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Title: 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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Keywords: dog, separation related disorder, vocalization, whine, bark

Corresponding Author: Dr. Péter Pongrácz, PhD

Corresponding Author's Institution: Eötvös Loránd University

First Author: Péter Pongrácz, PhD

Order of Authors: Péter Pongrácz, PhD; Rita Lenkei, BSc; András Marx, BSc; Tamás Faragó, PhD

Abstract: Separation-related disorder (SRD) is one of 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 SRD is usually characterized by a set of typical behaviors, the quick assessment of the condition is difficult because affected dogs produce symptoms typically at home. 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 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. Dogs' breed, sex and neuter status may modify the reaction to separation, we found that more intact dogs emitted whines during the separation, however, spayed/neutered dogs started to whine sooner. Purebred female dogs and mixed breed males start to whine sooner, and female dogs with SRD symptoms and non-affected males bark more often. This is the first study that targeted directly the vocal response of family dogs to separation from the owner, and we propose this simple, short experiment as a reliable method to detect easy-to-measure vocalization - whines - from canine candidates of SRD symptoms. Although the effect of other factors, such as sex, neuter status and breed cannot be ignored, the 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.

Cover letter for the manuscript entitled

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

written by: Pongrácz, P., Lenkei, R., Marx, A. and Faragó, T.

Corresponding author:

Péter Pongrácz, PhD (email: peter.pongracz@ttk.elte.hu)

Department of Ethology, Biological Institute

Eötvös Loránd University, Budapest

Pázmány Péter s. 1/c

1117 Hungary

Dear Editors,

We confirm that this research was not published before, and the manuscript is not submitted currently to other journals. The content of the manuscript is approved by all the authors.

Ethics: Subjects of the experiments were privately owned companion dogs. All procedures involving dogs and dog owners were approved by the Ethical Committee of Eötvös Loránd University (Permission # PEI/001/1056-4/2015), and conducted in accordance with the recommendations of the Hungarian State Health and Medical Service. The owners undertook the test on a voluntary basis and they were informed that they would participate in a scientific study. Dog owners were present at the tests and they were told that they can terminate the experiment at any time when they think their dog is under unwanted stress.

We hope that our study will meet with the high standards of Applied Animal Behaviour Science and you will find it worthy for the interest of the broader audience of your readers.

Sincerely yours (as corresponding author):

Péter Pongrácz, PhD

HIGHLIGHTS

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

Written by Pongrácz et al.

Separation-related disorder (SRD) is a common problem in family dogs.

Diagnosis is often difficult because of the idiopathic or context-specific symptoms.

Vocalizations of SRD and non-SRD dogs were compared in a short separation episode.

Instead of barking, whines were the most characteristic vocalizations of dogs with SRD.

Early onset and abundance of whining may serve as a reliable tool for diagnosing SRD.

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

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4 Pongrácz, Péter¹, Lenkei, Rita¹, Marx, András¹ and Faragó, Tamás^{1,2}

5

6 ¹ Department of Ethology, Eötvös Loránd University, Budapest, Hungary

7 ² MTA-ELTE Comparative Ethological Research Group, Budapest, Hungary

8

9 Corresponding author:

10 Péter Pongrácz

11 Department of Ethology, Eötvös Loránd University

12 Pázmány Péter s. 1/c

13 1117 Budapest

14 Hungary

15

16 Email: peter.pongracz@ttk.elte.hu

17

18 Phone: +36 30 262 1284

Abstract

Separation-related disorder (SRD) is one of 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 SRD is usually characterized by a set of typical behaviors, the quick assessment of the condition is difficult because affected dogs produce symptoms typically at home. 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 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. Dogs' breed, sex and neuter status may modify the reaction to separation, we found that more intact dogs emitted whines during the separation, however, spayed/neutered dogs started to whine sooner. Purebred female dogs and mixed breed males start to whine sooner, and female dogs with SRD symptoms and non-affected males bark more often. This is the first study that targeted directly the vocal response of family dogs to separation from the owner, and we propose this simple, short experiment as a reliable method to detect easy-to-measure vocalization – whines – from canine candidates of SRD symptoms. Although the effect of other factors, such as sex, neuter status and breed cannot be ignored, the 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. 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. When owners have been surveyed about their opinion, the most important features of an ‘ideal companion dog’ were described as low levels of aggression, disobedience, nervousness, excitability and (separation) anxiety/destructiveness (Bennett and Rohlf, 2007). These results were followed by the development of a program advocating the breeding of so-called ‘amicable dogs’ for a better fit with the life style of modern urban dog owners (King et al., 2011). 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 et al., 1998), and even shelter dogs quickly show primordial attachment-like tendencies towards a stranger after a short exposure to a particular person (Gácsi et al., 2001). Therefore the diagnosis of SRD can be difficult when it comes to distinguishing 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 therefore base their decision mostly 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; Podberscek et al., 1999; Takeuchi et al., 2000). Obviously, a questionnaire will contain subjective reports about the behavior of dogs, and the validation of such sources of data requires empirical testing. 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, although 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). Experiments like these in turn may include the difficulty of distinguishing dogs that show normal levels of anxiety from the ones that produce problematic behaviors because the tests are usually not long enough to elicit typical SRD-symptoms. Despite these shortcomings, 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). However vocalizations 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). The rather easy detectability of dog vocalizations, even by untrained individuals, is well demonstrated by the fact that excessive vocalization is among the leading causes of relinquishment of dogs to shelters (Salman et al., 2000) as well as legal steps against auditory nuisance by neighbors (Raglus et al., 2015).

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. It is already known it is 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, regardless of their previous experience with dogs (Molnár et al., 2010; Pongrácz et al., 2005; 2011). 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. Similarly, it is questionable whether barks are the only characteristic type of vocalization that dominantly occurs when a dog is separated from its owner. In an earlier comparative work, Cohen and Fox (1976) also 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 other more elusive vocalizations may also signal higher levels of distress in a dog affected by SRD. One likely candidate is the whine, characterized by some authors as a typical form of vocalization in dogs that experience frustration and other negative inner states (Custance and Mayer, 2012; Palestini et al., 2010).

In this paper we present the results of an experiment in which we compared the vocal responses of dogs with or without owner-reported symptoms of SRD 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). Our question was whether dogs with (owner-reported) SRD vocalize differently than dogs that do not show SRD symptoms at home. Based on the literature (e.g. Lund and Jørgensen, 1999), we hypothesized that dogs with SRD will bark more abundantly, and may also whine more than the non-affected dogs. We also tested for the possible effect of sex 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 Nesselrode, 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: $4 \pm$ 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. 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 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?"

151

152 **Experimental procedure**

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

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

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

169

170 **Data analysis**

171 From the recorded audio and video material we extracted the latency of first occurrence and the
172 frequency of barks and whines. Extraction and analysis were performed by a researcher who was not
173 aware of the group assignment of the subjects. Data extraction was performed by Solomon Coder (beta
174 15.03.15, copyright by András Péter). An independent coder reanalyzed 12 randomly chosen videos
175 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). As we had no initial hypothesis about the interactions of these factors, we included all two-way interactions in the initial models (except breed*neuter status due to imbalanced distribution of individuals between the 4 subcategories). 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 interactions and main effects (based on Akaike Information Criterion, stepAIC function in MASS package), and used Tukey post hoc analysis for pairwise comparisons (lsmeans and pair functions from the lsmeans 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 did not find any significant effect in case of the latency of barking while the owner left and hid from sight of the dog (cox-regression: $\chi^2(3)=2.338$; $p=0.505$; AIC= 171.149), nor during the departure phase only (cox-regression: $\chi^2(5)=9.84$; $p=0.08$; AIC=108.531). In contrast, we found that the gender and SRD status of the dogs had a significant interaction effect on their barking behavior (binom GLM: $\chi^2(3)= 7.807$; $p=0.05$; AIC= 57.479). Significantly more anxious female dogs barked than non-anxious, while in males we see an opposite effect ($z=2.12$; $p=0.034$) (Figure 2). While the owner was not visible for the dog, we found that neither of the factors were significant and the final, best fitting model was the nullmodel (AIC= 64.183).

Whines

In the case of whine latencies, during the entire separation we found a strong effect of SRD status (cox-regression: $\chi^2(1)= 4.699$; $p=0.03$; AIC= 238.498). Dogs with owner reported anxiety started to whine with two times higher probability than the non-anxious subjects (Exp(B)[95%CI]= 2.064 [1.061, 4.014]; $p= 0.03$) (Figure 3). During the departure phase the final model was also significant (cox-regression: $\chi^2(6)= 12.276$; $p=0.05$; AIC= 188.331) with the main effects of SRD (Exp(B)[95%CI]= 2.916 [1.105, 7.697]; $p= 0.03$) and neuter/spaying status (Exp(B)[95%CI]= 4.193 [1.126, 15.609]; $p= 0.033$). Here we found also a significant interaction between breed and sex of the dog (Exp(B)[95%CI]= 8.92 [1.603, 49.658]; $p= 0.012$). Dogs with SRD symptoms start whining sooner with 3 times higher chance than the non-affected dogs. Neutered dogs also start to whine

sooner with 4 times higher chance (Figure 4), while purebred females and mixed breed males started to whine the earliest (Figure 5).

In the case of the occurrence of whines, our final model was also significant (binomial GLM: $\chi^2(6) = 16.936$; $p = 0.009$; $AIC = 56.731$) and showed significant effect of SRD status in the departure phase ($z = 2.176$; $p = 0.03$). Significantly more dogs with SRD whine than non-SRD dogs. Similarly, the occurrence of whines was also affected significantly by the SRD status of the dogs during the absent owner phase (binomial GLM: $\chi^2(5) = 13.161$; $p = 0.022$; $AIC = 40.96$). Significantly more dogs with owner reported separation anxiety whined during the absence of the owner than non-SRD dogs did ($z = 2.211$; $P = 0.027$).

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 only weakly influenced by the SRD status in interaction with the sex of the subjects. According to this, being an SRD-dog enhanced the barking behavior only in females. 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 an interaction of breed and sex (purebred females and mixed breed males start to whine sooner).

The main goal of this study was to find out whether dogs with 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, with the exception of an interaction with the sex of the subject, where female SRD-dogs and male non-SRD dogs were the most likely to bark. It is possible that barking becomes 'excessive' only after a longer separation from the owner – 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. Pongrácz et al., 2005; 2014; Molnár et al., 2010). Another possibility is that the barks of anxiety-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 similar 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, and in our study mixed breed male subjects whined sooner than purebred males. As whining was found rather typical for dogs with owner reported SRD, our results indicate that mixed breed male dogs, especially when showing SRD symptoms, more likely whine than bark at the beginning of a separation situation (meanwhile barks were more typical for the non-SRD male dogs). Purebred female dogs can be characterized with a short latency of whining.

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). In our study dogs' sex alone did not have a decisive effect on the vocal behavior of the subjects. Purebred female dogs started to whine sooner, and if we consider that female-SRD dogs were more likely to bark than non-SRD females, we could conclude that female dogs may show a more vocal response to separation from the owner if other factors (like SRD, breed-status) are also present.

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, neutered/spayed dogs start to whine sooner when the owner is leaving. Interestingly, at the same time a higher proportion of intact dogs emitted whines than neutered/spayed dogs during this phase. Therefore we did not find a clear indication that intact or spayed/neutered dogs would show more intense SRD-related vocalizations, because although more intact dogs whined during the first phase of the test, this stress-related vocalization appeared sooner in the neutered/spayed subjects.

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.

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 bark easily and their barks are easy to recognize contextually (Pongrácz et al., 2005). More importantly, 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 propose that whining could be included as a canine SRD-symptom in the toolkit of behavioral professionals and dog owners as well, because 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, as barking appears both in SRD and non-SRD dogs during short outdoor separation episodes – we thereby suggest whines as an appropriate variable in the diagnosis of separation-related disorder.

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469

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

name	breed	age (month)	breed status	sex	neuter status	SRD status
Berci	mixed	153	mixed	male	neutered/spayed	non-anxious
Bogyó	Pumi	33	purebred	male	intact	non-anxious
Barka	English Cocker Spaniel	39	purebred	male	neutered/spayed	anxious
Plútó	mixed	26	mixed	male	neutered/spayed	anxious
Foltos	Beagle	76	purebred	female	neutered/spayed	non-anxious
Bolygó	mixed	23	mixed	female	intact	anxious
Miro	Beagle	47	purebred	male	intact	non-anxious
Appia	Transylvanian Hound	52	purebred	female	neutered/spayed	anxious
Brownie	Basset Hound	32	purebred	male	intact	anxious
Csikó	Whippet	54	purebred	male	neutered/spayed	anxious
Tappancs	Tibetan Terrier	80	purebred	female	intact	anxious
Helyes	Greyhound	73	purebred	male	neutered/spayed	anxious
Joda	mixed	129	mixed	male	neutered/spayed	non-anxious
Pimpa	mixed	51	mixed	female	neutered/spayed	non-anxious
Remi	Mudi	64	purebred	female	neutered/spayed	anxious
Csicsi	Mudi	39	purebred	female	intact	anxious
Borisz	Borzoi	39	purebred	male	intact	anxious
Mása	mixed	40	mixed	female	neutered/spayed	non-anxious
Nelson	Groenendael	131	purebred	male	intact	anxious
Bob	Border Collie	116	purebred	male	intact	non-anxious
Mazsola	mixed	69	mixed	female	neutered/spayed	non-anxious
Mila	Border Collie	54	purebred	female	intact	non-anxious
Guszt	Bichon Havanese	68	purebred	male	intact	non-anxious
Panna	Sheltie	51	purebred	female	intact	anxious
Athos	Bordeaux dog	66	purebred	male	intact	non-anxious
Brúnó	mixed	10	mixed	male	intact	non-anxious
Agima	Groenendael	82	purebred	female	neutered/spayed	anxious
Zsömi	mixed	29	mixed	male	neutered/spayed	anxious
Fickó	Hungarian Vizsla (wirehaired)	47	purebred	male	neutered/spayed	non-anxious
Dijon	Hungarian Vizsla (wirehaired)	47	purebred	male	intact	non-anxious
Monty	mixed	73	mixed	male	neutered/spayed	anxious
Fredó	Yorkshire Terrier	60	purebred	male	intact	non-anxious
Tessa	mixed	85	mixed	female	neutered/spayed	anxious
Panka	Dachshund	22	purebred	female	neutered/spayed	anxious
Szusi	mixed	12	mixed	male	intact	non-anxious

Szláva	Russian Black Terrier	22	purebred	female	intact	anxious
Lotte	Boxer	10	purebred	female	intact	non-anxious
Kefír	mixed	15	mixed	female	intact	anxious
Velúr	mixed	20	mixed	male	neutered/spayed	non-anxious
Ashley	Yorkshire Terrier	30	purebred	female	neutered/spayed	anxious
Ori	mixed	76	mixed	male	neutered/spayed	anxious
Zara	Hungarian Vizsla	21	purebred	female	neutered/spayed	anxious
Chandler	mixed	51	mixed	male	neutered/spayed	anxious
Koda	mixed	113	mixed	male	neutered/spayed	non-anxious
Mignon	mixed	34	mixed	female	neutered/spayed	anxious

Table 2 – The details of the final cox-regression models. Significant effects highlighted with bold.

<i>Overall separation</i>					
<i>Barks</i>	<i>coef</i>	<i>exp(coef)</i>	<i>se(coef)</i>	<i>z</i>	<i>Pr(> z)</i>
neut1	-0.5929	0.5527	0.6280	-0.944	0.345
SRA1	-0.5382	0.5838	0.6272	-0.858	0.391
neut1:SRA1	1.2599	3.5251	0.8704	1.447	0.148
<i>Whines</i>					
SRA1	0.7246	2.0639	0.3394	2.135	0.0328
<i>Departure phase</i>					
<i>Barks</i>					
sex2	-1.3945	0.2480	1.2367	-1.128	0.259
neut1	-1.4791	0.2278	1.1435	-1.294	0.196
SRA1	-0.9325	0.3936	1.1435	-0.816	0.415
sex2:neut1	1.8158	6.1462	1.3338	1.361	0.173
sex2:SRA1	2.5078	12.2780	1.5732	1.594	0.111
<i>Whines</i>					
sex2	0.2382	1.2690	0.6663	0.358	0.72066
neut1	-1.4335	0.2385	0.6706	-2.138	0.03255
mixed1	1.7796	5.9277	0.6452	2.758	0.00581
SRA1	1.0703	2.9163	0.4952	2.161	0.03066
sex2:neut1	1.3339	3.7957	0.8861	1.505	0.13225
sex2:mixed1	-2.1885	0.1121	0.8759	-2.499	0.01247

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

<i>Departure phase</i>				477
<i>Barks</i>	<i>Estimate</i>	<i>Std. Error</i>	<i>z value</i>	<i>Pr(> z)</i>
(Intercept)	-0.5878	0.5578	-1.054	0.292
sex2	-1.0217	1.2293	-0.831	0.406
SRA1	-1.7148	1.1877	-1.444	0.149
sex2:SRA1	3.6119	1.7036	2.120	0.034
<i>Whines</i>				
(Intercept)	-0.04084	0.70273	-0.058	0.9537
sex2	-0.08821	1.21187	-0.073	0.9420
neut1	-19.56476	2390.08797	-0.008	0.9935
mixed1	20.07043	2390.08799	0.008	0.9933
SRA1	1.83271	0.84243	2.176	0.0296
sex2:neut1	18.85462	2390.08822	0.008	0.9937
sex2:mixed1	-20.11441	2390.08822	-0.008	0.9933
<i>Absence phase</i>				
<i>Barks</i>				
(Intercept)	0.1335	0.2988	0.447	0.655
<i>Whines</i>				
(Intercept)	1.4283	0.6469	2.208	0.0272
sex2	-1.6243	0.9433	-1.722	0.0851
SRA1	2.1702	1.0008	2.168	0.0301

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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: Leéb Ádám.

Figure 2 – The occurrence of barks during the departure phase. Barking has a higher prevalence among female dogs that are reported to have separation related problems, while more male dogs with no reported SRD bark in this phase.

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). Anxious (SRD) dogs start to whine with significantly higher chance sooner than non-SRD dogs. Solid line: non-SRD dogs; dashed 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 as a function of their latencies during the departure of the owner, comparing neutered/spayed and intact dogs (neuter/spaying status). Neutered dogs start to whine with significantly higher chance sooner than intact dogs in the first 15 seconds, but after this more neutered/spayed dogs start to whine. Solid line: intact dogs; dashed line: neutered/spayed dogs. The graph shows how the cumulative ratio of whining dogs changes over time in the tested sample.

Figure 5 – The interaction between the breed (mixed or purebred) and the sex of the dogs in the departure phase. Solid line: male dogs; dashed line: female dogs. The graph shows how the cumulative ratio of whining dogs changes over time in the tested sample.

Figure 1

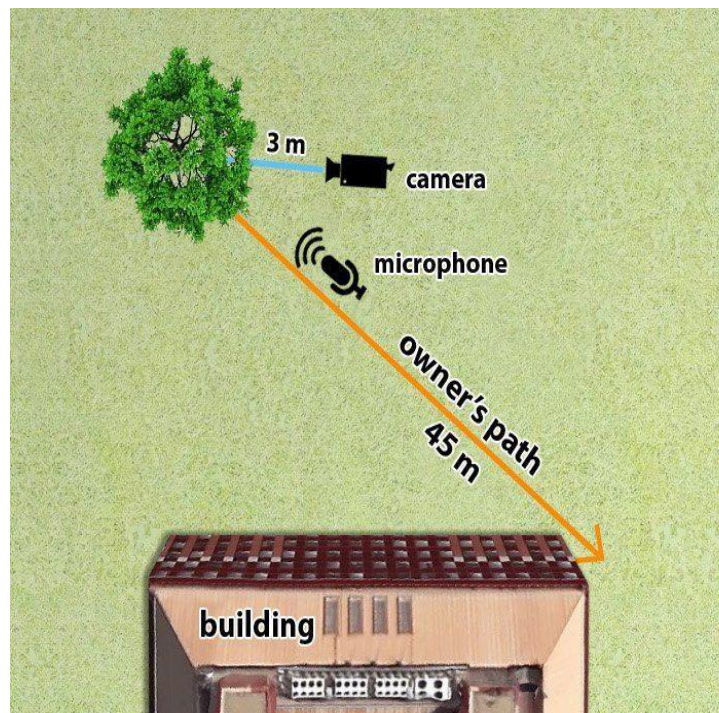


Figure 2

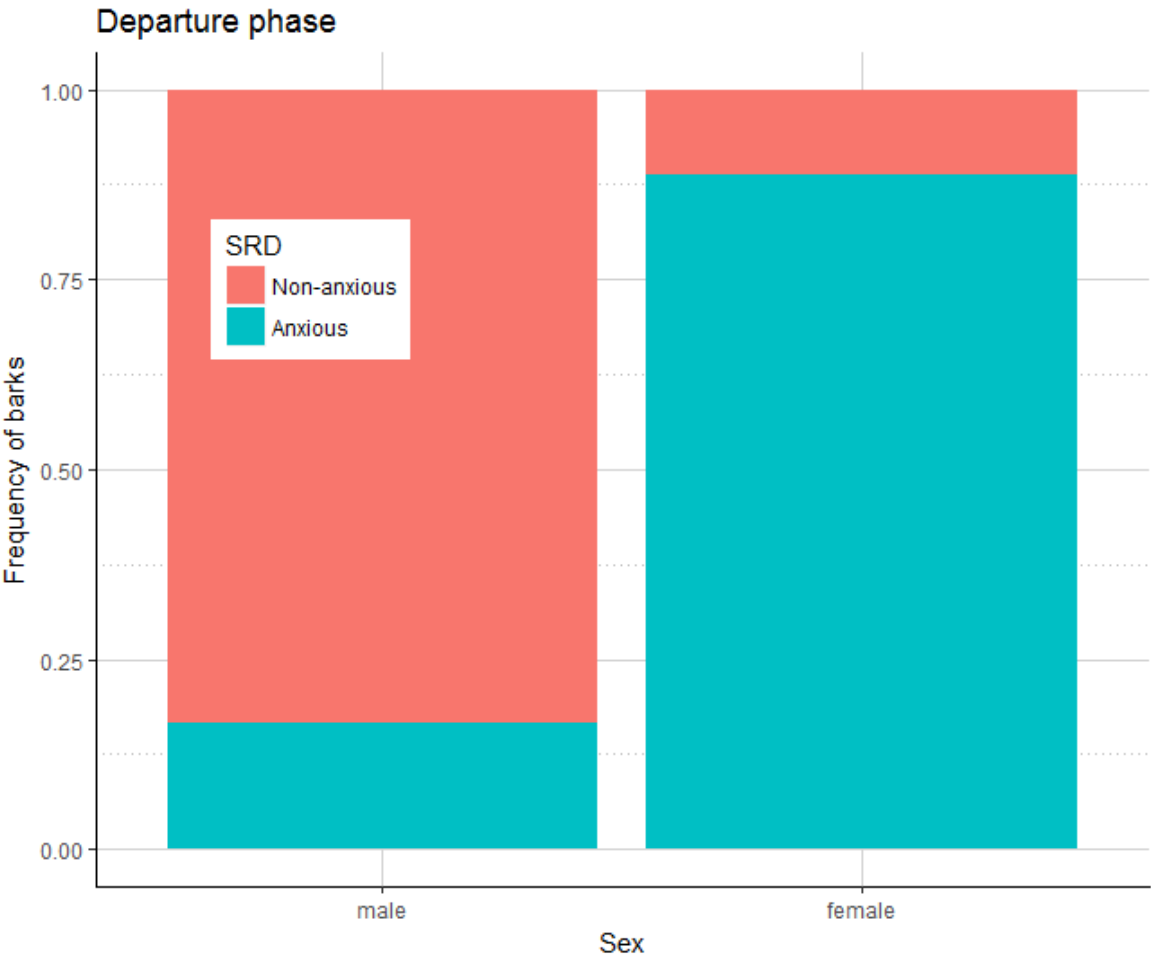


Figure 3

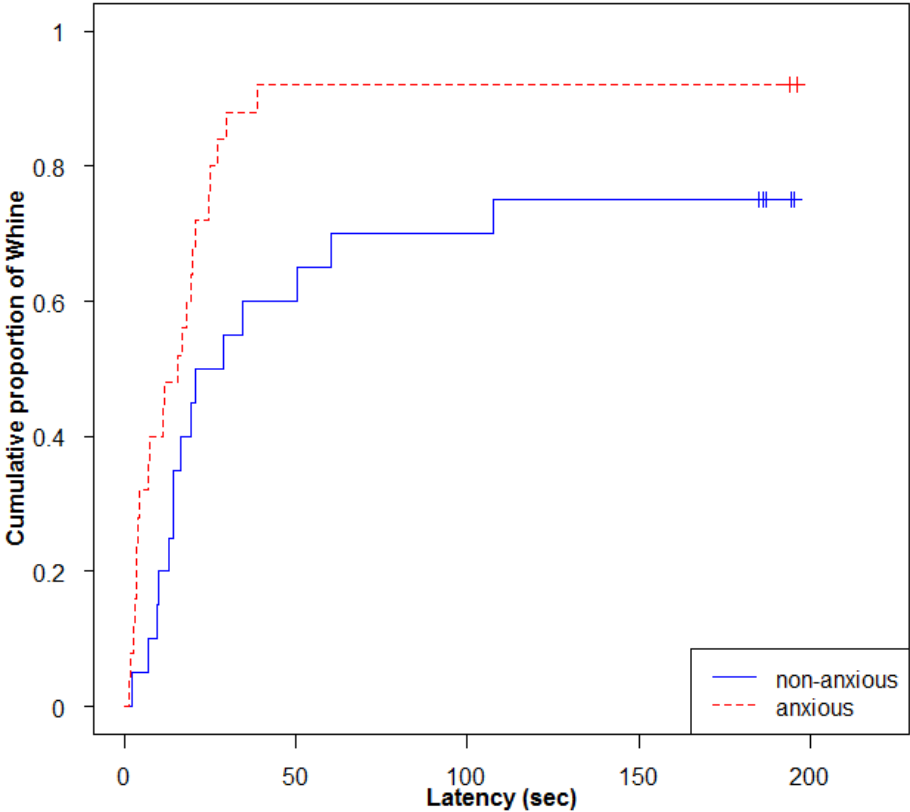


Figure 4

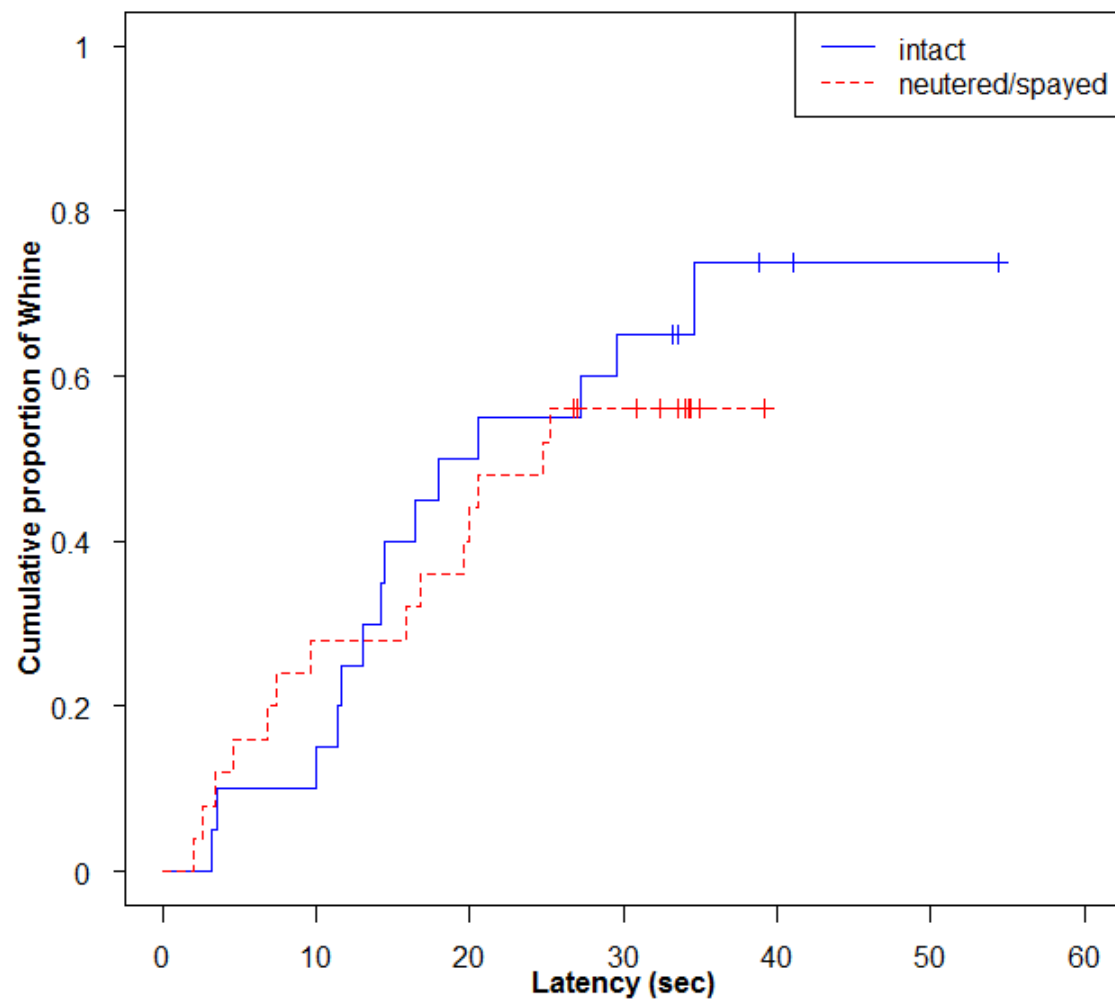
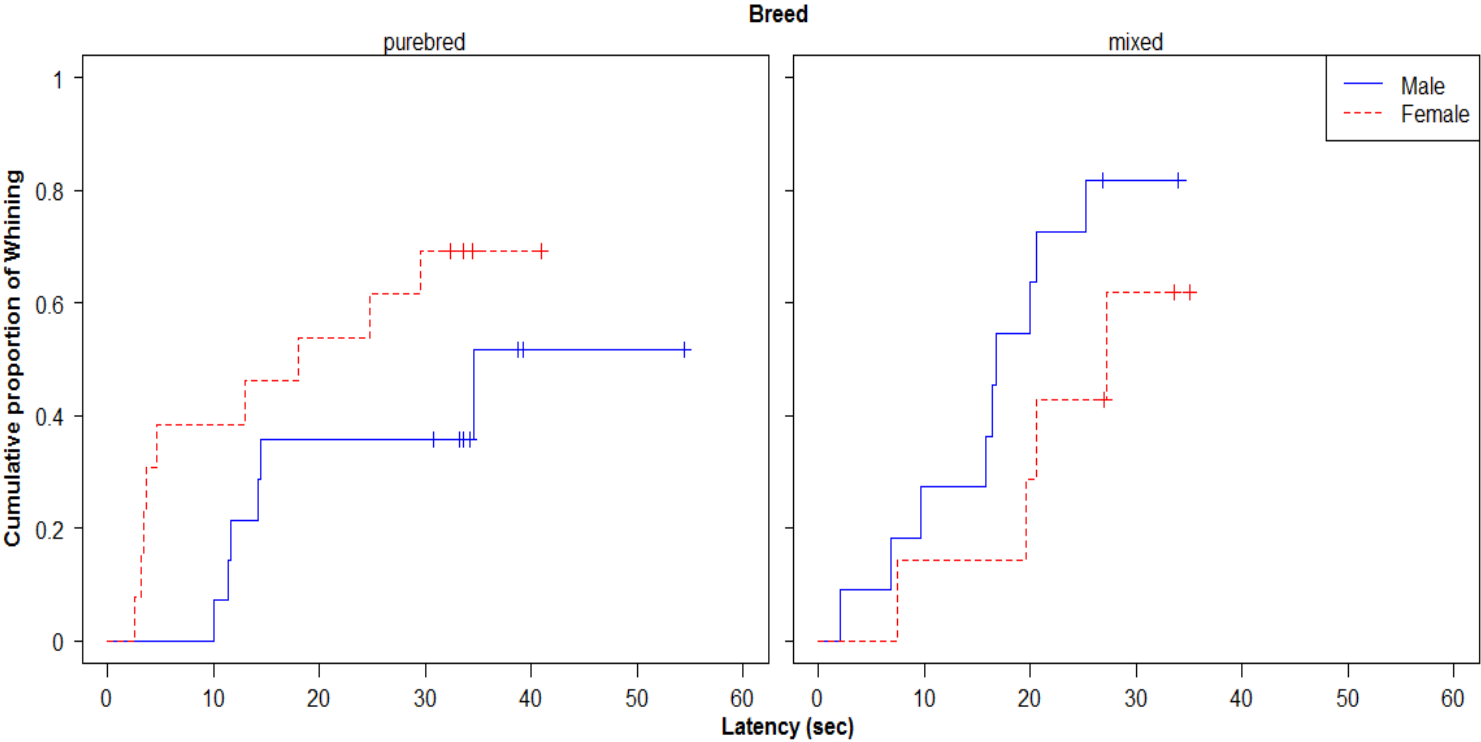


Figure 5



AUTHOR DECLARATION TEMPLATE

We wish to confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome.

We confirm that the manuscript has been read and approved by all named authors and that there are no other persons who satisfied the criteria for authorship but are not listed. We further confirm that the order of authors listed in the manuscript has been approved by all of us.

We confirm that we have given due consideration to the protection of intellectual property associated with this work and that there are no impediments to publication, including the timing of publication, with respect to intellectual property. In so doing we confirm that we have followed the regulations of our institutions concerning intellectual property.

We further confirm that any aspect of the work covered in this manuscript that has involved either experimental animals or human patients has been conducted with the ethical approval of all relevant bodies and that such approvals are acknowledged within the manuscript.

We understand that the Corresponding Author is the sole contact for the Editorial process (including Editorial Manager and direct communications with the office). He/she is responsible for communicating with the other authors about progress, submissions of revisions and final approval of proofs. We confirm that we have provided a current, correct email address (peter.eden@penngrove.ac.uk) which is accessible by the Corresponding Author and which has been configured to accept email from **Applied Animal Behaviour Science**.

Signed by all authors as follows:

Péter Pongrácz



(date: 2016 DEC 15)

Rita Lenkei



(date: 2016 12 15)

András Marx



(date: 2016 12 15)

Luisa Farnós



(date: 2016 12 15)