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Research Paper

Prevalence, comorbidity, and behavioral variation in canine anxiety

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ABSTRACT

Fear is an emotion needed to survive, but when prolonged and frequent, causes suffering in both humans and animals. The most common forms of canine anxiety are as follows: general fearfulness, noise sensitivity, and separation anxiety are responsible for a large proportion of behavioral problems. Information on the prevalence and comorbidity of different anxieties is necessary for breeding, veterinary behavior, and also for behavioral genetic research, where accurate information of the phenotype is essential. We used a validated owner-completed questionnaire to collect information on dogs' fearfulness (toward unfamiliar people, dogs, in new situations), noise sensitivity, separation anxiety, as well as aggressive behavior. We received 3284 answers from 192 breeds. The prevalence estimate for noise sensitivity was 39.2 %, 26.2% for general fearfulness, and 17.2% for separation anxiety. The owner reported the median onset age for noise sensitivity to be 2 years and varied between 8 weeks and 10 years ($N = 407$). High comorbidity was observed between different anxieties: fearful dogs had a significantly higher noise sensitivity ($P < 0.001$) and separation anxiety ($P < 0.001$) compared with nonfearful dogs. Fearful dogs were also more aggressive compared with nonfearful dogs ($P < 0.001$). Prevalence estimates of fearfulness, noise sensitivity, and separation anxiety are in agreement with earlier studies. Previous studies have suggested early onset of noise sensitivity during the first year of life; however, we found a later onset with large variation in the onset age. High comorbidity between anxieties suggests a genetic overlap. Fearful personality may predispose to specific anxieties such as noise sensitivity or separation anxiety.

Introduction

Fear and anxiety are among the most fundamental emotions required to survive or cope in potentially dangerous or harmful situations (Bateson, 2011; Hohoff, 2009). These evolutionary important and highly conserved emotional states are crucial for the fitness and survival in animals in nature. A fundamental emotion, such as fear, may, however, turn into pathological traits when prolonged and generalized. Anxiety disorders are among the most common disorders in humans with a prevalence of 28% (Kessler et al., 2005) and are part of behavioral problems observed in domestic dogs (Blackwell et al., 2013; Overall et al. 2001).

Research on fear and anxiety in animals is active in several research fields such as in evolutionary ecology, personality research, veterinary behavior, and neurobiology. However, although the studied phenomenon is highly overlapping, the used terminology varies between research fields. Fear and anxiety are both emotions with negative valence; however, fear is suggested to be brief in duration, stimulated by specific stimuli, resulting in active defensive (fight or flight) stimuli, whereas anxiety is prolonged, focused on the future, and does not necessarily have a specific object of threat (Dias et al., 2013; Epstein, 1972; Öhman, 2008). Fear is an emotional state, whereas fearfulness may also be defined as a personality trait, and has been characterized in various ways on the shyness-boldness continuum in animal personality research. A review study on canine personality research found trait fearfulness to be the most frequently emerging personality dimension among 50 publications (Jones and Gosling, 2005).

Fear stimulus activates the sympathetic nervous system with increased adrenaline and noradrenaline secretion and a rise in

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blood pressure and heart rate. The hypothalamic-pituitary-adrenal-cortical system is also activated, which may increase blood cortisol levels. The change in the physiological state alters behavior. Fear is expressed in animals in various ways: avoidance, flight, freezing, and aggression, which (in some cases) are all expressions of fear (King et al., 2003; Palestrini, 2009; Scott and Fuller, 1997). In dogs, behaviors such as panting, salivation, trembling, restless pacing, vocalization, and, in extreme cases, urination and defecation may also be signs of fear (Palestrini, 2009).

In dogs, fearfulness can be categorized into social and nonsocial fearfulness, based on the object and situation (Svartberg, 2007). The social category includes the fear of unfamiliar people and dogs, whereas the nonsocial fear category includes the fear of different objects/situations such as the fear of new situations, loud noises, heights, or shiny or slippery floors. All these specific fears are reported in dogs (Levine, 2009; Lindsay, 2001; Palestrini, 2009); however, their occurrence, comorbidity, age of onset, and affecting environmental factors are not thoroughly studied. An individual's fear and anxiety are considered to be affected both by predisposing genetic factors and environmental factors such as early-life experiences. Dogs can be afraid of unfamiliar people as a consequence of poor socialization or due to aversive experiences (Tiira and Lohi, 2015), but also genetics may have a major role (Murphree et al., 1974).

The fear of loud noises is often referred to as noise phobia in the literature because of extreme panic reactions in some cases. However, we prefer to use the proposed term "noise sensitivity" (Sherman and Mills, 2008) because often fearful behavioral reactions toward loud noises, such as thunderstorms, fireworks, or gunshots, do not fulfill the criteria of phobia. Separation anxiety refers to a behavior which includes signs of anxiety, fear, or phobia expressed by a dog when separated from the owner or from an important person(s) (Sherman and Mills, 2008). Separation anxiety is an intimate part of the human-dog relationship and is also likely dependent on the nature of attachment between the human and the dog (Schwartz, 2003).

The aim of this study was to assess the frequency and comorbidity of fearfulness, noise sensitivity, and separation anxiety in the Finnish family dog population. In addition to anxiety, we also collected information on the frequency and type of aggressive behavior in dogs. We did not divide owner-reported behavior in "normal" or "pathological" categories in this article but rather treated behaviors as continuous traits. This was done for 2 main reasons: first, a proper separation between "normal" or "pathological" behavior would require a clinical population-study setup, which we did not have. Second, treating behavior as a continuous/dimensional trait is most likely much closer to a real situation, in both humans and animals (Gratten et al. 2014), compared to "normal" and "pathological" categories. Data were collected using a validated owner-filled questionnaire, which has been shown earlier to correlate with dog behavior in test situations and to have good test-retest reliability (Tiira and Lohi, 2014).

Methods

Data collection

Data on dogs' behavior and environmental factors were collected using a validated owner-completed questionnaire survey. The questionnaire included altogether 35 questions (Supplement 1), and it has earlier been shown to correlate with dog behavior in test situations (external validity) and to have good test-retest reliability (Tiira and Lohi, 2014). The potential fearful reaction and frequency (0-4) toward unfamiliar people, unfamiliar and familiar dogs, loud noises (after Overall et al., 2006), and in new situations was asked about. To reduce the possible subjectivity of the owner's judgment, we added a question for owners to describe "how exactly" the dog behaved in a specific situation. If the owner reported that the dog was fearful when meeting a stranger (or strange dogs and/or novel situations), the owner had to indicate a specific reaction: how the dog behaves (e.g., the dog withdraws when meeting a stranger). Similarly, if the owner reported that the dog did not show fear toward a stranger, a more specific description of reactions was required to enable our own evaluation of the situation (Tiira and Lohi, 2014). During the data collection, the questionnaire was modified 3 times, resulting in 4 slightly different versions of the questionnaire (the first one being a paper version, the 3 others—online questionnaires). However, the main questions regarding our target traits, fearfulness toward unfamiliar people, dogs, and new situations, noise sensitivity and separation anxiety did not change between the versions. The major difference involved additional background questions to versions 3 and 4 (maternal care, place of birth, type of food, extra nutrients, time spent alone/day, daily exercise) to better document the early-life experiences and conditions of the dogs. Instead of trying to capture the entire spectrum of phenotypic variation in fearfulness, we aimed to structure the questionnaire so that it would identify the most fearful individuals as cases, and those with no marked fear reactions as controls. The frequency and type of aggressive behavior (barking, growling, bite/snap) toward unfamiliar and familiar people and dogs and also toward owners/family members was asked about. Separation anxiety was asked about in only 1 question (yes/no). We derived several independent behavioral variables from the questionnaire data that were later used in the analysis (Table 1).

The questionnaire was advertised for all breeds via breed clubs, the research group's Web pages and Facebook with a focus on the owners of target breeds such as Great Danes, German shepherds, Belgium shepherds, Staffordshire bull terriers, Lagotto Romagnolos and Salukis, due to a large number of existing samples in our Dog DNA bank. Both fearful and nonfearful individuals, as well as dogs with fearful reactions to loud noises and also dogs with no marked behavioral reaction to loud noises were encouraged to participate.

Statistical analysis and behavioral variables used

The comorbidity between fearfulness, noise sensitivity, and separation anxiety was analyzed with chi-square test using binary variables. Fearfulness was defined using fear status, noise sensitivity using noise sensitivity status, and separation anxiety using separation anxiety (see definitions in Table 1). The difference in aggressive behavior between dogs with or without fear, noise sensitivity, or separation anxiety was investigated using the Wilcoxon rank-sum test. The Spearman correlation test was used in the analysis to further investigate the association between fearfulness, noise sensitivity, and aggressiveness.

The fearful behavioral reactions expressed during thunderstorms and fireworks, toward unfamiliar people, and in new situations, were analyzed using Principal Component Analysis (PROC FACTOR, rotation varimax, priors = one, correlation matrix was used, SAS version 9.3; SAS Institute, Cary, NC, USA), and principal components with eigenvalue >1 were selected. Among the loud noises, only thunder and fireworks were included, as there were fewer dogs with marked fearful reactions toward gunshots, and unnecessary reduction of the sample size was avoided in the analysis. Variables with loading values >0.35 were considered to load for a particular component. The Wilcoxon rank-sum test was used to analyze the possible differences in behavioral reactions between fearful and nonfearful dogs, sexes, and sterilization status.