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Review

Use of questionnaire-based data to assess dog personality

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ABSTRACT

The study of dog personality is of general academic interest and also has applications for the management of both working dogs and pets. However, acquiring direct behavioral assessments of large numbers of animals is both time consuming and logistically difficult. An alternative approach that is becoming increasingly common is the collection of questionnaire-based information directly from dog owners. In this review, we discuss some commonly used questionnaires for dog personality traits and findings that have been published using these tools. We suggest that the use of such questionnaires may contribute to research that is based on estimation of effects from large sample sizes, for example, genomic analyses of dog personality traits.

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Introduction

The study of dog behavior has long been a topic of both academic and general interest. As a result of our long and close relationship with this species, humans are naturally intrigued by man's best friend, and from a practical point of view, dogs serve in various working roles for which an understanding of behavior is beneficial. Furthermore, dogs are viewed as good model organisms for the study of normal animal behavior and behavioral disorders (Scott and Fuller, 1965; Ley and Bennett, 2007; Hall and Wynne, 2012). Personality (individual consistency in behavioral responsiveness to stimuli and situations) is recognized in a wide range of animal species including dogs (Gosling and John, 1999). Assessments of dog personality have been used to identify behavior disorders (Kato et al., 2012) or to determine suitability for specific roles (Wilsson and Sundgren, 1997). Studies of personality generally require assessments of the response of individuals to a range of stimuli. However, carrying out a large number of standardized tests is time consuming and requires skilled assessors, thus making it expensive

and complicated to evaluate a large number of animals, as required for some objectives, such as genetic analyses. Some professional organizations, such as those providing and training assistance or police dogs, use qualified behavioral assessors and have developed in-house age-specific assessment methods (e.g., Svobodova et al., 2008; Asher et al., 2013). In addition, a few countries, like Sweden, have developed national testing schemes to evaluate dog behavior (Wilsson and Sundgren, 1997) and thus have been able to conduct large and effective research studies. However, this ability is unusual and unlikely to spread widely because of the costs. An alternative approach that is growing because of the availability of Internet resources is the use of owner or handler behavioral assessments, generally via questionnaires, in place of standardized tests. This application of citizen science (Hecht and Rice, 2015) or crowdsourcing could have a major effect on this area of research.

Assessment of reliability and validity of dog behavioral questionnaires

Various statistical techniques are used to extract information from questionnaires and to assess its quality. As questionnaires often pose many questions, it is necessary to distil these down to a smaller number of workable constructs. Multivariate statistical techniques such as factor analysis or principal component analysis (PCA) are the standard methods for extracting personality information from

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questionnaire-based data. It is assumed that a smaller number of unobserved variables (*components/factors/constructs*) underlie the responses to the questionnaire and that these variables can be estimated using linear combinations of the responses. The aim is to identify a reasonably small number of components that account for a substantial proportion of the variation and that are *interpretable* in terms of our understanding of dog behavior (e.g., in Lofgren et al., 2014, responses from 101 questions were reduced to 12 component scores representing personality characteristics).

Additional statistical tools are used to determine the *reliability* and *validity* of the components assessed by multivariate analysis of questionnaire data in a similar way to their application in canine behavioral testing (Diederich and Giffroy, 2006; Taylor and Mills, 2006). In the context of a questionnaire, *reliability* generally refers to the *internal consistency*, the degree to which individual questions associated with a specific construct are correlated (Jones and Gosling, 2005). Cronbach alpha coefficient (Cronbach, 1951) is often used as an estimate of internal consistency, where measures greater than 0.7 are generally considered acceptable. *Validity* in the context of a questionnaire generally refers to how well a component is correlated with independent measures (e.g., standardized behavioral tests, diagnosed behavioral disorders, or outcomes such as rejection from a service dog program). A common technique is to generate the components on a subset of the data and then assess reliability and validity on this subset and independent subsets (*cross validation*).

Most canine behavioral questionnaires published in the scientific literature have been assessed using this framework. There are many examples, thus it is not possible to review them all; a few of the most commonly used questionnaires are discussed here.

Canine Behavioral Assessment and Research Questionnaire

Canine Behavioral Assessment and Research Questionnaire (C-BARQ) is probably the most commonly used canine behavioral questionnaire, involving the owner grading a dog's typical behavior in certain situations (based on either severity or frequency of the behavior, on a 5-point scale). The first versions of the questionnaire were developed in the early 2000s and by 2005, it had stabilized at 101 questions. In the original evaluations, internal consistency of 8 (Serpell and Hsu, 2001) and 11 (Hsu and Serpell, 2003) factors was measured, based on 40 and 68 questions, respectively. The Cronbach alpha values were higher for the latter study with more questions; values exceeded 0.72 for 10 of 11 factors, whereas only 3 of 8 factors exhibited such levels of consistency in the earlier study. Validity in the first study (Serpell and Hsu, 2001) was assessed on candidate dogs from The Seeing Eye® organization (Morristown, NJ, USA), by comparing the factor scores to reasons for rejection from the Seeing Eye® program. Rejection determination was independent of the C-BARQ assessment, which had been done at an earlier stage by puppy raisers. There was general agreement between the questionnaire-based assessment and the rejection criteria with 7 of the 8 primary reasons for rejection significantly associated with at least 1 C-BARQ factor score; distraction was not significantly associated with any of the factor scores. The latter study (Hsu and Serpell, 2003) was validated using dogs with clinically diagnosed behavioral problems. Dogs with particular diagnoses had significantly higher scores for questionnaire factors corresponding to those disorders compared with dogs with unrelated diagnoses.

Since 2005, more than 25 published studies have used C-BARQ (or subsets of it). Svartberg (2005) compared C-BARQ results to those from the dog mentality assessment, the standardized behavioral test developed by the Swedish Working Dog Association to assist their breeding program. Based on a sample of approximately 700 dogs, he found that 4 of the behavioral test traits

(playfulness, curiosity/fearlessness, sociability, and distance playfulness) were significantly correlated with their corresponding questionnaire component scores. Subsequent studies have also found correlations between C-BARQ scores and behavioral test results (for aggression-related traits, van den Berg et al., 2006; for sociability-related traits, De Meester et al., 2008; and for stranger-directed fear and trainability, Kutsumi et al., 2013). Inter-rater reliability has been shown to be variable: 0.53–0.90 across 13 traits (Jakuba et al., 2013). Studies have also demonstrated correspondence between C-BARQ scores and various outcomes, including success as guide dogs or service dogs (Duffy and Serpell, 2012; Foyer et al., 2014) and adoption versus euthanasia for dogs relinquished to shelters (Duffy et al., 2014), but the predictive power is not overwhelmingly high; for example, the highest (absolute value of) correlation between early life C-BARQ traits and a later-assessed index value (an assessment of the suitability of a dog for becoming a working dog) was 0.36 in a study of German shepherd military dogs (Foyer et al., 2014).

C-BARQ has been used in multiple countries and translated into multiple languages. The factor structure observed in independent analyses from different countries shows some differences. Hsu and Sun (2010) found few differences for Taiwanese dogs, mainly related to fear and aggression components. Tamimi et al. (2015) found some differences in factor structure for Iranian dogs when compared with other studies. In their study, owner-directed aggression, dog-directed aggression, and touch/pain sensitivity did not feature as separate factors, and fear was a single factor (rather than 3 separate factors for some other studies). Hsu and Sun (2010) recommended that the factor structure of C-BARQ should be re-examined for each new language and culture.

In a study of Rough Collies, Arvelius et al. (2014) found that the heritabilities (proportion of the variance explained by additive genetic factors) for 18 behavioral components based on C-BARQ were of similar magnitude (0.06–0.36) to those estimated by the dog mentality assessment. The authors suggest that the reason for this somewhat surprising finding is that owners may compensate for lack of training and standardization with their greater knowledge of the individual dog compared with the opinion of a test judge who observes the dog for less than an hour. Our own research has estimated moderate-to-high heritabilities for several C-BARQ-based traits in Labrador retrievers (unpublished results), in line with the estimates of Arvelius et al. (2014).

Monash Canine Personality Questionnaire

The Monash Canine Personality Questionnaire-revised is a questionnaire based on owners rating their dogs on a 6-point score for 67 (later reduced to 41 and subsequently 26) personality adjectives (Ley et al., 2008, 2009a). PCA was used to derive 5 personality components for which Cronbach alpha ranged from 0.74 to 0.87 (Ley et al., 2009a). A later study (Ley et al., 2009b) evaluated moderate-to-high inter-rater reliability based on assessments of the same dog from couples (0.75–0.86, for the 5 components) and moderate-to-high test-retest reliability when the test was completed again after a 6-month interval (0.79–0.93). Since 2009, at least 2 studies have been published based on the MCPQ-R (Carrier et al., 2013; Smith, 2014) with several significant correlations shown between personality factors and behavior of dogs in a dog park (Carrier et al., 2013).

Other questionnaires

Use of another adjective-based questionnaire, the Dog Personality Questionnaire (Mirko et al., 2012), identified 4 personality components based on PCA. Internal validity was assessed by theta

(similar to Cronbach alpha), which was above 0.90 for all factors. This questionnaire was subsequently evaluated using a comparison with a series of behavioral tests (Mirko et al., 2013). Three of the 4 personality components were significantly correlated with relevant test behavior.

A number of other canine behavior questionnaires have been developed, including several that focus on specific characteristics. Most questionnaires now ask questions or provide statements for assessment about the dog's behavior in specific situations, rather than assigning personality adjectives. Several surveys focus specifically on aggression, fear, and anxiety. The questionnaire by Temesi et al. (2014), which focused on aggression, fear, and separation anxiety, incorporated 56 behavioral reactions that owners evaluated for their dogs in terms of the frequency of exhibition. The primary focus of the questionnaire by Blackwell et al. (2013) was responses to noise and whether noise-related fear behaviors were associated with other signs of fear or anxiety. Owners were asked whether specific behaviors currently occurred, occurred in the past and were relevant, and whether the behavior was considered to be a problem. Tiira and Lohi (2014) asked dog owners 32 questions about fear and anxiety responses, including what behaviors the dog exhibited in response to specific stimuli and how commonly the dog showed such reactions. Standardized behavioral tests were performed on a subset of dogs, and significant correlations were found between owner assessments and some test behaviors (e.g., reactions to a stranger, responses to novel objects), demonstrating external validity.

Several other surveys have focused on inattentiveness or excessive activity. Vas et al. (2007) modified a questionnaire used to evaluate attention-deficit hyperactivity disorder in humans to assess related characteristics in dogs. Owners were asked to rate how true 13 statements were for their dogs on a frequency scale. Using the same questionnaire, Hejjas et al. (2007) documented an association between the activity-impulsivity dimension and variation in a candidate behavior gene (dopamine D4 receptor).

Some issues related to canine behavioral questionnaires

For most behavioral characteristics, although owner-based questionnaires have logistical and financial advantages over behavioral testing, it is still generally assumed that standardized tests by trained observers provide more objective and precise assessments than those of the owner. In some cases, they are assessed on a quantitative scale (e.g., amount of time, number of events). Furthermore, they are free of owner bias, and a trained observer will have a better appreciation of the full range of dog behavior and what is normal and abnormal. One issue relates to cultural differences in dog ownership and interpretation of dog behavior. Few studies have assessed this, but Wan et al. (2009) found that owners of German shepherd dogs from the United States and Hungary differed in their average ratings of dogs for confidence, aggressiveness, and persistence. Although these differences may reflect genetic difference between the breed in the 2 countries, they could also reflect cultural differences in owner interpretation of behavior or issues related to translation of the questionnaires. However, this issue could also apply to subjective measures assessed by trained observers from different cultures.

Identification of factors associated with questionnaire-based behavioral assessments

A large number of studies have used the various questionnaires described previously to test for associations between behavioral/personality traits and genetic, demographic, management, lifestyle, and owner-related factors. Of studies that examined multiple breeds, breed has a large and significant effect on many behavioral

traits (Rugbjerg et al., 2003; Duffy et al., 2008; Blackwell et al., 2013; Starling et al., 2013b; Temesi et al., 2014; Asp et al., 2015). Other genetic (or partly genetic) effects have been documented within breeds, associated with subdivision within the breed. These include differences between working dogs and pets or show dogs (Serpell and Hsu, 2005; Lofgren et al., 2014) or between dogs with different coat colors (Lofgren et al., 2014). Sex and reproductive status (neutering) have been statistically associated with some behavioral characteristics, including dog-directed fear (Temesi et al., 2014), separation-related anxiety (McGreevy and Masters, 2008), fear of noises (Blackwell et al., 2013), compulsive tail chasing (Tiira et al., 2012), and boldness (Starling et al., 2013a). Age is also statistically associated with various traits, such that older dogs were found to show lower scores for boldness (Starling et al., 2013a), trainability (Kubinyi et al., 2009), inattentiveness (Vas et al., 2007), tendency to fetch (Lofgren et al., 2014), and human- or object-directed fear (Lofgren et al., 2014) as well as higher scores for calmness (Kubinyi et al., 2009), neuroticism (Temesi et al., 2014), fear of noises (Blackwell et al., 2013), and owner-directed aggression (Hsu and Sun, 2010), but the explanations for these associations may vary across traits and/or conditions. In some cases, the experience of the dog has been suggested to influence specific characteristics, for example, fear of noises was statistically associated with reported exposure to specific loud noises (Blackwell et al., 2013), and level of daily exercise was associated with several personality characteristics (Lofgren et al., 2014). Finally, both demographic and psychological characteristics of the owner may be associated with dog personality; in particular, several studies have found correlations between the owner's and dog's questionnaire-assessed personality traits (Turcsán et al., 2012; Konok et al., 2015).

Practical applications of questionnaire-based tests

Both C-BARQ and other questionnaires have been used to help in the identification of suitable guide dogs (Serpell and Hsu, 2001; Batt et al., 2009; Arata et al., 2010; Duffy and Serpell, 2012; Kobayashi et al., 2013). Arata et al. (2010) found that distraction, as assessed using their own questionnaire by guide dog trainers, was strongly associated with disqualification as a guide dog. Kobayashi et al. (2013) found that the distraction component in these older dogs was associated with questionnaire-based traits assessed by puppy raisers, and thus, disqualification might be predictable at the puppy stage. Similarly, Duffy and Serpell (2012) found that the C-BARQ question regarding tendency to pull excessively hard on the leash, also assessed by puppy raisers, was most strongly associated with disqualification. Guide dog training is expensive and time consuming, so better strategies are required to reduce the number of unsuitable dogs entering training programs. A combined approach of standardized questionnaires and novel tests (Asher et al., 2013; Harvey et al., 2016) may result in improved outcomes.

Questionnaire data have also been used to investigate dogs relinquished to shelters (Hennessy et al., 2001; Sergurson et al., 2005; Stephen and Ledger, 2007; Duffy et al., 2014). The results have been mixed, but some studies have shown that the assessments of relinquishing owners or dog shelter staff have predictive power for the behavior of dogs in new homes (Duffy et al., 2014) and thus may be useful in identifying suitable homes for sheltered dogs or dogs that require behavioral intervention before adoption.

Applications in genomic studies

The development of genomic tools has revolutionized most areas of the biological sciences, including the study of psychiatric disease (Ripke et al., 2013) and animal behavior (Gaertner et al., 2015), and is also extending its reach into the social sciences like

psychology (Christoforou et al., 2014). The key to the genetic dissection of complex traits like behavior, which are influenced by both genetic and environmental factors, is a large data set of genotypes and phenotypes, as exemplified by the development of large-scale studies on human diseases (e.g., 1000 genomes, Wellcome Trust Case Control Consortium). A simulation study (Spencer et al., 2009) showed that measurements from more than 5000 individuals were needed to detect an association between a genetic locus and a measurable trait for a trait with a small genetic effect. Many personality traits are thought to be in this category (Willis-Owen and Flint, 2006). For large numbers of behavioral test data to be used in such situations, participation in studies would have to be high and data collection efficient. It is easier for owners to complete questionnaires, which can be useful if validity and reliability are suitably high. Our own research using questionnaire data to study dog personality has demonstrated that large data sets can be assembled for relatively low cost and time input, where dog owners are interested and motivated to contribute (Lofgren et al., 2014). In addition to the moderate heritabilities estimated for questionnaire-based traits described previously, our preliminary research has also found several genomic associations with personality traits in Labrador retrievers (unpublished results), further supporting the validity of questionnaire-assessed behavior.

Conclusions

The use of questionnaire data shows great promise to further the dissection of behavioral traits in dogs. Research to date has demonstrated that questionnaire-based data are reliable and validated based on standard statistical criteria and that it can be used to help identify dogs suitable for specific roles. In cases such as genetic studies where data from hundreds or thousands of animals are required, data from questionnaires appear to be a viable option.

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Conflict of interest

The authors declare no conflict of interest.

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