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Applied Animal Behaviour Science 75 (2002) 161–176

APPLIED ANIMAL BEHAVIOUR SCIENCE

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An experimental study of the effects of play upon the dog–human relationship

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Accepted 7 September 2001

Abstract

It has often been suggested that intraspecific dominance relationships are established through play. By analogy, it is also claimed that the outcome of competitive games can affect dog–human relationships. This paper experimentally tests the latter idea. Fourteen Golden Retrievers were each subjected to two treatments; 20 sessions of a tug-of-war game with the experimenter which they were allowed to win, and 20 sessions which they lost. Their relationship with the experimenter was assessed, via a composite behavioural test, once at the outset and once after each treatment. Principal components analysis allowed the 52 behavioural measures to be combined into nine underlying factors. *Confidence* (the factor most closely corresponding to conventional dominance) was unaffected by the treatments. Dogs scored higher for *obedient attentiveness* after play treatments, irrespective of whether they won or lost, and *demandingness* scores increased with familiarity of the test person. The 10 most playful dogs scored significantly higher for *playful attention seeking* after winning than after losing. We conclude that, in this population, dominance dimensions of the dog–human relationship are unaffected by the outcome of repetitive tug-of-war games. However, we suggest that the effects of games may be modified by the presence of play signals, and when these signals are absent or misinterpreted the outcome of games may have more serious consequences. Games may also assume greater significance for a minority of ''potentially dominant'' dogs.

Keywords: Dog; Human–animal relationships; Dominance relationships; Play behaviour

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0168-1591/02/$ – see front matter
PII: S0168-1591(01)00192-7

1. Introduction

Intraspecific social play is an important part of the behavioural repertoire of many species and has been hypothesised to affect the players' relationships in a variety of ways (Fagen, 1981). One hypothesis is that dominance relationships are established and altered during play (see Smith, 1982). This hypothesis is based on correlations which exist between an individual's social status and characteristics of its play behaviour (e.g. coyotes, *Canis latrans*; Fox et al., 1976: wolves, *Canis lupus*; Zimen, 1975: rats, *Rattus norvegicus*; Panksepp, 1981). However, there is no conclusive proof that play is the cause, and increasing evidence suggests that play behaviour does not affect dominance, but rather reflects existing dominance relationships (e.g. humans; Clark et al., 1969: rats, *R. norvegicus*; Pellis and Pellis, 1991: squirrel monkeys, *Saimiri sciureus*; Biben, 1998).

However, in the popular literature on the behaviour of the domestic dog *C. familiaris* it is still commonly asserted that play between dogs and owners has significant effects upon the dominance dimensions of their relationship. Dog trainers and companion animal behaviour counsellors warn of the effects of certain games, in particular those which involve competition between the players (e.g. Appleby, 1997). Allowing a dog to win uncontrolled games, such as tug-of-war, is thought to increase the likelihood that it will attempt to become dominant over its owner (O'Farrell, 1992; Rogerson, 1992), and on this basis, controlled tug-of-war is used as part of the therapy to correct behavioural problems (Appleby, 1997). This "dominance enhancement theory" is commonly accepted, but remains, until now, empirically untested.

The concept of "dominance" is widely used to explain the social organisation of group-living animals, but there are great inconsistencies in its use (Drews, 1993) and some definitions would be inappropriate to describe an interspecific relationship between a dog and a human. We use the term "dominance" here to describe a tendency of one member of a dyad to assert itself over priority of access to resources. This is particularly relevant since, in Western cultures, it is generally assumed that owners can control the behaviour of their dogs and assert priority of access to resources. Additionally, disputes over priority of access can result in owner-directed aggression (Overall, 1997).

Although there have been attempts to assess general temperamental traits in dogs (e.g. van der Borg et al., 1991), we are unaware of any previous tests designed for specific dog–human partnerships. Therefore, we developed a novel behavioural test. Dominance relationships are multidimensional and can vary according to context and the resource under dispute (Wright, 1980; van Hooff and Wensing, 1987; Wickens, 1993), so our test examined the dogs' behaviour in a variety of contexts and when challenged for a range of resources. We made no a priori assumptions about what constitutes dominance, but took a post-hoc approach, measuring the dogs' behavioural responses and then applying statistical analysis to discover the underlying relationship dimensions.

A preliminary experiment using 30 Labrador Retrievers explored a range of game types and suggested that whether dogs win or lose tug-of-war does not affect their relationship with a human (Rooney, 1999). In this paper, we describe a more detailed study using Golden Retrievers (a breed reportedly prone to owner-directed aggression; Mugford, 1995), to test the null hypothesis that a dog's relationship with a human is unaffected by whether the dog wins or loses repetitive games of tug-of-war.

2. Methods

2.1. Subjects

The subjects were 14 Golden Retrievers, 3 males and 11 females, aged from 7 to 137 months (mean $\pm$ S.E. $= 65.7 \pm 12.7$ months). They were privately owned, by one family, used for breeding and showing purposes and were fed twice a day (11:00 and 18:00 h) with commercial dried food. The dogs were housed in the kitchen and utility room of the family home and, during daytime, had unrestricted access to an outside yard. Half way through the study, for practical reasons, unconnected with the experiment, the males were moved to a large kennel 200 m from the house, where they were housed communally for the remainder of the time. All dogs had met the experimenter on one occasion prior to the experiment.

2.2. Procedure

At the outset, the owner subjectively rated each of the subjects for dominance (relative to herself) and playfulness, both on a scale of 1–5. These ratings were used to construct balanced treatment groups. The experiment lasted for 30 days, following the format illustrated in Fig. 1, and was performed by a single, female, experimenter (NJR; 51 kg, 1.59 m).

2.2.1. Acclimatisation

Four 5 min acclimatisation sessions were used to familiarise the dogs with the experimenter. There were two sessions per day for two days, at 8:30 and 16:30 h. Each

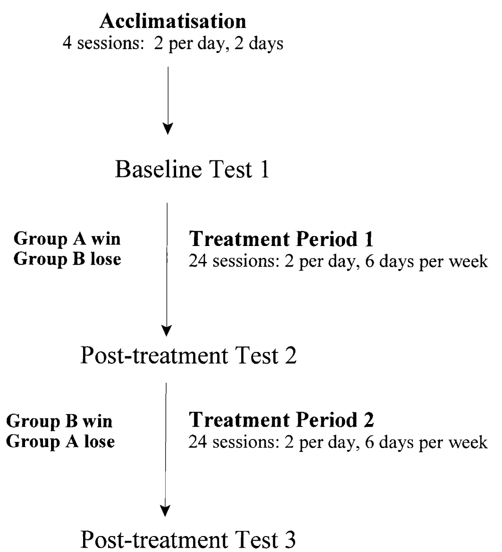

Fig. 1. Outline of the experimental protocol for testing the effects of tug-of-war games on the relationship between Golden Retrievers and the experimenter.

dog was taken into the garden adjacent to their living area. The experimenter sat on a chair and moderately petted the dog if it approached, but did not encourage it to do so.

2.2.2. Baseline test 1

Testing took place in a conservatory (6 m $\times$ 6 m) which linked the experimental garden area to the kitchen where the dogs lived. The door connecting the conservatory to the kitchen was closed to minimise disturbance, but the door to the garden was left open and the adjoining gardens used for some of the test procedures. Tests were filmed using a video camera (Sony Video 8 CCD-TR370E) on a tripod in the corner of the conservatory. Descriptions of the dog' behaviour were also recorded using a Dictaphone (Sony M-607 Micro-cassette recorder). All dogs were tested on one day, in an initially randomised order, which remained the same in subsequent tests.

The test had 13 components. The procedure during each component is described here; the variables measured are listed in Table 1. Components D2–D13 were carried out consecutively, in order, either before or after D1, which took place at the dogs' regular

Table 1
Behavioural variables measured during specific components of the dominance test[a]

Test component/ variable name	Description	Units
D1: Food removal		
Response intensity	Strategy dog uses to regain food (0: none; 1: circle; 2: push)	Scale: 0–2
Contact bowl	Dog contacts bowl whilst held by experimenter	0/1
Feed latency	Time until dog resumes feeding	s
D2: Call response		
Call lag	Latency of dog's approach to experimenter (mean of two trials)	s
Approach gait	Gait of dog's approach to experimenter (mean of two trials—0: walk; 1: trot; 2: run; 3: bound)	Scale: 0–3
Indirect approach	Dog takes indirect route to experimenter or sniffs en route	0/1
D3: Sit		
Sit latency	Time for dog to sit after command (mean of two trials)	s
No. of sit responses	No. of times dog responds to sit command (out of two trials)	Freq
Orientate away	Dog sits facing away from experimenter	0/1
D4: Eye contact		
Stare duration	Time before dog looks away from experimenter (mean of three trials)	s
D5: Forced down		
Comply latency	Time to force dog into lying position (mean of two trials)	s
No. of comply	No. of times dog lies in response to pressure on its shoulders (out of two trials)	Freq
D6: Rise		
Rise latency	Latency for dog to rise from lie after forced down	s
Reapproach gait	Gait of approach to experimenter following forced down (scale as in D2)	Scale: 0–3
D7: Approach		
Response positivity	Degree of dog's response to experimenter's approach (0: retreat; 1: unreactive; 2: approach; 3: jump up)	Scale: 0–3

Table 1 (*Continued*)

Test component/ variable name	Description	Units
D8: Toy removal		
Drop latency	Latency for dog to surrender toy after command (mean of two trials)	s
Force required	Action required to retrieve toy from dog (mean of two trials—0: command; 1: contact; 2: contact and command; 3: pull; 4: strong tug; 5: will not surrender)	Scale: 0–5
Brings toy	Dog brings toy to experimenter when instructed to give	0/1
Circles/blocks	Dog moves around experimenter evasively before surrendering toy	0/1
D9: Toy regain		
Regain latency	Time for dog to pick up toy following removal	s
D10: Shout		
Startle/change	Dog moves suddenly or changes posture immediately after shout	0/1
Approach	Dog approaches experimenter immediately after shout	0/1
D11: Lying		
Stance height	Posture assumed by dog for majority of 30 s whilst experimenter lies on the floor (0: lie; 1: sit; 2: stand; 3: move)	Scale: 0–3
Stand over torso	Dog stands over experimenter's torso	0/1
Nuzzle	Dog contacts experimenter with its head	0/1
Sit by	Dog sits next to lying experimenter	0/1
D12: Grooming		
Stance height	Posture of dog for most of grooming time (0: lie; 1: sit; 2: stand; 3: move)	Scale: 0–3
Cringe	Dog cowers when brushed on the head	0/1
D13: Door entry		
Position ahead	Position of dog relative to experimenter when exiting door (0: behind; 1: attempts level; 2: ahead)	Scale: 0–2

[a] Freq: frequency; s: second.

feeding time (11:00 h). All the commands used during the test had previously been taught by the owner during basic obedience training.

D1 *Food removal*: The dog was given its food by its owner and allowed to start eating. The experimenter then approached, and said ‘‘leave’’ once and removed the feeding bowl. The bowl was held above the dog's head for 10 s. It was then placed on the floor and the command ‘‘leave’’ given once. The experimenter then placed her hand between the dog and the bowl until the dog commenced eating or for a maximum of 20 s.

D2 *Call response*: The dog was allowed to roam freely for 20 s before the experimenter called the dog's name. If it did not approach, the call was repeated a maximum of three times at 2 s intervals.

D3 *Sit*: The experimenter stood facing the dog and gave the command ‘‘sit’’. If the dog did not respond, the instruction was repeated a maximum of three times with 5 s intervals. This was repeated once.

D4 *Eye contact*: The experimenter held the dog lightly under the chin and established eye contact. This was maintained for up to 30 s or until the dog looked away. This was performed three times.

D5 *Forced down*: This commenced with the dog in a sitting position. The experimenter placed her hand on the dog's shoulder and applied moderate pressure, continuing until the dog lay down, or for a maximum of 20 s. This was repeated once.

D6 *Rise*: After the dog had been forced down (after continuing with D5 for more than 20 s, if necessary), the experimenter gave the command "stay" and took five steps backwards. She remained facing the dog until it rose or for a maximum of 2 min. This was repeated after each Forced down.

D7 *Approach*: The dog was allowed to explore the garden area freely for 1 min. The experimenter then approached the dog at walking pace, halting when 10 cm away.

D8 *Toy removal*: The dog was given a squeaky toy (supplied by owner) and allowed to play freely for 20 s. The experimenter then stretched her arm towards the dog and gave the command "give". If the toy was not surrendered the command was repeated at 5 s intervals. After three commands, vocalisations were accompanied by physical intervention of increasing force until the toy was surrendered. This was carried out twice.

D9 *Toy regain*: After retrieving the toy, the experimenter held it out of the dog's reach for 10 s. She then placed it on the floor in front of the dog and gave the command "leave", once. This was repeated after each toy removal.

D10 *Shout*: The experimenter crouched and petted the dog for 10 s. She then rose suddenly and shouted "no", once.

D11 *Lying*: The experimenter lay on her back on the floor and remained motionless for 30 s.

D12 *Grooming*: The experimenter used a brush to lightly groom the dog for 1 min, attempting to cover the whole dorsal surface.

D13 *Door entry*: The dog was leashed. The experimenter walked the dog once around the experimental room at a constant pace and then approached and exited through a partially open door. The gap was sufficient to allow only one individual through at a time. Dog and experimenter approached side by side so the dog could either speed up to exit first, or slow down to allow the experimenter out first.

2.2.3. Treatment period 1

Dogs were divided into two groups, A and B. The subjects in each were balanced in age, sex, and their owner's ratings for dominance and playfulness. Each dog played with the experimenter for two 3 min sessions per day. Sessions took place at the same times, and in the same place, as the acclimatisation sessions. Games revolved around a Ragger (Petlove Ltd.: a 30 cm long piece of rope knotted at each end which can simultaneously be held by two players), but if the dog was reluctant to play with this, a preferred toy was used (e.g. a plastic tug-toy or squeaky toy). Group A dogs played tug-of-war *win* games; they were allowed to win the majority (at least two-thirds) of the competitions and maintain possession of the toy at the end of the game. The dogs in Group B played tug-of-war *lose* and the experimenter won at least two-thirds of the competitions. During each play session, the experimenter recorded the number of competitions won by each partner, and a subjective rating for the dog's *involvement* in the game (on a scale of 1 (least involved)–5 (most involved); for details of validation of this scale including inter-observer correlations, see Rooney, 1999).

2.2.4. Post-treatment test 2

After 24 treatment sessions, the dogs were re-tested using the same procedure and order as the baseline test (Section 2.2.2).

2.2.5. Treatment period 2

Twenty-four further treatment sessions followed, but the treatment groups were reversed; Group B dogs played tug-of-war *win* and Group A dogs tug-of-war *lose*.

2.2.6. Post-treatment test 3

The final test was a repetition of 2.2.2 and 2.2.4.

2.3. Behavioural measures

From the video and Dictaphone tapes, 52 variables were measured, all of which were both exhibited by, and showed variation in, at least 10% of subjects. Twenty-nine of the variables described the dog's behaviour during single test components (Table 1), but 23 behaviours could occur at various stages throughout the test so were recorded as the frequency (or average for tail position) of components in which they were observed (Table 2).

2.4. Statistical analysis

The standardised scores for each variable, during each of the three tests, were subjected to principal components analysis, without rotation (Dytham, 1999). For the resulting components, eigenvalues were plotted against component number to produce a scree diagram. The gradient of the plot had a distinct break above which the factors were considered "useful" and explored further.

Repeated measures analysis of variance (ANOVA) explored the effect of preceding treatment type upon the scores for each factor. Significant effects were explored using post-hoc Tukey's honestly significant difference tests. Further two-way repeated measures ANOVAs were performed on just the results of tests 2 and 3 (i.e. excluding baseline), to explore the effects of play treatment (*win* or *lose*) and test number (2 or 3) on each factor score.

Since dogs varied in playfulness, it is possible that the least playful dogs did not receive the experimental treatment necessary to induce a change in behaviour towards the experimenter. Therefore, we repeated the analysis, omitting the four dogs that had scored a mean of ≤ 3 for *involvement* throughout all 48 play sessions.

Table 2
Behavioural variables measured during all 13 dominance test components[a]

Variable	Description	Units
Ears pricked	Dog's ears are erect	Freq
Ears low	Dog's ears are held flat to its head or pulled back laterally	Freq
Tail movement	Dog wags its tail	Freq
Head in lap	Dog places its head in experimenter's lap	Freq
Lick experimenter	Dog contacts experimenter with its tongue	Freq
Mouth hand	Dog places its mouth around experimenter's hand	Freq
Climb up	Dog jumps up, placing its fore-paws on experimenter	Freq
Low body position	Dog exhibits low posture	Freq
Gaze aversion	Dog avoids eye contact with experimenter	Freq
Tail tucked	Dog tucks its tail between its legs	Freq
Lie	Dog lies down without command	Freq
Nuzzle	Dog contacts experimenter with its head	Freq
Sit	Dog sits uncommanded	Freq
Roll	Dog rolls over on the floor	Freq
Lick lips	Dog licks its lips	Freq
Paw	Dog raises its paw or places its paw on experimenter	Freq
Display	Dog displays its inguinal region towards experimenter	Freq
Growl/moan	Dog makes low pitched moaning or growling vocalisation	Freq
Submissive grin	Dog pulls the corners of its mouth back laterally in a "submissive grin" (Fox, 1970)	Freq
Whimper	Dog makes a high pitched whimpering vocalisation	Freq
Pant	Dog breathes audibly	Freq
Maintains contact	Dog moves to maintain contact with experimenter, e.g. by moving experimenter's arm onto itself	Freq
Tail height	Dog's average tail position throughout all components (1: tucked; 5: vertical)	Scale: 1–5

[a] Frequencies are recorded as the number of test components in which the behaviour occurs.

The effect of treatment type upon the experimenter's ratings for *involvement* was tested using repeated measures ANOVA. To eliminate response lags and carry-over effects, only the last 10 play sessions in each treatment period were analysed, i.e. scores during sessions 15–24 were compared to sessions 39–48 for each group.

3. Results

3.1. Data reduction

Principal components analysis reduced the 52 variables to nine underlying factors. These factors were all above the distinct break in the scree diagram, had eigenvalues of 2.05 or more, and jointly accounting for 66.4% of the variation in the data. Factor 1 was composed of variables which could conventionally be described as indicating many, but not all, attributes of "dominance" (Table 3). We have therefore labelled this *confidence*.

Since the remaining eight factors represent other dimensions of the dog–human relationship (less related to, or unrelated to, dominance), we restrict our consideration

Table 3
Key variables and their loadings on Factor 1: *confidence*[a]

Positively loaded variables			Negatively loaded variables		
Test component	Variable name	Loading factor	Test component	Variable name	Loading factor
Lying	Stand over torso	0.85	Toy regain	Regain	−0.62
All	Tail height	0.76	All	Gaze aversion	−0.58
All	Tail movement	0.71	Rise	Rise latency	−0.57
Call response	Call lag	0.70	All	Roll	−0.57
All	Climb up	0.65	Grooming	Cringe	−0.56
Approach	Response	0.64	All	Tail tucked	−0.53
All	Mouth hand	0.55	All	Display	−0.53
Shout	Approach	0.54	All	Ears low	−0.51
Grooming	Stance height	0.53	All	Lick lips	−0.51
Lying	Stance height	0.51			
Door entry	Position ahead	0.49			
Toy removal	Force required	0.48			
All	Maintains contact	0.47			

[a] All variables with loadings more than 50% of the maximum loading, irrespective of sign, are shown.

to only those factors which were affected by the treatments (Factors 3, 5 and 8; Tables 4–6). Details of the remaining five factors are given in Rooney (1999).

3.2. Effects of play treatments

Confidence (Factor 1) scores were not significantly affected by the treatment (ANOVA: $F_{(2,13)} = 1.56$, NS). The subjects showed no consistent pattern of change (Fig. 2), but for individual dogs, the three test scores were highly correlated (Pearson correlation test: all $r_P > 0.93$, $N = 14$, $P < 0.001$).

Obedient attentiveness (Factor 3) scores were significantly affected by preceding treatment (ANOVA: $F_{(2,13)} = 5.01$, $P < 0.05$), but the two play treatments formed a

Table 4
Key variables and their loadings on Factor 3: *obedient attentiveness*

Positively loaded variables			Negatively loaded variables		
Test component	Variable name	Loading factor	Test component	Variable name	Loading factor
All	Ears pricked	0.65	Food removal	Contact bowl	−0.50
Forced down	No. of comply	0.62	All	Gaze aversion	−0.46
All	Paw	0.55	All	Submissive grin	−0.41
All	Lick experimenter	0.47	Forced down	Comply latency	−0.37
All	Lie	0.41	All	Nuzzle	−0.37
Food removal	Feed latency	0.39	Lying	Stance height	−0.37
Eye contact	Stare duration	0.37	Food removal	Response intensity	−0.35
Call response	Call lag	0.35			

Table 5
Key variables and their loadings on Factor 5: *demandingness*

Positively loaded variables			Negatively loaded variables		
Test component	Variable name	Loading factor	Test component	Variable name	Loading factor
All	Growl/moan	0.54	Grooming	Stance height	−0.31
All	Ears low	0.50	Lying	Sit by	−0.29
Food removal	Response intensity	0.49	Lying	Stance height	−0.29
Rise	Reapproach gait	0.48	Food removal	Feed latency	−0.28
All	Maintains contact	0.47	All	Lick experimenter	−0.27
Call response	Indirect approach	0.45			
Toy removal	Drop latency	0.40			
All	Head in lap	0.30			
All	Display	0.29			
All	Lie	0.29			
Forced down	Comply latency	0.28			

Table 6
Key variables and their loadings on Factor 8: *playful attention seeking*

Positively loaded variables			Negatively loaded variables		
Test component	Variable name	Loading factor	Test component	Variable name	Loading factor
All	Nuzzle	0.61	Forced down	No. of comply	−0.41
All	Paw	0.52	Sit	Sit latency	−0.38
All	Submissive grin	0.42	Sit	Orientate away	−0.37
Food removal	Contact bowl	0.35	Door entry	Position ahead	−0.35
Call response	Approach gait	0.31			

homogeneous subset (Tukey's honestly significant difference: mean difference (MD) = 0.12, NS; Table 7). When considering only the post-treatment tests, neither treatment (ANOVA: $F_{(1,13)} = 0.34$, NS), nor test number (ANOVA: $F_{(1,13)} = 2.16$, NS), significantly affected the scores.

Demandingness (Factor 5) was also affected by preceding treatment (ANOVA: $F_{(2,13)} = 9.59$, $P < 0.001$). Again the two play treatments formed a homogeneous subset

Table 7
Effect of treatment type on Factor 3: *obedient attentiveness*

Treatment	Mean ± S.E. *obedient attentiveness* score
Baseline	−0.31 ± 0.23
Dog win	0.10 ± 0.28
Dog lose	0.22 ± 0.29

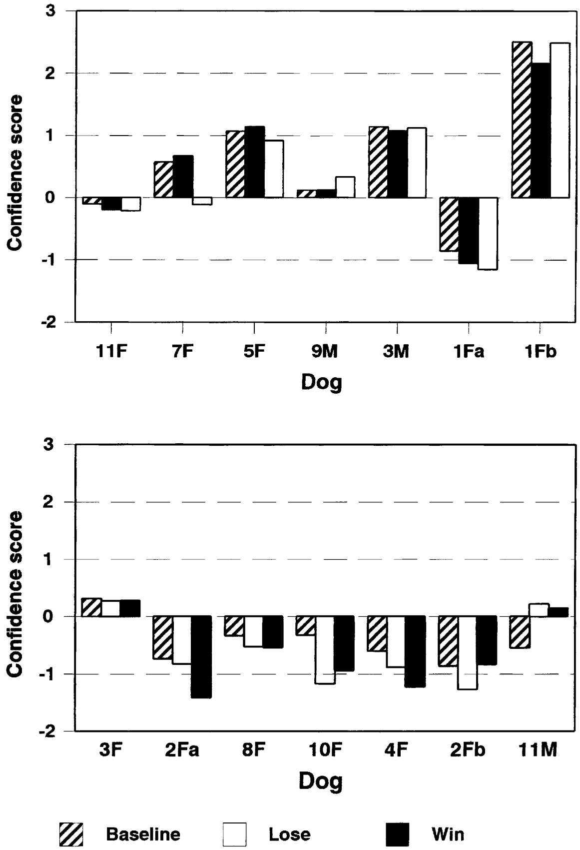

Fig. 2. *Confidence* scores of subjects in two treatment groups during three tests: baseline test (diagonal shading), after 20 sessions of tug-of-war *win* (filled) and after 20 sessions of tug-of-war *lose* (open). Each group contained seven Golden Retrievers evenly distributed for age, sex and playfulness. The code for each dog is the age to the nearest year, followed by the sex (M: male; F: female) and a suffix where two dogs would otherwise have the same code. Above: Group A; below: Group B.

(Tukey's honestly significant difference: MD = 0.15, NS). Considering only the post-treatment tests, treatment type exerted no significant effect (ANOVA: $F_{(1,13)} = 0.17$, NS), but test number had a powerful effect (ANOVA: $F_{(1,13)} = 23.86$, $P < 0.001$). *Demandingness* scores increased with successive testing sessions, irrespective of the order of treatments (Table 8). Factors 2, 4, 6, 7 and 8 were unaffected by the preceding treatment type.

3.3. Most playful dogs

When the sample was restricted to the 10 most playful dogs, the effects identified above (Factors 3 and 5) both remained significant. In addition, Factor 8 (*playful attention seeking*)

Table 8
Effect of test order on Factor 5: *demandingness*

Test number	Mean ± S.E. *demandingness* score
1	−0.76 ± 0.18
2	−0.13 ± 0.17
3	0.89 ± 0.24

Table 9
Effect of treatment type on Factor 8: *playful attention seeking*

Treatment	Mean ± S.E. *playful attention seeking* score
Baseline	−0.02 ± 0.32
Dog lose	0.08 ± 0.25
Dog win	−0.36 ± 0.31

was now significantly affected by treatment type; after winning at tug-of-war, the 10 dogs scored higher than after losing (ANOVA: $F_{(1,9)} = 5.54$, $P < 0.05$; Table 9).

3.4. Behaviour of dogs during play sessions

Group A won during period 1 and their *involvement* scores (during the last 10 sessions) were significantly higher than during period 2 when they lost (3.6 ± 0.1 versus 3.0 ± 0.1, ANOVA: $F_{(1,6)} = 6.43$, $P < 0.05$). Group B also scored higher for *involvement* during winning sessions (period 2), but the differences were not statistically significant (ANOVA: $F_{(1,6)} = 3.25$, NS; Fig. 3).

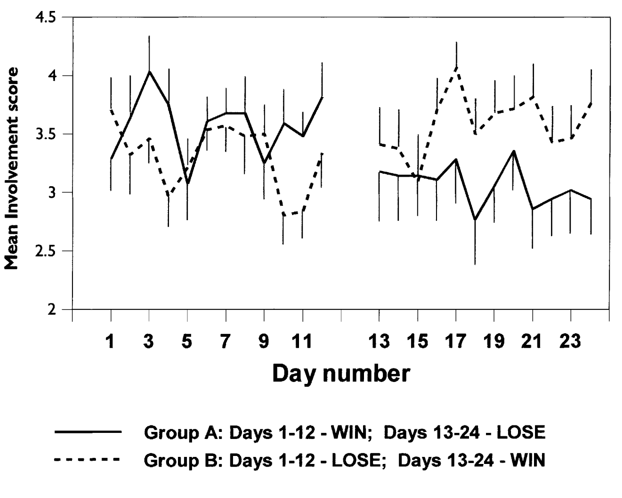

Fig. 3. Mean and standard errors for *involvement* scores per group, each day, over the treatment period—seven dogs in each group played with the experimenter during two 3 min sessions per day.

4. Discussion

4.1. Dominance-related effects of tug-of-war

The "dominance enhancement theory" states that the playing of uncontrolled tug-of-war leads to an increase in dominance dimensions of a dog's relationship with its human play partner. The behaviour patterns which contributed to high *confidence* scores would conventionally be ascribed to the dog behaving "dominantly" towards the experimenter (e.g. high tail positions; Beaver, 1982: standing over a lying person; Scott and Fuller, 1965: reluctance to surrender a toy; Overall, 1997: no rolling or displaying; Scott and Fuller, 1965). Therefore, the "dominance enhancement theory" predicts that dogs playing tug-of-war *win*, should increase in *confidence*, whilst players of tug-of-war *lose* would decrease in *confidence*. These predictions were not met. *Confidence* was not significantly affected by the treatment procedure for the entire or the restricted sample. This is consistent with the findings of a previous experiment on Labrador Retrievers (Rooney, 1999) and leads us to conclude that, in the populations tested, the outcome of tug-of-war games does not affect dominance dimensions of the dog–human relationship.

4.2. Effects on other aspects of the dog–human relationship

The treatment procedure was adequate to produce, and the testing sufficiently sensitive to detect, significant changes in two dimensions of the dog–human relationship. Dogs scored higher for *obedient attentiveness* post-treatment than during baseline testing. It is impossible to ascertain whether this represents a general effect of play or a result of increased familiarity with the experimenter and/or the test procedure. No order effect was found between post-treatment tests 2 and 3, so if this change was due to familiarity it did not extend beyond treatment period 1. There was also a gradual increase in *demandingness* with successive tests, suggesting a different effect of familiarity between dog and experimenter.

When examining only the most playful dogs, *playful attention seeking* was enhanced after the dog had won at tug-of-war relative to when it had lost. An increase in this factor corresponds to an increase in the frequency of behaviours such as nuzzling, pawing, and/or a decrease in variables such as sit latency and sitting orientated away from the experimenter. These changes cannot be interpreted by the conventional ideas of increased dominance, in fact, some of the accentuated behaviours (e.g. paw) are commonly interpreted as "submissive" (Fox, 1970).

In the treatment sessions, dogs scored higher for *involvement* during tug-of-war sessions which they were allowed to win (Fig. 3). It has previously been shown that squirrel monkeys select player partners against which they can win (Biben, 1986), and when no such partners are available they switch to nondirectional wrestling which has no clear winner (Biben, 1989). They are unlikely to play with a partner when the risk of losing is too great (over 60%; Biben, 1989). Play is also rewarding to rats (Panksepp et al., 1984) and winning is thought to be more so than losing (Calcagnetti and Schechter, 1992). We suggest that dogs also find play rewarding and hence they were more involved, or motivated, during play sessions they were allowed to win. This also explains why dogs reacted more playfully towards a play partner, and sought their attention more in a test following 20 winning play sessions than one following 20 losing sessions.

4.3. General discussion

Our results provide no support for the commonly postulated ‘‘dominance enhancement theory’’. Intraspecific play has been shown to have no deterministic role, but to reflect existing dominance asymmetries in rats (Pellis and Pellis, 1991), humans (Clark et al., 1969) and squirrel monkeys (Biben, 1998). We suggest this is also true for dog–human relationships. Characteristics of dog-owner play may be influenced by the current relationship, such that a dominant dog may be more likely to win at tug-of-war, but winning does not cause that dominance. It is also possible that the playing of specific games is symptomatic of general ownership styles. Owners who allow their dogs to win tug-of-war may be prone, for example, to allow their dog unlimited access to resources, e.g. space or food. Thus, other aspects of the owners' behaviour affect their dog–human relationship, and tug-of-war is a correlate, misidentified as the cause of the problem.

The ‘‘dominance enhancement theory’’ rests on the assumption that games are competitive and winning possession of the object is the dog's goal. Rooney et al. (2000) showed that dog–human play is less competitive than dog–dog play. There is little evidence that winning during intraspecific play enhances dominance (e.g. Biben, 1998) so it is not surprising that winning interspecific games does not. We hypothesise that the lack of competitiveness and consequent absence of dominance effects is because the players are aware of the playful context of the interaction. Pellegrini (1989) found that, in contrast to ‘‘popular children’’, sociometrically rejected subjects were unable to differentiate between aggression and rough-and-tumble play. Likewise, dogs in some situations may be unable to distinguish whether an interspecific interaction is playful, and a minority of dogs may never (or rarely) be able to make this distinction. For ‘‘true play’’ to occur both players must be aware of the playful nature of the interaction and this is generally achieved via play signals (Bekoff and Allen, 1998). We hypothesise that when play signals are absent or misinterpreted then the interaction may be perceived as competitive and dominance effects ensue (Rooney et al., 2001). Thus, dominance enhancement theory is applicable not to ‘‘true play’’, but to interactions which fail to be perceived as play by the canine partner.

Although we have found no evidence of dominance enhancement in this population, we cannot assume that this is universal. The effects of games vary considerably between dogs (Fig. 2) and so dominance enhancement effects may be limited to a small proportion of ‘‘potentially dominant dogs’’ (O'Farrell, 1992). Since pet behavioural counsellors who are the main supporters of this theory, observe a disproportionate number of problem dogs, this explanation is very plausible. Our experiments have been limited to gun-dog breeds and since behaviour varies between breeds of dog (Bradshaw et al., 1996) replication with other breed types may prove interesting. However, questionnaire surveys (Jagoe and Serpell, 1996; Rooney, 1999) and home-based studies (Rooney, 1999) of mixed-breed samples have found no correlations between the playing of tug-of-war and dominance and so, give us no reason to assume that the current findings are breed specific. Also, our work has concentrated on adult dog–human relationships so the findings may be different if the experiment were to be repeated using puppies as subjects.

In conclusion, in this population of Golden Retrievers, we found no evidence that dominance-dimensions of dog–human relationships are affected by the outcome of tug-of-war games. Allowing dogs to win games did not alter dominance-dimensions of their relationship with the experimenter, but it did lead them to perceive the experimenter as a more favourable play partner. We conclude that dog–human play, like rat, human and squirrel monkey play, is not a major determinant of dominance relationships.

Acknowledgements

We would like to thank the BBSRC and the Waltham Centre for Pet Nutrition for financial support of this project. We are very grateful to Rob Atkinson, Theresa Barlow, Candy D'Sa, Sarah Lowe, and Peter Hepper for comments on the manuscript. Finally, our sincere thanks to Pat and Fred Taylor for allowing us use of their Golden Retrievers, and also the staff of Waltham, for help with the preliminary study.

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