Should I whine or should I bark? Qualitative and quantitative differences between the vocalizations of dogs with and without separation-related symptoms

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Abstract

Separation-related disorder (SRD) is one of the most common behavioral problems of companion dogs, causing inconvenience and stress for dog owners and others living close by, as well as being considered as a major contributor to poor animal welfare. Although excessive vocalization is considered as one of the typical symptoms of SRD, until now there were no attempts to analyze and compare the vocal output of affected and non-affected dogs in a systematic, empirical test. In a three-stage outdoor separation experiment we investigated the vocal response of 25 family dogs with, and 20 family dogs without, owner-reported SRD symptoms to the (1) departure; (2) absence; and (3) return of the owner. After the analysis of the occurrence and onset latency of barks and whines, we found that contrary to the commonly held view of excessive barking being one of the trademarks of SRD, dogs with owner-reported SRD symptoms can be reliably characterized by the early onset and high occurrence of whines during the departure and 2 min long absence of the owner, while barks were affected mainly by the age of the dogs. Breed and neuter status may modify the vocal reaction to separation, we found that more purebred dogs barked sooner, while breed and neutering status affected the whines only during the departure of the owner, showing that more mixed breeds and intact dogs whined in this phase. This is the first study that targeted directly the vocal response of family dogs to separation from the owner, and according to the results, whines and barks reflect potentially different motivational/inner states of dogs during a short isolation episode. Although the effect of other factors, such as sex, neuter status and breed cannot be ignored, the owner reported SRD status of dogs showed a high coincidence with the early onset of whining, which in turn proved to be a good indicator of high stress levels of dogs in this situation.
Keywords: dog, separation related disorder, vocalization, whine, bark

**Introduction**

Dogs became increasingly popular as pets/companion animals in the urbanized world in the last few decades (McConnell et al., 2011). The benefits of having a dog are well documented from the side of recreational and emotional aspects (Archer, 1997), as well as the safety and health of the owner (Cutt et al., 2007; Friedman et al., 1983). However, with a relatively large proportion of the population involved directly or indirectly in coexisting with dogs, demands of both human and animal welfare arise as well. As it is more and more common that companion dogs spend longer periods of time alone while their owners are not at home, the way dogs cope with situations of separation draws growing interest (Sherman and Mills, 2008). The apparent behavioral extremities in particular dogs accompanying the shorter-longer absence of the owner, form a rather coherent system of symptoms (destructiveness (King et al., 2000); inappropriate and unprovoked soiling in the building (Overall et al., 2001); hypersalivation (Sherman, 2008); and excessive vocalization (Schwartz, 2003)) which have been called ‘separation anxiety’ (Flannigan and Dodman, 2001; Simpson, 2000), or more recently separation-related disorder ‘SRD’ (Appleby and Pluijmakers, 2004). Such symptoms are not only burdening the co-existence between dogs and humans (Lindell, 1997), but represent a serious problem for the welfare of the animal, requiring veterinary (e.g. Gruen and Sherman, 2008; Herron et al., 2008; Simpson et al., 2007) or therapeutic intervention (King et al., 2000; Podberscek et al., 1999; Sherman et al., 2008; Takeuchi et al., 2000), and often resulting in the relinquishment of the dog to a shelter (Flannigan and Dodman, 2001; Marston et al., 2004; Takeuchi et al., 2001).

Based on the theory of dog-human attachment, being separated from the owner causes a manageable level of distress in each dog that belongs to a particular person or family (Topál
During the diagnosis of SRD one should be able to distinguish between milder cases of symptomatic behavior and the signs of ‘ordinary’ attachment (e.g. Flannigan and Dodman, 2001; Parthasarathy and Crowell-Davis, 2006). Veterinarians, behavioral therapists and researchers often base their decision on surveying the owners with questionnaires, as it is usually the owner who experiences the response of his/her dog to separation (e.g. Overall et al., 2001; Podbersek et al., 1999; Takeuchi et al., 2000). Especially for reasons of confirming the presence of separation anxiety in particular canine patients, long-term video recordings may be taken in the home of the dog and evaluated later (e.g. Palestrini et al., 2010).

Meanwhile this type of observation provides a valuable wealth of information about the occurrence of various behavioral elements of affected dogs, the process is somewhat awkward to perform and these studies usually lack the involvement of control groups of non-SRD dogs (e.g. Lund and Jørgensen, 1999; Palestrini et al., 2010). A different approach to testing of separation-related behaviors concentrates on inducing experimentally separation-related stress with a short isolation of the dog from the owner in a controlled environment (e.g. Borg et al., 1991; Konok et al., 2011). There are promising results where simple behavioral tests (such as the ‘separation & greeting’ paradigm of Konok et al. 2011) could validate the reliability of owner-based questionnaires about SRD in dogs. On the other hand, the evaluation of these tests can be rather complicated because the observer/evaluator must record and analyze a rather high number of behavioral variables, which may be rather subtle and hard to distinguish (see for example Konok et al., 2011; Palestrini et al., 2005; Palmer and Custance, 2008; Prato-Previde et al., 2003). Vocalizations on the other hand theoretically offer a rather straightforward method for evaluating the status of dogs regarding their response to separation. Dogs often vocalize when they are isolated from or left alone by their owner (Kobelt et al., 2003), and there is ample evidence that SRD can be characterized by ‘excessive’ vocal behavior (Juarbe-Díaz, 1997).
Although vocal behaviors are often mentioned among the symptoms of SRD (see for a review Ogata, 2016), the detailed analyses of the vocal responses of dogs to separation are surprisingly rare, especially from the aspect of their possible applicability for diagnostic purposes regarding SRD. Authors mostly list different types of vocalizations (howls, barks, whines) as typical behaviors during separation (e.g. Horwitz, 2000), and in some cases they also provide a temporal analysis of the onset of vocal responses to separation. Lund and Jorgensen (1999) found for example that (along other SRD-related behaviors) whining reaches its peak intensity shortly after the owner’s departure. However, until now by our knowledge no attempt was made for the qualitative comparison of vocal patterns in SRD and non-SRD dogs, with a specific interest towards the possible differences between the communicative content of different types of canine vocalizations. It is already known that dogs that were left alone by their owners either in a room (Yin, 2002) or on the street tied to a tree (Pongrácz et al., 2005; 2006; 2014) emit barks with clearly distinguishable acoustic structure (high fundamental frequency, high tonality, low pulse). Human listeners can recognize these barks significantly above chance level (Molnár et al., 2010; Pongrácz et al., 2005; 2011); and they also characterize the barks of isolated dogs as showing high levels of despair and fear (Pongrácz et al., 2005; 2006). Recently it was also found that barks that show the acoustic characteristics of the vocalizations recorded during separation cause especially strong nuisance effect among human listeners (Pongrácz et al., 2016). However, it has not been investigated yet whether patterns of isolation-related barking would differ between dogs with or without SRD. Besides the barks that can be considered as medium-to-long distance calls and if emitted in isolation, there are also other vocalizations that can be relevant in the analysis of SRD. In an earlier comparative work, Cohen and Fox (1976) listed whines and howls in addition to barking, as vocalizations typical to dogs being left alone. Although barks and howls definitely possess the intensity and duration to be detectable from larger distances,
one could hypothesize that the more elusive (i.e. less intense, and/or short distance) whines could specifically signal the higher levels of distress in a dog affected by SRD. Some authors characterize whines as a typical form of vocalization in dogs that experience frustration and other negative inner states (Custance and Mayer, 2012; Palestrini et al., 2010). Moreover, the similarity of their acoustic structure to the general pattern of infant distress calls (Lingle et al. 2012) suggest that these vocalizations can be the remnants of infant contact calls functioning in the adult dogs as a distress vocalization signaling the negative inner state of the dog to the owner. Accordingly, Lund and Jorgensen (1999) considered whines of SRD-dogs as “attention-soliciting” behavior, which fits well to our hypothesis that meanwhile a large proportion of dogs vocalizes during a separation episode, the emotional background of this may differ between SRD and non-SRD dogs. According to this, subjects with separation-related symptoms would emit mostly fear and distress-related vocalizations (including a higher proportion of whines), non-SRD dogs could be rather characterized by vocalizations related to protest and frustration (higher prevalence of barks).

In this paper we present the results of an experiment in which we compared the vocal responses of dogs with or without owner-reported separation related problems during a short outdoor separation episode. For the assessment of the SRD status of dogs, we used the validated questionnaire of Konok et al. (2011). In that study, authors set up a short indoor separation situation for the assessment of whether the owners are able to recognize (via the completion of a questionnaire) their dog’s separation related problems. The questionnaire contained questions about the emotions of the owner when the dog is left alone and about the general opinion of the owner about the stress level of the dog when it’s left alone. It was found that dogs with owner-reported SRD showed more stress-related behavior (e.g.: vocalizing, physical contact with the door, rearing on the wall or the door), they spent less time near the owner’s chair during separation, and showed more intense greeting activity than
dogs without SRD. Non-affected dogs’ activity decreased with increasing separation
duration, but dogs with SRD did not show this change in their separation behavior. Based on
these results, in agreement with Konok et al., we can conclude that the owners can report
reliably their dog’s separation related problems.

Our question was whether the vocalizations of dogs with owner-reported SRD show
qualitative and quantitative differences compared to the vocalizations of dogs that do not
show SRD symptoms at home. We hypothesized that dogs with SRD will not only bark and
whine more abundantly than non-affected dogs (which could be expected based on the
literature (e.g. Lund and Jørgensen, 1999)), but we expected that whines will be the more
prevalent vocalization of SRD (compared to barks), because we hypothesized that whining is
the vocal manifestation of the negative inner state evoked by the absence of the attachment
figure of the dogs. We also tested for the possible effect of age, sex, neuter status and breed
(mixed or purebred) of dogs on their vocal responses. Although there are sporadic reports that
the dogs’ breed may affect their response to separation (i.e. mixed breed dogs more often
show SRD symptoms – Takeuchi et al., 2001), and behavioral problems are in general more
common in intact males than in female dogs (Takeuchi et al., 2001), there are also other
indications that occurrence of SRD is independent of breed and dogs’ sex (i.e. Flannigan and
Dodman, 2001; Wright and Nesselrote, 1987). Therefore we hypothesized that the actual SRD
status of a dog will have a stronger effect on the vocal responses to separation than the dogs’
sex or purebred status.

Materials and methods

Subjects
The subjects (N=45) were adult family dogs (older than one year, mean age: 4 ± years). Table 1 shows the breed and sex of the subjects. Dog owners were contacted and invited to the test on the basis of an online questionnaire about the vocal habits of dogs (https://goo.gl/forms/RBWgsY008Ru9rIs63) – we chose dogs where the owner had indicated that the dog vocalizes when left alone in a strange place. No other restrictions regarding the breed or sex of the dogs were made. Further assignment of the subjects into experimental groups was done with the help of another questionnaire (Konok et al., 2011) – see the next paragraph. Owners of the dogs were informed about the goals and circumstances of the experimental procedure a priori. Owners were present during the tests and we informed them that they can interrupt the experiment and withdraw their dog from participation if by their consideration the test was too stressful for their dog. The Animal Welfare Committee of the Eötvös Loránd University reviewed and accepted the protocol of the experiment (Ref. no.: PEI/001/1056-4/2015).

**Experimental groups**

Based on the owners’ answers given to the questionnaire developed and validated by Konok et al. (2011), subjects were sorted into the SRD (N=25; 11 males and 14 females; 16 purebred and 9 mixed breed) or the non-SRD (N=20; 14 males and 6 females; 11 purebred and 9 mixed breed) group – see Table 1. Dogs were sorted to the SRD group if the owner answered ‘yes’ to the question “Does your dog have separation anxiety, or any behavioral problem in connection to being left alone?”

**Experimental procedure**
The setup of the testing environment is shown in Figure 1. Dogs were tested outdoors, at the campus site of the Eötvös Loránd University, Budapest. The experiments were conducted during daylight, on a flat, grassy area, with minimal to no disturbance from people passing by in the distance.

The owner tethered the dog to a tree with a 1.5 m long leash, then he/she left the dog (after saying a brief sentence such as: “Be good, I will be back soon” etc.) and walked away in a straight line, until he/she disappeared behind the corner of a building 45 m away. We gave a timer to the owners that they started when they left the dog. When 3 min had elapsed, the owner reappeared from behind the building and walked back straightly to the dog. When he/she arrived, they greeted and unleashed the dog and the test was over.

During the test, we recorded the behavior and vocalizations of the subjects with a Panasonic HDC-SD10 video camera and a Sennheiser ME-66 shotgun microphone with K-6 power module connected to a Zoom H4n handheld audio recorder (PCM WAV 44.1 kHz, 16-bit). The devices were placed on tripods and handled by two experimenters (MA, LR and occasionally FT) who stayed with the dog but avoided any kind of interaction with the subject, including eye contact as well. One of the experimenters indicated verbally on the recordings the moment when the owner disappeared and again when he/she reappeared from the building.

**Data analysis**

From the recorded audio and video material we extracted the latency of first occurrence and the frequency of barks and whines. Extraction and analysis were performed by a researcher who was not aware of the group assignment of the subjects. Data extraction was performed by Solomon Coder (beta 15.03.15, copyright by András Péter). An independent coder reanalyzed
12 randomly chose videos for reliability testing. The coded latencies (Pearson’s correlation, 
barks - phase 1: \( r=0.999; p<0.001 \); phase 2: \( r=1; p<0.001 \); whines – phase 1: \( r=0.892; p<0.001 \); phase 2: \( r=0.952; p<0.001 \)) and frequencies (Pearson’s correlation, barks - phase 1: \( r=0.86; p<0.001 \); phase 2: \( r=0.873; p<0.001 \); whines – phase 1: \( r=0.936; p<0.001 \); phase 2: \( r=0.918; p<0.001 \)) showed strong correlation between the two coders thus we accepted the 
coding to be reliable.

Both in case of barks and whines the occurrences and latencies were analyzed on a 0.2s time 
basis. We considered two series of barks or whines as separate units if at least 0.4 s pause 
separated them. Each test was divided to three phases: departure (owner walks away from the 
dog, until disappearance); absence (owner is behind the building); return (owner re-appears 
and walks back to dog). Barks and whines were coded separately within the three phases. We 
first measured an overall latency of vocalizations during the separation (departure and 
absence phase together). As the departure phase was qualitatively different from the real 
separation as the owner was still visible during this phase, we also calculated and analyzed the 
latencies for the departure separately. As in the return phase the majority of the subjects 
remained silent, we omitted it from further analysis. Frequencies were measured separately in 
the first two phases, however due to the high number of non-vocalizing dogs, models with 
Poisson or negative binomial distributions showed low level of fit, we therefore decided to 
use this data in a simplified way, marking only the presence or absence of whines/barks. For 
both types of vocalization the following fixed factors were used: SRD-status, sex, 
neutered/spayed vs. intact, and breed (purebred vs. mixed breed) and age. All analyses were 
performed in R (R Core Team, 2016).

The occurrence of barks and whines was analyzed with Generalized Linear Models 
with Binomial response with logit link (glm function of stats package). We performed model 
selection by step-wise combined elimination/addition of main effects (based on Akaike
Information Criterion, stepAIC function in MASS package). Latencies were analyzed with Cox-regression (coxph function of the survival package), followed again by the same model selection. In both cases results from the final models are reported (for details see Tables 2-3).

Results

Barks

We found a significant effect of age in case of the latency of barking: while the owner left and remained hidden from sight, older dogs started to bark later (cox-regression (LR test): $\chi^2(1)=4.321; p=0.037; \text{AIC}= 165.166$), while during the departure phase only (cox-regression (LR test): $\chi^2(2)=10.055; p=0.006; \text{AIC}=102.33$) we found the age ($\chi^2(1)= 8.13; p=0.004$) and breed ($\chi^2(1)= 4.14; p=0.042$) of the dog significantly affecting the latency of barks: younger dogs and purebreds bark sooner while the owner leaves.

In contrast, we found that only the age of the dogs had a significant negative effect on the occurrence of barking behavior (binom GLM (LR test): $\chi^2(2)= 8.181; p=0.016; \text{AIC}= 55.105$). Older dogs barked significantly less during the departure of the owner ($z=-2.109; p=0.035$) (Figure 2). While the owner was not visible for the dog, we found only a non-significant trend effect of age (binom GLM (LR test): $\chi^2(1)= 3.816; p=0.051; \text{AIC}= 62.367$).

Whines

In the case of whine latencies, during the entire separation we found a strong effect of SRD status (cox-regression (LR test): $\chi^2(1)= 4.699; p=0.03; \text{AIC}= 238.498$). Dogs with owner reported separation problems started to whine with two times higher probability than the non-SRD subjects ($\text{Exp(B)}[95\%\text{CI}]= 2.064 [1.061, 4.014]; p= 0.033$) (Figure 3). During the
departure phase the final model showed a non-significant trend (cox-regression: $\chi^2(1)= 2.761$; $p=0.097$; AIC= 187.847).

In the case of the occurrence of whines, our final model was also significant (binomial GLM (LR test): $\chi^2(3)= 8.657$; $p=0.034$; AIC= 59.01) and showed significant effect of SRD ($z= 2.091$; $p=0.037$), neuter status ($z= -1.974$; $p=0.048$) and breed ($z= 1.974$; $p=0.048$) in the departure phase. Significantly more dogs with SRD whine than non-SRD dogs (Figure 4), and mixed and intact dogs also whine more. Similarly, the occurrence of whines was also affected significantly by the SRD status of the dogs during the absent owner phase (binomial GLM (LR test): $\chi^2(2)= 7.027$; $p= 0.03$; AIC= 41.094). Significantly more dogs with owner reported separation problems whined during the absence of the owner than non-SRD dogs did ($z= 2.168$; $P= 0.03$).

Discussion

The experiments presented here revealed the complexity of vocal responses of dogs to an outdoor separation episode from their owners. Dogs with owner-reported symptoms of separation related disorder (SRD) vocalized differently than non-SRD dogs during the departure and the absence of their owners. Barks, as expected, were observed frequently in these phases of the experiment, however, this type of vocalization was not influenced by the SRD status, only by the age and breed of the dogs. Whines on the other hand, were not only the other frequently encountered type of vocalization during the departure and absence phases of the experiment, but the occurrence and onset of whining gave an excellent match with the SRD status of the subjects. SRD-dogs start to whine sooner than dogs with no SRD symptoms, and more SRD-dogs whine than non-SRD dogs in both phases (departure and absence) of the separation test. Whining was additionally affected by the neuter status.
neutered/spayed dogs start to whine sooner, but eventually more intact dogs whined), and of the breed (purebreds whine more).

The main goal of this study was to find out whether dogs with owner-reported SRD symptoms vocalize differently than non-SRD dogs in a short episode of outdoor isolation from the owner. Rather surprisingly, the results showed that excessive barking was not the most typical form of vocalization in SRD-dogs. Abundant (‘excessive’) barking is one of the main and most noticeable symptoms of separation-related behaviors based on both questionnaire and descriptive surveys (Juarbe-Diaz, 1997; Kobelt et al., 2003; Lund and Jørgensen, 1999; Parthasarathy and Crowell-Davis, 2006; Wells and Hepper, 2000). However, in our experiment dogs that were reportedly affected by SRD did not bark more frequently or sooner than the non-affected subjects. Instead, dogs’ age was the most influential factor on the onset and abundance of barks – younger dogs started to bark sooner and barked more than older dogs did. It should be noted that our sample did not include juvenile dogs and had only a moderate fraction of old subjects (over 10 years of age). Therefore the found pattern can be considered as characteristic for the adult companion dogs. Our results can be explained with ontogenetic reasons – younger dogs are considered more active and excitable than older ones (Siwak et al., 2002; Vas et al., 2007), meanwhile older dogs might became more experienced with shorter periods of isolation from their owner, therefore show less stress and start to bark later and less than the younger dogs.

It is possible that barking becomes ‘excessive’ only after a longer separation from the owner (see for example Lund and Jorgensen (1999)) – although in other experimental studies researchers found behavioral differences between SRD and non-SRD dogs also relatively quickly (e.g. Konok et al., 2011; Mendl et al., 2010). Earlier it was also found that dogs bark readily when their owner leaves them alone on the street or in a park, therefore this particular ‘alone’ context was used regularly for collecting bark samples in many acoustic studies (e.g.
There is a possibility that the barks of SRD-affected dogs show qualitative differences compared to the non-SRD dogs. In a recent study (Pongrácz et al., 2016) we found that barks that show acoustic structure typical to dogs in separation elicit the strongest nuisance effect in human listeners. If the barking of SRD dogs is more annoying for the nearby audience, this can cause an over-representation of this behavior in the reports concerning symptoms of separation anxiety.

Regarding the role of other factors in determining the vocalization pattern of dogs during separation from the owner, the purebred status of the subjects had a somewhat contradicting effect to the findings of Takeuchi et al. (2001). They reported that mixed breed dogs were showing symptoms of SRD more often than purebred dogs, in contrast to our study where purebred subjects although barked sooner, but more mixed breeds whined than purebred dogs when the owner left them behind. As in our sample barking behavior had no connection with the owner reported SRD status, this also suggests that whining can be a better indicator of separation problems. Our results are in accordance with the recent findings of Turcsán et al., (2017), who found in a large-scale questionnaire study that mixed breed dogs exhibited more behavioral problems and they were less calm than purebreds – even if the samples were controlled for possibly influential demographic factors (like the neuter status or age of the dog when it was adopted by the owner).

Based on the literature, a dog’s sex is not among those factors that commonly influence the onset of SRD symptoms (e.g. Wright and Nesselrote, 1987; Flannigan and Dodman, 2001). Although other types of behavioral problems, such as different forms of aggression, are reported more frequently in intact male dogs (e.g. Borchelt, 1983), separation anxiety is found to be rather typical for the spayed/neutered dog population (Flannigan and Dodman, 2001). Accordingly, in our study dogs’ sex did not have a decisive effect on the vocal behavior of the subjects, while the neuter status had an effect on the occurrence of
whining: more intact dogs whined during the departure of the owner. The connection between
neuter status and the onset of SRD symptoms is rather controversial in the literature – while
Flannigan and Dodman (2001) found no effect of neutering on SRD, a later study (McGreevy
and Masters, 2008) mentioned that intact dogs showed a higher probability for SRD
symptoms than neutered/spayed ones. Regarding the results of our study, neuter status
affected dogs’ vocal behavior only in the departure phase (when the owner was still visible).
Regardless of their sex, a higher proportion of intact dogs emitted whines than
neutered/spayed dogs during this phase.

The main finding in our study was that dogs with SRD symptoms whined
significantly sooner than non-SRD dogs and more SRD-dogs also whined during the first two
phases of the test than subjects with no reported symptoms of SRD. In other words, dogs that
whined sooner and in the first two phases of the test were the ones that the owners
characterized as being affected with separation anxiety in the questionnaire. Whine is a well-
known manifestation of frustration and negative inner state in dogs (e.g. Custance and Mayer,
2012; Palestrini et al., 2010), however, as it is a relatively low-intensity sound, whining is
seldom noticed in the case of SRD-dogs, meanwhile the more robust (e.g. elimination,
destructive behavior) or longer distance (bark, howl) behaviors evoke stronger responses.
Although whining was found as being included to the vocal output of SRD-dogs in some
earlier studies (e.g. Lund and Jorgensen, 1999), the possible specificity of this type of
vocalization to separation-related problems has not been directly addressed so far. The lack of
attention-eliciting volume of dog whines warrants for the possibility of inaccurately diagnosed
separation-related symptoms in common veterinary practice, as dog owners concentrate
understandably on the more obvious symptoms. However, in case of need for quick
behavioral assessment, the early onset and dominant presence of whines may represent a
useful tool in determining the likelihood of a dog having problems with separation.
From the aspect of communicative relevance, barking can be considered as the behavioral stress response of dogs protesting against being isolated from their owner, especially when left alone at a strange place. Several studies showed that left alone dogs often bark and their barks are easy to recognize contextually (Pongrácz et al., 2005). Lund and Jorgensen (1999) found that left alone dogs with SRD symptoms react easily with barking to external stimuli, and importantly, they keep on barking longer time, with a more and more higher pitched bark that can be attributed to frustration. Wild relatives of dogs do not bark in isolation (Cohen and Fox, 1976; Tembrock, 1976), and according to a theory, parallel with domestication different acoustic variants of dog barking occupied several new communicative ‘niches’ related to dog-human communication (Pongrácz et al., 2010). As barks emitted in isolation are considered by human listeners mostly as ‘fearful’ and ‘desperate’ (Pongrácz et al., 2011; Molnár et al., 2010), we can assume that these vocalizations may in turn elicit helping/caregiving behavior from humans. Therefore when a dog barks when it is left alone at an unknown place it can be considered as an adaptive communicative behavior. Contrary to this, whining is a form of vocalization that occurs in similar circumstances in dogs and their close relatives (Tembrock, 1976), and can be considered as a footprint of negative inner states – distress is signaled not only in dogs, but even in human infants (Green et al., 2011; Johnson et al., 1975). The fact that in our study whining was characteristic to SRD dogs during the separation episode shows that these dogs may emit this kind of subtle vocalization rather as a symptom of their negative arousal (distress) than of any kind of communicative relevance. The function of such subtle, short-range vocalizations may be contact/comfort seeking in young puppies (Panskepp et al., 1978), therefore in adult dogs this stress-related behavior may be re-directed towards the owner.

In conclusion, we emphasize that the quickly emerging whining cannot be underestimated as a canine SRD-symptom, and additionally it is an easy to elicit and detect
behavioral response amid simple circumstances. Compared to dog barks that may convey a wide spectrum of inner states (from aggression to fear, frustration and joy), the emotional background of whines is simpler and more focused on negative states. Our results show that the abundance and early onset of whines correlates well with owner-reported SRD symptoms in family dogs, contrary to barking that appears both in SRD and non-SRD dogs during short outdoor separation episodes.

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Table 1 – Basic information of the dogs participating in our study. All dogs were family pets.
SRD-status was established on the basis of a questionnaire, completed by the dog owners.

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<th>sex</th>
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Table 2 – The details of the final cox-regression models. Significant effects highlighted with bold.

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<th>Age</th>
<th>Gender</th>
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<th>Separation</th>
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</table>

### Overall separation

| Barks | coef    | exp(coef) | se(coef) | z     | Pr(>|z|) |
|-------|---------|-----------|----------|-------|---------|
| age   | -0.013937 | 0.98616   | 0.007239 | -1.925 | 0.0542  |
| SRD   | 0.7246   | 2.0639    | 0.3394   | 2.135  | 0.0328  |

### Departure phase

| Barks | coef    | exp(coef) | se(coef) | z     | Pr(>|z|) |
|-------|---------|-----------|----------|-------|---------|
| breed | -1.21598 | 0.29642   | 0.63912  | -1.903 | 0.0571  |
| age   | -0.03390 | 0.96667   | 0.01423  | -2.382 | 0.0172  |
| Whines |         |           |          |       |         |
| SRD   | 0.6597   | 1.9343    | 0.4085   | 1.615  | 0.106   |

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Table 3 – The details of the final binomial models. Significant effects highlighted with bold.

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<td>Std. Error</td>
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<table>
<thead>
<tr>
<th></th>
<th>Whines</th>
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Figure captions

Figure 1 – On the left: schematic arrangement of the outdoor testing area. On the right: actual photograph of a subject (tethered to a tree) with the video camera and the shotgun microphone in the foreground. Photo credit: Leőb Ádám.

Figure 2 – The occurrence of barks during the departure phase. Older dogs bark less likely while the owner leaves them. The dots represent the individuals, the blue line is the binomial fit with the confidence intervals.

Figure 3 – The occurrence of whines as a function of their latencies during the entire separation event (owner leaves, then stays out of sight of the dog). SRD dogs start to whine with significantly higher chance, and sooner than non-SRD dogs. Red line: non-SRD dogs; Blue line: SRD dogs. The graph shows how the cumulative ratio of whining dogs changes over time in the tested sample.

Figure 4 - The occurrence of whines during the departure of the owner. Significantly more SRD dogs whine than non-SRD dogs already when the owner leaves but is still visible.