



A counterbalanced version of Ainsworth's Strange Situation Procedure reveals secure-base effects in dog–human relationships

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Abstract

It has been proposed that the dog–human relationship constitutes an infantile-like attachment. However, previous empirical support based on Ainsworth's Strange Situation test has proved inconclusive due to order effects inherent in the original procedure. In particular, these order effects compromise the ability to establish an essential facet of attachment: whether or not owners function as a secure base for their pet dogs. Order effects were counteracted in the present study by including a second condition in which the order of owner and stranger presence was counterbalanced. Hence, 38 adult dog-owner pairs were randomly placed in two conditions, both comprised of six 3-min episodes. In condition A, dogs entered an unfamiliar room with their owner; a stranger entered; the owner left the dog with the stranger; the dog was left alone in the room; the owner returned; and finally the dog was left with the stranger again. In condition B, the order in which owner and stranger were present was reversed. Secure-base effects were indicated in that the dogs explored, remained passive, played with the stranger and engaged in individual play more when in the presence of their owner than when left with the stranger or alone. Therefore, the dogs' behaviour provides evidence consistent with the hypothesis that the dog–human bond constitutes an attachment. The possible role of attachment in canine separation anxiety is briefly discussed.

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Despite evidence of a long and symbiotic history, few empirical studies have investigated the nature of the bond domestic dogs form with their human owners (Millot, 1994; Clutton-Brock, 1995; Wayne and Ostrander, 1999). Researchers have noted that much behaviour exhibited by

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young and old dogs alike toward their owners seems to elicit parental-like care (Hart, 1995; Askew, 2003). Indeed, some authors (Topal et al., 1998; Prato-Previde et al., 2003) have suggested that the dog–human bond is an infantile attachment (referred to as just attachment hereafter) which for the dog extends beyond infancy into adulthood.

Attachment refers to a particular type of bond that develops between an infant and its primary caregiver, usually the mother (Bowlby, 1958). Attached individuals tend to maintain proximity and contact and become distressed when involuntary separation occurs (Cassidy, 1999). In addition, caregivers provide the security and comfort needed to function as a secure base from which an infant can move off to engage confidently in other activities such as play or exploration (Ainsworth, 1989; Waters and Cummings, 2000).

The most commonly used empirical test for attachment is Ainsworth's Strange Situation Procedure (ASSP) (e.g., Ainsworth and Bell, 1970; Bard, 1991). In ASSP, an infant and his or her caregiver enter an unfamiliar room and are introduced to a stranger prior to experiencing three short episodes of separation and two of reunion. Typically the stress of separation activates the attachment system so that the infant becomes distressed and seeks to regain proximity and secure comfort on reunion.

Topal et al. (1998) were the first to show that adult dogs behave in a remarkably similar way to human infants during ASSP. However, most of Topal et al.'s findings provide evidence of no more than that dogs possess a preference for their owner over a stranger. In order to establish the relationship as an attachment, it is necessary to go beyond establishing a preference and to focus on behaviours that indicate security-, proximity- and comfort-seeking (Cassidy, 1999) and in particular one must show that the dog's owner functions as a secure base (Ainsworth, 1989).

Prato-Previde et al. (2003) used ASSP to look for specific attachment patterns, particularly secure-base effects. Despite detailed analyses, due to order effects inherent in ASSP, they were still unable to provide clear evidence that the dog–human bond constitutes an attachment. For example, they surmised that the significant decline in exploration from the first episode, when dogs were alone in the room with their owner, compared to episode 2, when the stranger entered, may simply have been due to lessening curiosity rather than wariness of the stranger. Furthermore, the decrease in social play with the stranger that occurred from between the last minute of episode 2 (owner and stranger present) and episode 3 (stranger present, owner absent) could possibly have been due to fatigue or reduced interest rather than the absence of the dog's "attachment figure". In short, the researchers concluded that the standardised order of ASSP episodes compromised their ability to isolate specific secure-base effects.

The present study addressed the issue of order effects by introducing a second counterbalanced condition which reversed the order of owner and stranger presence. Counterbalancing allowed us to be confident that any evidence indicating a secure-base effect, such as elevated levels of exploration in the presence of the owner versus the stranger, would be due to the identity of the person present and not just the order in which they appear during the course of the procedure. Additionally, in order to encourage an extended opportunity for exploration, a partition was pulled back at the end of the third episode allowing the dogs access to a second unfamiliar room. The inclusion of this novel modification to the procedure gave us further occasion to detect the secure-base effect of dogs returning to normal activity upon reunion with their owner.

In summary, we hypothesised that if owners function as attachment figures, we would find evidence not only of proximity-seeking, search behaviours and comfort-seeking, but also of specific secure-base effects. We predicted that: (1) the presence of the owner, over and above the stranger, would encourage calm passive behaviour, exploration, social play and independent play; (2) the dogs would exhibit similar stranger wariness as found in human infants and look

toward or approach their owner on the entrance of the stranger; (3) separation from the owner (either in isolation or with the stranger) would result in reduced play, exploration and passivity; (4) play, exploration and passivity would increase upon reunion with the owner; and (5) despite having access to the second room, the dogs would not begin to explore, to any great extent, until they were reunited with their owner. Counterbalanced conditions allow us to be confident that any differences in behaviour with respect to the owner's versus stranger's presence would not be due to order effects.

1. Method

1.1. Participants

Thirty-eight dog-owner pairs were recruited by personal contact and advertisements. Owners were all adults and comprised 33 women and 5 men. Dogs comprised 19 males and 19 females ranging from 1 to 10 years in age (mean = 4.67 years). There were 26 pedigrees and 12 crossbreeds or mongrels. Twelve dogs had been adopted from rescue centres; their ages at adoption ranged between 5 months and 7.5 years. The remaining 26 dogs had been raised in the same family home since puppy-hood: their age at acquisition ranged from birth to 9 months. All dogs were companion animals and had lived within their current human household for at least 6 months. Owners reported that their dog had never shown any aggression toward humans and they were accustomed both to being taken out of the home and to meeting human strangers. No dog had received any specialised training beyond basic obedience. Forty-five percent of owners ($N = 17$) reported that their dog manifested behaviours such as barking and whining, scratching doors or chewing household items when left at home alone, which could, in some cases, be due to separation anxiety. Nonetheless, all participants were randomly assigned to one of two conditions (Table 1) resulting in eight affected dogs being assigned to condition A and nine to condition B.

1.2. Testing area

The testing area (Fig. 1) comprised two relatively bare adjacent rooms that could be divided by closing a folding partition. Room 1 was 6 m × 4 m and room 2 was 4 m × 4 m. There were two exits; although the door in room 2 remained locked throughout the procedure. Both rooms were equipped with a selection of toys (e.g., balls, pull-toys, a mop head, squeaky toys, cardboard tubing and soft toys) and a water bowl. Room 1 contained two chairs, one labelled "owner", the other "stranger", placed so that they were equidistant to the door. The chairs' positions were swapped between each testing session within each condition. The second room contained one chair used alternately by owner and stranger. The floor of the

Table 1
Summary of counterbalanced strange situation procedure

Episode	Participants		Main response of dogs in episode
	Condition A	Condition B	
1	Owner and dog	Stranger and dog	Exploration of room 1
2	Owner, dog and stranger	Owner, dog and stranger	Response to stranger or owner entrance and attempts to initiate play
3	Stranger and dog	Owner and dog	Response to exit of stranger or owner and effect on play
4	Dog	Dog	Response to isolation with access to room 2
5	Owner and dog	Stranger and dog	Response to re-entry of stranger or owner
6	Stranger and dog	Owner and dog	Response to re-entry of owner or stranger

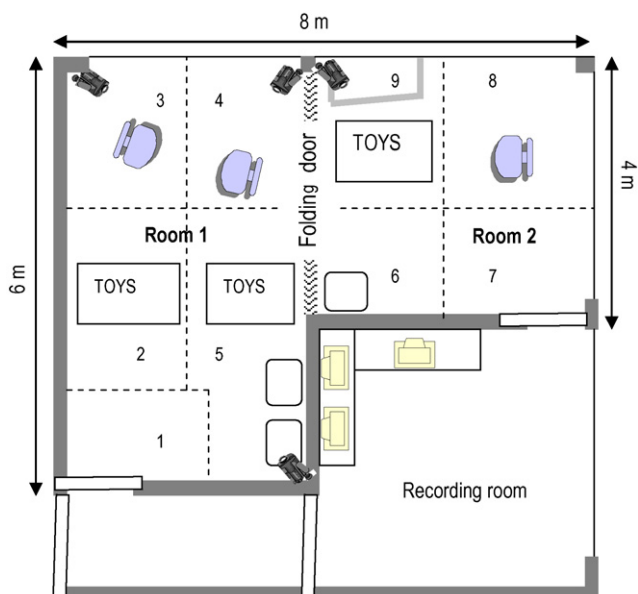


Fig. 1. An overhead view of the testing rooms. The solid outer walls are indicated by shaded thick lines. The windows are indicated by thin solid lines on the outer walls. The dashed lines indicate where white masking tape was placed on the floor to divide the surface area. Wall-mounted video cameras were placed in the upper corners of sections 3–5, and 9. The partial rectangle in area 9 indicates where a long table was placed on its side to prevent the dogs from going out of camera range. The boxes labelled “TOYS” indicate the areas where toys were scattered on the floor. The rounded-corner squares indicate low tables and the squares with small oblong attachments in areas 3, 4, and 7 indicate chairs. The long thin white rectangles indicate doors. Computers and video monitors are indicated as placed on shelving in the recording room.

experimental area was carpeted and divided using strips of white tape into nine separate sections to facilitate monitoring of the dogs’ location throughout the procedure. The experimental area contained four wall-mounted cameras linked to recording and monitoring equipment in an adjacent room. A further monitor was situated in a room 10 m away from the testing area to allow owners to observe episodes in which they were separated from their pet.

1.3. Procedure

There were two experimenters: one acted as escort and the other played “stranger”. Each session was divided into three phases.

1.3.1. Pre-experimental phase (approximately 10 min)

Owner and dog were met and escorted to a seating area outside the testing rooms. The procedure was briefly described to the owner and they were informed that the aim of the study was to investigate behaviour of dogs when in an unfamiliar environment. Specific goals were not explained until post-testing. The owner was asked to sign a consent form, after which video recording commenced and dog and owner were escorted into room 1 (Fig. 1).

1.3.2. Introductory period (approximately 2 min)

The owner led their dog into room 1 and removed the leash. In condition A, the escort guided owners to their chair and asked them to sit quietly and complete a demographic questionnaire about their pet while allowing the dog to wander around the room. They were instructed that they should not completely ignore their dog if it sought attention, but their primary activity should be filling in the questionnaire. Alternatively,

in condition B, the owner removed the leash, left the dog in the room with the stranger who was already seated, and accompanied the escort to the cubicle where they could observe the start of the procedure by remote monitor. As with owners in condition A, the stranger sat completing paperwork and only briefly interacted with the dogs if they actively sought attention.

1.3.3. *Experimental episodes*

The procedure comprised two conditions (A and B) each with six 3-min experimental episodes (Table 1). Hereafter the convention of a letter followed by a number is used to refer to conditions and episodes. Hence, A4 refers to condition A episode 4, B2 indicates condition B episode 2 and so forth. Condition A was a slightly modified version of the original sequence of ASSP episodes (Ainsworth and Bell, 1970). Condition B formed a counterbalanced version of the procedure and reversed the order of participation of owner and stranger (Table 1). Experimental episodes were as follows:

Episode 1: Owner/stranger sat completing paperwork and interacted only if dog sought attention.

Episode 2: Stranger/owner entered room, sat in vacant chair, remained silent for 1 min, conversed with the other person for 1 min and then attempted to initiate play with dog. In condition A, stranger made three attempts to initiate play with each of three toys, after which time, if dog refused, she returned to her chair. In condition B, owner was asked to make at least three attempts to play with dog with a number of toys, returning to chair only if dog refused. At the end of the episode owner/stranger said “goodbye” to dog and exited via the door in room 1.

Episode 3: Stranger/owner continued to play with dog if it was willing. If dog was inactive or distressed, they attempted to distract him or her with play (in the case of the stranger in condition A, this involved three attempts with three toys) or by offering comfort. At end of episode, stranger/owner pulled open partition thus allowing dog access to room 2 and exited via door in room 1.

Episode 4: Dog was left alone. Both owner and escort observed episode on remote monitor. Episode was curtailed if owner believed dog was becoming too distressed. Episode 4 was cut short at the owner’s request for a total of three participants. This occurred twice in condition B and once in condition A, these episodes were curtailed by between 20 and 50 s.

Episode 5: Owner/stranger entered room, paused for 5 s, greeted dog and then moved to room 2, sat and continued completing paperwork.

Episode 6: Stranger/owner entered room, paused for 5 s, greeted dog, moved to room 2, sat and continued completing paperwork, while previous person exited via room 1.

1.3.4. *Post-experimental phase (approximately 10 min)*

Owner/stranger and escort returned to testing rooms and owner was debriefed as to purpose of study. Immediately after each dog-owner pair had left, all toys and the water bowls were washed or sprayed with a mild non-toxic disinfectant. The carpeted floor-space was not disinfected because it was hoped that mounting scent would promote exploration in subsequent subjects. We reasoned that since conditions A and B were alternated from one dog to the next, scent would cause no systematic confounding effect across conditions.

2. Data collection and analysis

Each videotaped session was analysed and coded in a similar manner to Prato-Previde et al. (2003) with 5 s instantaneous time sampling for 18 behavioural categories (Table 2). The majority of these categories were classed as mutually exclusive in that the events were defined in such a way that they were recorded independently of each other. For example, a dog may follow a person while engaged in a bout of social play, but if this following occurred during a bout of vigorous activity, especially when accompanied with a galumphing gait, then social play was

Table 2
Behavioural categories

Label	Definition
Mutually exclusive categories	
Exploration	Activity directed toward physical environment, including sniffing, visual inspection and gentle oral examination
Passive	Sitting, standing or lying down without paying any obvious attention to physical or social environment
Independent play	Any vigorous or galumphing gaited behaviour, usually directed toward a toy, when clearly disengaged from social interaction
Social play	Any vigorous or galumphing gaited behaviour performed when interacting with owner or stranger often including a toy
Following	Walking in the same direction behind owner or stranger
Approach	Moving toward, while clearly visually oriented to, owner or stranger
Withdraw	Obvious avoidance of interaction with owner or stranger by moving away, clearly turning or looking away and distinct refusal of interaction
Oriented to door	Staring fixedly at the door either in close proximity or from a distance
Oriented to person	Staring fixedly at owner or stranger either in close proximity or from a distance, regardless of whether behaviour is reciprocated
Oriented to chair	Staring fixedly at empty chair
Contact door	All active behaviour resulting in physical contact with doors
Other	Any activity not included in the behavioural listing above, such as self-grooming, self-scratching, drinking, and any unclear transitional actions
Non-mutually exclusive categories	
Locomotion	Walking, pacing or running around the room (excluding when playing)
Contact person	Any physical contact with owner or stranger regardless of visual orientation
Contact chair	Any contact with owner's or stranger's chair whether empty or occupied
Vocalising	Any vocalisation, including barking, growling, whining and howling
Alert	Stood absolutely still with ears raised and often head cocked to one side
Greeting	Approaching, tail wagging, jumping and contact directed to entering person

recorded in preference to following. The greeting behaviour of the dogs towards the owner and stranger was recorded both quantitatively (duration of greeting before resumption of another behaviour) and qualitatively (intensity of greeting) for the first minute of episodes 5 and 6. Greetings were awarded points on a scale of 0–3 according to intensity. These ranged from 0 for 'no greeting' to a score of 3 for a full and 'intense greeting' with sustained contact. Additionally, the dog's location in relation to the numbered grids marked on the floor was noted at each sample point throughout the procedure.

Inter-observer reliability was assessed by means of independent parallel coding of 10% of the total sample (four videotaped sessions). An excellent level of agreement was attained with a Cohen's kappa of 0.91 (Altman, 1991). Kolmogorov–Smirnov and normal $Q-Q$ tests revealed that the majority of data were not normally distributed, therefore non-parametric statistical tests were performed throughout. Z-scores were reported for all Mann–Whitney tests to give an indication of effect size (Dancey and Reidy, 2002).

3. Results

Since Prato-Previde et al. (2003) clearly established that dogs show proximity-seeking, comfort-seeking and search behaviour in ASSP, it seems unnecessary to report our replication of

Table 3
Summary of results

Behaviour	Comparison	Result
Secure-base effects		
Exploration	A1 vs. B1; O vs. S (episodes 5 and 6)	Mann–Whitney: $z = 2.88$, $p = .003$; Wilcoxon: $z = 1.85$, $p = .064$
Passive	O vs. S (all episodes; and 5 and 6)	Wilcoxon: $z = 2.61$, $p = .009$; Wilcoxon: $z = 2.34$, $p = .019$
Independent play	A1 vs. B1; O vs. S (episodes 5 and 6)	Mann–Whitney: $z = 3.11$, $p = .025$; Wilcoxon: $z = 2.77$, $p = .006$
Social play	A3 vs. B3; A2 vs. A3	Mann–Whitney: $z = 2.41$, $p = .017$; Mann–Whitney: $z = 1.99$, $p = .053$
Proximity-seeking		
Following	O vs. S (A and B combined)	Mann–Whitney: $z = 3.13$, $p = .002$
Approach S	A vs. B	Mann–Whitney: $z = 3.13$, $p = .002$
Withdraw	A vs. B	Non-significant
Location	Rooms 1 and 2: O vs. S (episodes 5 and 6)	R1: Mann–Whitney B5: $z = 3.40$, $p \leq .001$; MW: A6: $z = 3.81$, $p \leq .001$ R2: Mann–Whitney A5: $z = 4.11$, $p \leq .001$; MW B6: $z = 3.76$, $p \leq .001$
Vocalising	A1 vs. B; A5 vs. B5	Mann–Whitney: $z = 4.46$, $p \leq .001$; MW: $z = 2.61$, $p = .017$
Search behaviours		
Oriented to door	A1 vs. B1; A5 vs. B5	Mann–Whitney: $z = 5.22$, $p = .001$; MW: $z = 4.47$, $p \leq .001$
Alert	A1 vs. B1; A3 vs. B3; A5 vs. B5	Mann–Whitney: $z = 2.04$, $p = .046$; MW: $z = 2.76$, $p = .032$; MW: $z = 4.36$, $p \leq .001$
Scratch door	A vs. B	Non-significant
Comfort-seeking		
Contact person	A2 vs. B2 O and S	O: Mann–Whitney: $z = 3.92$, $p = .001$ S; MW: non-significant
Greeting intensity	A5 vs. B5; A6 vs. B6 (first minute)	Mann–Whitney: $z = 2.08$, $p = .050$; MW: $z = 4.13$, $p \leq .001$
Greeting duration	A5 vs. B5; A6 vs. B6 (first minute)	Mann–Whitney: $z = 1.79$, $p = .075$; MW: $z = 4.13$, $p \leq .001$

Key: O = owner; S = stranger; A1–A6 = condition A episodes 1–6; B1–B6 = condition B episodes 1–6.

these data in detail, except to say that we found basically the same patterns (see Table 3 for a summary of results). Instead, we focus on the one aspect of the data that is crucial for establishing attachment and which previous studies using the traditional ASSP were unable to show: secure-base effects.

3.1. Exploration

If the dogs felt sufficiently confident in the presence of their owner, they should have been able to use him or her as a secure-base from which to explore the novel environment. Fig. 2 shows how the duration of exploration varied in successive episodes for both conditions. In support of the owner acting as a secure-base during episode 1, dogs in condition A, who were accompanied by

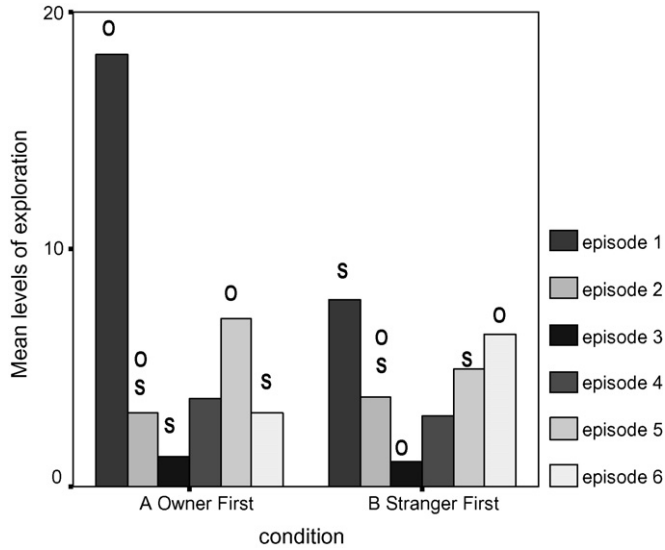


Fig. 2. Mean number of samples in which dogs were exploring in conditions A and B across all six episodes. O: owner present and S: stranger present.

their owner, explored significantly more of the time than those in condition B, where they were left with the stranger (Mann–Whitney: $z = 2.88, p = .003$).

Levels of exploration across the first 4 min of the procedure (episode 1 and the first minute of episode 2) are shown in Fig. 3. It is evident that in condition A there was a fairly steep, but steady decline in exploration across the first 3 min. However, there seems to have been an even sharper

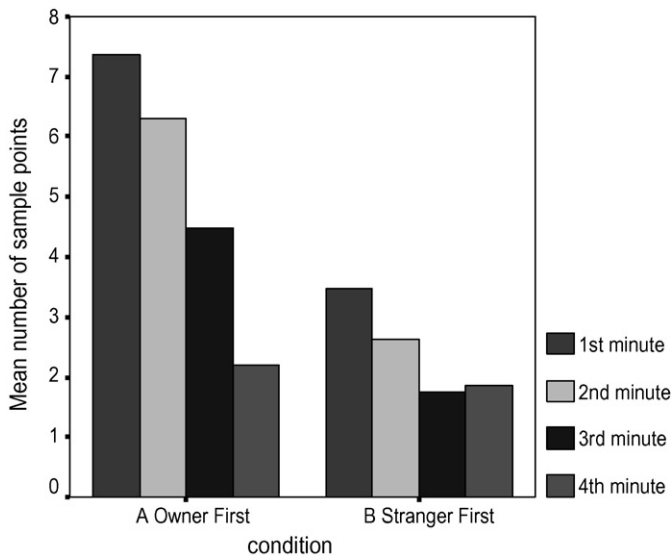


Fig. 3. Mean number of samples in which dogs were exploring in conditions A and B across the first 4 min of the procedure.

decline in exploration in the first minute of A2 when the stranger had entered the room (Wilcoxon: second and third min.: $z = 2.05$, $p = .040$; third and fourth min.: $z = 2.84$, $p = .005$). The same comparisons for condition B (where the dog remained initially with the stranger) failed to reach significance (Wilcoxon: second and third min.: $z = 1.44$, $p = .149$; third and fourth min.: $z = 0.25$, $p = .805$).

During episode 4, when the dogs were alone, exploration levels in general were very low. Only 12 out of the 38 dogs (31.58%) explored room 2 and even then exploration tended to be limited to between 1 and 4 sample points directly after the owner or stranger had opened the partition immediately prior to exiting from room 1. Collectively (i.e., combining data from conditions A and B) exploration levels increased significantly in episode 5 compared to episode 4 (Wilcoxon: $z = 2.31$, $p = .021$) and remained at a constant level in episode 6 (Wilcoxon: ns). Sixty-seven percent of exploration during episodes 5 and 6 took place in room 2. There was a non-significant trend for dogs to explore more upon reunion with their owner versus the stranger (Wilcoxon (A5 + B6 versus A6 + B5): $z = 1.85$, $p = .064$, Fig. 2).

3.2. Location

The dogs were given access to the second unfamiliar room from the beginning of episode 4 onwards. No cross condition differences were found in time spent in either room during episode 4. However, dogs in both conditions spent significantly more time in section 1 (i.e., in close proximity to the door) when they were in the company of the stranger compared to the owner (Mann–Whitney B5: $z = 3.40$, $p < .001$; A6: $z = 3.81$, $p < .001$). Dogs spent significantly more of their time in room 2 when they were accompanied by their owner versus the stranger (Mann–

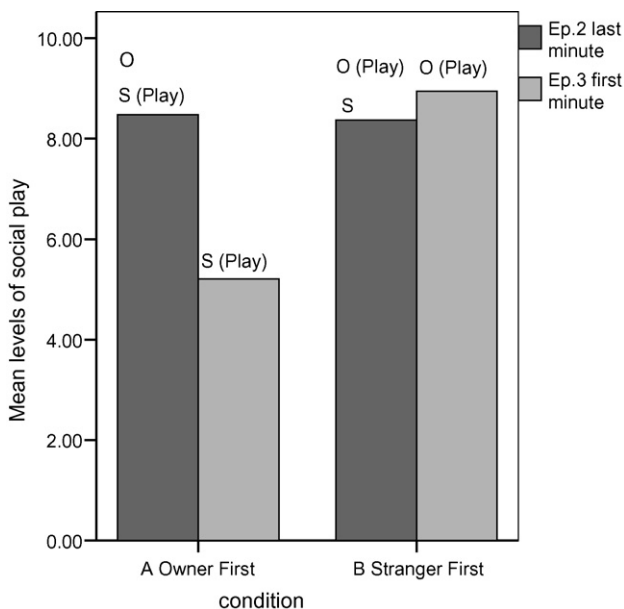


Fig. 4. Mean number of samples in which dogs were engaged in social play in conditions A and B across last minute of episode 2 and first minute of episode 3. O: owner and S: stranger. O/S (play) indicates the person who attempted to initiate play with the dog.

Whitney A5: $z = 4.11, p < .001$; B6: $z = 3.76, p < .001$). Therefore, dogs seemed less willing to spend time in the second unfamiliar area unless accompanied by their owner.

3.3. Play

The dogs initiated very few play requests (an average of 0.58 per dog) and no significant cross condition differences were found in this behaviour. However, a number of dogs were happy to engage in play when invited to by their owner or the stranger. Within ASSP, the opportunity for social play is restricted to the last minute of episode 2 and all of episode 3 (Fig. 4). The dogs exhibited a clear preference for playing with their owner, since in A3, where they were with the stranger only, levels of social play were significantly lower than in B3 when they remained with their owner (Mann–Whitney: $z = 2.41, p = .017$). Dogs in both conditions were equally happy to play with their owner or the stranger in episode 2 when their owner was always present (Mann–Whitney A2 versus B2: $z = .553, p = .603$). However, there was a non-significant trend for dogs to play less with the stranger once their owner had exited the room (Mann–Whitney A2 versus A3: $z = 1.997, p = .053$). This suggests that dogs were happier to engage in play with the stranger when their owner was present rather than absent, thereby indicating a secure-base effect.

Twenty-seven (71%) of the dogs engaged in some form of independent play. In A1, when dogs were accompanied by their owner, they spent significantly more time engaged in independent play than their condition B counterparts who were in the presence of the stranger (episode 1 Mann–Whitney: $z = 3.11, p = .025$). Levels were severely depressed during episode 4, when dogs were alone (Fig. 5) but recovered in episodes A5 and B6 where the owner rather than the stranger (episodes A6 and B5) had returned to the room (Wilcoxon A5 + B6 versus A6 + B5: $z = 2.77, p = .006$).

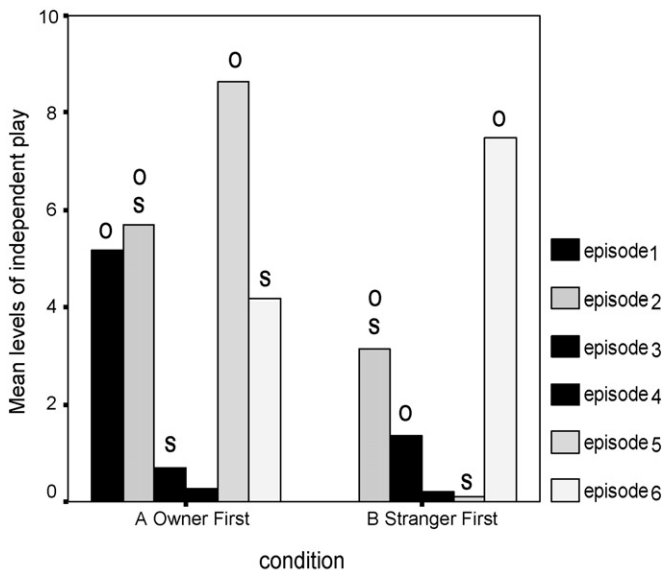


Fig. 5. Mean number of samples in which dogs were engaged in independent play in conditions A and B across all six episodes. O: owner present, S: stranger present.

3.4. Response to stranger

Young human infants are often wary of strangers and they will sometimes return to their mother's side when in the presence of an unfamiliar individual. Out of the 19 dogs in condition A, only 2 (10.5%) returned to their owner's side upon the entrance of the stranger at the beginning of episode 2. The majority of dogs seemed unwary of the stranger, and in fact many of them approached and greeted her when she first entered the room or simply ignored her entrance and continued with their previous activity.

3.5. Approach

Across the whole procedure, while no cross condition differences were found in the number of approaches made to the owner, dogs in condition B approached the stranger significantly less than those in condition A (Mann–Whitney: $z = -3.13$, $p = .002$).

3.6. Passive behaviour

Prato-Previde et al. (2003) surmised that if owners operated as a secure base, then dogs would feel sufficiently calm to engage in passive behaviour when in their owner's presence. We found no order effects in terms of significant within or cross condition differences in levels of passive behaviour. However, when data from both conditions were combined, it was found that over all episodes dogs were significantly more passive when in the company of their owner compared to the stranger (Wilcoxon: $z = 2.61$, $p = .009$). Furthermore, during the last two episodes, significantly more passive behaviour occurred when the owner was present (A5 and B6) compared to during episodes A6 and B5 when the dogs were alone with the stranger (Wilcoxon: $z = 2.34$, $p = .019$).

4. Discussion

The present study used a counterbalanced version of ASSP to overcome order effects inherent in the original procedure and also provided an experimental setting designed to promote sustained exploration of a novel environment in adult dogs. The primary aim was to establish to what extent the adult dog–human relationship conforms to Ainsworth's definition of attachment with particular emphasis placed upon specific secure-base measures (Ainsworth, 1989). Unlike previous studies (Topal et al., 1998; Prato-Previde et al., 2003) the present findings provide evidence of secure-base effects that are not compromised by the order of stranger and owner presence.

Several aspects of the dogs' behaviour conformed to a secure-base effect. For example, dogs in A1 explored significantly more in the presence of their owner than in B1 when they were with the stranger. Instead of comparing earlier and later episodes as with the traditional within-participants ASSP, all dogs in the counterbalanced procedure had only just entered the room for the first time. Therefore, differences in levels of exploration between conditions in episode 1 cannot be explained in terms of differentially diminishing levels of curiosity. The only difference between the two conditions was the identity of the dogs' companion. Hence, as predicted, dogs were less willing to explore when in the presence of a stranger compared to their owner.

Exploration levels when the dogs were completely alone were even further depressed, despite the fact that just prior to the exit of the owner or stranger, they were given access to a new room.

To constitute a secure-base effect, these levels should recover upon the return of the owner in either A5 or B6, which they clearly did, however levels also rose upon the stranger's entrance in B5. This suggests that although the dogs explored more often when with their owner, the presence of a human stranger also had an ameliorative effect (see also Pettijohn et al., 1977; Tuber et al., 1996). A similar pattern has been found in securely attached human infants (Cassidy, 1999).

In condition A in which dogs entered the room with their owner, there was a highly significant decrease in exploration levels from episode A1 to A2. Ainsworth and Bell (1970) interpreted a similar reduction in exploration in human infants as a result of stranger wariness. Children often look toward their mother or return to her side upon the entrance of the stranger. In contrast, few dogs in the present study (10.5%) returned to their owner's side. The majority exhibited little evidence of wariness, and in fact either approached and greeted the stranger, stopped whatever they were doing and stared at her or continued exploring or playing. Hence, it seems that contrary to our predictions, well socialised adult dogs show much less stranger wariness than that found in human infants and in this respect their behaviour was not consistent with the usual infantile pattern of attachment. It is possible that less well socialised or rescued dogs may exhibit elevated levels of stranger wariness than found in the present sample.

Nevertheless, we may have found subtle evidence of mild stranger wariness when studying the dogs' approach behaviour. Dogs in condition A approached the stranger significantly more than those in condition B: thus suggesting that separation from the owner in B1 caused the dogs' attachment system to become activated, resulting in heightened desire to obtain proximity to the owner and lessened acceptance of the stranger. This may be interpreted as evidence of a secure-base effect in that dogs in condition A, who had initially been introduced to the stranger in the security of their owners' presence, were thereafter more willing to approach the stranger.

The rates of independent play provided further evidence of a secure-base effect. Independent play was depressed when the dogs were alone or in the presence of just the stranger, but quickly recovered when they were reunited with their owners. Although actual rates of independent play were fairly low, the dogs still engaged in significantly more of such play when with their owner compared to the stranger.

Dogs in both conditions were equally happy to play with their owner or the stranger in episode 2 when their owner was always present; however this was not the case when the dogs were left with just the stranger in A3. The significantly lower levels of social play in A3 compared to B3 clearly show that the owner represented a preferred playmate. However, attachment involves more than exhibiting a preference for one individual over another. In order to provide evidence that owners act as a safe base for their dogs, one must show that dogs are more willing to play with a stranger when their owner is present versus absent. Prato-Previde et al. (2003) found that dogs in the traditional ASSP played significantly more with the stranger in the last minute of episode 2 when their owner was present versus the first minute episode 3 when the owner was absent. We found a similar, albeit, non-significant trend in our sample. The fact that dogs continued to play with the owner in B3 suggests that the lower levels of social play in condition A cannot be explained in terms of fatigue, satiation or as the simple result of interruption by the exiting of someone from the room. It is more likely that the attachment system was activated and that it interfered with play, suggesting that in episode 2 the owner was indeed functioning as a secure base for the dogs.

Finally, the dogs also remained passive more often when in the company of their owner than when they were left with the stranger or alone. On cessation of exploration, most dogs either engaged in independent play or exhibited passive behaviour. However, when their owner was not present, they remained alert and engaged in proximity or search behaviour. Most of them

remained oriented to the door through which their owner had exited until he or she returned. They only resumed a passive posture after reunion.

In summary, the present study identified three clear patterns of behaviour in pet dogs that were consistent with a secure-base effect. As predicted, the dogs showed significantly lower levels of (1) exploration, (2) passivity and (3) independent play when their owner was absent versus present. In addition, there was a non-significant trend for dogs to play with the stranger more while their owner remained in the room rather than after he or she had exited. During isolation the dogs exhibited reduced levels of play, exploration and passivity; all of these behaviours recovered somewhat upon reunion and were significantly higher after reunion with the owner compared to the stranger. Somewhat against our predictions, the present sample of dogs did not express the same levels of stranger wariness as is found in human infants. There was only a slight indication of possible stranger wariness in condition B in terms of the dogs being less willing to approach the stranger after they had been separated from their owner in episode 1. We also predicted that despite having access to the second unfamiliar room, the dogs would not begin to explore the area until reunited with their owner. This was not fully supported, however, since levels of exploration increased upon reunion with both the owner and the stranger: although, there was a non-significant trend for dogs to explore more after reunion with their owner. Despite these somewhat contradictory findings, in many respects our results suggest owners did provide a secure-base for their dogs and therefore we can conclude that the dog–human bond is consistent with an attachment.

Why is it important to establish whether or not the dog–human bond is an attachment? One possible application of attachment theory is with regards to developing a model of canine separation anxiety. It has been suggested that when dogs are inappropriately attached to their owners they are often unable to cope with separation (Parthasarathy and Crowell-Davis, 2001). There may be an inherited predisposition in domestic dogs to form infantile-like attachments (Serpell and Jagoe, 1995; Topal et al., 2005) and certain breeds, such as those bred primarily for companionship, may be more susceptible to separation anxiety than, for example, utility breeds. In addition, owners may inadvertently contribute to the problem by adopting a style of interaction that sustains infantile patterns of attachment, when adult patterns would allow dogs to better cope with separation (Pageat, 1998 in Appleby and Pluijmakers, 2003). Thus, the present empirical findings may provide evidence that both supports and informs existing therapeutic interventions that have been based on the assumption that the dog–human bond is an attachment.

5. Conclusion

A counterbalanced version of Ainsworth's Strange Situation Procedure counteracted order effects inherent in the traditional test thereby producing evidence of secure-base effects. Hence, for the first time there is clear empirical evidence that the dog–human bond conforms to an infantile-like system of attachment, which in turn might offer important insights into the condition of separation anxiety in dogs.

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