Validation of the Socially Acceptable Behaviour (SAB) test in a Central-Italy pet dog population

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Aggression, Behaviour, *Canis familiaris*, Dog, Questionnaire, Temperament test, Validity.

Summary
Aggressiveness is reported to be the most important public health issue related to both owned and free-roaming dogs. Common approaches to assess canine aggressiveness are temperament tests. The main aim of this study was to evaluate whether one such test, the Socially Acceptable Behaviour (SAB) test, created to evaluate aggressive and fearful behaviour in dogs in the Netherlands, could be used reliably to assess dog aggression and fear in a population of owned dogs in Central Italy. Reactions to the test were recorded and compared to the owners' perception of their dog's aggressiveness using a validated questionnaire (C-BARQ). Dogs showing aggressive reactions during the test obtained significantly higher (more aggressive) scores on the C-BARQ subscales 'stranger-directed aggression' (SDA $p < 0.001$), 'owner-directed aggression' (ODA $p = 0.03$), and 'familiar dog aggression' (FDA $p = 0.006$), than dogs who did not react aggressively. Logistic regression analysis revealed that 7 of the SAB-subtests were predictive of the SDA score. The findings indicated that aggression directed toward unfamiliar people can be reliably assessed using the SAB test for a population of Italian pet dogs.

Validazione del Socially Acceptable Behaviour (SAB) test su una popolazione di cani di proprietà del centro Italia

Parole chiave
Aggressività, *Canis familiaris,* Questionario, Socialità, Test di temperamento, Validazione.

Riassunto
L'aggressività verso l'uomo è considerata uno dei più seri problemi di salute pubblica tra quelli associati sia al cane randagio che a quello di proprietà. Gli approcci comunemente utilizzati per la valutazione della personalità canina prevedono l'applicazione di test di temperamento. Tuttavia, anche se validato, lo stesso strumento potrebbe fornire risultati differenti se utilizzato in Paesi diversi, in considerazione del fatto che il contesto culturale può variare notevolmente. Lo scopo principale di questo studio è di valutare se il Socially Acceptable Behaviour (SAB) test, creato nei Paesi Bassi per valutare il comportamento aggressivo e di paura nel cane, sia affidabile nella valutazione dell'aggressività anche in una popolazione di cani di proprietà in Italia centrale. Le reazioni dei cani al test sono state registrate e correlate alle risposte fornite attraverso un questionario validato (C-BARQ), relative alla percezione che i proprietari hanno dell'aggressività del proprio cane. I cani che hanno mostrato una reazione aggressiva durante il test hanno ottenuto un punteggio più alto (maggiore aggressività) nelle categorie del C-BARQ associate a "aggressività diretta verso estranei" (SDA $p < 0.001$), "aggressività diretta verso un membro della famiglia" (ODA $p = 0.03$) ed "aggressività diretta verso un altro cane della famiglia" (FDA $p < 0.006$), rispetto ai cani che non hanno mostrato segni di aggressività durante il test. La regressione lineare ha rivelato che sette SAB sub-test sono predittivi della categoria SDA del C-BARQ. Lo studio ha evidenziato che l'aggressività verso estranei può essere valutata in modo attendibile dal SAB test in una popolazione italiana di cani di proprietà.

Introduction

It has been estimated that in Italy 1 in 3 families owns a dog (Slater *et al.* 2008a), and that there are around 7 million dogs in total within the country (FEDIAF 2014) of which about 700.000 are free-roaming (SIVeMP 2012). Dogs are often considered members of the family (Miklòsi 2007), they live in close contact with humans, and their social place in Western society differs from that of other domesticated species (Serpell 1995). However, when a pet begins to display undesirable behaviours, such as destructiveness, fear- and anxiety-related behaviours, or aggression, the dog-owner relationship can deteriorate very quickly (Martinez *et al.* 2011). Aggressiveness is reported as the most important public health issue concerning both owned and free-roaming dogs. It may involve both physical (bite injuries, risks of zoonosis transmission) and psychological trauma, and it often leads to the relinquishment of pets to shelters (CDC 2013, Ostanello *et al.* 2005, Hsu and Sun 2010). Unfortunately, dog aggression is frequently diagnosed after a dog has already shown overt aggressive behaviour and has bitten someone. It is more difficult to predict which dogs are likely to pose a potential threat to humans due to aggression. For this reason, there is widespread public demand for reliable tools that can be used to make such predictions (Netto and Planta 1997, De Meester *et al.* 2008).

Several validated tools have been developed to measure canine behaviour or temperament. One common approach is to use temperament tests based on direct observation of the dog's responses to various environmental challenges in controlled situations (Planta and De Meester 2007, Haverbeke *et al.* 2009, Valsecchi *et al.* 2011). Although previously validated behavioural assessment tests may be used in countries other than the one of origin, it is important to establish whether such tools work effectively in different geographic and cultural contexts. Countries may, for example, have different attitudes to dogs and pet keeping (Serpell 1995), as well as different laws relating to the management of dogs in shelters or free-roaming dogs (Dalla Villa *et al.* 2010). In Italy, according to the National law 281/91[1], it is illegal to euthanize any dog (owned or stray) unless it is recognized by a veterinarian as "incurably ill" or "proven to be dangerous". Any dog that has been reported to the authorities as having attacked a person can be considered as such. The diagnosis is provided by a veterinarian, who will also decide the fate of the dog on the basis of its history, medical condition, and the circumstances of the aggression episodes. A reliable and standardized behavioural assessment test to determine levels of aggressiveness in dogs would be extremely valuable in this context. Such a test could be used by shelter veterinarian doctors as an additional diagnostic tool to assess the likelihood of the animal biting recurrently, thereby helping these professionals in their decision-making. However, at the time of the study, and still today, no officially recognized protocol is available to assess the aggressiveness of these animals.

This paper focuses on a behaviour test previously validated in the Netherlands (the Socially Acceptable Behaviour - SAB test), which was created to evaluate aggressive and fearful behaviour in dogs (Planta and De Meester 2007, De Meester *et al.* 2008) by analysing their response to 16 standardized subtests. Since the euthanasia of dogs in Italy is strictly regulated, it might be anticipated that there would be a higher prevalence of aggressive dogs in the Italian population compared to those of other countries. Thus, before any test can be accepted and employed in Italy, it will need to be separately validated for a population of Italian dogs.

The main aim of this study was to evaluate whether the SAB test could be used reliably to assess dog aggression in an Italian population of privately owned dogs. In order to do so, we investigated the degree of association between owners' assessments of their dogs' behaviour, using a previously validated and commonly used questionnaire, the C-BARQ (Hsu and Serpell 2003), and direct evaluation of the same dogs' behaviour using the SAB test.

Materials and methods

Subjects enrolled in the study were recruited by advertising at 95 local veterinary clinics in the municipalities of Teramo and Pescara in Central Italy. During the first part of the study, 1,000 hard copies of the C-BARQ were distributed to veterinarians enrolled on a voluntary basis. Dog owners who expressed an interest in participating in the study were required to complete a C-BARQ. These owners were then requested to contact 1 of the authors (CS) to arrange an appointment for the SAB test.

C-BARQ

The C-BARQ is a standardised questionnaire that is widely used to assess the prevalence and severity of behavioural problems in dogs. Using factor analysis, Hsu and Serpell (Hsu and Serpell 2003) identified 11 reliable behavioural factors or subscales, including 3 that measured aggression, 4 that measured fear/anxiety, and 4 additional factors that measured trainability, separation-related problems, excitability, and attachment/attention-seeking, respectively.

[1] Italian Law n. 281. 1991. Legge quadro in materia di animali di affezione e prevenzione del Randagismo. *Off J*, **203**, 30/08/1991.

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Subsequently, 2 new factors ("energy" and "familiar dog aggression") were added to the instrument.

The various C-BARQ factors and items have also been shown to have adequate internal reliabilities (Cronbach's alpha ≥ 0.7), and acceptable test-retest and inter-rater reliabilities (Duffy and Serpell 2008, Duffy and Serpell 2012, Jacuba *et al.* 2013). Initially, 7 of the original 11 subscales were successfully validated using a panel of 200 dogs previously diagnosed with specific behaviour problems (Hsu and Serpell 2003). More recently, other studies have provided criterion validation of the C-BARQ by demonstrating associations between the various factor and item scores and (a) training outcomes in working dogs (Duffy and Serpell 2012, Foyer *et al.* 2014), (b) the performance of dogs in various standardised behavioural tests, including the SAB test (Arvelius *et al.* 2014, Barnard *et al.* 2012, De Meester *et al.* 2008, Svartberg 2005, Van der Borg *et al.* 2010), and (c) neurophysiological markers of canine anxiety and compulsive disorders (Vermeire *et al.* 2011, Vermeire *et al.* 2012).

Although the C-BARQ has not been separately validated for use in Italy, the factor structure of the questionnaire has been shown to be highly consistent across different countries, including the USA, Japan, Taiwan, the Netherlands, Sweden, and Iran (Duffy and Serpell 2008, Hsu and Serpell 2003, Hsu and Sun 2010, Nagasawa *et al.* 2011, Tamimi *et al.* 2014, van den Berg *et al.* 2006, van den Berg *et al.* 2010).

For the purposes of this paper, questionnaire items representing 8 of these C-BARQ factors were selected, all of which corresponded to the various fear/anxiety or aggression-related behaviours assessed by the SAB test. Each of the C-BARQ items was professionally translated into Italian and then back-translated into English to verify the correctness of the translations. The selected C-BARQ factors were: "trainability" (T), "stranger-directed aggression" (SDA), "owner-directed aggression" (ODA), "stranger-directed fear" (SDF), "dog-directed fear or aggression" (DDFA), "familiar dog aggression" (FDA), "touch sensitivity" (TS), and "attachment or attention-seeking behaviour" (AAB). The original 5-point rating scales (Hsu and Serpell 2003) were maintained for the different sections of the questionnaire. The behavioural factors with all the representative C-BARQ items and the related rating scales are presented in Annex 1.

SAB test

The owners enrolled in the first part of the study were invited to participate with their pet in a standardised test (the SAB test) for direct evaluation of the dog temperament. Among these, 100 were selected to take the SAB test on a volunteer, first come, first served basis. The test was set-up following accurately the procedure described by Planta and De Meester (Planta and De Meester 2007). The SAB test was performed outdoors and the total time per dog was approximately 15 minutes. The SAB test consists of 16 subtests performed in a fixed order (Table I).

Presence/absence of aggressive behaviours during

Table I. *Main characteristics and order of the 16 spell out subtests.*

Subtest	Description	Presence of the owner
1	Friendly approach by one person who tries to pet the dog with an artificial hand	Yes
2	Exposure to an unfamiliar visual stimulus (flapping blanket)	Yes
3	Exposure to an unfamiliar visual stimulus (silhouette of a giant cat that suddenly appears from behind a screen)	Yes
4	Exposure to an unfamiliar sound (horn)	Yes
5	Exposure to an unfamiliar sound (metal cans behind a screen)	Yes
6	Neutral approach by three persons in a normal way	Yes
7	Neutral approach by three persons in an accelerated way	No
8	Approach by an unfamiliar dog of the same size, different breed and same sex	No
9	Friendly approach by one person who tries to pet the dog with an artificial hand	No
10	Exposure to an unfamiliar sound (bell)	No
11	Exposure to an unfamiliar visual stimulus (umbrella that is opened and closed rapidly)	No
12	Exposure to an unfamiliar visual stimulus (doll in a sledge that is pulled towards the dog)	No
13	Friendly approach by one person who tries to pet the dog with a doll	No
14	Approach by a person who is staring at the dog	No
15	Friendly approach by this same person, who then tries to pet the dog with an artificial hand	No
16	Friendly approach by the owner, who tries to pet the dog with a doll	Yes

each subtest was scored as: "aggressive biting" (AB, approach and full contact of the jaws with the target), "aggressive snapping" (AS, a clear intention to bite but without full contact of the jaws with the target), "aggressive attacking" (AA, lunging at the stimulus with open mouth, where biting is made impossible due to the safety design). In addition, the elements growling (G), barking (B), piloerection (P), bearing of teeth (BT), direct staring (DS), and stiffening of the body (SB) were recorded.

Based on their SAB test results, dogs were divided into either aggressive (SABPOS) or non-aggressive (SABNEG) groups. According to Planta and De Meester (Planta and De Meester 2007), a dog was defined as SABPOS whenever it showed 1 of the 3 aggressive behaviours (AB, AS or AA) in association with at least 1 of the other scored elements (G, B, P, BT, DS, SB).

Statistical analyses

Summated scales for the C-BARQ factors were calculated by averaging the scores of the representative items in each factor. When owners did not answer an item, the score was averaged for the remaining items (up to 25% of missing values allowed). A first descriptive analysis of the Italian pet dog population based on C-BARQ results was carried out.

Aggressive (SABPOS) and SABNEG groups were compared for age and weight of the dogs using Student's T test, and for sex and sexual status of the dogs using chi-square test.

Trait scores for the 8 C-BARQ factors studied (SDA, ODA, DDAF, FDA, T, SDF, TS, AAS) were compared between SABPOS and SABNEG groups, using analysis of variance (one-way ANOVA). ANOVA was chosen because it is robust to non-normality, uneven sample sizes, unequal variance, and their combined effects (Kikvidze and Moya-Laraño 2008). Differences were considered significant at $p \leq 0.05$. For those C-BARQ factors that were significantly associated with the SAB test results, a logistic regression analysis was carried out to determine which of the 16 SAB subtests were able to predict the C-BARQ factor scores. Since many of the C-BARQ scores had highly skewed distributions, they were dichotomised, in order to create a categorical variable, using the median value as the cut-off point. Scores below the median value were considered low scores, while scores above the median value were considered high scores. Each C-BARQ factor score was considered a dependent variable, while the scores of the 16 SAB subtests were considered as independent variables. Statistical significant differences were set at $p \leq 0.05$; SPSS 16.0 software was used for all statistical analyses.

Results

A total of 366 dog owners expressed interest in participating in the study and returned completed C-BARQs for analysis. Results showed that 185 of the dogs (50.5%) were females, of which 103 were spayed, and 181 (49.5%) were males, of which 20 were neutered. Ten male dog owners did not answer the question about the dog's sexual status. Overall 33.6% of dogs were spayed/neutered. Mean age was 5.4 ± 0.19 years (median = 5 years, min. 6 months, max. 16 years) and average weight was 21.2 ± 0.75Kg (median 20 kg, min. 1.2 kg, max. 90 kg). The sample comprised both pure (57.4%) and mixed breed (42.6%) dogs. Looking in detail at the purebred dogs, the most commonly represented (accounting for 50% of the total number of pure breed dogs) were German Shepherd (10%), Boxer (5%), Toy Pinscher (5%), Rottweiler (4%), Labrador Retriever (4%) Siberian Husky (4%), Beagle (3%), Cocker Spaniel (3%), Doberman Pinscher (3%), Yorkshire Terrier (3%), Dalmatian (2%), Irish Setter (2%), and Jack Russell Terrier (2%). All other breeds represented less than 2% of the sampled population of purebred dogs.

Overall there was a good response rate to the C-BARQ items: fewer than 7% of owners did not fill in all of the questions concerning ODA, SDF, TS, and AAS factors. Between 12% and 18% of the owners did not answer some of the items related to the SDA, DDAF, and T factors. Only owners with more than 1 dog in the household could answer to the items related to the FDA factor, according to these data, 47.6% of the owners owned at least another dog.

Among the owners that completed the C-BARQ, 100 were selected on a 'first come first served basis' according to their availability to take the SAB test. Two of these dog-owner pairs failed to show up on the day scheduled for the SAB test, and 1 of the dogs did not complete the SAB test because of his excessively fearful responses. Of the 97 remaining dogs, 53 were females of which 34 were spayed, and 44 were males of which 5 were castrated.

On the basis of their aggressive responses to the SAB test, 21 dogs scored positive (SABPOS) and 76 scored negative (SABNEG). SABPOS and SABNEG groups did not differ significantly in their composition for sex (chi-square = 0.57; $p = 0.45$), sexual status (chi-square = 0.53; $p = 0.47$), age ($t = 1.57$; $p = 0.12$) or weight ($t = 0.12$; $p = 0.91$).

Comparing the results of the SAB test with the C-BARQ (Table II), SABPOS dogs obtained significantly higher (more aggressive) scores on the C-BARQ subscales SDA ($F = 27.32$; $p < 0.001$), ODA ($F = 5.07$; $p = 0.03$) and FDA ($F = 8.29$; $p = 0.006$) than SABNEG dogs. Of the 97 dog-owner pairs that completed the study, 93 had valid scores for the SDA subscale, 96 for the ODA subscale, and 54 had valid scores for the

Table II. *Comparison between the mean (± SD) scores obtained by SABPOS and SABNEG groups for each C-BARQ factor included in the questionnaire.* P-values refer to the one-way ANOVA associating SAB test results to C-BARQ factors.

C-BARQ factors	SABNEG (mean ± SD)	SABPOS (mean ± SD)	p-value
Attachment or attention-seeking	2.67 ± 0.84	3.03 ± 0.67	ns
Dog-directed fear or aggression	0.96 ± 0.62	1.20 ± 0.68	ns
Familiar dog aggression	0.64 ± 0.77	1.53 ± 1.28	0.006
Owner-directed aggression	0.23 ± 0.34	0.48 ± 0.69	0.03
Stranger-directed aggression	0.52 ± 0.57	1.33 ± 0.73	0.001
Stranger-directed fear	0.37 ± 0.65	0.57 ± 0.75	ns
Touch sensitivity	0.70 ± 0.62	0.90 ± 0.57	ns
Trainability	2.33 ± 0.65	2.42 ± 0.60	ns

FDA subscales. The other C-BARQ factors did not differ between SAB groups, although mean values tended to be higher (*i.e.,* higher aggressive / fear component) for SABPOS compared to the SABNEG group (Table II).

Logistic regression analyses revealed that none of the SAB subtests was predictive of the C-BARQ "owner-directed aggression" and "familiar dog aggression"factor scores (model significance $p < 0.05$). The SAB-subtests N1 (OR = 1.92) N7 (OR = 2.86), N8 (OR = 2.86), N9 (OR = 8.94), N13 (OR = 5.76), N14 (OR = 4.97) and N15 (OR = 2.86) were, however, predictive of C-BARQ "stranger-directed aggression" scores (see Table I for a description of the subtests; model significance $p = 0.01$).

Discussion

The present study provides evidence that the SAB test is sufficiently sensitive to detect aggressive behaviour towards strangers among Italian dogs. Not only a number of SAB subtest scores was significantly associated with owner-reported aggression towards unfamiliar people (C-BARQ "stranger-directed aggression (SDA)" factor), but the SAB scores were also associated with owner-reported aggression towards familiar people and familiar dogs, although these are not directly measured by any of the SAB subtests and none of the 16 subtests is designed to predict the occurrence of aggression towards familiar people or dogs.

When we analysed the ability of each of the SAB subtests to predict C-BARQ scores, 7 subtests (N1, N7, N8, N9, N13, N14 and N15) were found to be predictive of the SDA factor. In other words, dogs showing aggressive behaviours (SABPOS) during these subtests, were very much more likely to be reported by their owners as displaying stranger-directed aggression in their normal lives. This finding agrees with the results of van den Berg and colleagues (van den Berg *et al.* 2010) confirming that these subtests provide a reliable assessment of individual differences in canine aggression towards strangers.

It is of interest that, although the SAB test is designed to detect aggression directed to people, dogs, and threatening stimuli outside the home environment, in this study its scores were also associated with C-BARQ scores for owner-directed aggression (ODA) and aggression toward familiar dogs (FDA), but not with dog-directed fear/aggression (DDFA). These results suggest that ODA and FDA, which have typically been related to hierarchical "dominance" conflicts with familiar persons or dogs, may also involve elements of fear and anxiety, as implied by more recent classifications of dog aggression problems (Hsu and Sun 2010, Bradshaw *et al.* 2009, De Keuster and Jung 2009). It should also be noted that SAB subtest N8 "Approach to an unfamiliar dog" failed to detect owner-reported aggression towards unfamiliar dogs, but was predictive of aggression towards unfamiliar people (SDA). As described by Rezac and colleagues (Rezac *et al.* 2011), there are many factors triggering aggressive behaviours in dogs during leash walks, and most of them are not present during the SAB test. Rezac and colleagues (Rezac *et al.* 2011) showed that threatening behaviours are more frequently when same sex dogs were interacting, while in the SAB test dogs were always of opposite sex. Furthermore, there seem to be many handler-related factors triggering the aggressive behaviours of dogs on leash (*e.g.,* the close presence of the owner or the tension on the leash that the owners apply when encountering another dog). In the SAB test, the dog met the unfamiliar dog without the presence of the owner and the handler was trained not to do anything that might have conditioned the dogs' reaction (aside from respecting a safe distance). Finally, the test dog for the SAB test was selected for its calm and non-threatening (to the dog tested) behaviour in order not to provoke an aggressive reaction in the opponent dog. Therefore, the aggressive response to test N8 may have been triggered by the presence of the unfamiliar handler rather than the unfamiliar dog, thus giving rise to a false positive. This also suggests that the ability to reliably detect canine aggression toward unfamiliar dogs in the Italian dog population may require the development of a different test procedure. Previous studies (Christensen *et al.* 2007) suggest that test procedures that allow dogs to interact directly (*i.e.*, no minimum safe distance) may be more sensitive at detecting dog-directed aggression than the SAB subtest. However, while such tests may be more

representative of typical interactions between dogs in uncontrolled settings, they also raise significant safety and welfare concerns for the subjects involved in the testing.

In agreement with the results obtained in 2 studies carried out in the Netherlands (Planta and De Meester 2007, De Meester *et al.* 2008), all the subtests that were predictive of SDA factor scores involved direct approaches by unfamiliar persons. In many of these tests, the person was also trying to establish physical contact with the tested dog using an object (*e.g.*, doll or fake hand). Among all the SDA-predictive subtests, subtest N13, "friendly approach by an unfamiliar person who tries to pet the dog with a doll," was the one that triggered the most aggressive behaviour (26%). The interpretation of dog reactions to a doll in temperament tests has been debated extensively, and its reliability as a technique to predict aggression toward children is controversial (Gácsi *et al.* 2009, Barnard *et al.* 2012). However, it appears to be a good tool to assess a fearful and defensive aggressive temperament, probably due either to the doll's novelty or its jerky movements (Barnard *et al.* 2012). Behavioural reactions of dogs during subtest N13 as reported by De Meester and colleagues (De Meester *et al.* 2008) confirms the previous statement: the doll seems to trigger higher levels of "calm avoiding behaviours" (68.7%), "aggressive biting" (31.2%), and "attempts to flee" (42.5%) compared to all other subtests.

Planta and De Meester (Planta and De Meester 2007) found that particular SAB subtests tended to trigger aggression from a larger proportion of dogs (accounting for 50% of their sample); namely subtests N1 (18%), N13 (13%), N9 (12%) and N15 (10%). In the present study the subtests that stimulated most aggression were N13 (26%), N11 (17%), N7 and N8 (11%). De Meester and colleagues (De Meester *et al.* 2008) also reported that subtests N13, N15, N8 and N9 triggered the highest number of aggressive responses. These differences among studies using the SAB test suggest that the different populations sampled may show qualitatively different responses to the tests, thus confirming the need to validate the SAB's different test components in specific cultural contexts before deploying it. The different responses may be related to different histories of early exposure (*i.e.,* during their sensitive period for socialization) to specific environmental stimuli. For example, the dogs enrolled in our study that received an early positive exposures to physical contact with unfamiliar people may have shown a lack of aggressive response when being petted in sub-tests N1 and N9. Although particular efforts were made to accurately reproduce the test in a standardized fashion, we cannot exclude the possibility that uncontrolled environmental variables may also have influenced different responses in the dogs tested.

While the present findings tend to confirm the value of the SAB test as a tool for measuring aggressive behaviour in Italian dogs, we acknowledge some potential limitations. The population from which our sample was drawn may not be representative of Italian dogs in general as it only included owners who volunteered to complete the C-BARQ. At the same time, since the goal of the study was to determine the degree of association between dogs' SAB test and C-BARQ scores rather than to evaluate the aggressiveness of Italian dogs, the use of a self-selected sample is not necessarily inappropriate. Another potential criticism concerns the decision to validate 1 behavioural measure (the SAB test) using a test (the C-BARQ) which has not yet been validated specifically for use in Italy. While analyses of C-BARQ data from various countries and dog populations have revealed minor differences in factor structure – most likely due to cultural influences – the overall composition of the different behavioural traits measured by the C-BARQ appears to be remarkably consistent. This suggests that these traits are common to dogs in general, rather than specific to particular populations of dogs (Duffy and Serpell 2008, Hsu and Serpell 2003, Hsu and Sun 2010, Nagasawa *et al.* 2011, Tamimi *et al.* 2014, van den Berg *et al.* 2006, van den Berg *et al.* 2010). In addition, the C-BARQ is currently the most widely used assessment tool of its kind, and it has been used previously to validate temperament and performance tests in dogs (Arvelius *et al.* 2014, Barnard *et al.* 2012, De Meester *et al.* 2008, Svartberg 2005).

Conclusions

Aggressive behaviour in a population of dogs from Central Italy was reliably assessed using certain components of the SAB test. Aggression detected by the SAB test was associated with owner-reported aggression towards unfamiliar and familiar people, and to familiar dogs, but not aggression or fear toward unfamiliar dogs. Temperamental fearfulness, detected by the SAB test, may explain why this test is able to predict fear-related aggressive behaviours other than aggression to unfamiliar people. Aggression to unfamiliar dogs has been shown to be influenced by several dog/owner-related factors, and these may have impacted the ability of the SAB test to detect aggression to unfamiliar dogs in the studied Italian population. Overall, the subtests that were predictive of owner-reported aggressive behaviour toward unfamiliar people were the same subtests that triggered a higher number of aggressive reactions in dogs in 2 previous studies (Planta and De Meester 2007, De Meester *et al.* 2008). Future research should evaluate whether these 8 subtests may be sufficiently reliable on their own

to measure aggression towards unfamiliar people, thereby reducing the total duration of the test and facilitating its application.

Due to the "no-kill" policy adopted by Italian shelters, only exceptionally aggressive dogs are euthanized in Italy. Therefore, a number of mildly to moderately aggressive dogs may be exposed to contact with people and other dogs. In this scenario, prevention of biting incidents should be based on the detection of aggressive dogs and education on responsible ownership, which also includes spaying and neutering dogs with a known history of aggression. Though we do not advocate the use of behaviour tests as the only or main tool to diagnose dog aggression, they represent a valid diagnostic aid. As shown in this work, the SAB test constitutes a valid tool to help with the assessment of aggressive behaviour in dogs of Central Italy.

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Annex 1

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C-BARQ items grouped in behavioural categories

1. Trainability

Dog

- Returns immediately when called while off leash
- Obeys a sit command immediately
- Obeys a stay command immediately
- Will fetch or attempt to fetch sticks, balls, and other objects
- Seems to attend to or listen closely to everything the owner say or does
- Is slow to respond to correction or punishment
- Is slow to learn new tricks or tasks
- Is easily distracted by interesting sights, sounds, or smells

2. Stranger-directed aggression

Dog acts aggressively

- When approached directly by an unfamiliar adult while being walked or exercised on a leash.
- When approached directly by an unfamiliar child while being walked or exercised on a leash
- Toward unfamiliar persons approaching the dog while it is in the owner's car
- When an unfamiliar person approaches the owner or a member of the owner's family at home
- When an unfamiliar person approaches the owner or a member of the owner's family away from home
- When mailmen or other delivery workers approach the home
- When strangers walk past the home while the dog is in the yard
- When joggers, cyclists, roller skaters, or skateboarders pass the home while the dog is in the yard
- Toward unfamiliar persons visiting the home
- When unfamiliar person tries to touch or pet the dog

3. Stranger-directed fear

Dog acts anxious or fearful

- When approached directly by an unfamiliar adult while away from the home
- When approached directly by an unfamiliar child while away from the home
- When unfamiliar person tries to touch or pet the dog
- When unfamiliar persons visit the home

4. Owner-directed aggression

Dog acts aggressively

- When verbally corrected or punished by a member of the household
- When toys, bones, or other objects are taken away by a member of the household
- When bathed or groomed by a member of the household
- When approached directly by a member of the household while it is eating
- When food is taken away by a member of the household
- When stared at directly by a member of the household
- When stepped over by a member of the household
- When a member of the household retrieves food or objects stolen by the dog

5. Dog-directed aggression/fear

Dog acts aggressively

- When approached directly by an unfamiliar male dog while being walked or exercised on a leash

Behavioural categories 2-3-4-5-6-8 were scored on five-point qualitative scales: 0= no sign of the asked behaviour, 1 to 3= mild to moderate sign of the behaviour, 4= high/severe sign of the behaviour.

Behavioural categories 1 and 7 were scored on a rating scale including five options, grading "never", "seldom", "sometimes", "usually", and "always".

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When approached directly by an unfamiliar female dog while being walked or exercised on a leash
Toward unfamiliar dogs visiting the home
When barked, growled or lunged at by an unfamiliar dog
Dog acts anxious or fearful
When approached directly by an unfamiliar dog of the same or larger size
When approached directly by an unfamiliar dog of a smaller size
When unfamiliar dog visit the house
When barked, growled or lunged at by an unfamiliar dog
When approached while playing with/chewing a favourite toy, object etc. by another household dog

6. Familiar dog aggression

Dog acts anxious or fearful

Towards a familiar dog in the household
When approached at a favourite resting/sleeping place by another household dog
When approached while eating by another household dog
When approached while playing with/chewing a favourite toy, object etc. by another household dog

7. Attachment or attention-seeking

Dog

Displays a strong attachment for a particular member of the household
Tends to follow a member of household from room to room about the house
Tends to sit close to or in contact with a member of the household when that individual is sitting down
Tends to nudge, nuzzle, or paw a member of the household for attention when that individual is sitting down
Becomes agitated when a member of the household shows affection for another person
Becomes agitated when a member of the household shows affection for another dog or animal

8. Touch sensitivity

Dog acts anxious or fearful

When examined or treated by a veterinarian
When having its nails clipped by a household member
When having paws towelled by a household member
When groomed or bathed by a household member

Behavioural categories 2-3-4-5-6-8 were scored on five-point qualitative scales: 0= no sign of the asked behaviour, 1 to 3= mild to moderate sign of the behaviour, 4= high/severe sign of the behaviour.

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