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Attachment Behavior in Dogs (Canis familiaris): A New Application of Ainsworth's (1969) Strange Situation Test

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

Fifty-one owner-dog pairs were observed in a modified version of M. D. S. Ainsworth's (1969) Strange Situation Test. The results demonstrate that adult dogs *(Canis familiaris)* show patterns of attachment behavior toward the owner. Although there was considerable variability in dogs' attachment behavior to humans, the authors did not find any effect of gender, age, living conditions, or breed on most of the behavioral variables. The human-dog relationship was described by means of a factor analysis in a 3-dimensional factor space: *Anxiety, Acceptance,* and *Attachment.* A cluster analysis revealed 5 substantially different classes of dogs, and dogs could be categorized along the secure-insecure attached dimensions of Ainsworth's original test. A dog's relationship to humans is analogous to child-parent and chimpanzee-human attachment behavior because the observed behavioral phenomena and the classification are similar to those described in mother-infant interactions.

Although the construct of attachment was first used to explain the affectional bond that develops between a human infant and its caregiver (Bowlby, 1958), this concept has been elaborated for behavioral phenomena that are fundamental in social species and has been approached in a number of ways over the years. It was considered a hypothetical factor that ties individuals together (Lorenz, 1966) or a behavior system that results in one individual seeking and maintaining proximity to another individual (Bowlby, 1972). Cohen (1974) defined *attachment* as a special affectional relationship between two individuals that is specific in its focus and endures over time. This relationship is based on dependency between individuals that becomes evident through behavioral preferences (Wickler, 1976).

The theories of attachment behavior range from the psychoanalytic approach (Freud, 1946) through the different learning theories (Cairns, 1966; Gewirtz, 1972; Hoffman & Ratner, 1973; Solomon & Corbit, 1973) to the ethological model of attachment (Ainsworth, 1969, 1972; Bowlby, 1958, 1969; for a review, see Rajecki, Lamb, & Obmascher, 1978). The ethological approach uses the term *attachment* in evolutionary and developmental contexts and emphasizes that attachment systems are neurobiological structures that have been shaped by the normal environment and that function best in that environment (Bowlby, 1958; Kraemer, 1992). The ultimate function of attachment may be to defend against predation (Bowlby, 1969) or to obtain necessary resources that are provided by the caregiver. Nevertheless, perhaps attachment has no distinct function but simply evolved as a consequence of a close relationship between two individuals (Gubernick, 1981).

Attachment is an organizational construct (J. P Connel & Goldsmith, 1982), a product of maturation that always denotes a one-to-one relationship with a particular other and manifests itself in different behaviors (Sears, Whiting, Novlis, & Sears, 1953). Although the operational criteria of attachment have been developed from research on humans and other primates, they can be applied to other species. Attachment presumes (a) the ability to discriminate and respond differentially to the object of attachment (i.e., the secure-base effect), (b) a preference for the attachment figure (e.g., proximity and contact seeking and maintenance of proximity), and (c) a response to separation from and reunion with the attachment figure that is distinct from responses to others (Crnic, Reite, & Shucard, 1982; Gubernick, 1981; Rajecki et al., 1978).

One of the most important methodological approaches with respect to the assessment of attachment is the Strange Situation Test elaborated by Ainsworth and Wittig (1969). This laboratory procedure was originally designed (Ainsworth, 1969) to examine the balance of attachment and exploratory behaviors under conditions of low and high stress. Researchers hypothesized that during the experimental conditions, the attachment behavior is activated by separation from and reunion with the attachment figure (see Ainsworth, Blehar, Waters, & Wall, 1978, for an assessment of the human infant-parent attachment). Infant responses to this situation are customarily classified as fitting into one of three overall patterns of behavioral organization: *secure* (the infant shows signs of missing the parent upon separation, greets the parent actively upon reunion, and then settles and returns to play; identified as Category B); *insecure-avoidant* (the infant shows little or no distress at separation from the parent and actively avoids and ignores the parent upon reunion; Category A); or *insecure-resistant* (the infant is

József Topál, Ádám Miklósi, Vilmos Csányi, and Antal Dóka, Department of Ethology, Loránd Eötvös University, Göd, Hungary.

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Correspondence concerning this article should be addressed to József Topál or Ádám Miklósi, Department of Ethology, Loránd Eötvös University, Jávorka S. U. 14, H-2131 Göd, Hungary. Electronic mail may be sent to jtopal@ludens.elte.hu or miklosa@ludens.elte.hu.

highly distressed by separation and seeks for contact on reunion but cannot be settled by the parent and may show strong resistance; Category C). Recently, Main and Solomon (1990) described an additional insecure attachment pattern and called it the *disorganized pattern* (Category D). Because the Strange Situation paradigm is based on the evolutionary approach of attachment behavior, some authors have successfully adapted it to ethological studies. For example, researchers have found that during separation from and reunion with cagemates, chimpanzees reacted similarly to children (Bard, 1983, 1991; Miller, Bard, Juno, & Nadler, 1986) and that not only conspecifics but also humans could serve as attachment figures for young chimpanzees (Miller, Bard, Juno, & Nadler, 1990).

With the exception of primate studies, only a limited number of studies have explored the animal to human attachment. One of the most promising subjects for investigating this topic is the dog *(Canis familiaris).* The origin of the dog-human relationship dates back through 10,000 years of domestication. The dog's ancestor was originally a social species (see, e.g., Serpell, 1995). Dogs were selectively bred not only for "sociocognitive abilities" and for "attachment to humans" (Millot, 1994), but also for "infantile" features (Coppinger et al., 1987). The human-dog relationship is in some sense similar to the parent-child relationship (i.e., asymmetrical and dependency based), and people are apt to consider their dog as a child substitute (Collis, 1995). As attachment theory presumes, "Dogs seem to miss their owners during an absence and will appear excited upon the owner's return" (New, 1995, p. 25). Dogs seem to be innately responsive to humans so that not even strict punishment conditions can extinguish the proximity seeking of pups to a handler (Fisher, 1955). The dog's orientation to humans is also supported by Pettijohn, Wont, Ebert, and Scott (1977), who found that separation distress in puppies was greatly reduced when a human being was nearby.

On the other hand, because the evidence for using a mother as a secure base is poor for dogs (Elliot & Scott, 1961; Frederickson, 1952; Ross, Scott, Cherner, & Denenberg, 1960) and the puppies' separation distress can be reduced also by nonconspecifics (Cairns & Werboff, 1967; Pettijohn et al., 1977), attachment behavior in dogs has been questioned by some researchers (Rajecki et al., 1978). However, it is important to distinguish the "attachment" behavior of puppies that still have not developed individual relationships with their owners from the attachment of adult dogs that have more individualized bonds to their human masters. The calming effect that the presence of a human has on puppies might simply be the result of general distress reduction by a supposed conspecific and thus has no direct relation to a dog's later attachment to a person.

Nevertheless, most researchers assume that the acceptance of human beings as conspecifics and the motherlike and effective security-providing role of humans for distressed puppies are results of domestication. For 10,000 years, artificial selection in dogs favored socialization with humans as if they were conspecifics (Kretchmer & Fox, 1975). The genetic changes regarding a dog's capacity for conspecific recognition might have played a key role in this process that resulted in a preference for humans. A dog's preparedness for forming a bond with humans, a bond that is rooted in the evolutionary past, would be a prerequisite for the development of attachment between a particular person (the owner) and the dog itself.

Apart from some questionnaire studies that addressed the psychological features of the dog-human bond (e.g., Barker & Barker, 1988; Cox, 1993; Voith, Wright, & Danneman, 1992), to date there have been no experimental studies that aimed to give a behavioral description of dog-human attachment. We may suppose that for dogs in strange situations, as for children, it is not only the separation from the attachment figure (owner) but the reunion with her or him that activates the dogs' attachment behavior. So the application of Ainsworth's (1969) Strange Situation Test could provide useful information regarding the owner-dog relationship. Additionally, by using analogous methods, researchers can see how the similarity of observed behavioral phenomena and the organizational system of owner-dog interactions could provide a useful model for human infant attachment.

The purposes of this article are to demonstrate adult dogs' attachment behavior toward humans, to describe the human-dog relationship by an ethological method used for evaluation of mother-child attachment, and to study the similarity of owner-dog relationships in the form of mother-child interactions.

Method

Participants

Fifty-one owner-dog pairs volunteered for our experiment from kennel clubs in the vicinity. In the group of owners, there were 31 women and 20 men whose ages ranged from 13 to 60 years (M = 30.1 ± 8.5 years). In the group of dogs (Canis familiaris), there were 28 males and 23 females whose ages ranged from 1 to 10 years (M = 3.12 ± 0.40 years). The dogs were from 20 different pure breeds: Belgian Shepherd (n = 17), English Setter (n = 3), Laika (n = 3), Staffordshire Terrier (n = 2), Hungarian Vizsla (n = 2), Irish Wolfhound (n = 2), German Shepherd (n = 2), Briard (n = 1), Bobtail (n = 1), Caucasian Shepherd (n = 1), Czech Wolf (n = 1), Doberman Pinscher (n = 1), Great Dane (n = 1), Husky (n = 1), Irish Setter (n = 1), Giant Schnauzer (n = 1), Golden Retriever (n = 1), Komondor (n = 1), Newfoundland (n = 1), and Spaniel (n = 1). There were also mixed-breed dogs in our sample (n = 7). According to the American Kennel Club's (A.K.C.'s) classification, the dogs fit into five groups: sporting dogs (n = 11), nonsporting dogs (n = 3), working dogs (n = 27), terriers (n = 3), and mixed breeds (n = 7). (The A.K.C. has divided recognized breeds into six main groups on the basis of behavioral characteristics rather than phylogeny.)

Experimental Arrangement

The basic experimental setup and the protocol were as similar as possible to that of Ainsworth et al. (1978). The novel environment was a relatively empty rectangular room (6 m long x 3 m wide x 2.5 m high) containing two chairs. At one end of the room (opposite the door), there were toys for dogs on the floor. The 14.5-min procedure consisted of an introductory episode and seven experimental episodes. The behavior of the dogs was videotaped and analyzed later.

Experimental Episodes of the Strange Situation Procedure

Introductory episode (30 s). The observer introduces the owner and dog to the experimental room and leaves.

Episode 1 (2 min): owner and dog. The owner is a nonparticipant while the dog explores. After 1.5 min, a signal (a knock on the wall) is given to the owner who stimulates play.

Episode 2 (2 min): stranger, owner, and dog. A stranger enters and sits down. After 30 s, she initiates conversation with the owner. At the 2nd-min mark, the stranger approaches the dog and tries to stimulate playing. At the end of this episode, the owner leaves as unobtrusively as possible, but the dog's leash remains on the chair.

Episode 3 (2 min): stranger and dog. This is the first separation episode. The stranger's behavior is geared to that of the dog. During the 1st min, the stranger tries to engage the dog and keep him or her out of the door by playing. If the dog is not ready to play, the stranger tries to engage the dog by petting. At the 2nd min-mark, the stranger stops playing. If the dog initiates petting, it is permitted.

Episode 4 (2 min): owner and dog. This is the first reunion episode. The owner approaches the closed door and calls the dog. The owner opens the door and pauses a moment to allow the dog to respond. The owner greets and comforts the dog. Meanwhile, the stranger leaves. After 2 min, the owner leaves and says to the dog "stay here." The leash is left on the chair.

Episode 5 (2 min): dog alone. This is the second separation episode.

Episode 6 (2 min): stranger and dog. This is a continuation of the second separation. The stranger enters and gears her behavior to that of the dog. During the 1 st min, the stranger tries to engage the dog and keep him or her out of the door by playing. If the dog is not ready to play, the stranger tries to engage the dog by petting. At the 2nd min-mark, the stranger stops playing. Petting is permitted if it is initiated by the dog.

Episode 7 (2 min): owner and dog. This is the second reunion episode. The owner opens the door and pauses a moment before greeting the dog, giving him or her an opportunity to respond spontaneously. Then the owner greets and comforts the dog. Meanwhile, the stranger leaves.

To conduct the Strange Situation Test in a standard manner, we gave several instructions (see Appendix) to the stranger (who was the same woman in all cases). The owners did not know anything about the real goals and the hypotheses of the study in advance; they were informed that this study was to examine the exploratory behavior of the dogs in a strange situation.

Observations and Behavior Categories

Two trained observers analyzed the 51 videotaped sessions using eight behavior categories. Each behavior listed was scored for both owner and stranger. Recorded variables were as follows: exploration in the presence of the owner (EXPO) and in the presence of the stranger (EXPS), playing in the presence of the owner (PLYO) and in the presence of the stranger (PLYS), passive behaviors in the presence of the owner (PASO) and in the presence of the stranger (PASS), physical contact with the owner (CONTO) and with the stranger (CONTS), and standing by the door in the presence of the owner (SBYO) and in the presence of the stranger (SBYS). The relative percentage of the time spent with these behaviors was established, and the relative duration of each behavioral variable was summed across Episodes 1-7 for the statistical analysis.

We also analyzed the greeting behavior of the dogs toward the owners during the reunion episodes (Episodes 4 and 7) and toward the entering stranger (Episodes 2 and 6). Greeting was characterized by proximity of, contact seeking by, and contact maintenance of the dogs toward the entering owner (COSO, DCONTO, and DELO) and toward the stranger (COSS, DCONTS, and DELS).

Interobserver agreement was assessed by means of parallel coding of 20% of the total sample (10 strange situation sessions). Behavior was point sampled every 10 s (for assessing confidence for Elements 1-5), and the greeting episodes were evaluated separately for assessing confidence. We assessed agreement in two ways: percentage agreement and Cohen's kappa, a statistic that corrects for chance agreement (Martin & Bateson, 1986). The descriptions for behavior categories and the kappa and percentage scores are given in Table 1.

Analysis of Data

We recorded behavioral data continuously during observations, and we calculated the relative percentage of the time spent in each behavior. Although some of the variables had a normal distribution, in eight cases the transformation of raw data was necessary for parametric statistical methods. To achieve normality, we had to perform a square-root transformation for PLYS, PASO, PASS, CONTS, SBYO, DELO, and DCONTS and a log transformation for DELS.

The behavior that the dogs exhibited in the presence of owner and the stranger was compared using two-tailed *t* tests. We studied the correlation pattern of the dog's behavior in the strange situation using a factor analysis, which was also used to get theoretical dimensions (superordinate variables) thought to account for individual differences in a set of behaviors observed in the Strange Situation Test (J. P Connel & Goldsmith, 1982).

We then reanalyzed all the behavioral variables by cluster analysis to classify the individuals according to their strange situation behavior and to establish categories for the dog-human relationship. In previous human studies, researchers also explored the quantitative consistency of the Ainsworth (1969) system using cluster analysis, and they found that the traditional A, B, and C classifications (see above) were more or less relevant (D. B. Connel, 1976; Gardner & Thompson, 1983) to the distinct clusters. Nevertheless, the categorization along the secure versus insecure dimension has seemingly more predictive power than the A, B, and C groups (Arend, Gove, & Sroufe, 1979; Matas, Arend, & Sroufe, 1978; Waters, Wippman, & Sroufe, 1979).

Finally, we analyzed the effects of independent variables (i.e., the owner's sex and the dog's gender and breed) on the strange situation behavior using three-way analyses of variance (ANOVAs) and correlation analysis (the dog's age and the number of family members). We also analysed the effect of breed differences on the strange situation behavior using an ANOVA and an F test for equality of variances on a matched-pair sample (a homogeneous and a heterogeneous subgroup of dogs).

Results

Dogs' Behavior in the Presence of the Owners Versus the Stranger

The dogs tended to play more (PLYO vs. PLYS: $t[50] = 5.4, p < 0.0001$) and spent more time exploring (EXPO vs. EXPS: $t[50] = 2.5, p = 0.013$) in the presence of their owners (Figure 1). Passive behaviors and physical contact did not show significant differences (PASO vs. PASS: $t[50] = 1.5$, p = ns; CONTO vs. CONTS: $t[50] = 1.5$,

Table 1
Behavioral Variables Observed in the Strange Situation Test

Variable	% agreement	Cohen's a
1. Exploration: activity directed toward nonmovable aspects of the environment, including sniffing, distal visual inspection (staring or scanning), close visual inspection, or oral examination; EXPO and EXPS.	96	0.90
2. Playing: any vigorous, toy- or social partner-related behavior, including running, jumping, or any physical contact with toys (chewing, biting); PLYO and PLYS.	98	0.92
3. Passive behaviors: sitting, standing, or lying down without any orientation toward the environment; PASO and PASS.	96	0.92
4. Physical contact; CONTO and CONTS.	100	1.00
5. Stand by the door: the time spent close to the door (<1 m) with the face oriented to the exit; SBYO and SBYS.	99	0.97
6. The score of contact seeking; that is, the sum of the following scores: approach initiation (+1); full approach, characterized by physical contact (+2); any sign of avoidance behavior (-1); COSO and COSS.	88	0.73
7. Delay of contact seeking: the amount of time (in s) from the moment of the opening of the door to the first sign of approaching behavior; DELO and DELS. (If approach was not recorded, DELO or DELS was considered to be the duration of full episode, or 120 s.)	98	0.96
8. Duration of physical contact while greeting; DCONTO and DCONTS.	100	1.00

Note. EXPO = exploration in the presence of owner; EXPS = exploration in the presence of stranger; PLYO = playing with owner present; PLYS = playing with stranger present; PASO = passive behavior in presence of owner; PASS = passive behavior in presence of stranger; CONTO = physical contact with owner; CONTS = physical contact with stranger; SBYO = standing by door with owner present; SBYS = standing by door with stranger present; COSO = contact seeking with entering owner; COSS = contact seeking with entering stranger; DELO = delay of contact seeking with owner; DELS = delay of contact seeking with stranger; DCONTO = duration of physical contact while greeting entering owner; DCONTS = duration of physical contact while greeting entering stranger.

p = ns, respectively). During the separation episodes (i.e., owner absent), the dogs stood by the door more than when the owner was present (SBYS vs. SBYO: *t[50] = 10.7,* p < 0.0001). Furthermore, dogs showed higher levels of contact seeking toward the entering owner compared with the stranger *(COSO vs. COSS: t[50] = 7.2, p < 0.0001).* In the case of the former, we also noticed a shorter delay of contact seeking (DELO vs. DELS: *t[50] = 7.0, p < 0.0001)*

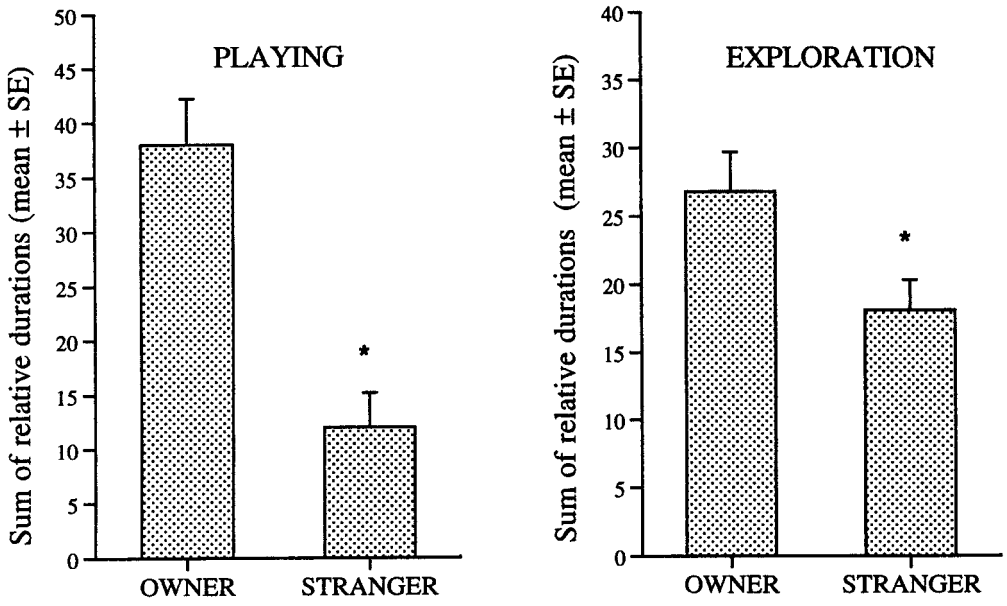

Figure 1. Relative duration of playing (left panel) and exploration (right panel) behaviors in the presence of the owner versus the stranger. *p < .02.

and a longer duration of first physical contact (DCONTO vs. DCONTS: $t(50) = 5.9$, $p < 0.0001$; see Figure 2).

Factor Analysis

Factor analysis performed on 14 behavioral variables (PASO, PASS, PLYO, PLYS, CONTO, CONTS, SBYO, SBYS, COSO, COSS, DELO, DELS, DCONTO, and DCONTS) resulted in three rotated factors (varimax rotation, eigenvalue > 1.5) that accounted for 57% of the total variability (29%, 15%, and 13% respectively). For the first factor, five behavioral variables were represented by high loadings (> 0.55). Individuals that scored high on this factor behaved passively (i.e., they did not play and spent long amounts of time exhibiting passive behaviors in the presence of the stranger compared with the owner) and strove for physical contact with the owner. So, this factor related to the stressfulness of the strange situation and can be referred to as the *Degree of Anxiety*. Because the second factor is characterized by long-lasting physical contact with the stranger (CONTS and DCONTS) and by a high level of contact seeking toward the entering stranger (COSS), it can be

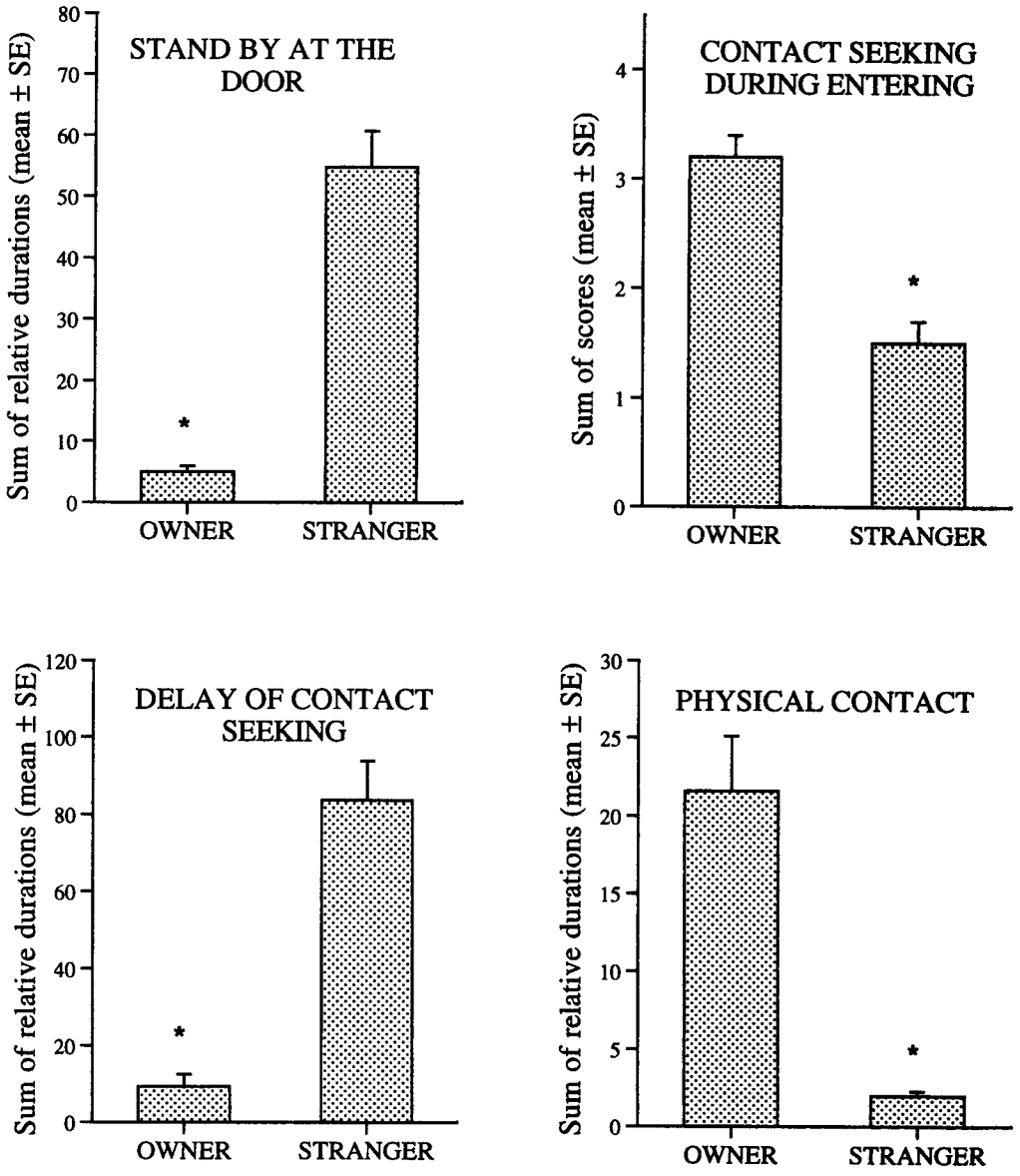

Figure 2. Scores of contact seeking toward the entering owner versus the stranger (upper right panel) and relative duration (in seconds) of different behaviors: stand by the door in the presence of the owner versus the stranger (upper left panel), delay of contact seeking toward the entering owner versus the stranger (lower left panel), and physical contact with the owner versus the stranger while greeting (lower right panel). *$p < .001$.

referred to as the *Acceptance of the Presence of the Stranger.* The third one is characterized by the high level of contact seeking toward the owner with low (if any) delay of approach and by permanent greeting contact with the entering owner (COSO, DELO, and DCONTO). So this factor is related to the owner-dog relationship and can be referred to as the factor *of Attachment.* The results *of* this analysis are given in Table 2.

Cluster Analysis

Using the same variables as the factor analysis, we calculated a hierarchical cluster analysis. Visual examination *of* the dendrogram (Figure 3) revealed that the dogs could be divided into three separate groups, and Group 1 and Group 3 each consisted *of* 2 subgroups (la, lb and 3a, 3b). The number *of* dogs in each group was as follows: la *(n* = 12), lb *(n* = 18), 2 *(n = 5),* 3a *(n = 9),* and 3b *(n = 7).* The categorization *of* dogs into these groups was further supported by the results *of* post hoc ANOVA tests on the behavioral variables using the groups as independent variables. We found significant differences among the groups in *10 of* the 16 observed behavioral variables. Furthermore, the post hoc Duncan multiple-range test showed significant ranges for a given dependent variable (this result revealed a characteristic behavior pattern for the groups). According to this latter analysis, the level *of* any behavioral variable could be low (L), medium (M), or high (H) in a given group (Table 3).

Because individual factor scores were also calculated, we used them for comparison *of* cluster analysis groups. This comparison resulted in significant differences for all three factorial variables (see, Table 4 and Figure 4), providing further evidence for the homogeneity *of* the dogs within a cluster group.

Table 2
Factor Loadings of Behavioral Variables

Behavior	Factor: Anxiety	Factor: Acceptance	Factor: Attachment
Playing			
PLYO	-.91	-.07	-.06
PLYS	-.89	.01	-.20
Passive behavior			
PASO	.91	.02	-.18
PASS	.80	.25	-.19
Physical contact			
CONTO	.59	.22	.22
CONTS	.27	.77	-.05
Stand by the door			
SBYO	.20	-.16	.48
SBYS	.07	-.46	.47
Score of contact seeking			
COSO	-.10	.11	.67
COSS	-.01	.58	-.07
Delay of contact seeking			
DELO	.09	.21	-.71
DELS	-.21	.06	.37
Duration of physical contact			
DCONTO	.15	.46	.61
DCONTS	.18	.78	.12

Note. PLYO = playing with owner present; PLYS = playing with stranger present; PASO = passive behavior in presence of owner; PASS = passive behavior in presence of stranger; CONTO = physical contact with owner; CONTS = physical contact with stranger; SBYO = standing by door with owner present; SBYS = standing by door with owner absent; COSO = contact seeking with entering owner; COSS = contact seeking with entering stranger; DELO = delay of contact seeking with owner; DELS = delay of contact seeking with stranger; DCONTO = duration of physical contact while greeting entering owner; DCONTS = duration of physical contact while greeting entering stranger. Boldface indicates behavioral variables with high loadings (>.55) on the three significant factors.

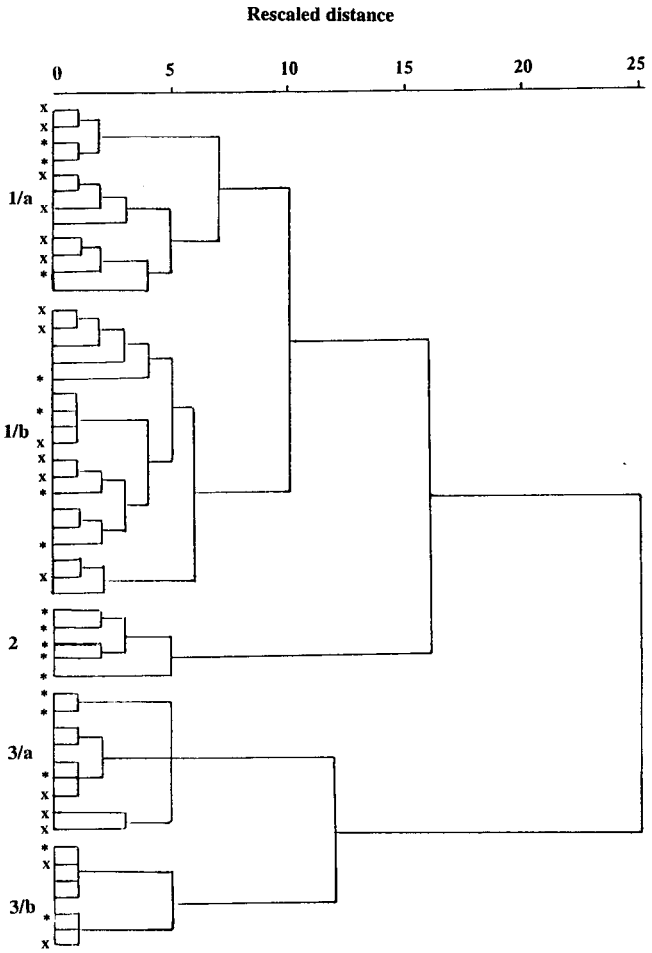

Figure 3. The result of the cluster analysis for Groups la, lb, 2, 3a, and 3b. * = dogs of homogeneous group (Belgian Shepherds); x = dogs of heterogeneous group.

Effects of Independent Variables on Strange Situation Behavior

We analyzed the observed behavioral variables and the three factor scores *of* the dogs by a three-way ANOVA using the independent variables recorded in this sample (i.e., the owner's sex, and the dog's gender and breed), but they had no significant effect on these variables.

The effects of the dog's age and the number of family members on the strange situation behavior were analyzed by correlation analysis. Only the number of family members correlated significantly with some of the variables (SBYS: -0.38, PASS: 0.43, $p < 0.01$ in each). That is, dogs living in large families tended to spend less time close to the door and showed more passive behaviors in the presence of the stranger.

The Effect of Breed Differences on Strange Situation Behavior

To study the effect of breed on the dog's behavior, we selected two subgroups from the 51 subjects. Subgroup 1 was a homogeneous group; it included the 17 Belgian Shepherds. Subgroup 2 was a heterogeneous group; it included 17 dogs of different breeds (a German Shepherd, an Irish Setter, a Giant Schnauzer, a Briard, a Staffordshire Terrier, a Golden Retriever, a Newfoundland, an Irish Wolfhound, a Caucasian Shepherd, a Laika, a Hungarian Vizsla, a Bobtail, and 5 dogs of mixed breed). The two groups were matched regarding the owners' sex and the sex of the dogs. Subgroups 1 and 2 were also balanced for all of the other independent variables except for breed. When we compared Subgroups 1 and 2, neither the mean ages, 2.7 and 4.0, years $F(1, 33) = 1.18$, ns, nor the average number of family members, 5.5 and 5.3, $F(1, 33) = 0.22$, ns, differed significantly.

We analyzed the effect of breed differences on the strange situation behavior of the dogs using an ANOVA that compared the homogeneous and the heterogeneous groups. Only 2 out of 16 variables differed significantly; that is, the Belgian Shepherds had a lower level of contact seeking toward the entering stranger, COSS: $F(1, 50) = 7.40$, $p = .01$, and they spent more time in close proximity to their owners, CONTO: $F(1, 50) = 10.40$, $p < .01$. Regarding the means of the dogs' individual factor scores, there were no significant differences between the Belgian Shepherds and the mixed group.

Nevertheless, we decided that comparing the variance scores of the observed variables might demonstrate more clearly the effect of breed differences on the strange situation behavior. To determine whether Belgian shepherds are a more homogeneous group than the mixed group, we used the F test of homogeneity of variance. With the exception of DELO, $F(16,16) = 3.78$, $p < .001$, there were no significant differences in variances of the behavioral variables and the factor scores. $F(16, 16)$ values are as follows ($p > .05$ in each): EXPO = 1.69, EXPS = 1.12, PLYO = 1.05, PLYS = 1.08, PASO = 1.42, PASS = 1.42, CONTO = 0.16, CONTS = 0.50, SBYO = 0.70, SBYS = 1.77, COSO = 1.12, COSS = 1.33, DELS = 0.44, DCONTO = 0.65, DCONTS = 0.47, Anxiety = 0.99, Acceptance = 0.81, and Attachment = 0.57.

Table 3
Behavior Patterns of the Five Cluster Groups

	Cluster group					ANOVA	
Variable	1a	1b	2	3a	3b	F(4, 50)	p
EXPO	L	L	L	M	H	5.30	.0014
EXPS	L	L	M	M	M	2.80	.035
PLYO	H	M	L	L	M	50.30	>.0001
PLYS	H	L	L	M	L	13.90	>.0001
PASO	L	L	M	M	H	13.70	>.0001
PASS	L	L	H	H	L	8.90	>.0001
CONTO	L	L	H	L	L	18.00	>.0001
CONTS	M	L	M	L	L	2.90	.03
SBYS	L	H	M	L	H	40.20	>.0001
COSO	H	H	H	L	H	2.40	.05
SBYO	—	—	—	—	—	1.27	ns
COSS	—	—	—	—	—	1.91	ns
DELO	—	—	—	—	—	1.69	ns
DELS	—	—	—	—	—	1.52	ns
DCONTO	—	—	—	—	—	1.26	ns
DCONTS	—	—	—	—	—	1.87	ns

Note. Dashes indicate that these variables cannot be divided into statistically different levels. EXPO = exploration in the presence of owner; EXPS = exploration in the presence of stranger; PLYO = playing with owner present; PLYS = playing with stranger present; PASO = passive behavior in presence of owner; PASS = passive behavior in presence of stranger; CONTO = physical contact with owner; CONTS = physical contact with stranger; SBYS = standing by door with owner absent; COSO = contact seeking with entering owner; SBYO = standing by door with owner present; COSS = contact seeking with entering stranger; DELO = delay of contact seeking with owner; DELS = delay of contact seeking with stranger; DCONTO = duration of physical contact while greeting entering owner; DCONTS = duration of physical contact while greeting entering stranger. L = low; M = medium; and H = high value of a given variable, which are significant ranges established by post hoc Duncan range test. ANOVA = analysis of variance.

Table 4
Factorial Patterns of the Five Cluster Groups

	Cluster group					ANOVA	
Factor	1a	1b	2	3a	3b	F(4,50)	p
Anxiety	L	L	H	M	M	25.0	>.0001
Acceptance	M	L	H	M	M	5.0	>.01
Attachment	L	M	H	L	M	6.4	>.01

Note. L = low; M = medium; and H = high value of a given variable, which are significant ranges established by post hoc Duncan range test. ANOVA = analysis of variance.

Discussion

The aim of this study was to investigate the human-dog relationship by means of Ainsworth's (1969) Strange Situation Test. As the results show, the experimental conditions of the test proved to be effective in activating the attachment behavior of owner-dog dyads, despite the fact that our participants were all physiologically adults, and attachment behavior is usually regarded as a feature of childhood, as a part of parent-offspring interactions. The observed attachment behavior of adult dogs toward owners is presumably the result of 10,000 years of domestication. During this time, dogs' dependency was increased by artificial selection, and thus long-lasting, caregiver-receiver relations between humans and dogs could be formed by way of socialization

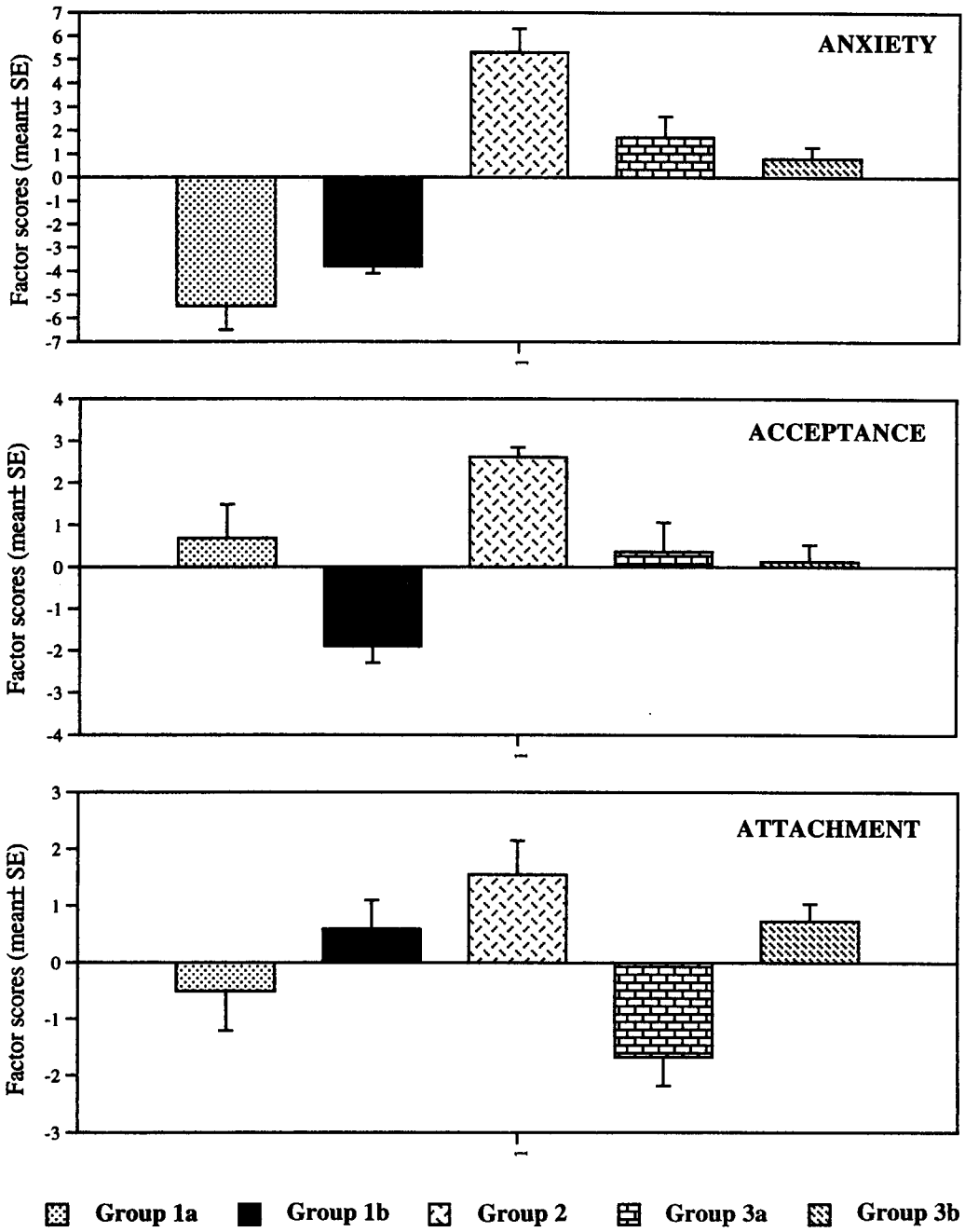

Figure 4. Means of individual factor scores of the Anxiety (top panel), Acceptance (middle panel), and Attachment (bottom panel) factors in the five cluster groups.

during an individual's life. Another possible explanation for the attachment behavior could be a tendency on the part of human breeders to select dogs that behave in social situations similarly to humans, especially children. The result of such a process is the domesticated dog that simulates many human (infant) behavior patterns such as attachment.

As was the case with children and human-reared chimpanzees (Bard, 1991), the observed behavioral changes in owner-dog dyads fulfilled the operational criteria of attachment (Gewirtz, 1972; Rajecki et al., 1978). A dog's use of the owner as a secure base and its specific reaction to separation from and reunion with the owner are clear behavioral manifestations of the attachment of dogs to human.

This secure-base effect was revealed by the dogs' increased exploration and by more frequent playing in the presence of the owners (caregivers), just as in children and chimpanzees. In the separation episodes, dogs stood at the

door for considerable lengths of time; the fact that this behavior was not reduced by the presence of the stranger suggests dogs' strong preference for their owners in stress situations. This reaction seems to be analogous to the "searching response" described in young children (Ainsworth, 1969), monkeys (Kaufmann & Rosenblum, 1969), and chimpanzees (Bard, 1991) that was interpreted as an effort to maintain the attachment-comfort bond (Gewirtz, 1961; Rheingold, 1961; Walters & Parke, 1964). The dogs' specific reaction to reunion with the owner was active and immediate contact seeking and a tendency toward contact maintenance for the returning owner (COSO, DELO, and DCONTO) but not the stranger.

None of the independent variables (age, sex of humans, and gender of dogs) seems to account for the dogs' considerable behavioral variability in the Strange Situation Test. However, dogs living in large families exhibited less proximity-seeking behavior toward the owner (SBYS) and tended to behave more passively (PASS) in the situation. This effect can be attributed to the differences in socialization of particular dogs because in larger families, pets probably form multiple attachments to some members of the family. On this basis, these dogs will show less clinging behavior toward the owner.

Moreover, the breed-specific differences, usually regarded as a major source of behavioral variability in dogs (Scott & Fuller, 1965), also had only a slight effect on the behavior of the dogs in the test. The comparison of mixed breed (heterogeneous) versus one purebred (homogeneous) group (Belgian Shepherds) showed only small differences. Because cluster analysis did not rank the individuals of different breeds into groups of distinct categories, perhaps the variability of the attachment behavior among breeds is similar. However, with regard to the behavioral parameters used in this study, one breed might be found to show a different kind of attachment compared with other breeds. This possibility underlines the necessity of the use of a multivariate approach because it reduces the effect of existing breed differences on the evaluation of attachment.

As was found in other studies of applied factor analysis (J. P Connel & Goldsmith, 1982; Miller et al., 1990), the strange situation behavior was influenced by different variables, including the dogs' reaction to a separation from the owner, the unfamiliar environment that was more or less stressful for dogs, and the dogs' responsiveness to the stranger. The results of our factor analysis support the notion that the strange situation behavior could be explained by three major hypothetical variables, including the dogs' reaction to separation from the owner (Factor 3: Attachment), the unfamiliar environment (Factor 1: Anxiety) that was more or less stressful for dogs, and the dogs' responsiveness to the stranger (Factor 2: Acceptance). In contrast with earlier attempts to validate traditional A, B, or C categorization (avoidant, secure, or resistant) by post hoc cluster analysis (D. B. Connel, 1976; Gardner & Thompson, 1983), we used this multivariate analysis to establish categories of dog-human relationships. The results of the exploratory cluster analysis showed that dogs could be separated into at least three or at most five major groups (see Figure 3). Although these groups differed with respect to many behavioral variables, the difference in the factorial variables was more pronounced. Starting from the principle that factorial variables can be divided into three statistically distinct categories (L, M, or H) we found five distinguishable groups that differed by at least one factorial variable from each other. Still, our findings support the view of J. P Connell and Goldsmith (1982) that group classification is best perceived as representing an underlying continuum in three dimensions.

Dogs that belonged to Cluster Group 1 were characterized by low anxiety in the stressful situation, but they differed in the interrelationship between their acceptance and attachment. The low levels of attachment to the owners in Group 1 a contrast with their medium level of acceptance of the stranger. Dogs in Group lb showed higher levels of attachment to the owner than acceptance of the stranger, suggesting that the former was more preferred for reducing stress in these dogs. Although one might suspect there was a difference in socialization of the dogs in the two subgroups, at the present time we have no evidence for this.

Cluster Group 2 was characterized by high anxiety related to a stressful situation, high levels of acceptance regarding the separation, and high levels of contact seeking and contact maintenance toward the entering owner. These dogs seemed not to distinguish between owner and stranger, which could have been the result of their marked stress during separation episodes. In sum, these dogs expressed the most extreme behavior of all subjects observed.

Cluster Group 3 was characterized by medium levels of anxiety and acceptance. There was a clear separation in two subgroups (3a and 3b) of the level of attachment to the owner. Whereas dogs in Group 3a showed low levels of attachment toward the owner, Group 3b was characterized by significantly higher attachment behavior in this situation. One might suppose well-socialized dogs should belong into this latter group (3b). We suspect that the dogs of Group 3a tended to avoid close -contact with the owner and the stranger, which was a more effective strategy for them in reducing stress during separation episodes.

Regarding the total sample, all of the five cluster groups and subgroups are represented by a considerable proportion of subjects (10%-35%). In other words, all these groups represent a relatively common form of attachment behavior, but the level of expression was influenced by the stressfulness of the strange situation.

Dogs in Group lb seemed to attach only to the owner. Dogs of Groups 2 and 3b both seemed to bond to humans, not just to a particular person (medium and high scores of Acceptance and Attachment). However, they differed in sensitivity to stress, and thus their reactions toward the owner also differed: The extremely anxious dogs (Group 2) showed more expressed attachment behavior and acceptance than the less anxious ones (Group 3b).

Dogs in two groups (la and 3a) avoided the owner (low Attachment scores). The difference between them was the level of anxiety. Compared with Group 2, the relative owner-avoidant behavior of nonanxious Group l a does not unconditionally mean a lack of attachment on the part of these dogs because we would not expect the activation of

attachment behavior under a condition of low stress. The dogs of Group 3a that were more susceptible to stress, but in spite of this fact behaved in a very avoidant manner, can be referred to as the nonattached group of our sample. The moderately anxious dogs of Group 3a seemed to bond to humans in general but not to the owner.

Because all of our subjects were more or less socialized dogs living in families, we did not find dogs that reject humans in general (low Attachment, low Acceptance). We suppose that extremely unsocialized dogs (feral dogs or some dogs from shelters) would prove to be more avoidant toward humans.

The establishment of these categories gives us an important tool for examining the effect of socialization of dogs and the genetic influences (breed differences) on the attachment of dogs to owners. Furthermore, we are now able to measure the temporal stability of owner-dog relationship and its development. All these issues should be the targets for future studies.

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Appendix

Instructions to the Stranger

1. In leaving during reunion episodes, the stranger must be unobtrusive and never interfere with the reunion (i.e., say nothing to the owner or dog, do not move between them, and leave quietly). If necessary, the stranger can wait to exit.

2. The stranger should never position herself between the dog and the owner, especially during reunions.

3. The stranger should never sit in the owner's chair.

4. When playing, the stranger should take her cue from the dog and do something similar.

5. In Episodes 3 and 6, if the dog is upset, the stranger should try to reassure it by petting and then distract it with toys.

6. At the end of Episodes 3 and 6, the stranger should never be playing or interacting with the dog so that the dog is not distracted when the owner returns.

7. In Episode 2, if the owner is not in her or his chair, the stranger may remind the owner to move to the chair.

8. The stranger must learn to remain calm in the presence of very distressed dogs and must not feel distressed if she cannot calm the dog.

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