Evaluation of aggression and fearfulness in domestic dog (*Canis familiaris*)*

Marta Dyjak[1],, Agnieszka Boruta[2], Ewa Adamkiewicz[1], Artur Walasek[3], Paweł Bury-Burzymski[2], Paweł Lisowski[1,4]**

[1] Institute of Genetics and Animal Biotechnology Polish Academy of Sciences, Jastrzębiec, Postępu 36A, 05-552 Magdalenka, Poland

[2] Warsaw University of Life Sciences, Faculty of Animal Sciences, Ciszewskiego 8, 02-786 Warsaw, Poland

[3] The Canine Department, Police Training Centre in Sułkowice, Ogrodowa 39, 05-650 Chynów, Poland

[4] Berlin Institute of Medical Systems Biology (BIMSB), Max Delbrück Center for Molecular Medicine (MDC),), Hannoversche STR.28, 10115 Berlin, Germany

Aggression is the major factor which underlies the attacks of the dogs, decreasing the welfare of these animals, their owners and the society. It is also undesirable trait in working dogs, as it reduces operational efficiency and security. It appears that fear-induced aggression in dogs is often implicated. In this study, we have investigated the aggression events, avoidance of various stimulus, body postures and stress-related behaviors based on set of tests, performed under controlled conditions, on the group of 144 police dog candidates. We demonstrated that the use of umbrella conducted in the absence of the dogs' handler elicits aggression of the almost 27% of animals. Umbrella test showed the highest correlation between arousal and aggression. Umbrella test enabled to describe fear in analyzed group of dogs: low body postures was manifested by 42.1% of dogs, avoidance in 11.7%.

Canine aggression is a serious veterinary and social problem, and has important implications for animal welfare [eg. Overall and Love M. 2001]. This complex social behavior is characterized by multiple mechanisms and causes [Veroude *et al*. 2016]. Different authors have divided aggressive behavior in various ways using either functional or categorical classifications. A commonly employed classification for aggression divides it into subtypes as follows: predatory, inter-male, fear induced, irritable, maternal, territorial, and instrumental aggression [Soma *et al*. 2008]. Simplified classification divides aggression into defensive and offensive based behaviors [Wall *et al*. 2003]. Some authors [eg. Duffy *et al*. 2008] have categorized aggression based on the target of the aggressive behaviors, such as strangers, owners or other dogs. In dogs, aggression may be manifested in growling, baring of teeth, snapping, or actual attack and subsequent consequences e.g. pain and injury [Catalán *et al*. 2020]. Although aggression is considered as a normal behavioral trait in all animal species, it becomes unacceptable to the immediate environment or to society in general when its level in an individual is too high, a situation often found in the case of aggression induced by fear or anxiety. In this form of behavior, dogs display submissive signs before an attack and it may include active avoidance, low body and tail posture, and trembling [Temesi *et al*. 2014]non-social fear, separation problems, anxiety/destructiveness and neuroticism. Fear may be triggered by environmental stimuli which are novel, have high intensity, for example being loud or large, have special evolutionary dangers such as heights, isolation and darkness, or arise from social interaction as contagious learning or that have been previously paired with adverse experiences [Gray 1987]. Aggression triggered by fear is particularly undesirable due to the fact that the attacking dog bites hard, in uncontrollable manner, very often discharging the emotion and frustration and becomes potentially dangerous for the environment [Goddard and Beilharz 1984]. The true motivation of aggressive behaviors however is not always known and clear. Different approaches are used for behavioral phenotyping and assessment of behavioral traits in dogs including owner questionnaire-surveys [van den Berg *et al*. 2006, Duffy *et al*. 2008], observational studies and test battery [Netto and Planta 1997, Haverbeke *et al*. 2009], owner-directed rating and expert rating [eg. Våge *et al*. 2010].

Here we investigated aggression events and fear to the reactions of police dogs' candidates, to various aggression inducting stimuli. We tried to answer the question which of the stimuli applied are the most effective for aggression and fear detection. The hypothesis of the study assumes that the aggressive and fearful phenotypes may be assessed using test batteries.

Material and methods

The study involved in total 144 adult dogs (>1 year): German Shepherd dogs (n= 134) and Belgian Malinois (n=10 BM), 124 males and 20 females, from the Canine Department of the Police Training Center in Sułkowice, Poland. Each dog underwent a clinical examination and was declared in good health at the moment of the study. The dogs behavior was assessed, at 2 weeks of their specialized training, by means of detailed test consisted of 15 sub-tests (trials) in a fixed order, based to the modified methodology proposed by Netto and Planta [1997], Haverbeke *et al.* [2009], and van der Borg *et al.* [2010], used to select against unwanted aggression and fear in specific dogs breeds. The procedure was conducted in the unfamiliar, open-air area, and novel people were involved as assistants (testers). Detailed elements of the procedure were as follows:

T1. Petting with artificial hand – unknown tester approaches the dog and pets it with an artificial hand, talking in a friendly manner at the same time.

T2. Presentation of a life size-doll (I) – a handler with a dog on a leash approaches the life-sized doll (65 cm tall) sitting on chair.

T3. Presentation of a life size-doll (II) – the dog's handler holds the doll (used in the point 2) and tries to pet the dog with the doll's hand.

T4. A blanket – unknow tester flaps a blanket in front of the dog (the distance of 1.5 m).

T5. Auditory stimulus (I) – exposure to a sudden car horn (stimulus invisible to the dog).

T6. Auditory stimulus (II) – exposure to a sudden rattling metal cans (stimulus invisible to the dog).

T7. Remote controlled toy car – sudden appearance of electric toy car that gradually increased speed (a car operator invisible to the dog).

T8. A doll on a trolley – a doll on a trolley pulled on a long line towards the dog by a tester who is invisible to the dog.

T9. Socialization test (I) – neutral approach by 3 unfamiliar people normal speed walking.

T10. Socialization test (II) – neutral approach by 3 unfamiliar people (same as in T9) fast speed walking.

T11. A male tester – a unknown tester (male) approaches the dog quickly, staring at it.

T12. A female tester – an unknown tester (female) approaches the dog quickly, staring at it.

T13. An umbrella – a tester repeatedly opens an umbrella in front of the dog.

T14. A foil blanket – a tester flaps an emergency foil blanket in front of the dog (the distance of 1.5 m).

T15. An unknown dog – a tester approaches a unknown dog on a leash up to a distance 2 m.

During all trials the dogs were equipped with a collar and harness and were on a leash. The **T1-T8** have been performed in the presence of the dogs' handlers, the remaining trials have been performed in the absence of the handlers. Each trial lasted roughly 20 seconds.

Behavior assessed

Aggression: barking-short barking sound; growling (low buzzing sound) and/ or barking; baring the teeth (upper lip is pulled up and the teeth are visible) with or without growling and/or barking; snapping movements (mouth opens and closes), with or without growling/or barking and/or showing the teeth; with uncompleted approach (stopping at some distance from stimulus) or without any approach any approach; biting or attacking with bite intention (approaching at high speed and coming as close as possible to victim with bite attempts; actual biting may be impossible because of the safety of the testers, with or without growling and/or barking and/or showing teeth [Netto and Planta 1997, Haverbeke *et al.* 2009]. *Avoidance of the stimuli*: the animal does not display intention of escape (the dog doesn't move back from the source of the stimulus); after a period of interest in the stimulus the dog moves from the source of the stimulus for a short distance; the dog is not interested in the stimulus origin, it turns its head from the stimulus and moves back from the source of the stimulus for a short distance; the dog is not interested in the stimulus and moves back from the stimulus as far as it is possible van der Borg *et al.* [2010]. *Body postures* was described as follows: high - the breed-specific posture as shown by dogs under neutral conditions, but, in addition, the tail is positioned higher or the position of the head is elevated and the ears are pointed forward; half high – a higher position of the tail, and elevation of the head and/or ears pointed forwards (or also: tail higher than neutral, ears backwards); neutral – the breed posture displayed by dogs under neutral conditions; half low – a lowered position of the tail, a backward position of the ears and/or bent legs (or also: tail lower than neutral or neutral and ears backwards); low – the position of the tail is lowered, the ears are positioned backwards and the legs are bent; very low – low posture, but the tail curled forward between the hind legs, the ears are positioned backwards [Beerda *et al.* 1998, Haverbeke *et al.* 2009]. *Stress related behaviors (CS)*, were categorized for 2 groups: (1) the behaviors in seconds scored in points (<10 s – 0.5 point, > 10 s – 1point): panting, sniffing, digging, barking with low mode; (2) the behaviors evaluated by their frequency (0.25 point for each): yawning, licking, sighing, turning the head and/or the body, stretching; nervous walking (1 point) [Netto and Planta 1997, Beerda *et al.* 1998, Haverbeke *et al.* 2009, van der Borg *et al.* 2010]. In the case of displaying of body shaking, yelping and/or nervous squeaking, urination, defecation, crouching down, attempting to run away "at all costs", the testing procedure was stopped. In addition total *arousal* was evaluated (low or lack *vs* medium or high).

All procedure was recorded by video camera.

Ethical clearance to conduct this research project was obtained from The 3rd Local Ethical Commission for Animal Experimentation in Warsaw, Poland #73/2012.

Statistical analyses

Chi-square test was applied to verify the relationship between nominal variables (aggression occurrence, body postures and avoidance in particular tests). Relationship between arousal and aggression, avoidance of the stimuli and CS was assessed using Spearman's correlation. Wilcoxon test was used in order to assess differences in the scope of the analyzed variables, i.e. between the presence of a handler and his absence was performed. Mann-Whitney U test were used to verify whether there are statistically significant differences between two independent groups of dogs. Cluster analysis was used to distinguish group of dogs that differ in terms of a aggression and fear. The p value <0.05 was used as statistically significant. All of analyses was performed using IBM SPSS Statistics 25 software.

Results and discussion

Aggression: The majority of dogs didn't display aggression during the tests (p<0.001). However, umbrella and unknown dog elicited the majority of aggression cases (26.9 and 23.9%, respectively – Fig. 1). *Body posture***:** neutral body posture was
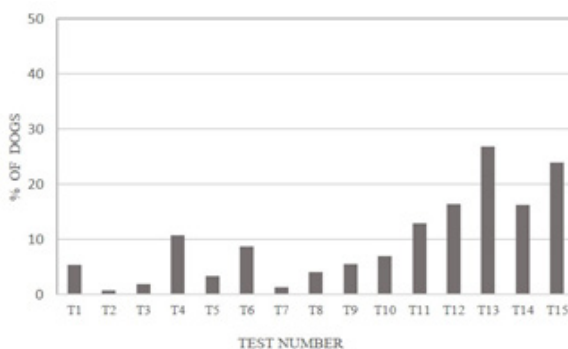

Fig. 1. Percent of dogs displaying at least one aggressive behavior in tests 1-15.

the most common during the tests (p<0.001). High body postures occurred in some dogs during umbrella test (9.7%). Low body posture was characteristic for the umbrella test (42.1%) and artificial hand test (45.3% – Fig. 2). *Avoidance of the stimuli:* The dogs avoided the following stimulus: remote controlled electric car (13.6%), the foil blanket (12.1%) and umbrella (11.7% – Fig 3). *Stress related behaviors***:** The highest level of *CS* was demonstrated by dogs during socialization tests: I, II a male tester, a female tester (Tab. 1). In general, the level of CS was significantly higher in the absence of dog's handler (Z=8.3, p<0.001 – Fig.4). *Arousal:* When considering all the test together significantly higher number of dogs displayed medium or high arousal ($\chi^2(1) = 32.39$; p<0.001).
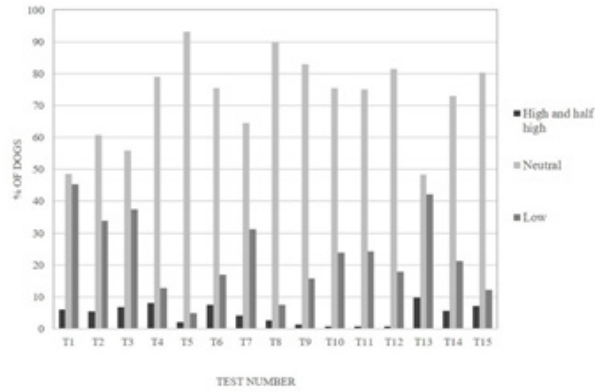
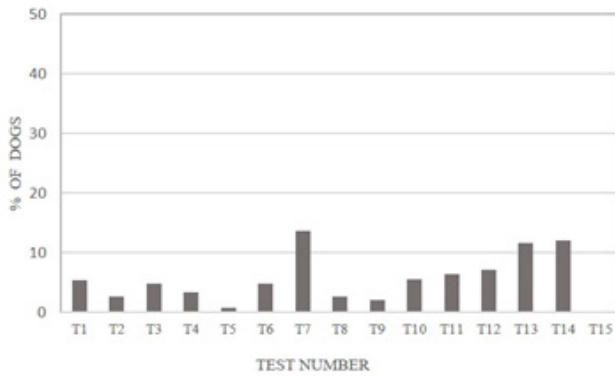Fig. 2. Percent of dogs displaying particular body postures in tests 1-15.
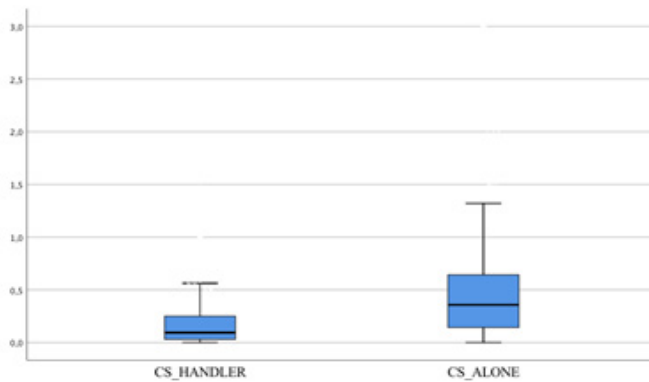

Fig. 3. Avoidance of stimulus source in test 1-15.

Fig. 4. Stress related behaviors (CS) level presented by dogs in the presence (T1-8) and absence (T9-15) of handler, Wilcoxon test, Z=8.3; p<0.001.

412

Table 1. Descriptive statistics for stress related behaviors (CS) in tests 1-15

Test	M	Me	SD	Min	Max	Q1	Q3
T1	0.37	0	0.61	0	3	0	0.5
T2	0.06	0	0.2	0	1.5	0	0
T3	0.19	0	0.55	0	4	0	0
T4	0.23	0	0.48	0	2.5	0	0.25
T5	0.13	0	0.33	0	2	0	0
T6	0.19	0	0.43	0	2	0	0
T7	0.1	0	0.33	0	2.5	0	0
T8	0.26	0	0.49	0	2	0	0.25
T9	0.57	0.25	0.73	0	3	0	0.75
T10	0.59	0.5	0.69	0	3	0	1
T11	0.45	0.25	0.6	0	2.5	0	0.75
T12	0.44	0.25	0.62	0	2.5	0	0.5
T13	0.41	0.13	0.65	0	4	0	0.5
T14	0.39	0	0.64	0	4	0	0.5
T15	0.24	0	0.49	0	2	0	0.25

Correlation between arousal and aggression, avoidance of the stimuli and CS

In total 11 significant positive correlations were observed, most of them related to aggression. The highest positive correlation between arousal and aggression was observed for umbrella (r_s=0.45; p<0.001), a blanket (r_s=0.39; p<0.001), petting with artificial hand (r_s=0.36; p<0.001), a foil blanket (r_s= 0.32; p<0.001), auditory stimulus (r_s=0.29; p<0.001), remote controlled toy car (r_s=0.24; p<0.004), a male tester (r_s=0.2; p<0.02), a doll on a trolley (r_s=0.18; p<0.03). Significant positive correlation was observed between arousal and CS for a male tester test (r_s=0.27; p<0.001). Significant positive correlation was observed between arousal and avoidance during remote controlled toy car test (r_s=0.18; p<0.03). Highly significant, negative correlation between arousal and body posture was observed during the presentation of a life size-doll (test II) (r_s=-0.19; p=0.02).

Identification of the best test(s) for aggression detection

Based on the above results , the following assumption was made that both umbrella and unknown dog tests are the most effective for the aggression detection. During these tests more than 30 animals displayed at least one aggressive behavior (n=39 and n=33, respectively). For remaining tests, the number of aggression events was low or very low, eg. one aggressive event was recorded during the first presentation of a life size-doll (I). Umbrella showed the highest correlation between arousal and aggression when comparing to remaining tests, for which r_s didn't exceed 0.4. In addition, it was demonstrated that aggression is characteristic for dogs that displayed average or high arousal during umbrella test ($\chi^2(1) = 16.06$; p<0.001). In turn, cluster analysis enabled for extraction of two clusters/groups of dogs in terms of aggressive behaviors. Both clusters differ significantly in terms of arousal level (U=491; p=0.006, Tab. 2).

Table 2. Arousal level in the extracted two cluster of dogs (umbrella test), Mann-Whitney U Test

Item	Cluster no.	M	Me	SD	Min	Max	Q1	Q3	Mann-Whitney U test
Arousal	1	2.92	3	0.78	1	4	2	3	U = 491;
	2	3.54	4	0.66	2	4	3	4	p = 0.006

Identification of the best test(s) for fearfulness detection

It was assumed that the best test(s) that detect fear includes parallel occurrence of the following behaviors: low body postures, avoidance of stimulus and significant level of stress related behaviors. Based on the previously performed statistical analysis dogs displayed low body postures mostly during the following tests: petting with artificial hand, presentation of a life size-doll (I, II), umbrella. Avoidance of stimuli was manifested particularly during the following tests: remoted controlled electric toy car, umbrella and foil blanket (Fig. 3). CS occurred in particular during socialization test I and II, approach of a male or female tester, and finally umbrella (Tab. 1). Umbrella test enabled to detect/describe fear in analyzed group of dogs: low body postures was manifested by 42,1% of dogs, avoidance in 11,7%. It is worth to notice that avoidance was slightly higher during electric toy car test and foil blanket test (13.6 and 12.1%, respectively). In summary, the highest level of stress related behavior was observed during socialization tests I and in particular during socialization test II (Me=0.5). Low body postures were typical for umbrella test, however there was a slightly higher percentage of dogs that manifested low body postures during petting the dog with an artificial hand (Fig. 2). The arises question is why umbrella was pointed out as the best test that trigger low body postures in analyzed group of dogs? This phenomenon could be explained - because umbrella was typical test that trigger aggression in the dogs' cohort. Umbrella caused low body postures in analyzed group of dogs, as well. And secondly, – petting with artificial hand hasn't turned out any statistically significant relationships with the arousal, what was found for aggression and umbrella test. Avoidance of stimulus was presented in the highest number of dogs when a fast-moving electric toy car suddenly appeared next to the dog (Fig. 3). In addition, remote controlled toy car as the only one test significantly correlated with avoidance of stimulus.

Different behavioral problems that occur in service dogs, e.g. high level of bite incidents, fearful behavior or low performance during obedience exercises inevitably impact on the efficiency of a dog-handler's teams whilst also initially producing a high time cost in terms of training or indeed a dog's disqualification from training. Desirable police dog candidates have to be physically sound, mature adult that exhibit balanced traits in social behavior, play behavior, search (predatory behavior), and aggression. Thus, behavioral tests are central in gauging these traits for police dog candidates in order to predict their likely efficiency in future work. In patrol dogs it is important to differentiate between desired and undesired aggression [Haverbeke *et*

al. 2009]. The former relates to the ability of the dog to react with aggression toward serious attack during guard duty. The latter is defined as cases of aggression toward individuals outside of a tolerated defense situation during guard duty. In this form of behavior, dogs display submissive signs before an attack. This kind of aggression is particularly undesirable in the case of service dogs due to the fact that the attacking animal bites hard, in uncontrollable manner, very often discharging the emotion and frustration and becomes potentially dangerous for the environment. In the Polish police force, the methods employed for evaluation and selection of dogs in terms of their suitability for professional training (patrol or patrol-searching specialization) consist of the main tasks: defense of the owner, chasing of an unfamiliar person, independence and watchfulness, exposure to gun shot, and assess fear, confidence and dogs' courage. Only dogs which positively passed the qualification procedure were acquired in our study, therefore we did not expect undesired behaviors during the procedure performed. We found that umbrella triggered fear in analyzed group of dogs and was manifested by low body postures and avoidance. However, avoidance of stimulus was the highest for remote controlled toy car and emergency foil blanket. Melzack [1952] claims that avoidance is associated with the size of the stimulus applied: dogs would exhibit generalized excitement to a balloon being slowly blown up in front of them but when it became extremely large, the dogs would invariably exhibit avoidance behavior by jumping backwards. The same author highlights that dogs tend to exhibit avoidance behavior towards sudden movement. King *et al.* [2003] claim that suddenness is an important factor in determining how effective a stimulus is in eliciting fear. In the study, King *et al.* [2003] used four tests: light/dark test, elevated plus maze test, novel object test (mechanical toys) and starling test to assess fearfulness in dogs. The results showed that the novel characteristic of the toy in the novel object test in association with the stimuli of both sudden movements were highly fear-provoking. Some of the dogs exhibited strong avoidance to the toy with starling response, while other animals remained for most of the test in close proximity to the stimulus. The stimulus, represented by the toy car was relatively smaller than the umbrella test and it approached gradually rather than being presented suddenly like the umbrella [King *et al.* 2003]. Studies, performed by Goddard and Beihlarz [1984], Netto and Planta [1997] indicated that opening umbrella, apart from the fear, elicits aggressive behavior in dogs. Our study demonstrated that umbrella provokes the majority of aggressive events in dogs, moreover aggression manifested during umbrella test was positively and highly correlated with dogs' arousal. Haverbeke *et al.* [2009] turned out that umbrella test elicited the highest level of aggression and the lowest body postures in the group of military working dogs. It is worth to mention that umbrella test was performed in the absence of the dogs' handler, and Haverbeke et al. [2009] categorized it as strong stress test. We found that 16.4% and roughly 14% of dogs displayed aggression toward unknown female and/or male tester, who slowly approached toward the dogs and starred at it. During socialization test I and II 5.5 and 7%, respectively, dogs that displayed aggression. Socialization tests induced the highest level of CS. Haverbeke *et al.* [2009] found that around 50%

of military working dogs showed at least one act of aggressive biting toward adult humans in the following tests: petting the dog using artificial hand, slow approach by 3 unknown testers, rapid approach by the same testers. The first test, with the use of artificial hand caused 38.7 % acts of aggressive biting. In addition, the test showed that the dog's body posture towards adult humans was lower than neutral [Haverbeke *et al.*, 2009]. The life size doll in the study of Haverbeke *et al.* [2009] resulted in 32.6% of act of aggressive behaviors and lower that neutral body postures. Based on the survey performed, the authors showed that 50% of the dogs had already been in contact with children (n=4) and afraid of children (n=1). There is no consensus about the context of showing aggression to people. For example, Casey *et al.* [2014] based on the survey performed, suggest that dogs show aggression towards unfamiliar people, particularly when entering house.

Noise aversions are quite common in dogs. Single traumatic experiences or repeated exposure to frightening stimuli can cause reactions ranging from mild fear to extreme phobic reactions. We used two kind of auditory stimuli: a sudden car horn and sudden rattling metal cans. We didn't find significant dependencies for them in terms of fearfulness. The fact that auditory stimulus was not significant in eliciting fear in dogs came as no surprise as police dogs' candidates are exposed to gunshots prior to their testing. This type of exposure is known as gunfire desensitization. A gun-sensitive dog can never be allowed to work as a police dogs as a gunshots will most definitely be encountered during its work [Slabbert and Odendaal 1999].

Conclusions and limitations

The results of the presented study show pros and cons of the applied elsewhere test and stimulus while evaluating aggression and/or fear in dogs. Additionally, we are aware of the bottlenecks. The dogs involved in the study already passed series of qualification test that verified some of the dogs' traits like fearfulness towards various stimulus. Statistical analysis didn't take into the consideration the dogs' breed and gender. In addition, we are aware of the challenges of accurately defining and measuring behavioral phenotypes. However, our results partially remain in concordance with the results presented by other authors, eg. Haverbeke *et al.* [2009]. Moreover, such results can be used for identification of dogs displaying aggression and fearfulness for further genetic studies.

Conflict of interest statement

The authors have nothing to disclose.

REFERENCES

1. BEERDA B., SCHILDER M.B.H., VAN HOOFF J.A.R.A.M., DE VRIES H.W., MOL J.A., 1998 – Behavioural, saliva cortisol and heart rate responses to different types of stimuli in dogs. *Applied Animal Behaviour Science 58*, 365-381.

2. CASEY R.A., LOFTUS B., BOLSTER C., RICHARDS G.J., BLACKWELL E.J., 2014 – Human directedaggression in domestic dogs (Canis familiaris): Occurrence in different contexts and risk factors. *Applied Animal Behaviour Science* 152, 52-63.

3. CATALÁN A.I., ROJAS C.A., CHÁVEZ G.A., 2020 – Recognition of aggressive and anxious behaviors in canines by a group of Chilean veterinarians. *Journal of Veterinary Behavior* 38, 8-13.

4. DUFFY D.L., HSU Y., SERPELL J.A., 2008 – Breed differences in canine aggression. *Applied Animal Behaviour Science* 114, 441-460.

5. GODDARD M.E., BEILHARZ R.G., 1984 – A factor analysis of fearfulness in potential guide dogs. *Applied Animal Behaviour Science 12*, 253-265.

6. GRAY J.A., 1987 – The Psychology of Fear and Stress, 2nd ed. Cambridge University Press.

7. HAVERBEKE A., DE SMET A., DEPIEREUX E., GIFFROY J.M., DIEDERICH C., 2009 – Assessing undesired aggression in military working dogs. *Applied Animal Behaviour Science* 117, 55-62.

8. KING T., HEMSWORTH P.H., COLEMAN G.J., 2003 – Fear of novel and startling stimuli indomestic dogs. *Applied Animal Behaviour Science* 82, 45-64.

9. MELZACK R., 1952 – Irrational fears in the dog. *Canadian Journal of Psychology 6*, 141-147.

10. NETTO W.J., PLANTA D.J.U., 1997 – Behavioural testing for aggression in the domestic dog. *Behavioural Problems of Small Animals 52*, 243-263.

11. OVERALL K.L., LOVE M., 2001 – Dog bites to humans – Demography, epidemiology, injury, and risk. *Journal of the American Veterinary Medical Association 218*, 1923-1934.

12. SLABBERT J.M., ODENDAAL J.S.J., 1999 – Early prediction of adult police dog efficiency – A longitudinal study. *Applied Animal Behaviour Science* 64, 269-288.

13. SOMA K.K., SCOTTI M.A.L., NEWMAN A.E.M., CHARLIER T.D., DEMAS G.E., 2008 – Novel mechanisms for neuroendocrine regulation of aggression. *Frontiers in Neuroendocrinology* 29, 476-489.

14. TEMESI A., TURCSÁN B., MIKLÓSI Á., 2014 – Measuring fear in dogs by questionnaires: An exploratory study toward a standardized inventory. *Applied Animal Behaviour Science* 161, 121-130.

15. VAN DEN BERG L., SCHILDER M.B.H., DE VRIES H., LEEGWATER P.A.J., VAN OOST B.A., 2006 – Phenotyping of Aggressive Behavior in Golden Retriever Dogs with a Questionnaire. *Behavior Genetics* 36, 882-902.

16. VAN DER BORG J.A.M., BEERDA B., OOMS M., DE SOUZA A.S., VAN HAGEN M., KEMP B., 2010 – Evaluation of behaviour testing for human directed aggression in dogs. *Applied Animal Behaviour Science* 128, 78-90.

17. VÅGE J., WADE C., BIAGI T., FATJÓ J., AMAT M., LINDBLAD-TOH K., LINGAAS F., 2010 – Association of dopamine- and serotonin-related genes with canine aggression. *Genes, Brain and Behavior* 9, 372-378.

18. VEROUDE K., ZHANG-JAMES Y., FERNÀNDEZ-CASTILLO N., BAKKER M.J., CORMAND B., FARAONE S.V., 2016 – Genetics of aggressive behavior: An overview. *American Journal of Medical Genetics Part B: Neuropsychiatric Genetics* 171, 3-43.

19. WALL P.M., BLANCHARD D.C., BLANCHARD R.J., 2003 – Behavioral and Neuropharmacological Differentiation of Offensive and Defensive Aggression in Experimental and Seminaturalistic Models. W M.P. Mattson (Ed.), Neurobiology of Aggression: Understanding and Preventing Violence (s. 7391). Humana Press.