than the nonhandled dogs: SBYO, $t(57) = -2.33$, $p < .05$. In those episodes when only the UP was present, there was no significant difference between the two groups: SBYS, $r(57) = 1.00$, $p = ns$ (see Figure 1). The greeting behavior of the two groups also differed depending on the entering person. Handled dogs showed higher levels of contact seeking toward the entering OW; that is, it was more common that they initiated the approach earlier, usually touched the OW, and displayed less avoidance than nonhandled dogs: COSO, $U(57) = 299.0$, $p = .05$ (see Figure 2). There was no difference in the level of contact seeking toward the UP: COSS, $U(57) = 334.5$, $p = ns$.

Two of the significant effects in the behavior of the handled dogs were related to the UP. Handled dogs had less physical contact with the UP during the episodes than nonhandled dogs: CONS, $t(57) = -2.83$, $p < .01$; but the two groups spent the same duration of time in physical contact with the OW: CONO, $t(57) = -0.88$, $p = ns$ (see Figure 3). Similar differences were found in the following behavior of the handled and nonhandled group. Although dogs in both groups tended to follow the departing OW in the presence of the UP to the same extent: FOLO, $U(57) = 388.5$, $p = ns$; the handled dogs were less likely to follow the departing UP in the presence of the OW: FOLS, $U(57) = 221.5$, $p < .01$.

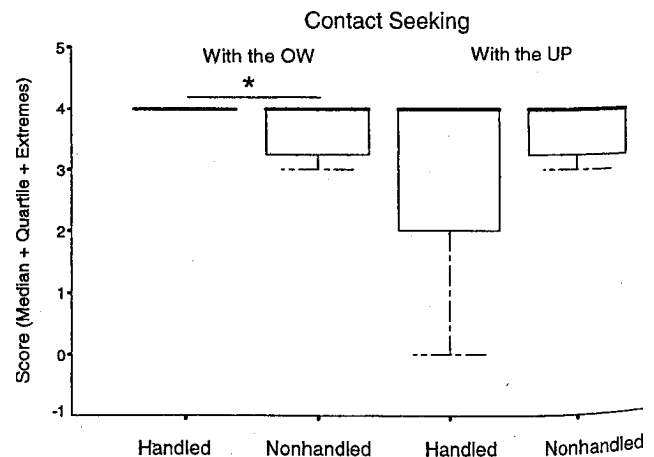


Figure 2. Score of contact seeking with the entering "owner" (OW) and the entering unfamiliar person (UP) in the nonhandled ($n = 20$) versus the handled group ($n = 39$). $*p = .05$.

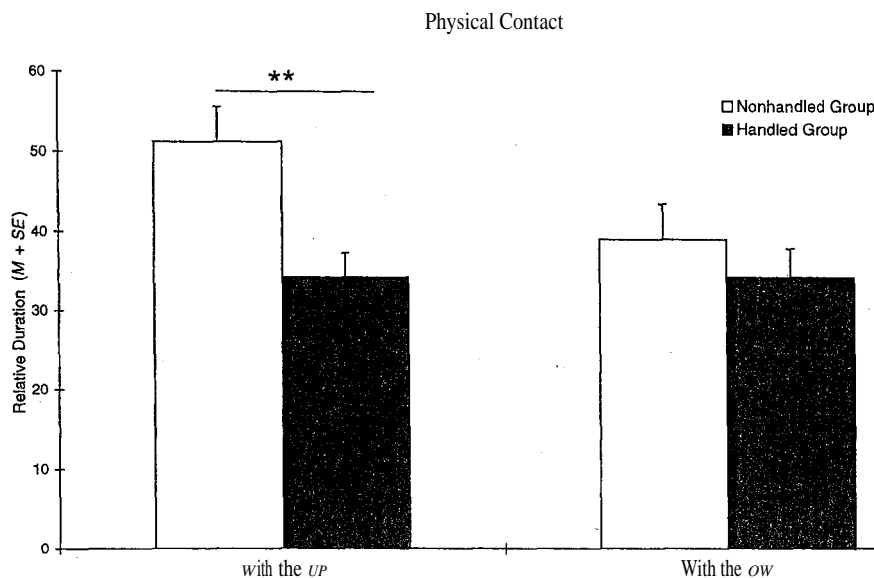


Figure 3. Relative duration of time spent in physical contact with the "owner" (OW) and the unfamiliar person (UP) in the nonhandled ($n = 20$) versus the handled group ($n = 39$) during the episodes. $**p < .01$.

There was no difference between the two groups in the time spent exhibiting passive behavior, which was the most frequent behavior during the episodes: PASO, $t(57) = -0.41$, $p = ns$; PASS, $t(57) = -1.66$, $p = ns$. Play and exploration also showed significant differences neither in the presence of the OW: PLYO, $t(57) = 0.15$, $p = ns$; EXPO, $t(57) = 0.28$, $p = ns$; nor in the presence of the UP: PLYS, $t(57) = -0.52$, $p = ns$; EXPS, $t(57) = 1.87$, $p = ns$. There was no difference in the delay of contact seeking and in the duration of physical contact at greetings in either case: DELO, $U(57) = 331.5$; DELS, $U(57) = 336.0$; DCONO, $t(57) = -0.28$; DCONS, $t(57) = 1.88$, $p = ns$ in all cases.

It can be argued that the handled dogs spent less time in physical contact with the UP as an indirect consequence of their avoidance of the UP. However, all 59 dogs approached the unfamiliar individuals during the test, and all of them spent several seconds (minimum 7 s) in physical contact with the UP. The dogs' physical contact with the experimenters was analyzed separately in Episode 2, as that was the only episode in the procedure when both the OW and the UP were present and that was the first time the dogs met the UP. Consequently, the dogs' simultaneous reaction to the OW and the UP could be compared in both groups. We found that all dogs except 1 spent several seconds in physical contact with the UP in this episode ($M = 32$ s). Moreover, the nonhandled dogs (with which both the OW and the UP were unfamiliar) that had already met the experimenter acting as the OW for 2 min during Episode 1 spent significantly more time in physical contact with the UP than with the OW in Episode 2: CON02 versus CONS2, $t(19) = 5.08$, $p < .01$. Even handled dogs did not have more physical contact with the OW than with the UP in this episode: CON02 versus CONS2, $t(38) = -1.03$, $p = ns$ (see Figure 4).

Discussion

As the modified version of Ainsworth's SST (Ainsworth & Wittig, 1969) proved to be an effective method in activating and observing the attachment behavior of adult family dogs with their owners (Topál et al., 1998), we used it to study the ability to form new attachment in dogs. By means of this experimental procedure, we could assess the behavioral manifestation of three short periods of handling in rescued dogs. We hypothesized that dogs living without social contact with humans for an extended period of time would show attachment behavior toward the so-far unfamiliar handler.

Our results showed that after three relatively short social interactions with an unfamiliar handler, in the test situation handled dogs behaved differently from the nonhandled dogs both toward the OW (played by the handler) and toward the UP. Compared with the behavior patterns of the nonhandled group, the specific behavior patterns that handled dogs showed toward the OW seem to fulfill the three operational criteria of attachment (Rajecki et al., 1978).

First, the fact that handled dogs stood by the door significantly less in the presence of the OW (SBYO) than did the nonhandled dogs suggests the handled dogs' ability to discriminate and respond differentially to the OW (i.e., their handler). This indicates that in the stressful situation created by the test conditions, handled dogs used the OW more often as a secure base for staying in the strange kennel rather than trying to find a way out. In the case of human infants, the ability to use the mother as a secure base from which to explore the environment serves as an important measure of attachment security (Bowlby, 1973). Nonhandled dogs stood more with an orientation toward the exit, ignoring the OW, who tried to play with them or offered petting. Moreover, handled dogs chose to stay in the strange place with the OW rather than to follow

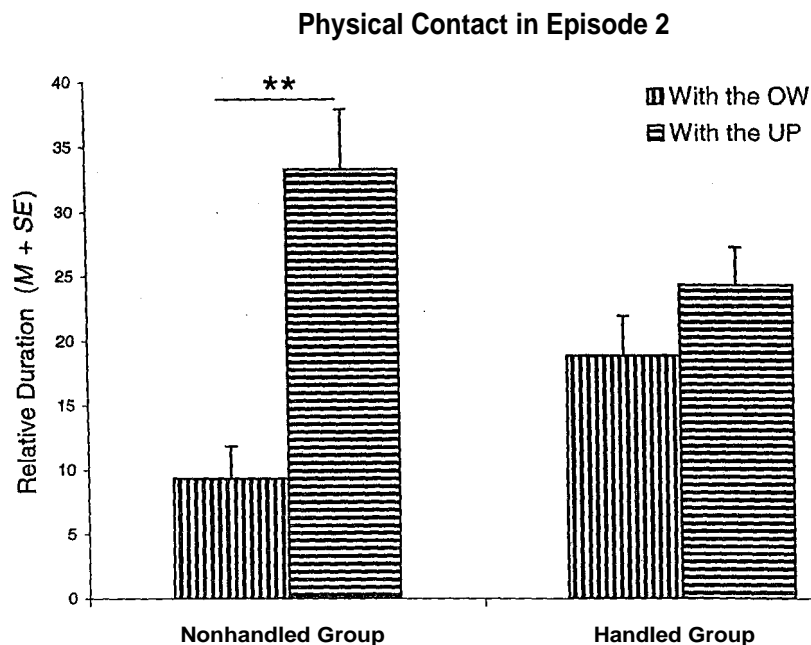


Figure 4. Relative duration of time spent in physical contact with the "owner" (OW) versus the unfamiliar person (UP) in Episode 2 in the nonhandled ($n = 20$) and the handled group ($n = 39$), analyzed using t tests for paired samples. $**p < .01$.

the departing UP (FOLS) and try to get out of the testing facility with her.

Second, the handled dogs' specific reaction to their reunion with the OW was demonstrated by more frequent approach initiation or full approach and less avoidance (COSO) during the greetings, which also indicates significant behavioral manifestation of preference for the *attachment* figure (i.e., the handler in the role of the OW).

Third, the shorter duration of time spent in physical contact with the UP by the handled group (CONS) reveals that the tendency for proximity seeking of an unfamiliar person decreased because of the handling.

An alternative explanation could be, however, that the handled dogs spent less time in physical contact with the UP (showed preference to the OW) not because of the separational distress, but as an indirect consequence of their avoidance of the UP. According to Scott et al. (1973), in dogs, two kinds of emotional reactions may be involved in separation: distress due to the absence of the familiar and that due to fear of the strange. Similarly, during the reunions, handled dogs may have tended to approach the familiar person and to avoid the unfamiliar one rather than to show attachment behavior. Some of our findings, however, seem to contradict this explanation. The dogs met the UP first in Episode 2, when the OW and the UP were both present. Nonhandled dogs showed preference for the UP in this episode by displaying more physical contact with her than with the OW, with whom they had already been together for 2 min in the previous episode. These data suggest that in this and the following episodes, handled dogs tended not to avoid but rather to ignore the UP in comparison to the nonhandled dogs.

So our results on physical contact seem to contradict the hypothesis suggesting that dogs tend to avoid the unfamiliar person.

On the contrary, dogs in both groups seemed to show interest in the friendly UP; however, this tendency was less strong in the handled group (see Figure 4).

It is also possible that dogs simply preferred the familiar individual over the unfamiliar one, even though they did not show fear or avoidance toward the unfamiliar experimenter. Preference alone, however, does not explain the decreased extent of the stand-by-the-door behavior shown by the handled group in the presence of the OW. This reaction and the tendency for the handled dogs not to follow the leaving UP when the OW was present seem to be analogous to the proximity-seeking behavior of adult pet dogs (Topál, Miklósi, & Csányi, 1997; Topál et al., 1998), human infants (Ainsworth & Wittig, 1969), and chimps (Bard, 1991) toward the attachment figure in stressful situations.

Although the ability to form attachments is usually associated with an early sensitive period, in this experiment we demonstrated that in certain conditions a short responsive interaction with an unfamiliar human individual may result in attachment behavior even in the case of dogs that are more than 1 year old. Our study shows that dogs of low or restricted contact with humans may retain their ability to form new attachment relationships with humans. Probably the extreme separation from human social contact (i.e., shelter conditions) has a crucial role in this sensitization process. In other words, dogs living in poor social conditions become more responsive to humans, which results in a remarkable readiness to form attachment relationships. It should be noted that in the case of rhesus monkeys, a similar effect has been shown because most abnormally socialized monkeys could be rehabilitated to a certain extent by appropriate exposure to conspecific groups and individuals (Harlow & Harlow, 1965).

Presumably as a result of domestication, the pursuit of social contact with humans has genetic bases in dogs (Zimen, 1987).

Humans' lengthy selection of dogs favored those with infantile features (Coppinger et al., 1987) in a way that physical paedomorphism has been accompanied by behavioral paedomorphism (Goodwin, Bradshaw, & Wickens, 1997). Thus, investigating the social relationship between dogs and owners is of great importance because the dog might serve as a model of human social behavior mechanisms because of its long history of artificial selection (see also Scott et al., 1973). Collis (1995) found that the parent-child and human-dog relationship can be characterized by a number of similar features, such as asymmetry and dependency. Further investigation of the phenomenon of attachment is important also because the quality of attachment seems to correlate with the manifestation of certain cognitive capacities both in children (Fónagy & Target, 1997; Matas, Arend, & Sroufe, 1978) and in dogs (Kubinyi, Miklósi, Topál, & Csányi, in press; Topál et al., 1997).

In sum, the results support our hypothesis that dogs living in rescue centers have a remarkable need for social contact with humans, which can lead to a relatively rapid formation of attachment to a potential attachment figure. This process seems to be accompanied by a tendency to show less approach and contact behavior toward an unfamiliar person. We should note that just as there were differences between the nonhandled and handled groups, there was a considerable individual variation in attachment behaviors toward the familiar handler among the handled dogs. The amount of the dogs' socialization with humans before their arrival at the rescue center could also influence their ability to form new attachment relationships (Freedman, King, & Elliot, 1961). On the basis of earlier observations (Scott & Fuller, 1965), it has generally been accepted that future owners should obtain and socialize their puppies by the age of 12 to 15 weeks; otherwise no attachment can be developed. This concept deters people from getting dogs from rescue centers. However, our study shows that dogs with low or restricted contact with humans may retain their ability to form new attachments. The experimental study of individual dogs at rescue centers using this or similar tests that assess the dog's capacity to form new attachment relationships could enhance the success rate of placing these dogs with new owners.

Although our results suggest that even three short handling encounters with a human handler may evoke attachment behavior in rescued dogs, we do not know how this attachment behavior corresponds with that shown by family dogs. Therefore, we plan to observe the attachment behavior of family dogs toward their owners by means of the same experimental procedure presented here. By comparing the attachment behavior of dogs living in families and in rescue centers, we hope to get more information on the development of attachment.

References

- Ainsworth, M. D. S., & Wittig, B. A. (1969). Attachment and exploratory behavior of one-year olds in a strange situation. In B. M. Foss (Ed.), *Determinants of infant behavior* (Vol. 4, pp. 111-136). London: Methuen.
- Bard, K. A. (1983). The effect of peer separation in young chimpanzees (*Pan troglodytes*). *American Journal of Primatology*, 5, 25-37.
- Bard, K. A. (1991). Distribution of attachment classifications in nursery chimpanzees. *American Journal of Primatology*, 24, 88.
- Bonas, S., McNicholas, J., & Collis, G. M. (1996, July). *Pets in the network of family relationships*. Paper presented at the conference of the International Society for Anthrozoology, Cambridge, England.
- Bowlby, J. (1958). The nature of the child's tie to his mother. *International Journal of Psychoanalysis*, 39, 350-373.
- Bowlby, J. (1969). *Attachment and loss: Vol. I. Attachment*. New York: Basic Books.
- Bowlby, J. (1972). *Attachment*. Middlesex, England: Penguin Books.
- Bowlby, J. (1973). *Attachment and loss: Vol. II. Separation anxiety and anger*. New York: Basic Books.
- Brodbeck, A. J. (1954). An exploratory study of the acquisition of dependency behavior in puppies. *Bulletin of the Ecological Society of America*, 35, 73.
- Caims, R. B., & Werboff, J. (1967, November 24). Behavior development in the dog: An interspecific analysis. *Science*, 156, 1070-1072.
- Collis, G. M. (1995). Health benefits of pet ownership: Attachment vs. psychological support. In *Animals, health and quality of life: 7th International Conference on Human Animal Interactions* (p. 7). Geneva, Switzerland: International Association of Human-Animal Interaction Organizations.
- Coppinger, R. J., Glendinning, E., Torop, C., Matthay, C., Sutherland, M., & Smith, C. (1987). Degree of behavioral neoteny differentiates canid polymorphs. *Ethology*, 75, 89-108.
- Cmic, L. S., Reite, M. L., & Shucard, D. W. (1982). Animal models of human behavior: Their application to the study of attachment. In R. N. Emde & R. J. Harmon (Eds.), *The development of attachment and affiliative systems*. New York: Plenum.
- Csányi, V. (2000). The "human behavior-complex" and the compulsion of communication: Key factors of human evolution. *Semiotica*, 128, 45-60.
- Fisher, A. E. (1955). *The effects of differential early treatment on the social and exploratory behavior of puppies*. Unpublished doctoral dissertation, Pennsylvania State University, University Park.
- Fónagy, P., & Target, M. (1997). The role of attachment and reflective function in the development of the self. *Developmental Psychopathology*, 9, 677-699.
- Fox, M. W. (1968). *Abnormal behavior in animals*. Philadelphia: Saunders.
- Fox, M. W. (1971). *Integrative development of brain and behavior in the dog*. Chicago: University of Chicago Press.
- Freedman, D. G. (1958, March 14). Constitutional and environmental interactions in tearing of four breeds of dogs. *Science*, 127, 585-586.
- Freedman, D. G., King, J. A., & Elliot, O. (1961, March 11). Critical period in the social development of dogs. *Science*, 133, 1016-1017.
- Goodwin, D., Bradshaw, J. W. S., & Wickens, S. M. (1997). Paedomorphosis affects agonistic visual signals of domestic dogs. *Animal Behaviour*, 53, 297-304.
- Gubemick, D. J. (1981). Parent and infant attachment in mammals. In D. J. Gubemick & P. H. Klopfer (Eds.), *Parental care in mammals* (pp. 243-300). London: Plenum.
- Harlow, H. F., & Harlow, M. K. (1965). The affectional systems. In A. M. Schrier, H. F. Harlow, & F. Stollnitz (Eds.), *Behavior in nonhuman primates* (Vol. 2, pp. 287-334). New York: Academic Press.
- Heinroth, O. (1910). Beiträge zur Biologie, namentlich Ethologie und Psychologie der Anatiden [Addition to biology, namely ethology and the psychology of anatids]. *Verhalten Vergleichender Internationaler Ornithologischer Kongress*, 5, 589-597.
- Holm, S. (1979). A simple sequentially rejective multiple test procedure. *Scandinavian Journal of Statistics*, 6, 65-70.
- Kretschmer, K. R., & Fox, M. W. (1975). Effects of domestication on animal behavior. *Veterinary Record*, 96, 102-108.
- Kubinyi, E., Miklósi, Á., Topál, J., & Csányi, V. (in press). Allelonymic behavior and social anticipation in dogs: Preliminary results. *Animal Cognition*.
- Martin, P., & Bateson, P. (1986). *Measuring behavior*. Cambridge, England: Cambridge University Press.
- Matas, L., Arend, R. A., & Sroufe, L. A. (1978). Continuity of adaptation

- in the second year: The relationship between quality of attachment and later competence. *Child Development*, 49, 547-556.
- Miller, L. C., Bard, K. A., Juno, C. J., & Nadler, R. D. (1990). Behavioral responsiveness to strangers in young chimpanzees (*Pan troglodytes*). *Folia Primatologica*, 55, 142-155.
- Millot, J. L. (1994). Olfactory and visual cues in the interaction systems between dogs and children. *Behavioural Processes*, 33, 177-188.
- Paxton, D. W. (2000). A case for a naturalistic perspective. *Anthrozoos*, 13, 5-8.
- Pettijohn, T. F., Wont, T. W., Ebert, P. D., & Scott, J. P. (1977). Alleviation of separation distress in 3 breeds of young dogs. *Developmental Psychobiology*, 10, 373-381.
- Pongrácz, P., & Altbacker, V. (1999). The effect of early handling is dependent upon the state of the rabbit (*Oryctolagus cuniculus*) pups around nursing. *Developmental Psychobiology*, 35, 241-251.
- Rajecki, D. W., Lamb, M. E., & Obmascher, P. (1978). Toward a general theory of infantile attachment: A Comparative review of aspects of the social bond. *Behavioral and Brain Sciences*, 3, 417-464.
- Rheingold, H. L., & Eckerman, C. O. (1973). Fear of the stranger: A critical examination. In H. Reese (Ed.), *Advances in child development and behavior* (Vol. 8, pp. 65-83). London: Academic Press.
- Sackett, G. P., Porter, M., & Holmes, H. (1964, January 25). Choice behavior in rhesus monkeys: Effect of stimulation during the first month of life. *Science*, 147, 304-306.
- Schleidt, W. M. (1998). Is humaneness canine? *Human Ethology Bulletin*, 13, 1-4.
- Scott, J. P. (1945). Social behavior, organization and leadership in a small flock of domestic sheep. *Comparative Psychology Monographs*, 96, 1-29.
- Scott, J. P., & Fuller, J. L. (1965). *Genetics and the social behavior of the dog*. Chicago: University of Chicago Press.
- Scott, J. P., Stewart, J. M., & DeGhett, V. J. (1973). Separation of infant dogs. In E. Senay & J. P. Scott (Eds.), *Separation and depression: Clinical and research aspects* (p. 28). Washington, DC: American Association for the Advancement of Science.
- Sears, R. R., Whiting, J. W. M., Novlis, V., & Sears, P. S. (1953). Some child-tearing antecedents of aggression and dependency in young children. *Genetic Psychology Monographs*, 47, 135-236.
- Serpell, J. A. (1996). Evidence for an association between pet behavior and owner attachment level. *Applied Animal Behaviour Science*, 47, 49-60.
- Topál, J., Miklósi, Á., & Csányi, V. (1997). Dog-human relationship affects problem solving behavior in the dog. *Anthrozoos*, 10, 214-224.
- Topál, J., Miklósi, Á., Csányi, V., & Dóka, A. (1998). Attachment behavior in dogs (*Canis familiaris*): A new application of Ainsworth's (1969) Strange Situation Test. *Journal of Comparative Psychology*, 112, 219-229.
- Tuber, D. S., Hennessey, M. B., Sanders, S., & Miller, J. A. (1996). Behavioral and glucocorticoid responses of adult domestic dogs (*Canis familiaris*) to companionship and social separation. *Journal of Comparative Psychology*, 110, 103-108.
- Vilá, C., Savolainen, P., Maldonado, J. E., Amorim, I. E., Rice, J. E., Honeycutt, R. L., Crandall, K. A., Lundeberg, J., & Wayne, R. K. (1997, June 13). Multiple and ancient origins of the domestic dog. *Science*, 276, 1687-1689.
- Wickler, W. (1976). The ethological analysis of attachment: Sociometric, motivational and sociophysiological aspects. *Zeitschrift für Tierpsychologie*, 42, 12-28.
- Wilson, C. C., Netting, F. E., & New, J. C. (1985). The Pet Attitude Inventory (PAI). *Anthrozoos*, 1, 76-78.
- Zimen, E. (1987). Ontogeny of approach and flight behavior towards humans in wolves, poodles and wolf-poodle hybrids. In H. Frank (Ed.), *Man and wolf* (pp. 275-292). Dordrecht, The Netherlands: W. J. Publishers.

Appendix

Behavioral Variables Observed in the Strange Situation Test

Abbreviation	Detailed description of the behavior categories
EXP	Exploration: Activity directed toward various aspects of the environment (except the toys), including sniffing, distal and close visual inspection, and oral examination.
PAS	Passive behavior: Sitting, standing, or lying down without any orientation toward the environment (includes grooming).
PLY	Playing: Any vigorous, toy- or social partner-related behavior, including any physical contact with toys (chewing).
SBY	Stand by the door: The time spent close to the door (< 1 m) with dog's face oriented to the exit.
CON	Duration of physical contact with a person.
COS	Contact seeking toward the entering person. The score is the sum of the following scores: (a) approach initiation = +1; (b) full approach toward the entering person, characterized by physical contact = +1; any sign of avoidance behavior = -1. The maximum score could be 4 in respect to the OW and the UP as well, because both of them enter the kennel twice.
DCON	Duration of physical contact while greeting the entering person.
DEL	Delay of contact seeking: The amount of time (in seconds) from the moment the door was opened to the first sign of approach behavior. (If approach was not recorded, DEL was considered to be 15 s.)
FOL	Following of the departing person. The score of following is (a) 0, if the dog did not orient toward the departing person at all, or did so for less than 1 s only; (b) 1, if the dog oriented toward the departing person for more than 1 s; (c) 2, if the dog followed the departing person to the door; (d) 3, if the dog tried to get through the door or stood by the door for more than 1 s. This score was recorded only when one person left while the other stayed with the dog in the beginning of Episode 3 for the OW and in the beginning of Episodes 4 and 7 for the UP. (In the case of the UP, the mean of the two scores was used.)

Note. OW = owner; UP = unfamiliar person.

Received December 6, 2000
Revision received May 9, 2001
Accepted May 13, 2001