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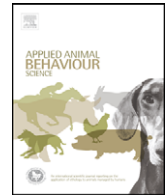
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2 Video analysis of dogs with separation-related behaviors

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ABSTRACT

Separation-related behaviors are described as problematic behaviors that occur exclusively in the owner's absence or virtual absence. Diagnosis is generally based on indirect evidence such as elimination or destruction that occurs during owner absence. Questionnaire studies are based on owner perception and might therefore underestimate the actual proportion of dogs with separation problems. The aim of this study was to film dogs with separation-related problems when left home alone and compile objective information on behaviors exhibited. Twenty-three dogs, ranging in age from 5 months to 13 years (2.9 ± 2.7 years), were filmed home alone for 20–60 min (49.87 ± 12.9 min) after owner departure.

Analysis of behaviors on tape showed that dogs spent most of their time vocalizing ($22.95 \pm 12.3\%$ of total observed time) and being oriented to the environment ($21 \pm 20\%$). Dogs also exhibited panting ($14 \pm 18\%$), were passive ($12 \pm 27\%$) and were destroying ($6 \pm 6\%$) during owner absence. Most dogs displayed signs within less than 10 min after owner departure, such as vocalizing (mean latency 3.25 min) and/or destroying (mean latency 7.13 min). Barking and oriented to the environment tended to decrease (respectively $p = 0.08$ and $p = 0.07$) and conversely panting tended to increase over time ($p = 0.07$).

Diagnosis of separation-related problems is traditionally dependant on owner reports. Although owner observation may be informative, direct observation and standardized behavioral measurement of dogs with separation-related problems, before and after treatment, would be the best way to diagnose and to measure behavioral improvement.

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7
8 1. Introduction

9 Problems that occur when the owner is absent
10 represent one of the principal causes for the breakdown
11 of the human–companion animal bond and can lead to
12 surrender of numerous dogs to shelters (Miller et al., 1996;
13 Van der Borg et al., 1991).

14 In the literature, undesirable behavior problems that
15 occur during owner absence are listed as separation
16 anxiety, separation-related problems, isolation anxiety,
17 separation reactions, separation-related distress and

separation anxiety syndrome. Separation anxiety is described as problematic behavior motivated by anxiety that occurs exclusively in the owner's absence or virtual absence (Appleby and Pluijmakers, 2004; Borchelt and Voith, 1982; Flannigan and Dodman, 2001; Overall, 1997). Anxiety-related disorders and separation anxiety are among the most common behavioral problems in domestic dogs (Overall et al., 2001) with separation anxiety being diagnosed in 20–40% of dogs referred to animal behavior practices in North America (Simpson, 2000; Takeuchi et al., 2000; Voith and Borchelt, 1996). Some authors and veterinarians question whether dogs with separation-related problems are truly anxious (Papurt, 2001).

Separation-related distress has, for many years, been believed to be a distress response to separation from the

figure to whom the dog is attached (Voith and Borchelt, 1985). In most cases, the attachment figure is the dog's owner or a person in the household with whom the dog displays a strong affiliation. The degree of distress is thought to be related to the degree of the attachment to the absent figure (Schwartz, 2003). It is likely that separation-related distress in dogs has a multi-faceted etiology, so various authors have advocated symptom-based approaches for data collection since these approaches may avoid inappropriate interpretation of animals' motivation (Blackwell et al., 2006; McCrave, 1991; McGreevy and Masters, 2008).

The most common complaints are destructive behavior directed at the home, self-inflicted-trauma, inappropriate elimination, increased and repetitive motor activity (pacing, circling) and excessive vocalization (whining, barking, or howling) in the owner's absence (Appleby and Pluijmakers, 2004; King et al., 2000; Simpson, 2000).

Destructive behavior (chewing, digging and scratching) is usually directed at exit points such as doors, windows and gates (McCrave, 1991). Specific objects in the apartment or the house are scratched, chewed or torn apart. Occasionally this behavior may even lead to extensive destruction of furniture. Diagnosis is generally based on indirect evidence such as elimination or destruction during owner absence instead of visualizing tapes of actual behaviors and body language. Several owners will be made aware of a problem only because neighbors complain about excessive vocalization. Separation-related problems may therefore be underestimated if elimination does not occur, destruction is absent or minor and if no one hears the dog vocalize. Some behavioral signs, such as pacing, circling, or other repetitive actions can only be identified if a video-recorded film is done during owner absence. Therefore, questionnaire studies based on owner perceptions may underestimate the real proportion of dogs with separation problems, as well as the severity of the signs.

To our knowledge, only one study (Lund and Jørgensen, 1999) reported observations of filmed behaviors exhibited by dogs with separation problems in their own environment. The aim of this study was to film dogs with separation-related problems when left home alone and compile additional objective information on behaviors exhibited.

2. Materials and methods

2.1. Subjects

Twenty-three dogs (three intact and seven spayed females, nine neutered and four intact males) ranging in age from 5 months to 13 years (2.9 ± 0.7 years) were included. Dogs were chosen among patients presented for separation-related problems to two Behavior Clinics.

Breeds included two Siberian huskies and two Beagles, and one of each of the following: Golden Retriever, Poodle, English Cocker Spaniel, West Highland White Terrier, Wire Fox Terrier, Basset Hound, Doberman, American Staffordshire Terrier, Dachshund, as well as 10 mixed breeds.

Dogs were filmed under routine conditions normally adopted by the owners: 11 dogs were allowed to run freely in the home, nine were kept in a cage and three were confined in a room.

2.2. Data collection

The owners were asked to fill out a questionnaire including information on the dog's characteristics and history as well as on the physical and social environment of the dog. Questions touched on home environment, management, age (current, age at acquisition), sex, reproductive status (entire or neutered/spayed), breed, number of adults and children in the household (children older than 18 years were considered adults), source of dog (breeder, pet store, shelter, rescue, family, friends or stray), and number of dogs and cats in the household. Other specific questions about the dog's behavior during owner absence were also compiled (house soiling, destruction, vocalization).

A video camera was installed in the room where the dog usually stayed during owner absence. If the dog was allowed to roam freely, the camera was installed where the dog was believed to spend most of its time. The owners were asked to start the camera immediately prior to their departure from home. The dogs were filmed when left home alone for variable periods ranging from 20 to 60 min (49.87 ± 12.9 min) depending on the owner's schedule.

2.3. Data collection and analysis

2.3.1. Questionnaire

Answers to the questionnaire were scored. Absolute and relative frequencies were calculated and expressed as percentage.

2.3.2. Video recording

The behavior of each dog was video-recorded and every videotape session was subsequently analyzed. Twenty categories covering all recorded behaviors were established (Table 1). A focal animal continuous recording method (Martin and Bateson, 1993) was used to describe the dog's activity. Behaviors were recorded in terms of duration of occurrence or frequency. Behaviors recorded as states were: exploration, locomotion, circling, passive behavior, orientation to environment, scratching, oral behavior, play, panting, grooming, ears back, barking, whining, howling, trembling, paw up and not visible. Yawning, lip licking, elimination were recorded as events.

Inter-observer reliability was assessed by two observers that scored independently a random sample of three videotaped sessions, for a total duration of 3 h of observation. The reliability was calculated by means of percentage agreement and Spearman's correlation. Percentage agreement was always more than 87%, Spearman's Rho = 0.983, $p < 0.001$.

2.3.3. Statistical analysis

In order to describe duration and frequency for each behavior a descriptive analysis was first performed. Categories such as play, grooming, ears back, trembling, circling, elimination and not visible were not considered for statistical analysis either because of total absence of the given behavior or short duration.

Table 1
Behavioral categories and their definition.

Behavioral category	Definition
Duration	
Exploration—EX	Motor activity directed toward physical aspects of the environment, including sniffing, and gentle oral examination such as licking
Locomotion—LO	Walking or running around without exploring the environment (pacing)
Passive behavior—PA	Lying down with the head on ground without any obvious orientation toward the physical or social environment
Oriented to the environment—OE	Sitting, standing or lying down (the head does not rest on the ground) with obvious orientation toward the physical or social environment, including sniffing, close visual inspection, distant visual inspection (vigilance or scanning)
Scratching—SC	All active behaviors resulting in physical contact with the cage/door, including scratching the cage/door with the paws, jumping on the cage/door, handling with the forelimbs
Oral behavior—OB	Any vigorous behavior directed toward the environment/cage using the mouth (including chewing, biting, shaking, pulling with the mouth)
Play—PL	Any vigorous or galloping gaited behavior directed toward a toy; including chewing, biting, shaking from side to side, scratching or batting with the paw, chasing rolling balls and tossing using the mouth. Although, the dog may take the objects into its mouth, destruction is not included in this category
Panting—PT	Panting
Not visible—NV	Not visible (during these periods, activities like barking, whining, scratching, chewing, were identified and recorded by the sound of the activity)
Grooming—GR	The action of cleaning the body surface by licking, nibbling, picking, rubbing, scratching, etc. directed toward the animal's body (self-grooming)
Ears back—EB	Ears flattened and back
Barking—BA	Barking
Whining—WH	Whining
Howling—HO	Howling
Trembling—TR	Trembling/shaking movements of the body or head
Paw up—PU	Front limb raised
Circling—CI	Movement of the dog in circles
Frequency	
Yawning—YA	Yawning
Lip licking—LL	Part of tongue is shown and moved along the upper lip
Elimination—EL	Defecation or urination in sitting or standing position

Based on the total length of the observation, durations of states were calculated as percentage of total observation time and events were expressed as hourly frequencies.

A multivariate statistical analysis (Principal Component Analysis—PCA) was used for the remaining observed behavioral categories as an exploratory analysis to detect the underlying relationships among the observed behaviors and to identify cases clusters. Data assumptions were checked, KMO (Keiser Meyer Olkin) and Barlett's test of sphericity were performed in order to test the suitability of the data for structure detection. Factor scores were calculated for dogs when the component's Eigen value was greater than one, to evaluate the distribution of the subjects according to the considered variables and classed using the categories obtained from the questionnaire. Any differences in behavior which may have occurred in dogs owing to different classes of age at adoption, sex, source of acquisition, presence of other dogs in the household and various confinement styles (dogs free versus confined in a cage or a room) were evaluated by comparing dog scores on the main PCA factors using a Mann–Whitney or a Kruskal–Wallis non-parametric tests.

Seventeen dogs out of 23 were filmed for more than 40 min. For these dogs, the first 40 min of each video was evaluated to determine how the behaviors changed over time. A General Linear Model (GLM) analysis of variance for repeated measures was performed on log transformed data in order to analyze the temporal distribution of behaviors during subsequent intervals of 10 min for the first 40 min.

3. Results

Sixty per cent of the subjects lived in an apartment, 33.3% in a house and the others (6.7%) in various environmental contexts. Most dogs (76.5%) came from households without children, whereas some (23.5%) lived with adults, and teenagers or children. In 45.6% of cases, the dog was a single pet. In about half the households (54.4%), another animal was present, a dog in 25% of cases and a cat in the remaining 29.4%. Access to outdoors was limited (fenced yard) for 14.3% of the dogs, 28.6% were taken out on leash, 21.4% were allowed to roam free while outside and 35.7% were both out on leash or in a fenced yard.

Twenty-five per cent of the dogs were acquired from the local animal shelter, 31.2% were adopted from another person, 12.5% were adopted directly from breeders, 6.2% were purchased from a pet store, and the remaining dogs (25.1%) came from a different source.

Age at adoption ranged from birth to 60 days for 22.2% of the dogs, between 2 and 3 months for 38.9%, from 3 to 12 months for 16.7% of the dogs and 22.2% were adopted after 1 year of age.

Based on owner answers to the questionnaire, 60.8% of the dogs reacted to thunderstorms, 71.4% of the dogs destroyed and 53.3% eliminated when left home alone.
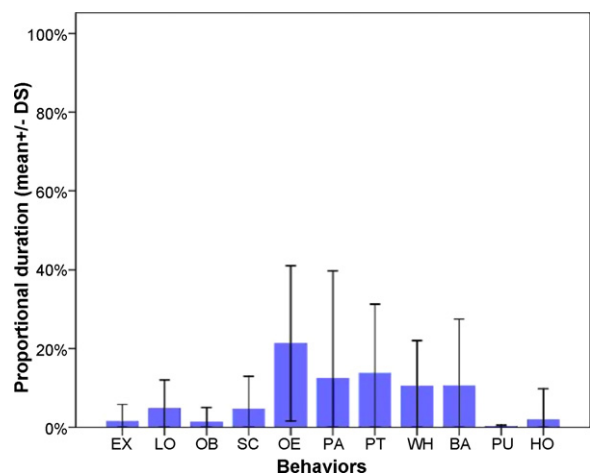
Fig. 1. Proportional duration of behaviors (mean ± SD).

Table 2
Principal Component Analysis (PCA) of quantitative data calculated from correlation matrix.

	Eigen value	Explained variance %	Cumulative explained variance %
PC1	3.012	30.122	30.122
PC2	1.731	17.307	47.429
PC3	1.452	14.520	61.949

Behavior	Component		
	1	2	3
Exploration	−.093	.097	−**.408**[a]
Locomotion	−.169	**.730**	−.034
Oriented to environment	−.200	−.309	**.638**
Passive	−.284	−**.612**	−.386
Panting	**.864**	.196	−.104
Paw raised	**.714**	.075	.358
Lip licking	**.879**	.213	−.022
Yawning	**.762**	.413	−.012
Vocalization	.055	.425	**.651**
Destruction	.492	**.526**	−.406

[a] The most significant behaviors for each component are bold typed.

Based on owner perception or neighbor complaints, 88.2% of the dogs vocalized when left home alone.

Analysis of behavior on tape is shown in Fig. 1. Considering behaviors like barking, whining and howling together as vocalization and oral behavior and scratching as destruction, it is possible to evidence that dogs spent most of their time (22.95%) vocalizing (barking 11%, whining 10% and howling 1.95%) as opposed to being oriented to the environment (21%). Panting, passive, and destructive behavior were exhibited respectively for 14% and 12% and 6% (5% scratching at the cage, door, environment; 1% oral destruction of items or cage) of the time while other behaviors were only observed for shorter periods.

Hourly average for lip licking and yawning, was respectively 27 and 3. No dog played during owner absence, two dogs trembled and three dogs eliminated. Based on these videotaped records, most dogs displayed signs such as vocalizing (mean latency 3.25 min) and/or destroying (mean latency 7.13 min) shortly after the owner's departure. A good suitability of data for PCA analysis was valued (KMO = 0.609 and Barlett's test $p < 0.001$). The PCA (Table 2) revealed three main factors with Eigenvectors greater than one, which together explain 61.9% of the variation between dogs.

As shown in Fig. 2, the first factor (PC1) shows positive loading for the behaviors panting, lip licking, yawning and paw raised, all behaviors that can indicate distress. The second factor (PC2) showed positive loading for locomotion and destruction (oral behavior and scratching), and negative loadings for passive behavior (suggesting that dogs scoring high on this factor can be described as more active than dogs with low scores). These behaviors correspond to a state of activity/inactivity. The third (PC3) factor shows positive loadings for vocalization (howling, whining and barking) and oriented to the environment and negative loadings for exploration and may indicate a condition of anxiety as opposed to being more interactive with the environment.

Based on age of adoption, dogs did not gather homogeneously, but rather significantly ($p < 0.05$) separated into two groups on PC2: one group with higher variable values associated with behaviors such as locomotion and destruction and the second group identified by higher variable values for passive behavior.

As shown in Fig. 3, dogs adopted before 2 months and after 3 months of age (Group 2) are clustered indicating that they appear to be more active (walking or running around without exploring the environment, and destroying) than dogs adopted between 2 and 3 months of age (Group 1) which spent more time in passive behavior.

Analysis of factor scores of dogs revealed that sex, source of acquisition and the presence of other dogs in the household did not affect the distribution of the dogs on the first three PCs. Caged dogs yawned and licked their lips significantly more ($p < 0.05$) than dogs running freely or confined in a room. No other significant difference in behavior was detected.
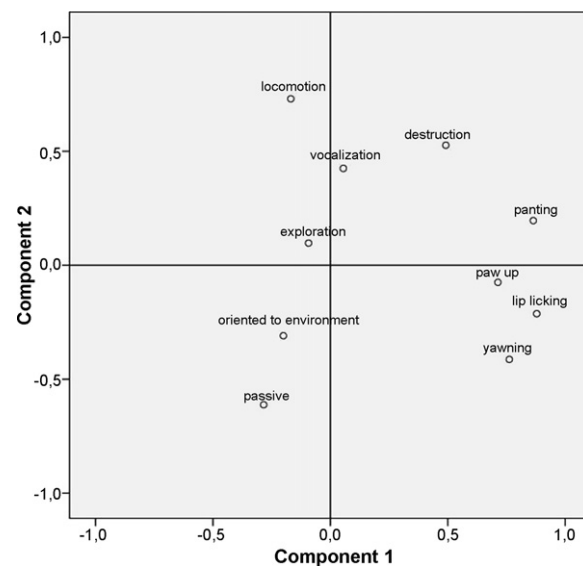

Fig. 2. Projection for the loadings of the behavioral variables considered for the First and Second Principal Component.
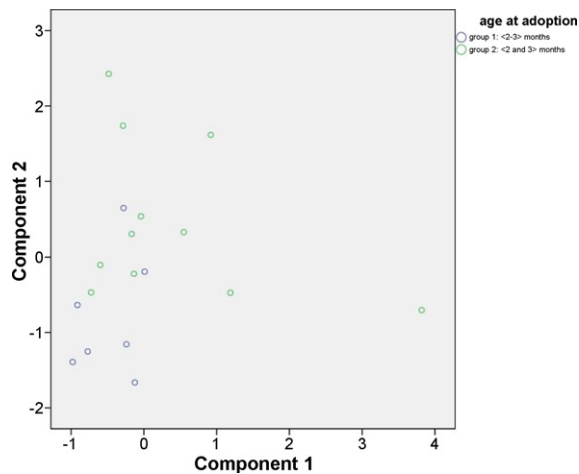
Fig. 3. Score plot of dogs in terms of age of adoption.

257 Behaviors such as whining, scratching and passive did
258 not change significantly over successive interval times.
259 Barking and oriented to the environment tended to
260 decrease (respectively $p = 0.08$ and $p = 0.07$) and conver-
261 sely, panting tended to increase over time ($p = 0.07$).

4. Discussion

263 The aim of this study was to film dogs with separation-
264 related problems when left home alone and compile
265 additional objective information on behaviors exhibited.
266 Our research included a small sample of dogs of different
267 breeds and ages displaying various degrees of separation-
268 related behaviors. Therefore, they may not be representative
269 of the entire population of dogs with separation-related
270 behavior problems, and caution should be exercised not to
271 generalize these results. Our study does show that dogs with
272 separation-related problems do not all exhibit the same
273 signs and these signs can vary in intensity.
274 Vocalization, in the form of barking, whining or howling
275 was the behavior exhibited most often by our dogs. Twenty
276 dogs out of 23 vocalized during owner absence. Dogs
277 barked and whined more than howled, and similarly to
278 Lund and Jørgensen (1999), we frequently found that the
279 different forms of vocalization were mixed. Although the
280 type of vocalization in our study did vary to a certain extent
281 among dogs, all but three were whining. Whining is a
282 social signal providing information about the emotional
283 state of the dog calling for attention (Lund and Jørgensen,
284 1999). The emotional state of a whining dog exposed to
285 social isolation may be distress related to fear (Lund and
286 Jørgensen, 1999). If this is the case, then fear was involved
287 in the separation-related behaviors observed in our study.
288 Barking can occur in response to external stimuli and may
289 reflect arousal (Lund and Jørgensen, 1999). When visualiz-
290 ing and listening to the tapes, we were unable to identify
291 any external stimulus that could have elicited vocalization.
292 In some contexts barks are acoustically different which
293 means that the acoustic features of the bark depend either
294 on the motivational/emotional state and/or on the actual
295 context (Molnár et al., 2008).

Howling is used in wolves for long distance commu-
nication when an individual has been separated from the
pack (Fox, 1971; Mech, 1977). Therefore, howling may be
considered a natural response in separated dogs experien-
cing the discomfort of being left alone (Lund and Jørgensen,
1999).

Hence, vocalization in dogs left home alone can occur as
a consequence of discomfort, fear or anxiety (Landsberg
et al., 2003; Overall, 1997). Analysis of dog behavior on
tape showed that they spent most of their time being
oriented to the environment (21%) and this could be
explained by the fact that anxiety elicits behaviors that
enable the animal to approach the source of (perceived)
threat (McNaughton and Corr, 2004) by increasing
attention and stimulating risk assessment (Lang et al.,
2000; Ohl et al., 2008). Furthermore, during risk assess-
ment, non-defensive behavior, such as environmental
exploration, self-grooming, feeding and social interaction
are inhibited (Blanchard et al., 1998; Mastripieri et al.,
1992; Shuhama et al., 2007), and the degree of suppression
of these behaviors may be used as an indirect index of
defensiveness or anxiety (Shuhama et al., 2007). Explora-
tion can in fact be partially or completely inhibited by
anxiety, therefore reduced exploration might represent an
indirect measure of anxiety (Crawley and Goodwin, 1980;
Ohl et al., 2008). In our sample of dogs, self-grooming was
never observed and exploratory behavior was observed
only for short periods which is compatible with a state of
anxiety. Withdrawal, behavioral inhibition and immobility
are also considered symptoms of separation anxiety
(Horwitz, 2002; Takeuchi et al., 2000). In our study,
passive behavior was exhibited by eight dogs, two of which
were trembling for short periods of time thus perhaps
indicating behavioral inhibition of these dogs rather than a
relaxed or stress-free state.

Destruction can occur as an element of play or
exploratory behavior in young active animals without
appropriate exercise (Simpson, 2000), or in the course of
territorial displays at windows and doors as well as during
phobic episodes related to noises or storms (Horwitz,
2002). In some cases, there is the possibility that fear
responses causing these behaviors are only seen during
owner absence (Horwitz, 2002). In our study 74% ($n = 17$)
of dogs displayed both destructive behavior and vocaliza-
tion (barking, howling, whining). Of the 19 dogs exhibiting
destructive behavior, 15 did not howl, and only one of the
five howling dogs did not exhibit destructive behavior.
Therefore in our study, as well as in Lund and Jørgensen's
study, discrimination between "vocalizing" or "howlers"
and "destructive" dogs does not seem justified.

Elimination has been interpreted as symptomatic of a
general anxiety-like state (Bradshaw et al., 2002). Elim-
ination behavior reported by other authors (Borchelt and
Voith, 1982; Horwitz, 2002; Simpson, 2000) and consid-
ered among the most common symptoms of separation
anxiety was found in only one case by Lund and Jørgensen
(1999) and three cases in our study.

Based on owner answers to the questionnaire, 60.8% of
the dogs in our study reacted to thunderstorms. Noise
phobias and separation anxiety may in fact be associated
(Overall et al., 2001). Anxiety and fear of novel situations,

fear of strangers, aggression and compulsive behaviors may all occur in conjunction with separation anxiety (Overall, 1998) or with separation-related problems (Horwitz, 2002). When an extremely fearful dog encounters the fear-producing stimuli while the owner is absent, they may engage in behaviors (especially destruction) that may mimic separation anxiety (Horwitz, 2002). Restlessness, pacing and escape behaviors were noted in our study and are also frequently observed in fearful or phobic dogs (Neilson, 2002; Overall, 2002), as well as reported in many publications (Borchelt and Voith, 1982; McCrave, 1991; Overall, 1997; Simpson, 2000) on separation anxiety. In contrast to the Lund and Jørgensen (1999) study, in which behaviors related to separation were divided in either (1) exploratory, (2) object play/predatory, (3) destructive or (4) vocalization, our study seems to indicate that separation-related problems could be the consequence of different underlying conditions such as fear, phobia, or anxiety, with overlapping signs of different intensities and frequencies. Results from PCA analysis, in fact, identified dogs with three different responses to being home alone: (1) a "discomfort response" associated with signs of distress (Schwizgebel, 1982), such as lip licking, yawning and paw raised, (2) a "fearful response" shown either by increased motor activity and escape (flight) behavior ("hyperactivity" subgroup) or behavioral inhibition ("freezing" subgroup), and (3) an "anxious response" with increased attention toward the environment, vocalization and reduced exploration.

Based on our results, an inappropriate age at adoption may influence behaviors such as increased locomotion and destruction that are related to the "fearful response" of dogs. Experiences during developmental stages such as early separation from the mother or other incidents of separation are in fact important for the sensitivity of the stress response in adult animals and may produce subsequent difficulties with routine separation (Boissy, 1995; Serpell and Jagoe, 1995).

In agreement with Lund and Jørgensen (1999), in our study sex, source of acquisition and despite what owners commonly believe (separation-related behavior may disappear if they buy a second dog to provide company), the presence of other dogs in the household, had no effect on dog behaviors. Some authors suggest a confinement area such as a crate or a room to alleviate the anxiety associated with owner departure (Horwitz, 2002). However, in our study cage confinement seems to increase the "discomfort" response. Behaviors, such as yawning and lip licking were performed significantly more by caged dogs than dogs allowed to run freely or confined in a room. While many dogs respond favorably to having a smaller place where they can feel secure, some dogs panic at being put into an enclosed space, and such dogs should never be forced into a crate (Overall, 2002).

In agreement with other authors (Borchelt and Voith, 1982; Lund and Jørgensen, 1999), in our study separation-related behaviors start at the time of the owner's departure or very shortly thereafter (vocalizing at 3.25 min and/or destroying at 7.13 min).

Most behaviors in our dogs did not change over time. Nevertheless, barking and oriented to the environment

tended to decrease over time while panting tended to increase possibly as a consequence of exhaustion.

Diagnosis of separation-related problems is largely dependant on owner reports. Questionnaire based studies (Appleby and Pluijmakers, 2004; Flannigan and Dodman, 2001; Podberscek et al., 1999) report that the most common signs shown by the dogs when left home alone include destruction, excessive vocalization and inappropriate elimination. If only minor or no destruction occurs, separation problems may not be recognized by owners. In some cases, owners are made aware of their dog's problem only because the neighbor complains about excessive vocalization. If neighbors do not complain, or the destructive behavior is of no importance to the owner, the problem can be underestimated even if both forms of behavior are actually displayed by the dog (Lund and Jørgensen, 1999).

Although owner observation may be informative and useful for general identification of behavioral problems, direct observation and standardized behavioral measurement of dogs with separation-related problems when alone, before and after treatment, would be the best way to diagnose and to measure behavioral improvement (Cottam et al., 2008).

5. Conclusion

Separation-related problems are commonly reported as a reason for consultation in referral behavior practices. Our results supported the view that separation-related disorders could be the consequence of different underlying states such as (1) discomfort, (2) fear ("hyperactive" and "freezing" subgroups), or (3) anxiety, along with overlapping signs of different intensities and frequencies.

If these separation-related behaviors are compatible with one or several underlying states, it is then possible that different clinical syndromes may have been grouped under the same label. This inaccurate categorization could explain the discrepancy in opinions on how to treat separation anxiety as well as explain some treatment failures (Frank, 2005). The diagnosis for most authors relies almost exclusively on owner reports, and the actual behaviors are rarely videotaped to confirm the diagnosis or to assess treatment response. The need for better diagnostic tools is essential and has consequences for the treatment of the affected animals by helping individuals cope adequately with their environment (Ohl et al., 2008).

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