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Behavioral and cortisol responses of shelter dogs to a cognitive bias test after olfactory enrichment with essential oils

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Abstract: A shelter environment tends to present different types of stressors dogs need to cope with. Recent work has shown that olfactory enrichment with essential oils might be able to modify the affective states of certain species (dogs, cats, horses, zoo animals…). In these studies, the welfare measurements included physiological indicators, such as corticosteroid levels, and/or behaviors related to chronic stress. The olfactory effects of 9 essential oils (*Cananga odorata,Cistus ladaniferus, Citrus aurantium, Cupressus sempervirens, Juniperus communis* var. *montana, Lavandula angustifolia, Laurus nobilis, Litsea citrata, Pelargonium graveolens*) and a blend of these oils were explored on a cognitive bias test, cortisol levels and the behaviors of 110 shelter dogs (n = 10 dogs within each group). Olfactory enrichment with the blend resulted in a reduced latency to the ambiguous cue, indicating a more optimistic bias and improved welfare. The results of this study suggest that olfactory enrichment with essential oils can have specific effects on the affective states and behaviors of shelter dogs, and could therefore be useful for shelter management. In addition, as not all of the essential oils tested individually were effective, more research should be conducted to better understand the effects of each individual essential oils on dogs.

Key Words: behavior; cognitive bias; cortisol; dogs; essential oils; olfactory enrichment; shelter; welfare.

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Introduction

A shelter environment tends to present different types of stressors dogs need to cope with: social stressors (reduced intraspecific and/or interspecific social contacts), environmental stressors (restraint for medical procedures, separation from a caretaker or handler) or psychogenic stressors (separation anxiety, use of aversive training methods by a previous owner/lack of ethological knowledge in caretakers). Moreover, stressors are known to cause activation of metabolic and endocrine responses in sheltered animals (Titulaer et al., 2013).

Recent work has shown that essential oils might be able to modify the affective states of certain species (dogs, cats, horses and zoo animals: Wells, 2004; Graham et al., 2005; Ferguson et al., 2013; Wells & Egli, 2015; Binks et al., 2018). In these studies, the welfare measurements included physiological indicators, such as corticosteroid levels (Beerda et al., 1998) or behaviors related to chronic stress, such as repetitive behaviors, nosing, paw-lifting, increased locomotion, displacement behavior or excessive drinking (Beerda et al., 1998; Haverbeke et al., 2008).

However, interpretation of these indicators can be difficult (Titulaer et al., 2013). Therefore the detection of a cognitive bias might be a complementary solution. A recent and innovative approach utilizes the influence of affective states on the interpretation of current experience. The resulting affect-induced cognitive biases can be measured (Mendl et al., 2009) through cognitive bias tests as indicators of the animal's psychological well-being (Mendl et al., 2009; Paul et al., 2005). A cognitive bias test in this context refers to the propensity of a subject to show

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behavior indicating the anticipation of either relatively positive or relatively negative outcomes in response to affectively ambiguous stimuli (Mendl et al., 2009). Changes in cognitive bias reflect an individual's experience of positive and negative events and thus its affective valence and welfare (Mendl et al., 2010). The effects of environmental enrichment have been already tested through cognitive bias test in different species such as rats (Brydges et al., 2011), pigs (Douglas et al., 2012) and European starling (Bateson & Matheson, 2007).

Several studies have found correlations between cognitive biases and affective states in a wide range of species, including mammals (Mendl et al., 2009; Doyle et al., 2010) and birds (Matheson et al., 2008; Salmeto et al., 2011). The aim of the current study was to assess whether olfactory enrichment through essential oils influences the affective states of sheltered dogs. To do that, the possible effects of 9 different of essential oils (*Cananga odorata, Cistus ladaniferus, Citrus aurantium, Cupressus sempervirens, Juniperus communis* var. *montana, Lavandula angustifolia, Laurus nobilis, Litsea citrata, Pelargonium graveolens*) and a blend of these oils on a cognitive bias test, cortisol levels and behavior of 110 shelter dogs were explored.

Materials and Methods

Participants

One hundred ten dogs ranging in age from 1 to 10 years, of both sexes, and of either pure or mixed breed, were enrolled in the study and randomly allocated to one of 11 different groups (Table 1). The dogs lived in groups of three in kennels with an indoor section measuring 1.5 meters x1.5 meters and an outdoor run measuring 1.5 meters x 2 meters, joined by a metal door operated by staff. Water was available *ad libitum*, and food was provided twice per day, at 8 am and 6 pm.

Dogs were selected based on the following criteria: (a) success at the training phase, (b) no previous diagnosis of anxiety or aggressive behavior, (c) some socialization prerequisites, such as the ability to deal with people without fear, (d) the veterinarian's agreement and (e) ability to walk on leash (f) good medical health.

Table 1. Description of the study protocol.

Group	Number of dogs	Pre-test training	Cognitive test 1	Exposure to collar for 3 hours	Cognitive test 2
1	10	Yes	Before exposure to collar and after collection of saliva at T0	No addition (control group)	After exposure to collar and after collection of saliva at T1
2	10	Yes	Before exposure to collar and after collection of saliva at T0	The blend	After exposure to collar and after collection of saliva at T1
3	10	Yes	Before exposure to collar and after collection of saliva at T0	*Litsea citrata*	After exposure to collar and after collection of saliva at T1
4	10	Yes	Before exposure to collar and after collection of saliva at T0	*Cupressus sempervirens*	After exposure to collar and after collection of saliva at T1
5	10	Yes	Before exposure to collar and after collection of saliva at T0	*Citrus aurantium*	After exposure to collar and after collection of saliva at T1
6	10	Yes	Before exposure to collar and after collection of saliva at T0	*Pelargonium graveolens*	After exposure to collar and after collection of saliva at T1

7	10	Yes	Before exposure to collar and after collection of saliva at T0	*Lavandula angustifolia*	After exposure to collar and after collection of saliva at T1
8	10	Yes	Before exposure to collar and after collection of saliva at T0	*Cananga odorata*	After exposure to collar and after collection of saliva at T1
9	10	Yes	Before exposure to collar and after collection of saliva at T0	*Juniperus communis* var. Montana	After exposure to collar and after collection of saliva at T1
10	10	Yes	Before exposure to collar and after collection of saliva at T0	*Cistus ladaniferus*	After exposure to collar and after collection of saliva at T1
11	10	Yes	Before exposure to collar and after collection of saliva at T0	*Laurus nobilis*	After exposure to collar and after collection of saliva at T1

Olfactory enrichment

A blend of 9 essential oils (Arhomani, Belgium) and each separate oil of the blend (Flora s.r.l., Pisa, Italy) were tested, for a total of 10 treatments and a control group (Table 1). Essential oils were diffused through a cotton collar worn by the dogs for 3 hours before starting the second cognitive test procedure (see below). The collar, just before being applied to the dog, had 1 drop of an individual oil or of the blend added to it. The control group, as the experimental groups, wore a cotton collar for 3 hours but without any oils or other addition.

During this part of the experiment, the dogs stayed in the pen where they routinely spent time. Dogs were allowed to mix in the same pen only if they were allocated to the same essential oil group. In order to avoid odour contamination, there was a distance of 500m between the different pens.

Test protocol

Cognitive test

All dogs of the 11 groups were subjected to two cognitive bias (CB) tests (modified from (Mendl et al., 2010), one prior to (CB 1) and one after essential oil exposure (CB 2). CB 2 was performed 3 hours after T0. To avoid more stress caused by a different routine in the shelter, we could not control for order effects. All the dogs were tested on the second cognitive bias test following olfactory enrichment.The protocol of (Mendl et al., 2010) and (Owczarczak-Garstecka & Burman, 2016) was modified in this study based on a pilot study we carried out, in which we observed that dogs in the shelter were unable to maintain attention during the original cognitive test as proposed in (Mendl et al., 2010) and (Owczarczak-Garstecka & Burman, 2016). For this reason, we used a shortened version. During the training session, all dogs received a minimum of 8 training trials instead of 15. During the test, we used just one ambiguous location instead of three ambiguous locations. The test phase involved 6 trials (instead of the 32 proposed by (Mendl et al., 2010).

In addition, during the pilot study, we realized that shelter dogs were much more interested in humans than in food, so we changed the original protocol by having the researcher behind the camera rather than behind the bowl put on the ground, in order to avoid the dog choosing that bowl for its closeness with a person (the researcher).

Training and cognitive tests were performed with each dog enrolled in the experiment individually led to a test area (6 meters x 6 meters) within the shelter, the same for all sessions and all dogs. The setting is described in figure 1. The bowl was placed at one of three predetermined locations (two during the training) 4 meters in front of the dog's fixed starting position. The

latency to reach the bowl, was defined as the time elapsed between release from the lead and the dog putting its head into the bowl, or touching the rim of the bowl with its nose (Mendl et al., 2010). CB tests were video recorded and then analysed as described below.

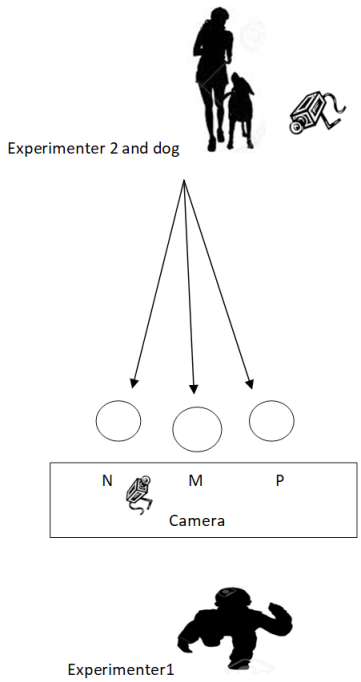

Figure 1. Experimental setting.

Training

Dogs were first trained to associate a certain location with a reward. During the training, the distance between the two bowls (Positive and Negative) was 1meter.When the bowl was placed at the 'positive' location (P) on one side of the test area, it contained food, and when it was placed at the 'negative' location (N) on the opposite side of the test area, it was empty. Two visually identical bowls were used for rewarded (P) and non-rewarded (N) locations, and both bowls had a piece of food taped to their bottom sides that were inaccessible to the dogs to control for odour cues. Training was complete when the dogs reached a pre-set criterion, that is, when the dog ran to the positive location faster than to the negative one twice consecutively.

Each training session started after a 10-minute period of habituation with the researchers in the experimental area (Figure 1). The dog was put on a lead and held by one of the researchers behind a barrier, while the other researcher stood at the far end of the room and baited (or did not bait, depending on trial type) a food bowl with 50 gr of commercial dog food. The dog was released to approach the bowl. Each dog received at least 8 training trials conducted so that no location was repeated more than twice. Each training session started with two positive (rewarded) trials to encourage participation, followed by two negative (non-rewarded) trials. The remaining trials were randomly assigned to be rewarded or non-rewarded. The latency to reach the bowl, defined as the time elapsed between release from the lead and the dog putting its head into the bowl or touching the rim of the bowl with its nose, was recorded for each trial using a stopwatch. The maximum time allowed per trial was 30 seconds. If the dog did not reach the food bowl within that time, the maximum time was scored.

Test

When the training was completed, the test started. Each dog was presented a food bowl in three locations, positive (P), negative (N) and intermediate (M).The Middle bowl was located between Positive and Negative bowl. The distance between Positive (or Negative) and Middle Bowl was 50 cm.The bowl was presented in each location twice (P1, M1, N1 and P2, M2, N2) but in different order. The accessible food was only present in the positive location (P). Negative (N) and Intermediate (M) locations remained empty but with olfactory control cues. All the tests were videorecorded. Since in each CB the locations were tested twice, we used mean values for each location in CB 1 and in CB 2 in further analyses.

Behavioral observations

The observations of dog behaviors were carried out on the videos recorded during the whole test. Each dog was observed using a continuous sampling method.

The behavioral analysis was conducted using the ethogram reported in Table 2 and 3 (Haverbeke et al., 2008). Depending on the type of behavior, either the duration (in seconds) or the number of occurrences was recorded.

Table 2. Behaviors scored in terms of number of occurrences.

Behavior	Description
Oral behaviors: Yawning	Mouth open to apparent fullest extent while eyes are closed
Non-directed licking Snout licking	Tongue out, the tip of the tongue is briefly extended Part of the tongue is shown and moved along the upper lip
No oral behaviors Paw lifting	Fore paw lifted into a position of approximately 45°
Urinatingsquat	Urinating by squatting while keeping both hind limbs on cage floor
Urinating, limbraised	Urinating while raising one hind limb
Defecating	Excreting the contents of the bowels

Table 3. Behaviors analysed in terms of duration (seconds).

Behaviors	
Repetitive or stereotypicbehavior	
Pacing	Immediately repeating a path just taken and continuing in the repetition in circles, in a figure eight pattern or fence/wall-line running
Circling	Continuous walking in short circles, apparently chasing its tail or hind limbs
Other behaviors	Manipulating environment (Stereotypic interactions with elements from the environment, such as digging (scratching the floor with the forepaws in a way that is similar to how dogs dig holes), floor licking (licking the floor with the tongue)), Auto grooming
Notseen	Unable to determine behavior of the dog owing to darkness or the position of the dog
Miscellaneousoralbehaviors	
Barking	loud, rough noise
Roaring	loud, deep sound
Growling	low, rough sound
Whining	long, high sound
Yelping	sudden, short, high sound
Panting	Increased frequency of inhalation and exhalation often in combination with the opening of the mouth
Teethclapping	Making short loud noise by hitting teeth together

Notseen	Unable to determine the behavior of the dog owing to darkness or the position of the dog
Locomotive states	
Prone, head down	Trunk of body on floor, chin or side of head in contact with the floor, paws or limbs
Prone, head up	Trunk of body on the floor, no part of the head in contact with the paws
Sitting	Only hindquarters and front paws in contact with the floor
Standing	Upright with at least three paws in contact with the floor without any walk
Walking	Takes at least one step, shifting body position
Highly active	Any motion across floor faster than a walk, including trotting and jumping
Changing from one state of locomotion to another	
Notseen	Unable to determine behavior of dog owing to darkness or the position of the dog
Postures	
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 forwards, or the animal is standing extremely erect
Neutral	The breed posture shown by dogs under neutral conditions
Halflow	Two or more of the following three features are displayed: a lowered position of the tail (compared to the neutral posture), a backward position of the ears and bent legs
Low	The position of the tail is lowered, the ears are positioned backwards, and the legs are bent
Verylow	Low posture, but now the tail is curled forward between the hind legs
Notseen	Unable to determine the behavior of the dog owing to darkness or the position of the dog

Cortisol

Saliva samples for the assessment of plasma cortisol concentrations were collected, at the same time in the day, before the addition of the oils at T0 (to identify the basal cortisol levels) and at T1, i.e. after 3 hours exposure to the collar for all groups, including the control one. Collection was always carried out before the cognitive bias tests at T0 and T1. Saliva samples were collected using Salivette Cortisol code blue(Sarstedt, Nümbrecht, Germany) and stored at-20 °C until they were further processed using a commercial ELISA kit (Diametra, Milano, Italy).

Statistical analysis

The statistical analysis was performed using IBM SPSS Statistics for Windows, version 22.0 (Armonk, NY: IBM Corp). For each of the oils under study, the difference in the variables measured before and after exposure was tested using a Wilcoxon signed-rank test. This paired difference test was used because each subject is measured twice, resulting in *pairs* of observations. This reduces the effect of confounders like individual differences (e.g. in pace length or in interest in food) between dogs. The test statistics (sum of positive ranks) as well as the two-sided p-values are reported in the results below. P values ≤ 0.05 were deemed statistically significant.

We additionally tested for T0 as well as T1 whether the dogs' responses during the cognitive bias tests were appropriate (i.e. dogs were slower to approach the 'negative' location N when compared to the 'positive' location P) by using a one-sided paired t-test comparing latency to approach N versus latency to approach P. Statistical p values ≤ 0.05 were deemed statistically significant.

Results

Cognitive test

We explored the dogs' latency to approach P and N, just to make sure dogs' response to the CB test 1 (before exposure) and CB test 2 (after exposure) was appropriate (i.e. animals were slower to approach N than P). The results are reported in Table 4.

Table 4. Statistical results of the comparison between latency to reach positive and negative locations before exposure and after exposure to essential oils (CB 1: Cognitive test before exposure; CB 2: Cognitive test after exposure).

		Mean (seconds)	N	Standard. Deviation	Standard Error Mean
CB 1	Latency before exposure P location	19.32	110	17.01	1.62
	Latency before exposure N location	24.18	110	27.28	2.60
CB 2	Latency after exposure P location	2.64	110	0.48	0.05
	Latency after exposure N location	13.81	110	13.53	1.29

The analysis revealed a significant effect of the blend "The blend" in reducing the latency to reach the intermediate position (test statistic=3; n=10; p=0.039). We also observed a trend towards reducing the latency to reach the intermediate position (test statistic=5; n=10; p=0.078) for *Litsea citrata* oil (Table 5).

Table 5. Latency (mean ± Standard Deviation in seconds before and after 3 hours of exposure) and cortisol values (mean ± Standard Deviation in ng/ml before and after 3 hours of exposure) to each essential oil or after 3 hours without any exposure in the control group (P < 0.05, *).

	Before exposure	After 3 hours of exposure (T1)	Statistical results	Before exposure	After 3 hours of exposure (T1)	Statistical results
	Latency value (seconds)			Cortisol value (ng/ml)		
Control group (no exposure)	20.60±11.00	15.95±10.98	P=0.38	2.406 ± 0.30*	1.762 ± 0.435	P=0.03*
Cananga odorata	18.65±7.84	16.92±9.35	P=0.84	1.923 ± 0.70	1.512 ± 0.111	P=0.08
Cistus ladaniferus	18.77±11.78	14.98±11.93	P=0.54	1.538 ± 0.22	1.424 ± 0.132	P=0.18
Citrus aurantium	17.22±12.48	11.21±11.98	P=0.35	1.642 ± 0.21	1.507 ± 0.196	P=0.43
Cupres sussempervirens	24.47±7.14	18.46±11.32	P=0.19	1.766 ± 0.58	2.175 ± 0.424	P=0.12
Juniperus communis var. Montana	21.93±9.30	14.06±13.71	P=0.20	1.397 ± 0.30	1.497 ± 0.364	P=0.74
Laurus nobilis	20.80 ±11.35	15.45±9.59	P=0.10	1.082 ± 0.45	1.435 ± 0.198	P=0.14
Lavandula angustifolia	22.19±9.60	16.70±14.08	P=0.29	1.821 ± 0.39*	1.549 ± 0.245	P=0.03*
Litsea citrate	21.97±9.34	14.70±10.39	P=0.078	1.467 ± 0.30	1.919 ± 0.313	P=0.078
Pelargonium graveolens	20.74±9.58	15.48±10.70	P=0.10	1.287 ± 0.33	1.596 ± 0.504	P=0.10
The blend	23.83±9.80	13.46±11.28	P=0.039*	1.557 ± 0.49	1.316 ± 0.119	P=0.25

Behavioral observations

Only the olfactory enrichment with *Laurus nobilis* induced a significantly longer duration of high posture among these dogs (test statistic=26.5; n=10; p=0.047).

The analysis revealed non-significant trends for different oils: *Cananga odorata* reduced the "nosing" time (test statistic=9; n=10; p=0.064), *Citrus aurantium* (test statistic=46; n=10; p=0.064) and *Cupressus sempervirens* (test statistic=39; n=10; p=0.055) increased the time spent in "tail wagging", and *Pelargonium graveolens* (test statistic=3; n=10; p=0.078) reduced the time spent in "non-oral stress behaviors" (circling, pacing, manipulation of environment, autogrooming).

Cortisol

Olfactory enrichment with *Lavandula angustifolia* induced a significant reduction in saliva cortisol levels (test statistic=3; n=8; p=0.039). A similar significant reduction was also found in the control group (test statistic= 0; n=6; p=0.031) (Table 5).

Discussion

Cognitive test

In the present study, authors applied a cognitive test to evaluate the effectiveness of olfactory enrichment with essential oils in reducing the level of stress in sheltered dogs. Olfactory enrichment with the blend of oils resulted in a reduced latency to the ambiguous cue in the cognitive test, indicating a more optimistic bias and, consequently, an improved welfare (Mendl et al., 2010). These results provide support for the idea that the interactions between compounds often result in biological activity that is greater than the activity of the isolated compounds(Galindo et al., 2010).

Many domestic dogs are kept in rescue and rehoming shelters which are frequently stressful and impoverished environments. Dog's welfare is often compromised within these environments and there is a need to determine new practical and effective methods to improve the welfare of these kenneled dogs (Binks et al., 2018).The development of objective methods to assess the affective states of non-human animals is a crucial step in improving animal welfare (e.g. Dawkins, 2008.). Mendl (Mendl et al., 2009) enumerated several potential advantages of the cognitive bias test, including the ability to make *a priori* predictions for different species: mammals (Mendl et al., 2009; Doyle et al., 2010), birds (Matheson et al., 2008; Salmeto et al., 2011) and insects (Salmeto et al., 2011). Douglas et al. (2012) support the hypothesis that an enriched environment induces a more optimistic cognitive bias indicative of a more positive affective state and better welfare in pigs.

Negative effects from inadequate environmental manipulations have been investigated by several researchers. Environmental manipulations chosen to induce negative effect produce pessimistic cognitive biases in animals' responses to ambiguous stimuli (reviewed in (Mendl et al., 2009)). Rats show pessimistic responses when housed in impoverished cages but switch to optimistic responses when moved to enriched cages (Brydges et al., 2011).

To our knowledge, this is the first time that a cognitive bias test has been applied to assess the effect of olfactory enrichment with essential oils. Although this is a first study on this topic and the number of dogs tested in each experimental group was relatively low, it is remarkable that the statistical analysis revealed some significant differences. In particular, the results regarding the blend of oils are in line with previous studies that reported improved optimism through environmental enrichment (Douglas et al., 2012) in pigs.

However, we should take into account that the medium latency for reaching the positive location in the cognitive bias test 2 (P2- after exposure) is significantly lower than the medium latency

for reaching the positive location in test 1 (P1- before exposure). So although the dogs respond appropriate to each CB-test (i.e. approaching N significantly slower than P), they approach both P and N significantly faster during CB2 than during CB1, which might suggest some eagerness to participate in the test.

Behavioral observations

The results of the present study indicate that olfactory enrichment with *Laurus nobilis* induced high posture among dogs. In volatiles, *Laurus nobilis* has been reported to improve vigilance performance in a discrimination task (Matsubara et al., 2011), which could be interpreted positively as increased self-confidence (Fatjó et al., 2007) or alternatively as a heightened alertness due to a negative state. In humans, a high individual variability in response to olfactory exposure to 1,8-cineol (major component of *Laurus nobilis*), jasmine absolute ether, linalyl acetate and peppermint essential oil has been observed on vigilance (Heuberger & Ilmberger, 2010). In the present study, dog's high posture after olfactory exposure with *Laurus nobilis*is not accompanied by other signs of alertness and can therefore be interpreted as a sign of improved self-confidence in line with Haverbeke et al. (2008).

Some essential oils had a slight effect on behavior. Olfactory enrichment with *Cananga odorata* reduced the "nosing" time. This could indicate a decrease of stress among the dogs (Beerda et al., 1998). In line with these interpretations, Hongratanaworakit and Buchbauer (2004) showed that in humans *Cananga odorata* decreases blood pressure and pulse rate and increases subjective attentiveness and alertness. Olfactory enrichment with *Citrus aurantium* and *Cupressus sempervirens* increased the time spent in "tail wagging". Tail wagging can be seen in the interactive social context or to facilitate interaction and could have ambivalent interpretations going from an increase to a decrease in confidence in dogs (Gasci et al., 2005). In the present study, the exposure of dogs to *Citrus aurantium* and *Cupressus sempervirens* are not accompanied by other changes. Therefore it is likely that in this study tail wagging is a sign of relaxation. This is in line with previous results that have demonstrated anti-anxiety effects of both *Citrus aurantium* (in humans (Akhlaghi et al., 2011; Carvalho-Freitas et al., 2002; De Moraes Pultrini et al., 2006) and rats (Leite et al., 2008) and *Cupressus sempervirens*(in humans Bouguenoun et al., 2006).

Olfactory enrichment with *Pelargonium graveolens* reduced the time spent in "non-oral stress behaviors" (circling, pacing, manipulation of environment, autogrooming). This observed reduction of stress behaviors (Haverbeke et al., 2008) is in line with the findings of Rashidi Fakari et al., 2015, who observed an anxiolytic and sedative effect of *Pelargonium graveolens* in humans.

Cortisol

The observed reduction in saliva cortisol with *Lavandula angustifolia*is in line with Atsumi & Tonosaki who have observed a decrease of salivary cortisol level on humans after smelling lavender essential oil (Atsumi & Tonosaki, 2007). In addition, a previous study using olfactory enrichment with *Lavandula angustifolia* on sheltered dogs showed a change in dogs' activities (resting time) suggestive of relaxation (Graham et al., 2005).

We also observed a reduction of cortisol levels in the control group. This finding is in line with previous research in dogs (Shiverdecker et al., 2013; Cobb et al., 2016). One possible explanation is that, the mere application of a cognitive test can result in a stress relieving factor, being a sort of cognitive enrichment for sheltered dogs. However, this does not explain why the cognitive test with essential oil exposure had no effect on cortisol levels except in the *Lavandula angustifolia* group. Another explanation is that essential oils (except *Lavandula angustifolia*) has increased neophobia (i.e. the fear of novelty, which can be sometimes observed in captive animals that have received little or no previous novel sensory stimulation (Mason et al., 1991) as observed in Goeldi's monkeys exposed to peppermint oil (Boon, 2003) and in a young tiger exposed to catnip

(Todd, 2015). However, as dogs belong to a species who tends to be very neophilic (Kaulfuss & Mills, 2008) this explanation might probably not be considered for the canine species.As the interpretation remains open, further studies are required in order to demonstrate through a more detailed and rigorous analysis the effects of *Lavandula angustifolia* essential oil on cortisol levels versus the effects of the other essential oils.

Although saliva collection was carried out at different times of the day, it is unlikely that the differences we observed were influenced by this. In fact, previous research has not found a circadian rhythm in the HPA (Hypothalamic Pituitary Adrenal) activity of dogs: neither in laboratory dogs at 30 minutes intervals over a period of 28 hours (Takahashi et al., 1981) nor at 20 minutes intervals over a period of 25 hours (Kemppainen & Sartin, 1994), nor in working dogs exposed to defense training and trailing tasks at 90-180 minutes intervals over a period of 24 hours (Kolevska et al., 2003).

The saliva cortisol collected after T1 could not have reflected an earlier emotional state (pre-olfactory enrichment), because cortisol concentrations rise approximately 20 minutes after a dog encounters a stressor (Vincent & Michell, 1992). Moreover, previous authors (Kirschbaum & Hellhammer, 2000) have shown that changes in plasma and salivary cortisol levels are closely synchronized: after injections of cortisol, salivary levels increase within 1 minute and peak concentrations in blood are seen 2-3 minutes later in saliva.

Some methodological limitations have been encountered during this study. Firstly, we used a short version of the cognitive bias test because the sheltered dogs were not able to perform the longer test (author's observations in an unpublished, pilot study). Their limited performance might be due to the fact that these dogs were not accustomed to be involved in cognitive activities in their actual environment (presence of physical and social stimuli).

Secondly, being a study carried out in the field and not in a laboratory setting, many factors could not be controlled. For instance, there is a potential risk of olfactory confounding effects. However, in order to reduce the risk of crossed stimulation among different essential oils groups, a distance of 500 meters from one pen to another was set. Further, in a shelter environment the quantity of olfactory stimuli is high and similar for all dogs. Thus a possible effect of odours other than essential oils should be equally distributed for all dogs, which is not the case in the present study. Lastly, even if we might consider any olfactory confounding effect, the main olfactory effect should still remain the one obtained by the tested essential oil as it is the most proximate odour from the dog's nose. In order to confirm our results, further research should investigate the maximum or minimum distance necessary to create an olfactory effect with essential oils.

Thirdly, the findings should be interpreted with caution because it is possible that the dogs' behavior was influenced by a learning effect and a decreased interest because the cognitive bias test was repeated twice. However, each time that a cognitive bias test is being used, information processing, including attention, learning, memory and decision-making is being addressed (Mendl et al., 2009).

Fourthly, in our study all the dogs were tested on the second cognitive bias test following olfactory enrichment. Unfortunately, we could not control for any order effects, because a different protocol would have caused changes in the shelter routine and therefore additional stress for the shelter dogs and the staff. Nevertheless, as the order was the same for the tested dogs, the results of a potential order effect should be the same for all groups. The different findings observed in sub samples suggest that essential oils have different effects: this could be a combination of essential oils' stimulation and repetition of the test. Further research should investigate the effects of single essential oils in different conditions.The tendencies or significant decreases that are found in different behaviors in various groups could be caused by an increase in confidence the dogs experienced in the second CB (they were familiar with the CB and might have been eager to

participate and enjoy human contact or the enrichment).If a design would be applied in which 50% of the dogs start with essential oils (group 1) and 50% of the dogs without essential oils (group 2), it is not possible to conduct the control-CB within the same day as the essential oil-CB for the first group. It is quite likely that after 3 hours of exposure to essential oils, an effect of essential oils would still be present during the control-CB. Conducting the control-CB at another day would generate a confounding effect of day.

Lastly, we should take into account that Galindo (Galindo et al., 2010) affirmed that effects of essential oils can vary considerably depending on the dosage. In our study, we used the same dosage for each oil. Further studies will need to focus on the effects which obtained by diffusing different concentrations of essential oils.

Conclusions

These preliminary results suggest that olfactory enrichment with essential oils can influence the affective states and behaviors of shelter dogs. More research is needed to understand the impact of each individual essential oil and its effect on dog's welfare, considering possible factors affecting their influence, including individual factors or different concentrations of the essential oils.

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Author Contributions

The idea for the paper was conceived by Haverbeke A. and Uccheddu S. The experimental protocol was designed by Uccheddu S., Haverbeke A. and Mariti C. The data were statistically analysed by Arnouts H. and Sannen A. and discussed by all authors. The videos were analysed by Gutierrez Rufo J. The cortisol concentration in the saliva was analysed by Mariti C. and Gazzano A.. The paper was written by Uccheddu S. and Haverbeke A. and discussed by all authors.

Conflicts of Interest

There could be a potential conflict of interest because Haverbeke A. has selected the composition of the oils of the blend. The funding sponsors had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, and in the decision to publish the results.

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Risposte comportamentali e del cortisolo di cani di canile sottoposti ad un "Cognitive bias test" dopo arricchimento olfattivo con olii essenziali

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Sintesi

L'ambiente di canile comporta per gli animali diverse forme di stress a cui i cani devono adattarsi. Recenti ricerche hanno dimostrato che l'arricchimento con olii essenziali potrebbe essere in grado di modificare lo stato emozionale di certe specie animali (cani, gatti, animali di zoo..). In questi studi la valutazione del welfare includeva indicatori fisiologici, come ad esempio le concentrazioni di corticosteroidi e/o comportamenti correlati allo stress cronico.

L'effetto olfattorio di 9 olii essenziali (*Cananga odorata, Cistus ladaniferus, Citrus aurantium, Cupressus sempervirens, Juniperus communis* var. *montana, Lavandula angustifolia, Laurus nobilis, Litsea citrata, Pelargonium graveolens*) e di una miscela di questi olii è stato valutato sui risultati di un "Cognitive bias test", sui livelli di cortisolo e sul comportamento di 110 cani di canile (n= 10 cani per ogni gruppo).

L'arricchimento olfattivo con la miscela di olii ha ridotto la latenza della scelta dello stimolo ambiguo, indicando un pregiudizio ottimistico ed un miglioramento del welfare.

I risultati di questo studio suggeriscono che l'arricchimento olfattivo con olii essenziali può avere un effetto specifico sullo stato emozionale e sul comportamento dei cani di canile e potrebbe perciò essere utile nel management di queste strutture.

Inoltre, poiché non tutti gli olii testati singolarmente si sono dimostrati efficaci, ulteriori ricerche dovrebbero essere effettuate per comprendere meglio gli effetti dei singoli olii sul cane.

Retrospective study on hypersensitivity-hyperactivity syndrome in dogs: long-term outcome of high dose fluoxetine treatment and proposal of a clinical score

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Abstract: In the French veterinary psychiatry model, the canine version of attention deficit hyperactivity disorder is called Hypersensitivity-Hyperactivity Syndrome (HSHA) and it includes two stages, depending on the symptom severity. Since methylphenidate is not authorized for veterinary use in France, HSHA dogs are commonly treated with 2 to 4 mg/kg Fluoxetine associated with behavioral modifications. Thus, the aim of this study was to analyze the long-term outcome of this approach. Twenty-four dogs diagnosed with HSHA were included. For each dog, 42 descriptive data were analyzed. Primary reasons for consulting were variable if the dogs had an additional behavioral diagnosis (i.e. 33% of the dogs): complaints were linked to the comorbid diagnosis (e.g. bite on strangers, people phobia), whereas they were linked to autocontrol deficiency for the dogs diagnosed with HSHA only (e.g. destructive, mouth, jumps on people). HSHA affection deeply alters the dog-human bond, as severe cases often lead owners to think about euthanasia or rehoming (12% for stage 1, but 83% for stage 2).

Neither the possibility to have access to a garden nor the quantity of daily exercise were linked to HSHA stages (respectively, fisher's exact test, p=0.69, and Kruskal-Wallis, p=0.88).

Eighty-three percent of the dogs attended training classes before consulting, with no noticeable improvement (mean training improvement score 1.7/10). In addition, training seemed even less efficient on severe cases, i.e. stage 2 dogs (Kruskall-Wallis, p<0.03).

After two months of high dose Fluoxetine (2 to 4 mg/kg), the average score of improvement given by owners was 7.2/10 compared to 0/10 at start. No long-term adverse effect was reported.

A HSHA clinical score (0 to 5 scale) was built to better categorize the dogs and to conduct the follow-up. The HSHA clinical score was correlated to Fluoxetine dose (Pearson correlation, p<0.01) and duration (Pearson correlation, p<0.05). A successful weaning from treatment was possible for 54% of the dogs.

These results suggest that HSHA spectrum can range from mild clinical signs to widely pervasive and invalidating ones. Starting the treatment as early as possible seems determinant for the welfare of the dog and for the dog-owner relationship, but doesn't allow a shorter treatment (Kruskall-Wallis, p=0.84) or more chances for a weaning (Fisher's exact test, p=0.88). However, high dose Fluoxetine associated with behavioral modifications appear to be useful and well tolerated to treat this complex syndrome.

Key Words: dog; hyperactivity; impulsivity; hypersensitivity; hyperreactivity; fluoxetine; ADHD-like syndrome.

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Introduction

Attention deficit hyperactivity disorder (ADHD) is characterized in humans by pervasive and impairing symptoms of inattention, hyperactivity and impulsivity (American Psychiatric Association, 2017). It is one of the most thoroughly researched disorders in human medicine, with a worldwide prevalence going from 8-12% (Faraone et al., 2003) up to 20% depending on the studies (Polanczyk et al., 2007). This neurodevelopmental disorder has been associated to many negative outcomes for the patients and a financial burden for families and society (NIH consensus statement, 2000).

In the veterinary field, many names can be found embracing the concept of impulsive, rest-

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less and inattentive dogs like overactivity, hyperactivity/hyperkinesis, hyperreactivity (Overall, 2013), hypermotricity (Landsberg et al., 1997), impulsivity (Wright et al., 2012), hypersensitivity-hyperactivity syndrome (HSHA) (Pageat, 1998).

In the last decade, two owner-based questionnaires have been built in order to measure attention skills and activity/impulsivity in pet dogs (Vas et al., 2007; Wright et al., 2011). Recently, more evidence has been reported to support the idea that dog might be a spontaneous model of ADHD (Lit et al., 2010; Puurunen et al., 2016). However, the limit between normal and pathological levels of impulsivity in dogs remains undefined.

Since methylphenidate was the first-choice treatment for ADHD in humans, research focused on dopamine receptors. However, it also has been established that psychostimulant primary calming effect in dopamine transporter knock-out mice was mediated by the serotoninergic system (Gainetdinov et al., 1999). More results using rodent models provided strong evidence to support the importance of serotonin in behavioural persistence and impulse control (Fonseca et al., 2015). Recently, glutamate (Isherwood et al., 2017; Miller, 2014) and GABA (Boy et al., 2011) have also been reported to play some role, illustrating the complexity of ADHD pathophysiology and indicating that many neurotransmitters are involved. In humans, the picture emerging from studies of dopamine, serotonin and impulsivity, is that different types of impulsivity appear to be modulated differentially by the different monoamines (Dalley & Roiser, 2012). Finally, despite the fact that the majority of research has focused on the role of dopamine in impulsivity over the past decade, a return to serotonin seems warranted. In particular, it will be important to characterize further the nature of interactions between dopamine and serotonin in influencing different types of impulsivity (Dalley & Roiser, 2012; Oades, 2007).

In dogs, genetic research focused on the canine dopamine receptor D4 (Ito et al., 2004) and suggested its association with activity-impulsivity endophenotype (Hejjas et al., 2007). Methylphenidate has been reported as a possible treatment of HSHA for dogs too (Piturru, 2014), but this drug is not available in France for veterinarians. Hence, the most common medication used by French veterinarians to treat HSHA syndrome is fluoxetine at a dose of 2-4 mg/kg per day (Beata, 2017; Marlois et al., 2017). This dosage is higher than the usual use of fluoxetine at 1 to 2 mg/kg, but it has been established by experience of veterinary behaviorist over 20 years of practice (Mege et al., 2003). Such treatment has been also supported by several studies in humans (Barrickman et al., 1991; Carlisi et al., 2016; Chantiluke et al., 2015) without adverse effects, even on patients with epilepsy (Kanner, 2016). In dogs, Fluoxetine has been used for long in behavioural medicine (Dodman et al., 1996; Wynchank & Berk, 1998) in other indications, and always at lower doses ranging from 0.1 to 2 mg/kg (Denenberg 2015; Dodman et al., 1996; Ibáñez & Anzola, 2009; Irimajiri et al., 2009; Pineda et al., 2014; Simpson et al., 2007; Wynchank & Berk, 1998). One recent case report concerned HSHA, but the dose was around 1 mg/kg per day (Luno et al., 2015).

Therefore, the main purpose of this study was to assess the efficiency of a treatment of Fluoxetine at 2-4 mg/kg combined to behavioral modification on HSHA dogs. Secondly, as the clinical pattern of this syndrome is very rich and complex, we aimed to propose a clinical scoring system based on categories of clinical signs that could be helpful for veterinarians to resume the severity of the HSHA syndrome and to propose a prognosis.

Materials and methods

Case selection

Computer data files from the first author practice were extracted for records of dogs with a diagnosis of HSHA (using Mege and colleagues' criteria (2003)) that were examined for the first

time between 1st January 2016 and 31th December 2016. This selection resulted in 28 cases with a HSHA diagnosis (among a total of 75 cases referred for behavior consultation). Four cases were excluded from the current study because 2 dogs were given another treatment than Fluoxetine, and 2 owners refused to give any medication to their dogs.

Finally, 24 dogs were included in the study and all of them attended one or several follow up consultations between 11th March 2016 and 31th December 2017.

Behavior consultations

As shown in Figure 1, each dog included in the study attended an initial consultation of 90 min. It included the review of the history form completed at the arrival of the owner in the practice, discussion of behavioral issues and main complaints, detailed description of each behavior, direct observation of the dog and physical examination. Each consultation was conducted by a veterinary behaviorist (i.e. first author).

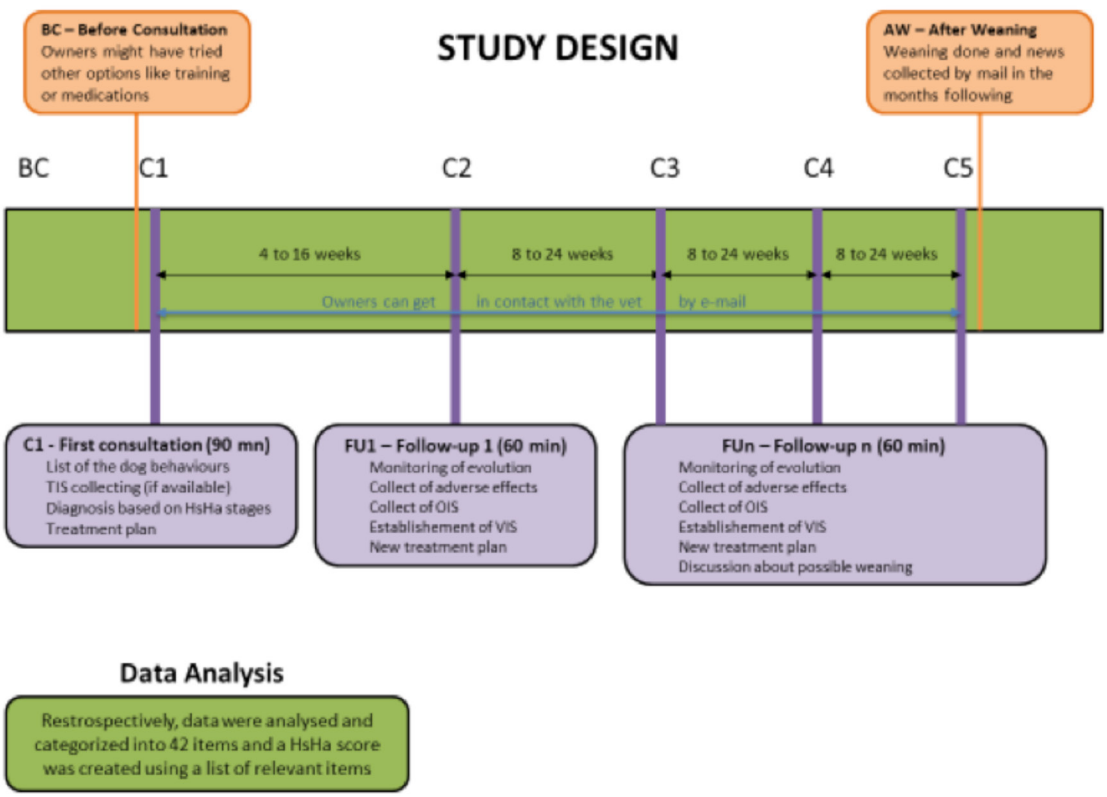

Figure 1. Study design.

HSHA diagnoses were established using Mege and colleague's definition of the HSHA syndrome (Mege et al., 2003). The two HSHA stages initially defined by Pageat (Pageat, 1998) were slightly modified by adding an intermediate stage for dogs fitting only one of the two criteria (no food satiety or hyposomnia) of the stage 2. This intermediate stage was called stage 1.5 (Table 1).

Table 1. Criteria used to diagnose and categorize HSHA.

HSHA stage	Diagnosis criteria
1	Non-acquisition of bite inhibition after 2 months of age Hypermotricity: incapacity to stop a behavior after the consumer phase, on the contrary, re-appearance of a new appetitive phase Hypersensitivity: reaction to stimuli that are permanently present in the environment Normal food satiety and sleeping behavior
1.5	Stage 1 criteria Lack of food satiety OR hyposomnia: under 8 hours of sleep per 24 hours
2	Stage 1 criteria Lack of food satiety Hyposomnia: under 8 hours of sleep per 24 hours

A suitable treatment plan was developed for each dog including medication and environmental and behavioral modifications. In order to ensure humane and non-aversive care, qualified trainers addresses were given to owners to follow the training plan. Concerning medication, an initial Fluoxetine dose was prescribed.

Considering the dosages prescribed, all the owners were clearly informed about the possible adverse effects that they could observe during the first ten days of treatment and the first author was available by mail if they had questions about it. In addition, after information, they were given the choice to accept the medication or not. If adverse effects (AEs) were reported by owners, the dose was adjusted until the AEs resolve. The doses reported in the study are the adjusted ones, which were kept for the duration of the treatment: they are the lowest efficacious doses. Fluoxetine doses were also adjusted during the follow up consultations to keep the dosage per dog's weight constant.

A follow-up consultation was planned between one and four months after the first one, depending on the severity of the case and the need for a close monitoring. However, medication was always prescribed for a maximum of 6 months, to allow a re-examination of the dogs under treatment. Medical records of the dogs were obtained when needed from the referring veterinarians. When drug prescription exceeded 6 months, biochemical analyses were asked (ALP, ALT, glucose, total protein, creatinine, and urea) in order to assess the liver function. All 24 cases attended at least one follow-up consultation to monitor the case evolution, which included self-reported owner compliance, recording of side-effects, dog improvement scale (owner based), monitoring of the problematic behaviors and direct observation. In addition, owners could contact the veterinarian by e-mail between appointments if they wanted to.

Data collection

Data collected from case records included dog signalment and history, clinician observations, recommendations and prescription. Descriptive data recorded included name, age, breed, sex, weight and neuter status of each dog. During the consultation, owners provided information by responding to open-ended questions. This included adoption history, systematic behavior work up (eating, drinking, sleeping, playing, exploring, agonistic, housetraining, somatosensory, phobias, sexual), attachment evaluation, previous training history and methods, living conditions (garden access, daily exercise: type and length). One close ended-question was asked to assess the emergency of the situation, asking the owners if they were thinking about euthanasia or re-homing of their dog.

The retrospective aspect of the study led the authors to choose a limited number of items that would be available from most the reports and that seemed relevant for HSHA assessment. This

resulted in 42 items that were filled up for each dog to conduct the data analysis (Table 2).

Table 2. List of the items used to analyze the data.

Item Category	Item list	N°
Descriptive data	Date of the first consultation	1
	Owner name	2
	Dog name	3
	Dog breed	4
	Age of the dog when first consultation occurred	5
	Age class: puppy, puberty, adult	6
	Dog sex: male, neutered male, female, neutered female	7
	Dog weight	8
Diagnoses	Nosographic diagnosis: HSHA1, HSHA1.5, HSHA2	9
	Comorbid behavioural diagnosis	10
Follow-up	Number of follow-up consultations	11
Presenting complaint	Presenting complaint	12
	Did you ever think about euthanasia or rehoming? yes, no	13
Medical treatment	Name of the prescribed drug	14
	Dose in mg per day	15
	Dose in mg/kg	16
	Side effects reported	17
	Additional drug prescription	18
	Treatment duration before weaning	19
Adoption context	Development conditions before adoption	20
	Age of adoption	21
Autocontrol items	Age of acquired bite inhibition	22
	Oral exploration of non-edible items after 6 months of age	23
	Ingestion of non-edible items: yes, no	24
	Hypersensitivity (i.e. too low trigger threshold): yes, no	25
	Hyper-reactivity (too high intensity): yes, no	26
	Self-stopping capacity when no stimulation: yes no	27
	Tachycardia, tachypnea: yes, no	28
	Food satiety: normal, no satiety	29
	Sleep duration in hours	30
	Exploration description: as example messy, mouthing, in height,..	31
	Play description: as example brutal, never stops, mouth,…	32
Agonistic behavior	Aggression type	33
Environment factors	Other adult dog present in the house: yes, no	34
	Length of daily exercise outside the dog home in minutes per day	35
	Access to a garden	36
Training	Length of education before consultation in months	37
	Training method: aversive, non-aversive, both, unknown	38
	Training Improvement Score (TIS)	39
Improvement	Owner Improvement Score (OIS): -10 to +10 scale	40
	Veterinary Improvement Score (VIS): -10 to +10 scale	41
Weaning	Reason for no weaning	42

For the owners who followed training classes before the consultation, an assessment of the training efficacy regarding the presenting complaint was recorded during the initial consultation, ranging from -10 (the dog behavior worsened dramatically) to +10 (the dog behavior improved dramatically) and ranking the dog at 0 when training started. This score, filled with the owner during the consultation 1, was called Training Improvement Score (TIS).

During the follow-up consultations, all undesirable or abnormal behaviors were rechecked with the owners to monitor the clinical improvement. An Owner Improvement Score (OIS) of the dog was filled with the owners, using a -10 (dog behavior has worsened dramatically) to +

10 (dog behavior improved dramatically) scale, considering that the dog started with a 0 score at the first appointment.

The practitioner also scored the dog improvements based on the symptoms collected, using a similar scale ranging from -10 (symptoms worsened dramatically) to +10 (symptoms improved dramatically). We called it Veterinarian Improvement Score (VIS). OIS directly testifies the owner satisfaction, whereas VIS is rather reflecting the dogs' clinical improvement.

However, OIS and VIS were not always collected at a similar rhythm from one case to another because the length between appointments could vary amongst dogs. Hence a choice was made by the authors to choose the latest OIS and VIS collected to conduct the analysis from baseline in order to have a long-term picture of the global trend. Nevertheless, the authors checked that OIS and VIS scores were always equal or better than the previous one.

Relevant HSHA items and HSHA clinical score

Several items were chosen to conduct the statistical analysis because they seemed relevant regarding HSHA syndrome (Table 3a).

Table 3a. Definition of items used to establish the HSHA clinical score.

List of the selected items used to calculate HSHA score	**Definition**
Bite inhibition	Capacity of the dog to control his bite when excited, resulting in the total absence of wounds on the human skin during play sessions
Oral exploration after 6 months	Chewing and destruction of non-edible items after the age of 6 months
Non-edible item ingestion	Ingestion of non-edible items including plastic, stones, wood, fabric, toys
Hypersensitivity	Too low reactivity threshold. Example: the dog will react to stimulus that shouldn't make him react, like low sounds, or movements, or unmoving items.
Hyper-reactivity	Too high intensity of the dog reaction. Example: the dog will overreact when playing, greeting people
Spontaneous stopping capacity	Capacity of the dog to stop moving and rest when no stimulation is around him, without being told to do so. Example: without stimulations (sound or movement) when he is home a dog without stopping capacity will never settle if not told to do so
Tachycardia-Tachypnea	Tachypnea: respiratory rhythm over 40 per minute Tachycardia: Cardiac rhythm over 120 per minute (large dogs) or 160 (puppies and small dogs)
Lack of food satiety	Inability of the dog to stop eating even after his physiological needs are reached. Owners will report very fast ingestion, food stealing, capacity to eat a meal twice in a raw, brutality when taking food from hands, high motivation around food
Hyposomnia	Sleeping time under 8 hours a day
Abnormal game	Were considered abnormal games the following items (reported by owners and under direct observation): Brutality: the dog can hurt people while playing (runs into them, pushes them, … Incapacity to give item back Endless play while the partner plays Endless play alone: as long as a toy is present the dog will play obsessively

Abnormal exploration	The following items were considered abnormal exploration under direct observation of the dog in a new environment: Messy: zapping from one item to another without finishing any exploration sequence Jumping: the dog jumps to explore what is on tables Endless: the dog never stopped to move for 90 minutes Oral: the dog grabs items in the consultation
Aggression	Any form of aggression (growl or bite) was collected, including Play aggression Pain aggression Fear aggression Food-related aggression Possessive: to protect an item Protective: to protect a person Inter-dog aggression Territorial aggression

A HSHA clinical score was created to get a quantitative value of the severity of the clinical picture (Table 3b), and to assess the reliability of this score with the duration of the treatment or the possibility of successful weaning.

Table 3b. Values used to establish HSHA score.

Score Name	**Scale used for scoring**	
Bite Inhibition	0	Acquired at 2 months
	1	Acquired at 4 months
	3	Acquired at 6 months
	5	Acquired after 6 months (or never)
Oral exploration	0	No oral exploration after 6 months old
	1	Can shred non-edible objects occasionally
	3	Shred non-edible objects regularly and/or a lot of different types
	5	Ingestion of non-edible objects
Reactivity	Each of the five item is scored 0 or 1 (presence/absence) and added up for a 0 to 5 score: hypersensistivity, hyperreactivity, spontaneous stopping capacity, Tachycardia-tachypnea, lack of food satiety	
Sleeping	0	> 10 hours
	1	> 8 to 10 hours
	3	> 7 to 8 hours
	5	< 7 hours
Playing	0	Able to play without brutality and respecting the partner rules
	1	Brutal and won't give back toys
	3	Endless play as long as the dog has a partner
	5	Obsessive play as long as a toy is available
Aggression	0	No aggression
	1	Only play aggression
	3	Other aggressions than during play appearing after puberty
	5	Other aggressions than play exhibited very early before puberty

This score calculation was based on the quantitative evaluation of 6 clinical items ranging from 0 to 5 (Table 3a&b). It was calculated using the average of the 6 items. Five items of the score were clinical items directly available during behavior consultation, and one – age of acquisition of bite inhibition – was only available through the owner report. For adopted dogs for which this item was missing, the clinical score was the average of 5 items instead of 6.

Statistical analysis

Because it was assumed that the data could not be normally distributed, non-parametric statistical tests were preferred to analyze the data, including Pearson Chi-squared tests, Fisher's exact tests, and Kruskall-Wallis for qualitative data, Wilcoxon signed rank tests and Mann-Whitney for quantitative data. For each record, 42 pieces of descriptive data were entered for analysis. Results of the tests were obtained using R statistical software (https://www.r-project.org).

A p value of < 0.05 was chosen as threshold for statistical significance.

Results

Dogs characteristics

The study involved 14 males (58%) and 10 females (42%). Fifty three percent of the males (n=6) and 20% of the females (n=2) were neutered. Dogs weighted 7 to 53 kg (average 22.1 kg). Their age ranged from 4 months old to 60 months old at the time of the initial consultation (mean 14.2 months).

According to the owner's descriptions and to direct observations, the 24 dogs were grouped according to FCI (Fédération Cynologique Internationale). Six out of the nine groups were represented in the study as follows: sheep dogs and cattle dogs (n=11), molossoid (n=1), terrier (n=4), pointing dogs (n=2), retrievers (n=4), companion and toy dogs (n=2). Eleven dogs were purebred (46%), seven were of breeds not recognized by the FCI (29%) and six were of mixed breeds (25%).

One dog had concomitant pathological conditions (chronic otitis and atopic dermatitis). An encephalic scan was asked for another of the dog because his response to medication was inconsistent and the examination revealed hydrocephalia explaining the erratic outcome.

The number of follow-up appointments ranged from 1 to 4 as follow: six dogs (4/24 [17%]) attended one follow-up consultation, eight dogs (8/24 [33%]) attended two, nine dogs (9/24 [37%]) attended three and three dogs (3/24 [13%]) attended four.

Reasons for consulting and associated diagnoses

To analyze the reasons for consulting, dogs were divided into two groups: dogs diagnosed only with HSHA (HSHA only group) and dogs diagnosed with a comorbid behavioural diagnosis (HSHA+ group). HSHA only group consisted of 16 dogs (67%, N=16/24), including 5 adults, 5 teenagers and 6 puppies, whereas HSHA+ group consisted of 8 dogs (33%, N=8/24), 3 adults and 5 teenagers. The age of the dog at the first appointment was 13.8 months average for the HSHA only dogs and 14.8 months average for the HSHA+ group. The comorbid diagnoses included communication trouble (17%, N=4/24), sociopathy (8%, N=2/24), deprivation syndrome (8%, N=2/24).

However, their distribution is different depending on the HSHA stage: in HSHA stage 2 dogs, the only comorbid diagnosis was communication trouble, whereas in dogs with lower stages, other comorbidity diseases were diagnosed.

Our results show that the reasons for consulting were different in both groups like illustrated

by Figure 2: complaints in HSHA only group were linked to autocontrol deficiency signs (e.g. destructive, grabs or mouth, jumps on people, …), whereas complaints in HSHA+ group were more often signs linked to comorbid diagnosis (e.g. bite on strangers, people phobia).

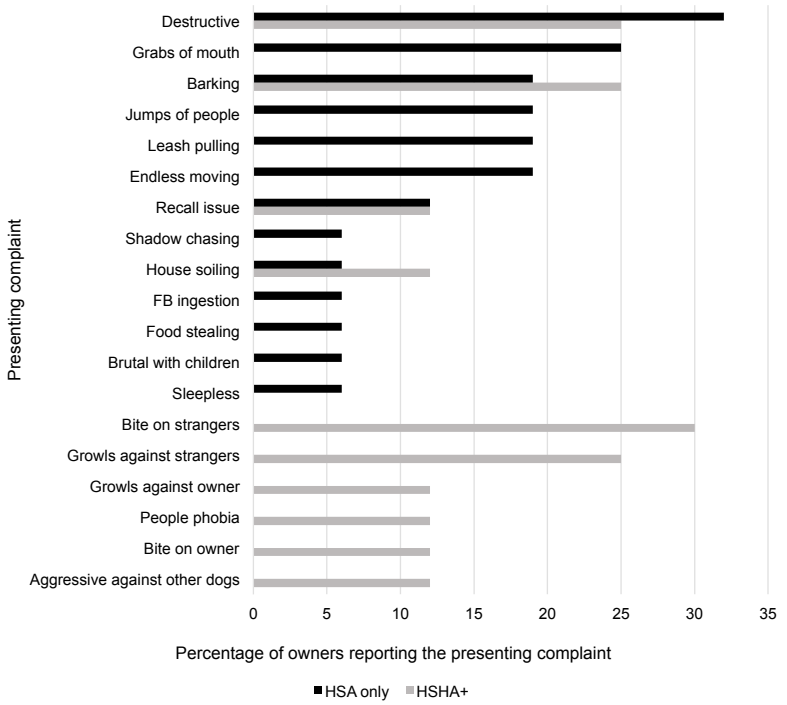

Figure 2. Comparison of the owner's reasons driving to consultation between HSHA only dogs and HSHA+ dogs.

Link with euthanasia or rehoming

Fifty-four percent of the owners (n=13) answered that they were thinking about euthanasia or rehoming/relinquishment of their dog during the first consultation. Such solution was considered by 12% (N=1/8) of the owners of dogs with a stage 1 diagnosis, compared to 50% (N= 2/4) for stage 1.5, and 83% (N=10/12) for stage 2 (Fisher's exact test, $p < 0.01$).

Age of acquisition of bite inhibition appears to be another at risk factor: when inhibition was not acquired after 4 months, 58% owners (N=7/12) thought about euthanasia or rehoming, whereas only 28% (N=2/7) thought about it when bite inhibition was already acquired at 4 months, but Fisher's exact test gave a non-significant result ($p = 0.34$). For 5 dogs the information was not available because they were adopted adult and all of their owners (N=5/5) were thinking about euthanasia or rehoming.

Sleeping duration appears as a determinant cofactor in euthanasia or rehoming decision. Normal sleep duration was indeed recently evaluated around 12 to 16 hours, with variations depending on age and feeding frequency (Zanghi et al., 2013). 83% (N=10/12) of owners of dogs sleeping less 8 hours thought to euthanasia or rehoming compared to 25% (N=3/12) of owners with dogs sleeping more than eight hours (Fisher's exact test; $p < 0.02$).

Out of the 24 dogs included in this study, no one got euthanized or abandoned up to the time this article has been written. One of the dog diagnosed with HSHA stage 2 and hydrocephalia died later during a surgery (enterectomy performed after foreign body ingestion).

Training methods and physiological needs prior to the first consultation

19/24 (79%) dogs had access to a garden and 17/24 (71%) were walked daily (75 min of mean

walking in stage 1 dogs, 52 min for stage 1.5 and 64 min for stage 2), and these opportunities to do physical exercise were not linked to HSHA stages (respectively, Fisher's exact test, p=0.69, and Kruskal-Wallis, p=0.88).

Out of the 24 dogs, 83% (N=20/24) attended training classes. The length of the training ranged from 1 to 12 months prior to the first behaviour consultation. Thirty percent (N=6/20) described aversive training methods, while the other 70% described non-aversive ones. Aversive training methods were not more significantly used with dogs presenting comorbidity, than with dogs presenting HSHA only (Fisher's exact test, p =0.12). Duration of attendance to training classes (4 months for stage 1 dogs, 5.5 months for stage 1.5 dogs and 4.6 months for stage 2 dogs) was not linked to HSHA stage (Kruskal-Wallis, p=0.41).

The average TIS reported was 1.7. No significant difference was found concerning TIS between aversive training group (arithmetic mean TIS = 2) and reward-based training group (mean TIS = 1.5) (Kruskal-Wallis,p=0.36). In addition, HSHA2 dogs have significant less improvement with training than other dogs (Kruskall-Wallis, p<0.03).

Medication choice, doses and adverse effects

The 24 dogs were all treated with Fluoxetine. Among them, 12.5% started with another medication (Clomipramine or Selegiline) but they finally received Fluoxetine at a dose ranging from 2.2 to 4.4 mg/kg single in day (Figure 3).

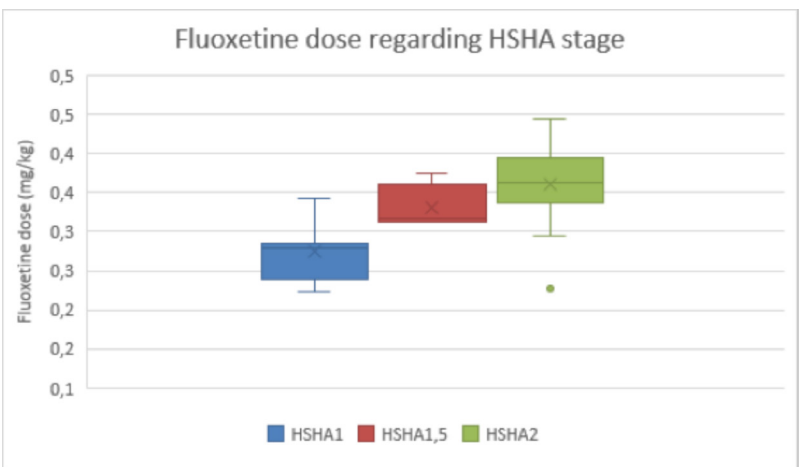

Figure 3. Fluoxetine administered dose versus HSHA stage.

A higher dose of Fluoxetine was needed to stabilize dogs behavior when the HSHA stage was more severe, with a mean dose of 2.8 mg/kg in HSHA stage 1 compared to 3.2 mg/kg for stage 1.5 dogs and 3.6 mg/kg for stage 2 dogs (Kruskal-Wallis; p<0.01,). Fluoxetine dose correlated with HSHA score (Pearson correlation, p<0.01). For two dogs, administration of Cyproterone acetate at 2 mg/kg twice a day was added afterwards, because Fluoxetine alone was not sufficient to control the exhibited symptoms.

Concerning AEs, each owner was explained, during the first consultation, the possible adverse effects expected especially during the two first weeks of treatment: decrease in appetite and lethargy. 29% of owners reported side effects during the first follow-up consultation, including appetite decrease (N=4/24), shaking (N=3/24), lethargy (N=1/24). The doses were adjusted for 2 dogs (going from 2.6 to 2.3 mg/kg and from 3.5 to 3.2 mg/kg for the other dog), because of the AEs reported. No other side effect was reported afterwards.

Concerning the blood controls asked to the owners when the treatment duration exceeded 6 months (N=17/24), not all the owners agreed to do them, especially because the dogs exhibited no side effects. However, 12 out of 17 reported the results of the blood tests and none was outside of the normal range (ALP, ALT, glucose, total protein, creatinine, and urea).

Improvement assessment

Improvement was assessed subjectively through the two scores performed by the owner, i.e. TIS and OIS, and by the veterinarians with the VIS (Figure 4).

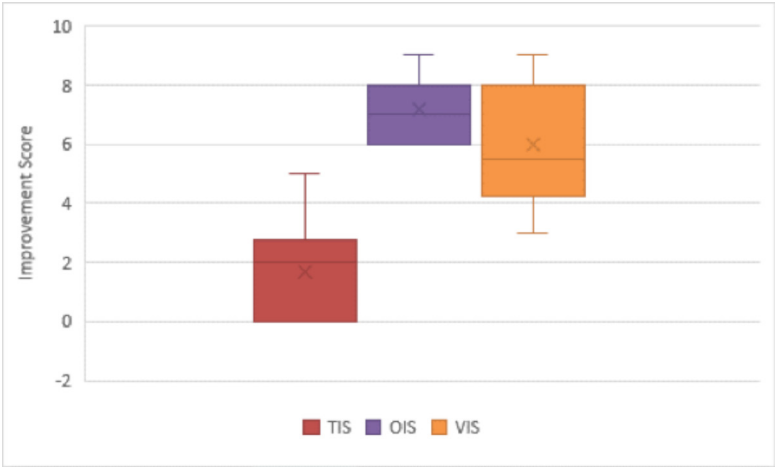

Figure 4. TIS, OIS and VIS Improvement Scores.

According to owners, dog improvement was significantly higher after a high dose Fluoxetine treatment combined with behavioral modification (mean OIS=7.2) compared to training alone (mean TIS=1.7) (Mann-Whitney U test; $p<0.01$).

The owners seem more positive in assessing their dogs than the veterinarian with OIS score being significantly higher than VIS, with mean values of respectively 7.2/10 for OIS and 6/10 for VIS (Kruskall-Wallis: $p<0.03$). The OIS and VIS were not significantly different according to HSHA stages.

Medication duration

A rule was consistently applied by the practitioner: a therapeutic weaning would be encouraged if the improvement score provided by owners was 6/10 for at least four months.

To analyze the data for treatment duration, statistic tests were done considering that the treatment ended on 31th December 2017 (i.e. when the data collecting ended). The Fluoxetine treatment duration ranged from 3 to a minimum of 24 months (study end). When comparing the treatment duration to HSHA stage, it appeared that the higher the HSHA stage was, the longer the treatment was, with a mean of 8 months for stage 1 dogs, 13 months for stage 1.5 dogs and 17 months for stage 2 dogs (Kruskall-Wallis, $p< 0.03$).

As several dogs were still under treatment at the end of the study, the relation between HSHA stage and duration should be even more significant.

Finally, the starting age of the treatment was not linked to the treatment duration (Kruskall-Wallis, $p=0.84$)

HSHA clinical score

The HSHA clinical score was significantly correlated with the HSHA stage diagnosed during the consultation (Kruskall-Wallis, $p<0.01$) (Figure 5).

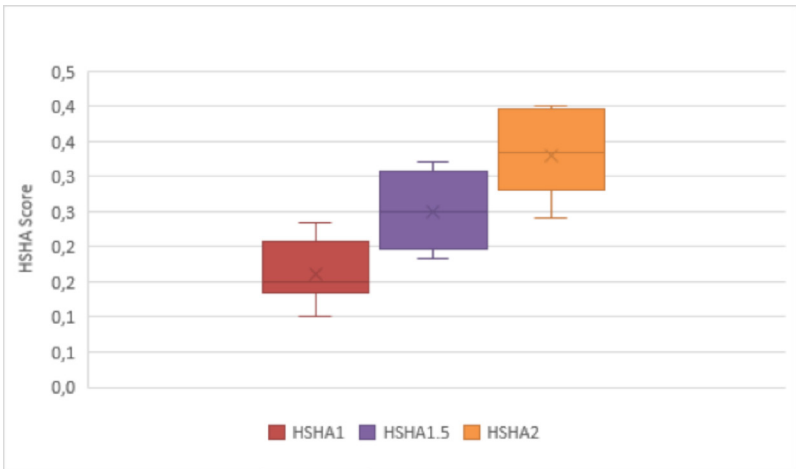

Figure 5. Relation between HSHA score and HSHA stage.

The HSHA clinical score was correlated to Fluoxetine dose (Pearson correlation, $p<0.01$) and duration (Pearson correlation, $p<0.05$). As several dogs were still under treatment at the end of the study, the relation between HSHA clinical score and duration should be even more significant.

Therapeutic weaning

Therapeutic weaning was successfully possible for 54% (N=13/24) of the dogs; respectively 100% of the HSHA stage 1 dogs (N=8/8), 75% of the HSHA stage 1.5 dogs (N=3/4), and 17% of the HSHA stage 2 dogs (N=2/12). Thus, weaning was significantly linked to HSHA stage (Chi^2, $p < 0.01$). But weaning was not linked to the age when the treatment was initiated (Fisher' exact test: $p=0.88$).

For the 11 remaining dogs, weaning either failed (N=3/11) or was not tried (N=8/11). The reasons of the weaning failure (or no weaning attempt) were the same and included reappearance (or still presence) of the following clinical signs: lack of food-satiety, destructive behavior, mouthing, hypersensitivity, aggression, impulsivity. For those dogs, OIS and VIS mean scores were respectively 6.6/10 and 5.6/10 after 12 to 24 months of Fluoxetine treatment, with a mean dose at 3.7 mg/kg. For those 11 dogs, a lifelong treatment was discussed and decided with the owners, as long as the treatment was well tolerated, which was assessed by doing regular biochemistry analysis to monitor long-term liver effect.

Discussion

The authors are aware of the fact that the doses used in this study are higher than the one recommended by the National Agency of Veterinary Medication (ANMV), which is 1-2 mg/kg. In addition, and to the author's knowledge, there is no wide peer-reviewed publication reporting the use of Fluoxetine at such dosage. However, in France, the 2-4 mg/kg dose is considered as a standard by veterinary behaviorist, based on over 20 years of experience. It has been indicated in several continuing education papers and books: in 2003, a national behavior handbook was edited by sev-

eral veterinary behaviorist amongst whom two diplomats from the ECAWBM. The use of 2-4 mg/kg fluoxetine for dogs diagnosed with HSHA syndrome, especially stage 2 is indicated. (Mege et al., 2003). In "Behavior Problem of the dog and cat, 3rd edition" G. Landsberg reported the use of such dosage of Fluoxetine as "reported dose range", which designs known practices without published references (Landsberg, 2013). Numerous shorter French continuing education reports state the use of such dose without adverse consequences (Beata, 2007; Dramard 2007; Marlois et al., 2013; Marlois, 2013). In the future, more standardized clinical studies are required in order to confirm the need of such 2-4 mg/kg dosage for the treatment of HSHA diagnosed dogs.

Despite the youth of the dogs in the study (mean 14.2 months), a high proportion of owners (54%) were thinking about abandon or euthanasia when the first consultation occurred. These results underscore how pervasive and invalidating this neurodevelopmental disorder can be. Moreover, all the re-adopted dogs (i.e. from a shelter or from a first family) of the study were at risk for a new abandon, suggesting that HSHA could have been the initial cause of the abandon. This corroborates previous results acknowledging the primary role of behaviour problems in euthanasia and rehoming (Marston et al., 2004).

Thirty-three percent of dogs diagnosed with HSHA had an ancillary behavioral diagnosis, which confirms an important risk of comorbidity like in human ADHD (Barrickman et al., 1991; Chantiluke et al., 2015).

In stage 2 group, the only comorbid diagnosis identified in our study was communication trouble. It could be due to the small size of the sample, but also to the fact that the disorder is so invading and challenging to live with, that owners punish them sooner, resulting in anxiety and aggressions (Ziv, 2017). The HSHA symptoms might also be so pervasive that it could hide other milder symptoms.

Taken together, these results suggest that this disorder needs to be diagnosed and taken in charge as early as possible (i.e. through behavioral work-up during routine appointments), before owners get so overwhelmed that the dog-human bond is altered (e.g. before euthanasia or rehoming becomes an option).

Another important result comes from the fact that training alone was not efficient to decrease the symptoms, especially in the case of dogs exhibiting a high HSHA score, as demonstrated by the significant difference between TIS and OIS. Access to a garden or tries to calm the dog by increasing daily exercise was not significant either. After the first consultation, some of the owners kept the same training methods while others changed, but all the dogs improved, which suggests that Fluoxetine treatment was a key in the improvement witnessed.

Regarding the two dogs that were excluded from the study at inclusion because they refused the treatment plan, especially the medication, they were contacted a year after the initial consultation to ask if the HSHA conditions had changed and they did not.

All together, these results confirm what has been demonstrated in humans: patients with ADHD do have a brain disorder which is not only a label for difficult children/dogs or caused by incompetent parenting/training (Hoogman et al., 2017), but a long-lasting disease needing behavioral care and medication.

Treatment efficacy was evaluated using owner (TIS and OIS) and veterinary scores (VIS). The significant results obtained, for both OIS and VIS, support the idea that 2 to 4 mg/kg Fluoxetine combined to behavior modification plan was efficient to control HSHA in dogs. OIS and VIS showed close mean even if VIS was slightly lower. OIS directly testifies the owner satisfaction, whereas VIS is more reflecting the dogs' clinical improvement. No matter how subjective these scores can be, the high proportion of owners willing to abandon their dog before treatment compared to the long-term outcome (no euthanasia or abandon, OIS> 7/10 with half dogs weaned) is a solid demonstration of the restoration of the dog-human bond and a better quality of life.

The reported adverse effects (29% of owners) could be under evaluated (especially the mild and transient ones) considering that owners were explained what could be expected. However,

owners did not report new adverse effects with 2 to 4 mg/kg dose compared to those usually reported at 1 to 2 mg/kg (i.e. decreased appetite and lethargy) (Irimajiri et al., 2009; Simpson et al., 2007), and not for longer durations (i.e. resolving under 10 days). No weaning or break in the medication was done for adverse effects reasons, which suggests that Fluoxetine at a dose of 2 to 4 mg/kg seems well tolerated even for long durations (i.e. up to 24 months in the study).

Fluoxetine dose and duration were correlated to the clinical HSHA clinical score, but not to the dog age, which suggests that treating the dog earlier will not allow an earlier weaning. This concurs with recent results of Hoogman and colleagues who demonstrated that volume differences in the brain between ADHD and healthy individuals clustered in children but not in adults. (Hoogman et al., 2017). If this is confirmed by future research, this would explain why treatment often needs to be maintained until reaching social maturity, i.e. when the prefrontal cortex is fully mature.

However, starting the treatment early might prevent the alteration of the dog-owner relationship and the use of aversive methods. In addition, this result suggests that the HSHA score could be of a significant help for clinicians to make a prognosis and give information to owners on the length of the therapeutic treatment.

One limit of the present study comes from the fact that only one veterinarian realized all the consultations (i.e. the first author). Thus, the results observed could partly be influenced by the practitioner skills, or by the local network of trainers used to help owners on the behavioral modification part. On the other hand, it provides a consistent way of evaluating the dogs. However, a replication of this work would be needed to validate the results including a higher number of veterinary behaviorists. The relatively small number of cases is an obvious limit to the generalization of our results. However, the results obtained here are highly significant, which provides a real interest to this retrospective study.

In human literature, ADHD has been reported with a larger ratio for males versus females of 2.28:1, but other studies also suggest that female cases are underdiagnosed (Ramtekkar et al., 2010). In dogs, agitated behavior has also been reported more often in Australian male dogs than females, with a 1.7:1 ratio (Col et al., 2016). Nevertheless, in the questionnaire built by Vas and colleagues to measure attention deficit and activity in dogs (2007), no effect of gender was found, which was confirmed by Lit and colleagues (2010). In our study, the gender ratio of 1.4:1, was not significant, suggesting no effect of gender in HSHA in dogs.

With 6 out of 10 males neutered in our HSHA cases, the proportion seems overrepresented compared to the canine French population (TNS SOFRES 2014). This could suggest that owners tried to neuter their dog hoping for an improvement in the behavior. However, the fact that they seek help afterwards, suggests that neutering had no effect on HSHA symptoms.

We could not draw any conclusion concerning breeds. One recently published study has concluded that the differences of impulsivity between dogs within a breed exceed the differences observed between breed (Fadel et al., 2016).

Our clinical HSHA score was correlated to treatment duration and to Fluoxetine dose needed to observe behavior improvement, i.e. minimal efficacious dose. These findings support the idea that HSHA clinical spectrum is ranging from very mild to pervasive and invalidating picture. The use of such score makes consequently more sense than the original two stages. In addition, the most severe cases seem to require life-long medical treatment, which is an important information that could be given to owners quite early in the care process. Considering the complexity of the underlying mechanisms (Carlisi et al., 2016; Dalley & Roiser, 2012) it is illusory to expect that the HSHA clinical score proposed here would be an exhaustive and definitive tool. However, it could be seen as a proposal to collect clinical data on HSHA in a more organized manner across the scientific community and also as a way to have a control on the starting dose for the treatment, especially for dogs with a score under 2 that shouldn't get a higher than 2 mg/kg dose as first intent.

Another interesting perspective of research would be to study the link between this clinical HSHA score and existing questionnaires, such as Vas and colleagues one's (Vas et al., 2007). Making more research concerning quality of life of these dogs and their owners is also a request, and it could be done by following and comparing HSHA clinical score and quality of life questionnaire (Oyama et al., 2017).

Finally, a large communication effort should be continued towards veterinarians and trainers in order to educate them on the importance of looking for HSHA signs such as ingestion of non-edible items, hyposomnia, children of the family being afraid of play sessions with the puppy, bite marks on owner arms. The encouraging long-term results observed in this study (i.e. key role of the medication, improvement of the quality of life, reduction of euthanasia/abandon) gather strong arguments to oppose to the owners that are reluctant to the use of psychotropic medication.

Conclusion

This case report study provides promising results concerning the long-term efficacy and safety of 2 to 4 mg/kg Fluoxetine combined with behavior modification therapy on HSHA dogs. The results obtained via the HSHA clinical score suggest that this disorder includes a wide spectrum of clinical signs, more or less pervasive and invalidating.

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Conflict of interest

The authors declare no conflict of interest

Authorship statement

The idea of the paper was conceived by Sylvia Masson and Emmanuel Gaultier
The experiments were performed by Sylvia Masson
The data were analyzed by Sylvia Masson and Emmanuel Gaultier
The paper was written by Sylvia Masson and Emmanuel Gaultier
All authors have approved the final article

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Studio retrospettivo sulla sindrome di Iper-sensibilità ed Iper-reattività nel cane: risultati di trattamenti con alte dosi di Fluoxetina e proposta di uno score clinico

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Sintesi

Nel modello francese di psichiatria veterinaria, la patologia corrispondente a quella umana, consistente in iperattività ed in un deficit di attenzione, è denominata sindrome di iper-sensibilità – iper-reattività (HSHA) ed include due stadi, differenziabili in base alla gravità dei sintomi clinici. Poiché l'uso del Metilfenidato non è autorizzato in Francia, i cani affetti da HSHA sono trattati normalmente con Fluoxetina (2-4 mg/kg), associata con terapie di modificazione comportamentale.

Lo scopo di questo studio è stato quindi quello di analizzare i risultati a lungo termine di questo tipo di terapia. Nello studio sono stati inclusi 24 cani con diagnosi di HSHA e per ogni cane sono stati analizzati 42 dati descrittivi. Le ragioni principali per la richiesta di una consulenza erano variabili, poiché il cane poteva essere affetto anche da altre patologie comportamentali (33% dei cani). Le lamentele dei proprietari erano legate alla patologia coesistente con l'HSHA (per esempio aggressività verso gli estranei, fobia delle persone) o alla mancanza di autocontrollo del cane (distruzioni, masticazione di oggetti, saltare sopra le persone). La sindrome HSHA altera in modo sostanziale il legame tra cane e proprietario, portando quest'ultimo ad un tale stato di esasperazione da considerare di poter dare il cane in adozione o di volerlo sopprimere (12% dei casi allo stadio 1 della sindrome, 83% allo stadio 2). I risultati della ricerca mostrano che non vi è alcun nesso tra la possibilità di avere accesso al giardino o la quantità di esercizio fisico giornaliero e lo stadio di HSHA in cui il cane si trova. L'83% dei cani ha seguito corsi di educazione cinofila prima di essere portato in consulenza ma senza miglioramenti apprezzabili. Il training sembra essere ancora meno efficace nei casi più gravi, cioè nei cani allo stadio 2. Dopo due mesi di terapia con Fluoxetina ad alte dosi (2-4 mg/Kg), il punteggio medio di miglioramento attribuito dai proprietari fu di 7,2 su10, a differenza del punteggio iniziale di 0 su 10. Non sono stati notati effetti avversi prolungati. Uno score clinico per l'HSHA è stato realizzato per meglio categorizzare i cani e condurre il follow-up, correlandolo con la dose e la durata del trattamento. Per il 54% dei cani è stato possibile effettuare una sospensione della cura in seguito alla remissione dei sintomi. Questi risultati suggeriscono che lo spettro HSHA può presentare segni clinica di media o elevata gravità. Un inizio precoce del trattamento sembra essere importante per il benessere del cane e per salvaguardare la sua relazione col proprietario ma ciò non garantisce che la cura sia più breve o che vi siano più possibilità di terminarla. In conclusione, alti dosi di Fluoxetina, associate con modificazioni comportamentali, sembrano essere efficaci nel trattare questa sindrome complessa e ben tollerate.

Electronic training devices: European Society of Veterinary Clinical Ethology (ESVCE) position statement

This position statement of the European Society of Clinical veterinary Ethology (ESVCE) was prepared by an ESVCE working group consisting of Sylvia Masson, Angelo Gazzano, Esther Schalke and Silvia de la Vega; Elisabeth Walsh helped with the English. The final text was presented at the Annual General Meeting of ESVCE in 2017 in Samorin, Slovakia, and unanimously adopted by the members.

Introduction

E-collars, also known as "shock collars" are used in dog training. There are three types of electronic devices commonly used in dog training (Polsky, 1994):

1. Bark activated collars that operate automatically in response to the dog barking.
2. Electronic boundary fences that are activated at a boundary line to keep the dog inside.
3. Remote controlled collars that are activated manually via a remote-controlled transmitter.

Their use employs learning theory and the principles of conditioning: positive punishment (if used after an undesirable behaviour) and negative reinforcement (if maintained until a desired behaviour is shown). Their use is controversial, and several European countries have decided to either ban or restrict their use, in the interest of dog welfare, which is at risk.

Having researched and compiled current available scientific articles, our working group edited the following lines as a position statement to inform the public and to take a position regarding the possible use of this technique as an educational tool for dogs.

E-COLLAR PROS: *are they admissible arguments?*

- Precisely controllable intensity: indisputably proved incorrect by Polsky (1994), below.
- Low cost (Polsky, 1994): not a valid argument when in relation to the welfare of dogs.
- Aversive enough to suppress an undesired behaviour (Polsky, 1994; Christiansen et al., 2001): alternative non-aversive techniques can alter undesired behaviour as shown in Polsky (2000) and importantly not just suppress it.
- When used as a negative reinforcer they reinforce alternative behaviour: as do other non-aversive techniques as shown in Polsky (2000).
- E-collars pose a smaller risk to the long-term welfare of dogs than other punishing techniques (Lindsay, 2005): e-collars pose a higher risk to the welfare of dogs compared to positive training techniques as shown in Polsky (2000).
- E-collars can solve behavioral issues that no other technique can: no evidence of this could be found in the scientific literature available.

  Hence, no argument makes a valid point to use an e-collar for dog training.

E-COLLAR CONS: *what are the risks of using e-collars?*

1. **E-collar intensity.**

- Not controllable: many parameters are likely to modify the shock and consequently the level of pain which the animal receives: shock intensity (Schilder & Van Der Borg, 2004; Lindsay, 2005), shock duration (Schilder & Van Der Borg, 2004), electrode size (Lindsay, 2005), beep warning (Schalke et al., 2007), degree of humidity and the morphology of the dog itself (hair

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length, moisture level of skin, subcutaneous fat level) (Jacques & Myers, 2007).

- It is not possible to determine the appropriate intensity for a dog (Lindsay, 2005; Jacques & Myers, 2007) which leads to two possible risks when using the e-collar:
  1. too high intensity which may induce intense fear or pain (Schalke, 2007), aggression (Polsky, 2000), phobias (Polsky, 2000), high levels of stress may block or lower an animal's ability to learn (Blackwell et al., 2006).
  2. Not high enough intensity (may induce habituation): the undesired behaviour will remain, but the animal will habituate to pain.

2. **Association with external stimuli: a major risk**.

In an everyday situation, many uncontrolled and un-associated environmental stimuli can be associated with the shock (Polsky, 2000; Blackwell et al., 2006), including the trainer (Schilder & Van Der Borg, 2004).

3. **Perfect timing required.**

E-collar use requires perfect timing between the undesired behaviour and the presentation of the shock (Schalke, 2007; Blackwell et al., 2006; Polsky, 2000). Without this flawless timing, both fearful and aggressive responses have increased likelihood of presenting and of becoming part of the dog's behavioural repertoire (Polsky, 1994; Christiansen et al., 2001). Consequently, unqualified trainers carry a higher risk of negative outcome when using e-collars (Salgerli et al., 2012).

4. **Risk of abuse**.

There is a risk of abuse when an owner activates the collar when in a negative emotional state such as when angry (Schilder, 2004; Schalke, 2007; Blackwell et al., 2006).

5. **Physiological risks.**

The following physiological risks have been reported when using e-collars: a raise in salivary cortisol (Beerda et al., 2001), a raise in heart rate (both increase with shock unpredictability) (Schalke, 2007), intense burn sensation than can lead to physical burns with skin necrosis (Lindsay, 2005).

6. **Stress related behaviors**.

These include high risk of: distress, suffering stress-related behaviours (yelping, tongue flicking, lowering of tail position, inhibition) becoming part of the dog's behavioural repertoire outside of the training context (Schilder, 2004).

7. **Other risks when using any punishing technique**.

Punishing training methods induce higher risks of aggression (Polsky, 1994; Herron et al., 2009), fear, anxiety (Arhant et al., 2010) and undesirable behaviours (Blackwell et al., 2008), while they decrease the quality of the dog owner relationship (Deldalle & Gaunet, 2014), dog welfare and dog-human team performance (Haverbeke et al., 2008), compared to non-aversive techniques. This is especially the case with positive punishment, where an aversive event (an electric shock, a kick, etc.) follows an undesirable dog behaviour and in the case of negative reinforcement where an aversive event (an electric shock, a sharp pull or a check on a choke or prong collar) ends after a desired dog behaviour.

8. **Efficacy**.

No study shows a superior efficacy when comparing an e-collar to positive training. Some conclude a superior efficacy of positive training (Blackwell et al., 2012; while others show no difference in efficacy but a decrease in welfare when using e-collars (Hiby et al., 2014). In relation to fence collars, one study even suggests a higher risk of escape when using an e-fence rather than a normal fence (Starinsky et al., 2017).

9. **The "easy fix" illusion.**

E-collars are seen as an "easy fix" (even if as demonstrated above they are not). This neglects a more preferable approach which would seek to understand the mechanisms of canine behaviour on every level which cause undesirable behaviour and then identify a successful and welfare compatible resolution (Schilder, 2004).

Conclusions

In conclusion, e-collar training is associated with numerous well documented risks concerning dog health, behaviour and welfare. Any existing behaviour problem is likely to deteriorate, or an additional problem is likely to emerge, when such a collar is used. This becomes an even greater risk when this aversive tool is used by an unqualified trainer (as training is largely unregulated throughout the EU, it appears that a large number of trainers are unqualified). Additionally, the efficacy of these collars has not been proven to be more effective than other alternatives such as positive training. Hence, ESVCE encourages education programmes which employ positive reinforcement methods (while avoiding positive punishment and negative reinforcement) thereby promoting positive dog welfare and a humane, ethical and moral approach to dog training at all times.

Members of ESVCE position strongly against the use of e-collars in dog training, using the above argument as a basis for our position and urge all European countries to take an interest and position in this welfare matter.

ESVCE proposal

As stated above, ESVCE members argue that there is no strong evidence to justify e-collar use on dogs. On the contrary, there are many reasons to never use these and better training options exist. This said, the aim of ESVCE is to improve dog welfare and consequently ESVCE has been working on possible solutions to manage situations where e-collars have been a choice.

The following alternative suggestions respect the precautionary principle:

1. ban e-collar sale, use, distribution, promotion (including internet sale and promotion within Europe), under European legislation immediately applicable in all member states.
2. Ensure that the law is enforced and adhered to: employing the animal welfare acts or equivalent in each member state, significant fines might be introduced for a first or minor offence, that is an offence where unintentional harm is caused to the dog. In the case of successive offences or where a collar has been used to intentionally abuse a dog, a custodial sentence in line with that applicable to similar offences might be introduced. Additionally, significant fines need to be implemented for persons identified selling, distributing or promoting e-collars.
3. Suggest an alternative: spray collars could be used under veterinary or qualified behavioural supervision, instead of bark activated collars and remote-controlled collars. This would allow the cause of the behaviour problem to be addressed and not just the symptom.
4. Electronic boundary fences could be replaced with actual fences (even actual electrified fences) which would prevent the electronic fences being used incorrectly and the dog not being given opportunity to learn; for example, if the owner does not use the flags which should be supplied to condition the dog to where the fence "is".

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La posizione dell'European Society of Veterinary Clinical Ethology (ESVCE) sull'uso del collare elettrico

Questo documento è stato prodotto dal Gruppo di lavoro dell'ESVCE costituito da Sylvia Masson, Angelo Gazzano, Esther Schalke and Silvia de la Vega; Elisabeth Walsh ha curato la versione in lingua inglese. Il testo finale è stato presentato all'Assemblea Generale Annuale 2017 dell'ESVCE in Samorin e approvato all'unanimità dai membri.

Introduzione

I collari elettrici (E-collar), anche conosciuti con il nome di "shock-collar" sono strumenti utilizzati nell'addestramento del cane. Ne esistono di tre tipi (Polsky, 1994):

1. Collari attivati dall'abbaio che si attivano automaticamente in risposta all'abbaio del cane.
2. Collari collegati alle recinzioni elettriche perimetrali e che si attivano ad una certa distanza dalla recinzione ed hanno la finalità di impedire la fuga del cane.
3. Collari attivati a distanza che sono azionati manualmente attraverso un telecomando.

Il loro utilizzo si basa sulla teoria dell'apprendimento ed in particolare sui principi del condizionamento operante: agiscono infatti come una punizione positiva se lo shock elettrico è applicato dopo un comportamento indesiderato che si vuole scoraggiare o come un rinforzo negativo se lo shock elettrico è mantenuto per il tempo sufficiente affinché un dato comportamento sia manifestato per sottrarsi allo stimolo doloroso.

Il loro utilizzo è oggetto di controversie ed alcuni Paesi Europei hanno deciso di vietarli o di limitare il loro uso per proteggere il benessere del cane che potrebbe essere a rischio.

In base alla letteratura scientifica esistente, il gruppo di lavoro dell'ESVCE ha prodotto questo documento per informare il pubblico e come presa di posizione dell'associazione circa il possibile uso di questa tecnica come mezzo educativo del cane.

Ci sono argomenti a favore dell'utilizzo del collare elettrico?

- Intensità precisamente controllabile: confutata da (Polsky, 1994).
- Basso costo: non è un argomento valido quando si parla di benessere del cane. (Polsky, 1994).
- Sufficientemente avversativi da estinguere il comportamento indesiderato (Polsky, 1994; Christiansen et al., 2001): esistono però tecniche alternative non avversative che possono modificare il comportamento indesiderato, come dimostrato da Polsky (2000) e, soprattutto, non estinguerlo solamente.
- Quando il collare elettrico è utilizzato come rinforzo negativo, esso rinforza comportamenti alternativi, come accade anche con tecniche non avversative come dimostrato da Polsky (2000).
- Il collare elettrico mette a rischio il benessere del cane nel lungo periodo, molto meno di altre tecniche punitive (Lindsay, 2005): in realtà il collare elettrico mette ad alto rischio il benessere del cane in confronto a tecniche di training gentile (Polsky, 2000).
- Il collare elettrico può risolvere problematiche comportamentali che altre tecniche non riescono a fare: nessuna evidenza di questa affermazione è reperibile nella letteratura scientifica.

Non ci sono quindi argomenti validi a sostegno dell'utilizzo del collare elettrico per l'addestramento del cane.

Argomenti a sfavore dell'utilizzo del collare elettrico: quali rischi esistono?

1. **Intensità dalla scarica elettrica rilasciata dal collare.**

- Non è controllabile: molti fattori possono, verosimilmente, modificare lo shock elettrico e di conseguenza il livello di dolore sperimentato dall'animale: intensità della scarica elettrica (Schilder & Van Der Borg, 2004; Lindsay, 2005), durata della scarica (Schilder & Van Der Borg, 2004), dimensioni dell'elettrodo (Lindsay, 2005), segnale di avvertimento (Schalke et al., 2007), grado di umidità e morfologia del cane (lunghezza del pelo, umidità della cute, spessore dell'adipe sottocutaneo) (Jacques & Myers, 2007).
- Non è possibile determinare l'intensità della scarica appropriata per il cane (Lindsay, 2005; Jacques & Myers, 2007) e questo determina due possibili rischi nell'utilizzo del collare:
  1. Un'intensità della scarica troppo elevata può indurre una paura intensa o dolore (Schalke, 2007), aggressività (Polsky, 2000), fobie (Polsky, 2000), livelli elevati di stress che possono bloccare o diminuire la capacità di apprendere dell'animale (Blackwell et al., 2006).
  2. Un'intensità della scarica non abbastanza elevata può indurre assuefazione: il comportamento indesiderato permane ma l'animale sviluppa assuefazione al dolore.

2. **Associazione con gli stimoli esterni: il rischio maggiore.**

Nelle situazioni di ogni giorno, molti stimuli incontrollabili possono essere associati con lo shock elettrico (Polsky, 2000; Blackwell et al., 2006), compreso l'addestratore (Schilder & Van Der Borg, 2004).

3. **Necessità di un tempismo perfetto.**

L'uso del collare elettrico richiede un tempismo perfetto tra il comportamento indesiderato e la comparsa dello shock elettrico (Schalke, 2007; Blackwell et al., 2006; Polsky, 2000). Senza questo perfetto tempismo, aumenta la probabilità che si presentino risposte di paura ed aggressive che diventino parte del repertorio comportamentale del cane (Polsky, 1994; Christiansen et al., 2001). Di conseguenza, addestratori non qualificati corrono un serio rischio di fallimento quando utilizzano il collare elettrico (Salgerli et al., 2012).

4. **Rischio di abuso**.

Vi è la possibilità di un abuso quando il proprietario utilizza il collare quando è di cattivo umore o arrabbiato (Schilder, 2004; Schalke, 2007; Blackwell et al., 2006).

5. **Rischio fisiologico.**

I seguenti rischi fisiologici sono stati riportati in seguito all'uso del collare elettrico: aumento del cortisolo salivare (Beerda et al., 2001), aumento nella frequenza cardiaca (aumento di entrambi quando lo shock non è prevedibile) (Schalke, 2007), sensazione di intenso bruciore che può portare a ustioni con necrosi della pelle (Lindsay, 2005).

6. **Comportamenti correlati allo stress.**

L'utilizzo del collare elettrico può produrre il rischio che comportamenti di Distres, oppure conseguenti ad una sensazione dolorosa (guaiti, leccamenti del naso, posizione della coda tra le zampe posteriori, inibizione) diventino parte del repertorio comportamentale dell'animale, anche al di fuori delle sessioni di addestramento (Schilder, 2004).

7. **Altri possibili rischi nell'utilizzo di tecniche avversative**.

Le tecniche avversative di addestramento incorrono nel forte rischio di indurre un comportamento aggressivo (Polsky, 1994; Herron et al., 2009), oltre che paura ed ansia (Arhant et al., 2010) e la comparsa di altri comportamenti indesiderati (Blackwell et al., 2008), mentre peggiorano la qualità della relazione tra cane e proprietario (Deldalle & Gaunet, 2014), il benessere del cane e la performance del binomio, uomo-cane (Haverbeke et al., 2008). Questo è particolarmente vero per le punizioni positive, dove un evento avversativo (uno shock elettrico, una percossa) segue un comportamento indesiderabile del cane e per i rinforzi negativi, dove un evento spiacevole (uno shock elettrico, uno strattone improvviso al collare o la costrizione sul collo provocata dal collare a scorrimento o dal collare con le punte) termina quando il cane emette il comportamento desiderato.

8. **Efficacia.**

Non esiste alcuna dimostrazione scientifica che l'utilizzo di un collare elettrico sia più efficace dell'applicazione di una tecnica di addestramento gentile.

Alcune ricerche hanno dimostrato una maggior efficacia dell'addestramento gentile (Blackwell et al., 2012) mentre altri studi non hanno evidenziato differenze nell'efficacia tra i due metodi ma sottolineato una riduzione del benessere dell'animale con l'utilizzo del collare elettrico (Hiby et al., 2014).

In relazione al collare elettrico collegato alla recinzione perimetrale, una ricerca ha evidenziato un maggior rischio di fuga rispetto all'utilizzo di una semplice recinzione (Starinsky et al., 2017).

9. **L'illusione della facile fissazione del comportamento.**

I collari elettrici sono ritenuti in grado di fissare facilmente un comportamento (anche se è stato dimostrato nelle righe precedenti che ciò non è vero). In questo modo sono tralasciati approcci più preferibili che potrebbero tentare di comprendere i meccanismi che causano quel comportamento indesiderato e quindi individuare una soluzione adeguata e compatibile con il benessere del cane (Schilder, 2004).

Conclusioni

In conclusione, il training con il collare elettrico è associabile a numerosi e ben documentati rischi per la salute, il comportamento ed il benessere del cane. Qualsiasi problema comportamentale già in atto potrà, verosimilmente, peggiorare o potrà emergere un nuovo problema quando questo tipo di collare è utilizzato.

Il rischio diventa ancora maggiore quando questo strumento avversativo è utilizzato da trainer non qualificati (e poiché l'istruzione cinofila non è regolamentata in molte nazione europee, è verosimile supporre che un gran numero di addestratori non sia qualificato). Inoltre, non è stato dimostrato che l'efficacia di questi collari sia superiore a quella di altre tecniche positive. Per questi motivi l'ESVCE incoraggia programmi educativi che utilizzino rinforzi positivi (evitando punizioni positive e rinforzi negativi), promuovendo un approccio gentile, etico ed umano al benessere del cane.

I membri dell'ESVCE prendono decisamente posizione CONTRO l'uso del collare elettrico nell'addestramento del cane, sulla base delle argomentazioni sopra elencate e invitano tutte le nazioni europee a prendere una chiara posizione in merito al benessere del cane.

Le proposte dell'ESVCE

I membri dell'ESVCE ritengono che non vi siano reali evidenze scientifiche che giustifichino l'uso del collare elettrico. Al contrario vi sono numerose ragioni che ne sconsigliano l'uso, in favore di tecniche di training migliori.

Il fine dell'ESVCE è quello di migliorare il benessere del cane e per questa ragione è al lavoro per risolvere situazioni in cui il collare elettrico è stato utilizzato.

Nel rispetto del principio di precauzione, si suggeriscono le seguenti alternative:

1. Proibire la vendita, l'uso, la distribuzione e la pubblicità del collare elettrico (inclusa la vendita on-line e la pubblicità all'interno dell'Unione Europea) attraverso una legislazione europea, immediatamente applicabile in tutti gli stati membri dell'Unione.
2. Assicurare che la legge sia applicata e rispettata: impiegando le leggi di protezione del benessere degli animali o equivalenti in ogni stato membro, potrebbero essere introdotte multe significative per un primo o minore reato, ovvero un'offesa in cui un danno involontario è causato al cane. Nel caso di reati successivi o in cui un collare è stato utilizzato per abusa-

re intenzionalmente di un cane, potrebbe essere introdotta una pena detentiva in linea con quella applicabile a reati simili. Inoltre, è necessario incrementare le multe in modo significativo per i soggetti che vendono, distribuiscono o promuovono gli e-collari.

3. Suggerisce come alternativa al collare anti-abbaio o al collare elettrico telecomandato a distanza, il collare spray, usato sotto la supervisione di un veterinario esperto in comportamento o di un comportamentalista. In questo modo la causa del problema comportamentale potrebbe essere risolta e non si agirebbe solo sul sintomo.

Le recinzioni collegate al collare elettrico potrebbero essere sostituite da recinzioni reali (anche elettrificate) in modo da impedirne utilizzi impropri, impedendo al cane di imparare ad evitarle: ad esempio, se il proprietario non utilizza le bandierine di avviso che segnalano al cane la presenza del recinto elettrificato.

Scavenging Hypothesis: Lack of evidence for Dog Domestication on the Waste Dump

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Abstract: In the debate on canine domestication, researchers have identified a lot of valid information regarding the time, the region and the ancestor of the dog. But researchers are still figuring out, why and how this process started. The scavenging hypothesis, first proposed 2001 by Ray and Lorna Coppinger, proclaims the first human waste dumps as the ecological niche for the self-domestication-process of dogs. Many scientists refer to that model, sometimes partly modified. The scavenging hypothesis is broadcasted by most public media as the commonly accepted model of dog's domestication. Thus, we have to deal with that popular model. Based on a broad multi-disciplinary approach like human evolution, archaeology, palaeogenetics, psychology and neurobiology, we will look for evidence. Investigating nine assumptions of the scavenging hypothesis we did not find any evidence. Dog's domestication started thousands of years before the advent of food waste dumps. The scavenging hypothesis cannot explain why only wolves and never foxes nor jackals have been domesticated. Paleolithic people and ancient wolves were living together closely in the same ecological niche hunting the same prey with the same cooperative methods. It is likely that they met very often and knew each other very well. We have some hints, that ancient wolves and people treated each other with respect cooperatively. We have hints for an active cooperation from humans and dogs starting in the Upper Paleolithic period long before it would have even been possible scavenging human waste. We have hints for emotional bonds between ancient people and dogs. Emotional bonds would have been unlikely for an animal hanging around human settlements while scavenging carrion and feces, like the scavenging hypothesizes describe. Looking at recent dogs and humans we have evidence for strong unique similarities in the psychological and neurobiological structures eventually allowing interspecific bonding, communication and working. Interspecific cooperation decreased the level of the stress axis of both species in the Paleolithic period and even does so today, what improves our social and cognitive abilities. We propose that dogs domestication could be understand as an active social process of both sides. Further investigations need a closely networked multidisciplinary approach.

Key Words: dog, wolf, domestication; scavenging hypothesis; stress-axis; coevolution.

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Introduction

Dogs (*Canis lupus familiaris*) are called our best friends. They are living in close proximity with us round over the world in quite all cultures during each historical period. But it is still an open question, how and why dog derived. Ray and Lorna Coppinger proposed a process of self-domestication as scavengers on the first human waste dumps (Coppinger & Coppinger, 2001; 2016). They observed recent dog populations in special ecological niches like on Pemba Island (Tanzania) or on the Mexico City waste dump. Those dogs are living primarily on and from human waste. Coppingers argue, that those dogs would be the original dog type. When human started the epoch of agriculture and permanent settlement, they produced first food waste dumps. These dumps have been a new ecological niche for wolves (*Canis lupus*). While scavenging and hanging around on the dumps, wolves with a temperament allowing them to approach humans showed higher reproductive success. Over the time specimens more tolerant to humans have been selected naturally. Thus, dog should have been derived. Many scientists refer to that hypothesis in their papers and even public media like BBC (2011) or New York Times (2017) are broadcasting this version. Therefore, it is worth looking for evidence supporting that popular model.

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In the early two thousands dogs were making a comeback in science. Especially in the last years, a lot of valid research from several disciplines e.g. human evolution, archaeology, paleozoology, palaeogenetics, biology, psychology and particularly neurobiology has been published, providing hints and evidence for a better insight to understand how dog evolved. Thus searching for evidence of the scavenging hypothesis, we have to take a multi-disciplinary point of view. First, we will explore nine basic assumptions of this special dog domestication model.

1. *The time range dog domestication started*

The scavenging model envisages dogs coming up around 8,000 years ago (Coppinger, 2016, p.220), when human started the epoch of agriculture and permanent settlement in the region of the Fertile Crescent. Those human settlements produced first food waste dumps, which should have provided the new ecological niche where dog derived from wolf. However, there is clear evidence of much older dogs, pushing their origin back into an epoch at least 15,000 years ago when our ancestors were still hunting and gathering (Botiqué et al., 2017; Thalmann et al., 2013; Ovodov et al., 2011). Today it is commonly accepted, that dog derived in the Paleolithic period, thousands of years before the epoch of settled agriculture started, perhaps more than once, but especially in the area of the former Eurasian cold steppe, where we found the most remains of early dogs or protodogs, advent of agriculture started at first thousands of years later. As commonly accepted dog-remains in that region are much older (Germonpré et al., 2009, 2015; Losey et al., 2013; Janssens et al., 2018).

2. *Paleolithic people did not produce food waste dumps*

The Paleolithic Homo sapiens did not build any slaughter or kitchen dumps (Havlícek, 2015; Havlícek & Kuca, 2017). Even when they lived as nomads with regularly summer and winter camps they did not produce any dumps containing food. Nevertheless, it is quite unlikely, that butchering place and camping place have been at the same site. Butchering places were separated. They did not want to alert predators to their camps and they could not shoulder a killed mammoth. Nevertheless, our ancestors sometimes had a problem with waste. Archeologists describe four dump types during the Paleolithic period:

a) Archeologists have found several stone tool factories with a lot of stone tool waste (Havlícek, 2015; Rust, 1948).
b) In some caves burned bone dumps have been found (Jelínek, 1977; Boscha, 2012).
c) And archeologists have found a lot of shell midden which did not have any potential benefit neither as construction material nor as fuel and surely not as wolf-food (Gutiérrez-Zugasti et al., 2011; Havlícek, 2015).
d) Archeologists even found mammoth-bone accumulations, but without any tracks of bites from wolves or dogs. These mammoth-bone dumps served as a store of construction material or fuel (Boscha, 2012). In the cold steppe there was not enough construction- or firewood. Thus bones, fat and quite all other remains of the prey were used in daily life.

In sum Paleolithic people used the entirety of the carcasses for eating, clothing, warming or as tools or fuel. First waste dumps regularly containing food first appeared in the Neolithic period.

3. *And never enough*

Coppingers schedules the new ecological niche starting with the advent of settled agriculture. Other scholars, promoting this model, are pushing the timeline back to the period of hunters and gatherers. “First a founder group of less-fearful wolves would have been pulled

toward nomadic encampments to scavenge kills or perhaps salvage wounded escapees from the hunt." (Driscoll et al. 2009) But, even if nomadic hunters might have temporarily produced food remains, it could never have been enough to feed a founder group of wolves. Paleolithic hunter clans consisted only of 20 to 50 individuals (Groeneveld, 2016). Nomadic hunters in the Eurasian cold steppe were permanently following the big herds of bovids or mammoths (Amkreutz et al., 2018). Even if they lived in temporarily camps producing food waste, it would have been never nearly enough to feed a founder population. Archaeologists argue: "When wastes accumulated, nomadic people would simply move to another location." (Pichtel, 2005). To establish the new wolf-population shaping dogs, the Coppingers calculated, a dump size should provide food for 20 specimens, because 20 specimens were needed for a reproductive population to found a new wolf-type from which dogs could have been derived (Coppinger & Coppinger, 2016). The Coppingers further calculated that one dog needs the waste and feces of 14 people to survive (Coppinger & Coppinger, 2016). Therefore, we would need the waste and feces of at least 280 people for only one wolf-dog founder population. That is at least six-times too much for the real Homo sapiens living in that period – even if he would have produced food waste dumps. Paleolithic (temporarily) settlements simply could not have been big enough to provide a wolf-dog-founder population even if they would have produced feces and food remains.

4. *Adaptation to starch-rich diet started long after*

The scavenging hypothesis proclaims: "The dog is a shape that evolved to a new niche that was created when people switched from hunting and gathering to growing grain. The waste products of that activity created a food supply that supports village dogs". (Coppinger, 2016) Some authors are going on to say, that: "Only a time-machine would allow us to determine which scenario occurred, and quite possibly both processes played a role. However, independently of which pathway dogs took during domestication, the feeding niche of today's wolves and dogs is remarkably different from each other and likely has been since the advent of cultivation" (Marshall-Pescini et al., 2015). Today's dogs are living together with humans and they are used to human food as nutrition for thousands of years before the advent of settled agriculture. During the time range humans were living as hunters together with their dogs – a time range quite longer than the time range of settled agriculture – meat has been used as dog's main or only diet, sometimes maybe a special meat diet. From the Gravettian site of Predmostí I, 25-27,000 years old, we have evidence, that protodogs had a high proportion of reindeer and muskox in their specific diet (Bocherens et al., 2014). At the beginning of settled agriculture, dogs had been slowly and only partly adapted to starch-rich diet (Axelsson et al., 2013), starting 7,000 years before present (Ollivier et al., 2016). Diet adaptation in dog even reflects the spread of prehistoric agriculture. Thus Nordic dog breeds are showing very little adaptation to starch-rich food till today (Arendt et al., 2016) and some breeds e.g. Laiki are still hunting small game for their own food (Beregovoy, 2001). On the other side some recent wolf populations are adapted to marine dietary niches (Darimont et al., 2014). Therefore, today's food habits cannot create any explanation for domestication much more than 10,000 years ago. Domestication of plants as the basic feature of agriculture (settled or not) started less than 12.000 years bp (Meyer & Purugganan, 2013). Dogs derived many thousands of years before that period and especially before grain became a regular ingredient of dog's diet.

5. *Why wolves and not foxes?*

The scavenging hypothesis argues, that it was only the wolf which occupied the new ecological niche provided by human food waste. Scavenging and hanging around human settlements wolves with a temperament allowing them to approach these dumps showed higher reproduc-

tive success which favored their self-domestication. From generation to generation, they were genetically selected to be more tolerant to humans. Thus, dogs derived. Actually, it is commonly accepted that an ancient subspecies of the wolf was the only ancestor of recent dogs (Skoglund, 2015; Fan et al., 2016; Freedman et al., 2014; Thalmann et al., 2013). However, why wolves and not hyenas, bears, badgers, jackals, coyotes or foxes have been domesticated? They all were living in that period in the proximity to Homo sapiens. Many predators scavenging at least occasionally were living in the Paleolithic cold steppe, even Homo sapiens himself. Foxes (*Vulpes vulpes*) like scavenging on waste dumps (Hewson, 1983; Young, 2015). Foxes can be tamed very well as demonstrated in the Farm-fox experiment (Trut, 1999). They are smaller than wolves and, living near or inside the camps, they would have been no potential risk for death of clan members, especially toddlers (Kubinyi et al., 2007). Foxes like scavenging even downtown in big cities like Berlin (Hewson, 1983; Young, 2015). If scavenging and hanging around human settlements would have been the crucial impact of domestication, foxes or jackals would have been much better candidates for a self-domestication process on the waste dump. But it is likely, that neither foxes nor jackals were ever been domesticated in any culture or at any time. The scavenging hypothesis cannot explain why only the wolf, a potential dangerous and direct competitor, living in the same ecological niche, hunting the same game, should have been domesticated.

6. *Evidence for pre-historic working dogs*

We have evidence for dogs specialized in polar bear hunting and also special sled dog "breeds" (something like breeds) working together with hunter-gatherers 8,000 years ago (Pitulko & Kasparov, 2017). On Zhokhov Island in the far north of Siberia humans always lived in hunter groups. They never built any permanent settlements. Since the beginning of the Neolithic period, we have growing evidence for dogs as specialized working partners for hunting, herding, sledding, guarding in many regions (Guagnin et al., 2018; Pitulko & Kasparov, 2017; Perri, 2016; Jung, 2011). We know cave paintings and rock art from northern-Africa or the Arabian Peninsula showing man and dog hunting or herding together thousands of years before advent of settled agriculture in these regions (Guagnin et al., 2018; Coulson & Campbell, 2001; Holl, 2004). A dog, able to work together with humans, an already specialized dog, maybe something like an early dog breed, could not derive just from scavenging and hanging around on waste dumps. "Breed" dogs when fossilized are only the late, visual result, not the (practical) beginning of an active partnership. The early onset of specialized working "breeds" (fossilized) means a much older working-together-culture.

7. *Honor for a scavenger?*

Archaeologists have found a lot of Paleolithic graves containing dogs or dogs and humans together all over the world e.g. in the Green County, Illinois, USA, 8,500 years old, a human-dog grave in Israel 12,000 years old and in Oberkassel, Germany, 14,200 years old (Morey & Wiant, 1992; Morey, 1994; Janssens et al., 2018). It surely was a hard work to scoop out a grave with stone tools. The corpses had been buried carefully, partly provided with food for a life after death. From a psychological point of view, we can assess such burials as an honor. It seems very unlikely, that so much respect had been shown just for a scavenger hanging around. We further might argue that such dogs were ceremonially buried to serve as guards or to help a dead hunter in the afterlife. And this would have been an honor for the dogs as well. Both options do not fit to an animal characterized as a scavenger, hanging around, eating carrion and feces. Careful analysis of the remains of the oldest human-dog grave in Oberkassel gives us an impression about dogs emotional relationship to Paleolithic people (Janssens et al., 2018). The grave in Oberkassel contained two humans and in addition the remains of two dogs, an older one and a

puppy. The pup died at an age of seven months. An analysis of its bones and teeth revealed that it likely had a serious case of morbillivirus and it likely contracted the disease at around three to four months of age. It probably suffered from two or three periods of serious illness. Without special care, this young dog would have died very shortly after contracting it the first time. But it received intensive human care. "Without adequate care, a dog with a serious case of distemper will die in less than three weeks", lead-researcher Janssens explains (Janssens, 2018). This dog was clearly seriously ill but it survived a further eight weeks, which would only be possible if it had been well cared for. Janssens goes on to say: "That would mean keeping it warm and clean and giving it food and water, even though, while it was sick, the dog would not have been of any practical use as a working animal. This, together with the fact that the dogs were buried with people who we may assume were their owners, suggests that there was a unique relationship of care between humans and dogs as long as 14,000 years ago." (Janssens, 2018) Working and living together, not side by side, leads to interspecific emotional bonds, to reputation and honor. Would have people shown so much care just for a scavenger?

8. *Cooperation or competition*

Recent European and North American cultures produce an image of the human-wolf relationship as a hostile rivalry and the wolf is seen only as a competitor (Fogg & Pierotti, 2017). In all regions of Europe wolves have been strongly hunted for hundreds of years. Wolves have been exterminated in wide areas, from Europe over Asia up to North America since a long time. To survive gray wolves have to become very timid. Their recent behavior is the result of a strong selection favoring the shyest and least human socialize able specimen (Boitani, 1995). Thus, recent wolves have strongly internalized to avoid any human contact. But not all wild wolves do so. The Artic wolves on Ellesmere or Baffin Islands in the far north of America do not fear humans as much. Artic wolves (*Canis lupus arctos*) have never been hunted in large scale. They are interested to contact humans (Mech, 1997; Marshall Thomas, 2000; DeLallo, 2011). It is documented, that human lived with Arctic wolf packs over several month, even allowed to look after the pups in the den when the pack was hunting (Fogg & Pierotti, 2017). Those Artic wolves accepted human individuals as a kind of pack members.

9. *Wolf as a friend in Native cultures*

Indigenous peoples use to describe wolves are brother, grandfather, relative, companion, teacher and even creator (Schlesier, 1987; Marshall 1995; Fogg et al., 2015). From hunters of Siberia to Native Americans wolves and dogs are seen with much respect, mostly as friends or companions. In the pre-Christian religions and mythologies wolf is described in a similar way and regularly as a divinity or a companion of a divinity (Oeser, 2007). It is quite rarely that the wolf is mainly described as an aggressive animal or only as a competitor. But the Wolf is never described as scavenger nor hanging around human settlements (Fogg & Pierotti, 2017).

Discussion

In these nine issues, we did not find any evidence for the basic assumptions of the scavenging hypotheses neither from an archaeological, nor from an evolutionary, paleozoological, biological or cultural point of view. The fundamental assumption of the scavenging hypotheses in all variations is, that the ecology of wolves, characterized by "Group-hunting of ungulates" should have been changed to a new ecology of dogs characterized by "Human refuse scavenging" (Marshall-Pescini et al., 2015). These models proclaim that the domestication process of dogs would

have been based fundamentally on a scavenging niche provided by humans and scavenging would be the real nature of dogs until today. Coppingers assume: "The message of this chapter is, those look-a-like dogs, in the same way as look-a-like pigeons, have evolved right there in their niche and are uniquely adapted to this niche. They are not escapees from irresponsible dog (or pigeon) owners. They are a natural species that lives close to humans, finds its own food, and mates perfectly well without human control" (Coppinger & Coppinger, 2016). We have demonstrated that it is quite unlikely, that a sufficient scavenging niche existed during the time range dog originated. It is unlikely as well, that the scavenging hypothesis should be the main evolutionary story for a non-human animal, called human's "best friend", closely living and cooperatively working with humans.

Interspecific emotional bonding

Unfortunately, we do not have a time machine, but scientists from many disciplines are collecting hints and even evidence to fill out the dog domestication mosaic. Step by step, we are getting a more accurate approach to the time range when the domestication of the wolf began (Theofanopoulou et al., 2017). The grave in Oberkassel e.g. gives as a serious hint about dog's emotional relationship to the Paleolithic people, like basically all burials of dogs in that period. In addition, we have many psychological and neurobiological arguments not only to explain reliably such emotional bonds in the Paleolithic period. Emotional bonds and common graves are indicating that both species had shared their lifetime. Humans and dogs had lived together, not side by side like animals hanging around as scavengers on hypothetic waste dumps. Human associated wolves and hunter-gatherers became familiar, behavioral cultures were formed (Wayne, 2014; Foote et al., 2016; Filatova et al., 2015; Avital & Jablonka, 2000). It is likely that humans and dogs were working together and that dogs had been selected therefore which had been started in the Upper Paleolithic period (Wang, 2013; Jung, 2011). Man and dog hunted together in the Eurasian cold steppe (Shipman 2015; Coulson & Campbell, 2001; Holl, 2004) as well as in many other regions e.g. Persia (Hole, 2007), Japan (Perri, 2016) or the Arabian Peninsula (Guagnin et al., 2018). Lead researcher Guagnin (2017) goes on to resume: "Hunting scenes depicted in the rock art illustrate dog-assisted hunting strategies from the 7th and possibly the 8th millennium BC, predating the spread of pastoralism." Working together with dogs must have been an essential condition for humans to keep wild goats starting the era of livestock farming. Man and dog protected each other to avert danger. Dogs are used for transportation for at least 9.000 years (Pitulko & Kasparov, 2017). Pitulko & Kasparov assume: "It can be hypothesized that dog teams might have been used in Siberia as early as 15,000 years ago." It is a long way to develop the ability to herd, hunt and transport together as an interspecific team. Even the tamest wolf would never be interested in herding, sledding, or hunting together. Dogs are actively interested in working together with their people. This trait is commonly called "will-to-please". If we have specialized dogs as herding, hunting, sledding partners since thousands of years. Hence, dogs must have been evolved completely and segregated from their wild ancestors. This segregation should have been primarily based on mental skills (Saetre et al., 2014; Pörtl & Jung, 2015, 2017; Fogg & Pierotti, 2017). Canis lupus really provided all basic requirements to evolve such abilities of cooperation with humans as later seen in dogs.

Why foxes cannot become dogs

Foxes do not provide these basic requirements, although they are also canid hunters and scavengers. They like human waste dumps. Foxes use to steal chicken in the middle of human settlements and do not have any fear of living close to humans even downtown in the biggest cities with much traffic (Plumer, 2014). Therefore, they should have been the fittest candidates

for a domestication process as scavenger on human waste dumps. Nevertheless, foxes have never been domesticated naturally. Foxes are loner, whereas wolves are highly social. That is one of the crucial differences. Jackals (*Canis aureus*) are socially living in family groups. They are scavengers and hunters. However, they are hunting only small game, mainly rodents, and mostly alone (Lanszki & Heltai, 2002). Hunter and gatherer in the Paleolithic period preferred big game like mammoth or bison. They were hunting collectively. Human and wolf hunted the same big mammals with the same cooperative methods in exactly the same ecological niche. Arriving in the Paleolithic cold steppe at least 40,000 years ago, our human ancestors did not have any practice how to hunt a mammoth (Shipman, 2015; Fogg & Pierotti, 2017). Wolves already lived there for many thousands of years well used to hunt big dangerous prey very successfully. It is not unlikely that the first Homo sapiens observed wolf packs hunting big prey and so learned better how to do it by himself. Native American people claim to have learned to hunt from wolves (Schlesier, 1987; Marshall, 1995; Fogg et al., 2015). Native people in Northern America used to hunt bison with a wolf mask (Marshall, 1995; Fogg & Pierotti, 2017).

The crucial role of the HPAaxis...

The Siberian Farm-fox-experiment demonstrates that modulations of the Hypothalamic-pituitary-adrenal (HPA) stress axis are playing a key role in domestication (Hekman et al., 2018). Domestication includes decreased aggression and decreased flight distance concerning to humans (Benecke, 1994; Hare et al., 2012). Thus, a decrease of HPAaxis activity is fundamental in dog's domestication process (Pörtl & Jung, 2017). Regulation of HPAaxis is inherited epigenetically and thus operates very quickly during evolution (Pörtl & Jung, 2017; Ahmed et al., 2014; Trut et al., 2009; Buschdorf & Meaney, 2015). Due to increased interspecific pro-social contacts between wolves and humans epigenetically based down regulation of HPAaxis promoted better executive functions and improved social learning capability in both species (Miklosi et al., 2003; Hare et al., 2005). Thus, tamed wolves became domestic dogs by integrating themselves into human social structures. And humans increased their social and cultural practice also described as human self-domestication syndrome (Hare, 2012).

… and social similarities.

It is commonly accepted, that humans and wolves period lived in similar structured highly social family groups during the Paleolithic (Mech, 1999¸ Page et al., 2017). They reared their offspring collectively (Page et al., 2017). Both hunted in-group cooperatively in exactly the same ecological niche (Shipman, 2015). They must have seen, smelled, heard and felt each other very intensively. Thus, individual bonding was enabled (Bartal et al., 2011; Romero et al., 2014; Joly-Mascheroni et al., 2008). Sharing the same ecological niche and the same behavior leads to similar experience. Hence creating an enlarged interspecific resonance space facilitating empathy. We have to deal with those social traits to identify the neurobiological reasons for the wolf's self-domestication and the deriving cooperation abilities.

Behavioral cultures for cooperation

In the today's western culture, the wolf is seen only as a competitor (Fogg & Pierotti, 2017). Recent Arctic wolves, mythologies all over the world and the cultural heritage of native Nordic peoples report an alternate role (Fogg & Pierotti, 2017). The wolf is described as a cooperation partner, as a teacher, a friend like described above. Wolves and dogs have never been addressed as scavengers hanging around humans – neither in mythologies nor from Native Peoples. Recent Artic wolves are actively interested in contact with humans, even joining to them. There-

fore, it seems not to be unlikely that some Paleolithic hunter clans and some wolf packs once established a loose tradition of cooperation. Both species are able to form behavioral cultures for interspecific cooperation and to pass them on from generation to generation (Heinrich, 1999; Wayne, 2013). Later on as result: Better hunting success and more power to defend the carcass against third predators could have been some of the direct advantages of this cooperation. Nevertheless, the main impact might have been on the mental site.

Neurobiological requirements for cooperation

Scientific research of different disciplines like neurosciences and psychology validates increased evidence for similar social functions of dogs and humans (Spunt et al., 2017; MacLean et al., 2017b). Research of brain activities demonstrate very similar mental functions (Ledoux, 2012; Gimpl & Fahrenholz, 2001; Reep et al., 2007) which enabled both of them to interact and communicate with each other (Heberlein et al., 2016; Darwin, 1910). fMRI pictures and movies demonstrate nearly same activities of brain regions in dogs and humans (Desmet et al., 2017; Andics et al., 2014; Berns et al., 2012; Berns, 2015, 2017) like EEG transients as well (Iotchev et al., 2017). We can measure basically the same release of neurohormones in both species (MacLean et al., 2017a; Berns, 2015, 2017). We have reliable evidence concerning interspecific functions like mirror neurons, joint attention and even empathy (Romero et al., 2013; Szánthó et al., 2017). Dogs are able to discriminate and recognize the emotion of a human face simply by using parts of human faces (Huber et al., 2013; Albuquerque et al., 2016). Dogs show emotional contagion with other dogs, but also with humans (D'Aniello et al., 2018; Takaoka et al., 2015; Custance & Meyer, 2012; Yong & Ruffman, 2014; Huber et al., 2006). Dogs understand a lot of communicative signals like odor, expressions, gazing or pointing and even some of our intentions (Kaminsky et al., 2013; Kujala et al., 2017; Schwab & Huber, 2017). Eventually we have preliminary evidence for interspecific Theory of Mind in dogs in relation to humans (Müller et al., 2015). Last but not least we have to deal with very interesting facts due to modulations of neurotransmitters and stress axis functions, where we see significant similarities in functions and epigenetic modulations (Meaney & Szyf, 2005; Kis et al., 2017; Cimarelli et al., 2017; Hekman et al., 2018). In sum we have reliable evidence for similar social skills of human and dog due to similar brain functions. These similarities are much stronger than similarities with our closed genetic relatives under the non-human animal kingdom.

Today's evidence for similar social skills are at least reliable hints at social skills of Paleolithic humans and their evolving dogs (Theofanopoulou et al., 2017). To sum up, with archaeological, paleogenetical and paleozoological findings we got a powerful framework to understand the mental and social conditions of dog domestication. Therefore, we get a growing foundation to understand the inner processes that turn a wolf into a dog. 40.000 years ago, the invasive Homo sapiens, capturing the Eurasian cold steppe, really created a new ecological niche: himself. The nature of this new niche was not mainly or even only waste. Our hypothesis states, that it must have been essentially a broad social process. The engine promoting this special domestication process must have been much more than only a simple genetically selection for tameness. It must have been an active socially based process on both sides driven by epigenetic features.

Conclusions

The scavenging hypothesis describes the first human waste dumps as the new ecological niche for dog's domestication initiating genetic selection for tameness. Genetic selection for the ability "to eat in the presence of people" (Coppinger & Coppinger, 2016) should have been the only or at least the main factor in this self-domestication process. Eventually dogs should to be

characterized as scavengers, wolves as hunters (Coppinger, 2001, 2016; Marshall-Pescini et al., 2015). In our review we have summarized that these models are unlikely and should have been dropped.

The variety of disciplines, we have studied, do not provide any reliable evidence for human waste dumps as a hypothetic ecological niche for dog's domestication. Nevertheless, it is likely that scavenging carcasses would have been one of the sites humans and wolves met each other. And there should have been much more options to meet and to get known, eventually becoming familiar with each other e.g. while hunting or camping, while defending killed prey against thirds or rearing a lonely wolf pup. We think it is much more helpful to look at the psychological factors allowing a wild wolf to live voluntary within human societies without stress on both sides, without leashes and eventually working cooperatively with humans. We suggest genetic selection as a necessary prediction but not a sufficient explanation of dog's domestication pathway (Jensen, 2015).

We are proposing the hypothesis of the "Active Social Domestication" of dog (Pörtl & Jung, 2013, 2015, 2017). As the name already implies, this model describes dog's self-domestication as an active socially based process concerning both species. This unique kind of domestication was primarily an interspecific social process. Prosocial interactions reduce the activity of the stress axis via epigenetic modulations (Oliva et al., 2016; Meany, 2001; Weaver et al., 2004). The wolf integrated himself into the way of life of Paleolithic hunters. It was an active process on both sides. Evolutionary continuity of mammalian brains enabled both, human and wolf, mutual interactions which reduced stress on both sides and eventually favored what we call domestication (Ledoux, 2012; Gimpl & Fahrenholz, 2001; Reep et al., 2007; Spunt et al., 2017). Both of them wanted to cooperate, to live together and to work with each other (Pörtl & Jung, 2015, 2017). Advantages are known on both sides but not primarily in immediate effects like better hunting success, protecting, watching or warming. Lower permanent stress levels promote the frontal brain functions, contributing to better executive functions and improving social learning capabilities in both species (Hare et al., 2012). This allowed human associated wolves to grow into domestic dogs. We suggest, that modulations of the HPA axis are playing a key role (Hekman et al., 2018).

During the last 150 years most dogs turned from a role in human production to one in our mental welfare (Jung, 2011; Jung & Pörtl, 2015). But this role is neither new nor less important. Dogs have been – and still are – our social bonding partners for thousands of years. Even today we have some preliminary evidence, that dogs provide a general healthy influence (Mubanga et al., 2017) and specially a healthy influence on human stress system (O›Haire & Rodriguez, 2018; Julius et al. 2014; Beetz et al., 2012). Dogs improve our social and cognitive abilities. In addition, dogs feel like us as shown by neurobiological investigations (Berns, 2017).

For a better understanding of the metamorphism from the wild wolf to our family dogs, it is indispensable to take a multi-disciplinary approach. Co-Evolution of men and wolf resp. dog is a unique phenomenon in nature. It is an important part of our culture, social history and economic development. To understand dogs we have to understand humans. Dog's evolution is very closely linked to human evolution and history. It is an archaeological and paleogenetical issue and particularly a unique psychological and neurobiological challenge still today. Further research should deal with psychology, neurosciences, epigenetics and further disciplines in a broad and close multidisciplinary way.

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L'ipotesi della domesticazione attraverso il commensalismo (ipotesi "scavenging"): non esistono evidenze scientifiche di una domesticazione del cane nelle discariche

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Sintesi

Nel dibattito sulla domesticazione dei cani i ricercatori hanno identificato molte informazioni riguardanti il tempo, la regione e l'antenato del cane. Ma i ricercatori stanno ancora cercando di capire perché e come sia iniziato questo processo. La "scavenging" ipotesi, proposta per la prima volta nel 2001 da Ray e Lorna Coppinger, sostiene che le prime discariche di rifiuti umani siano state la nicchia ecologica per il processo di auto-domesticazione dei cani. Molti ricercatori si riferiscono a quel modello, a volte parzialmente modificato. L'ipotesi di scavenging è diffusa dalla maggior parte dei media pubblici come il modello comunemente accettato di domesticazione del cane. Quindi dobbiamo occuparci di quel modello popolare. Basandoci su un ampio approccio multidisciplinare come evoluzione umana, archeologia, paleogenetica, psicologia e neurobiologia, cercheremo di trovare le prove esitenti.

Indagando su nove ipotesi dell'ipotesi di "scavenging", non abbiamo trovato alcuna prova. La domesticazione del cane iniziò migliaia di anni prima dell'avvento delle discariche di rifiuti alimentari. L'ipotesi di "scavenging" non può spiegare perché solo i lupi e non le volpi e gli sciacalli siano stati addomesticati.

I popoli paleolitici e i lupi vivevano insieme nella stessa nicchia ecologica, cacciando le stesse prede con gli stessi metodi cooperativi. È probabile che si siano incontrati molto spesso e si conoscessero molto bene. Esistono alcuni indizi che i lupi e le persone si siano trattati con rispetto in modo cooperativo e che vi sia stata una cooperazione attiva tra uomini e cani a partire dal Paleolitico superiore, molto prima che fosse possibile nutrirsi di rifiuti umani. Esistono prove di legami emotivi tra l'uomo preistorico e cani. I legami emotivi sarebbero stati improbabili per un animale che gironzolava attorno agli insediamenti umani mentre scavava carogne e feci, come descrivono le ipotesi di "scavenging". Guardando i cani e gli esseri umani attuali abbiamo prove di forti somiglianze uniche nelle strutture psicologiche e neurobiologiche che consentono un legame interspecifico, la comunicazione e il lavoro.

La cooperazione interspecifica ha ridotto l'attività dell'asse ipotalamo-ipofisi e surrene di entrambe le specie nel periodo Paleolitico e lo fa anche oggi e ciò migliora le nostre capacità sociali e cognitive. In questa review si propone che l'addomesticamento dei cani possa essere inteso come un processo sociale attivo di entrambe le parti. Ulteriori indagini richiedono un approccio multidisciplinare strettamente connesso.

Compulsive acral dermatitis in a mongrel dog

Valentina Nuti

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Abstract: A male mongrel dog, Labrador Retriever crossbreed, about 6 years old, after various therapies by a veterinary dermatologistis was sent to behavioral counselling for acral lick dermatitis.

Since the dog had not been diagnosed with any organic disease and had a negative neurological examination, the diagnosis and treatment were directed towards an attachment disorder and environmental anxiety with substitutive and ritualistic behaviors. Initially a nutraceutical (Calmex) for 2 weeks was prescribed and, in the meantime, the behavior modification program with the dog trainer began with bi-weekly training sessions at the owner's home.

After the first 2 weeks the dog began to interact with the dog trainer without mounting behaviors and he diminished the vocalizations in the absence of the owners but he continued to injure his skin during the night and to destroy the objects of cloth when frustrated.

In association with the meetings with the dog trainer, the owners accepted to start the drug therapy and Clomipramine was prescribed in increasing doses starting from 1 mg/kg bid in increments every 15 days up to the dose of 3 mg/kg bid.

After about 10 months the dog no longer showed compulsive licking; he learned to manage interactions with children and to move away and relax in his enclosure when he got frustrated instead of manifesting "mounts" and hyperkinesia.

Clomipramine administration was discontinued gradually according to custom.

Key Words: dog, acral dermatitis, compulsive behaviors, anxiety, phobia.

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Presentation

The patient is a mongrel dog, about 6 years old, male, medium / large size apparently Labrador crossed, brought into the shelter at the age (hypothesized) of 7-8 months and remained there until the age of about 3 years. Adopted by a married young couple without children, lived, together with the mother of the wife, in a villa with a large enclosed garden.

The case was sent by a dermatologist for the presence of a severe lick injury in the left carpus refractory to any medical treatment.

History and presenting signs

Since the first day he arrived at home, the dog showed a "particular" attachment towards the wife. In her absence, the dog vocalized, and, in her presence, he showed continuous search for physical contact and attention seeking. When on a leash he was very excitable, while if left free he calmed down and explored in a more serene way.

The owners immediately noticed that the dog was very scared when bottles of sparkling wine were uncorked and if he heard the noise of applause but not if there were other types of loud noises.

Since about 1 year he started to chew and ingest pieces of fabric when he had no interaction with the owners. In the evening when he was in the living room or in the room with the owners he compulsively licked the skin of the left carpus provoking a rather extended injury (about 5 cm in diameter).

The veterinary dermatologist who visited the dog, after various therapies, managed to improve the situation only with the application of the Elizabethan collar but the problem reappeared with greater severity when the collar was removed. For this reason, the dog was sent for a behavioral consultation.

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Physical examination

The first interview took place at the clinic during non-opening hours in order to have less possible interference.

The dog showed, for the duration of the interview (about 1 hour), hyperkinetic behavior, polypnea and frequent and insistent attention-seeking behavior using his paws, stroking with the muzzle, attempting to get on the chairs with his owners.

The dog accepted interactions from the veterinarian but only for a very short time and aimed at obtaining food tidbit without crossing the eyes and without direct physical contact.

The dog had a good nutrition status, the laboratory tests for the hepato-renal function, carried out a few days before, were in the normal range. The blood cells count and blood chemistry tests were normal; the coat was shiny and thick but with a large erosive and crusty lesion at the level of the left carpus.

There were no external parasites or skin lesions in other parts of the body.

The second interview took place at home of the owners with the presence of the mother of the wife and the dog trainer with whom the author of the report usually collaborates.

In this environment, however, the dog showed hyperkinetic behavior but always when he was near to people. The dog took a blanket from his bed and began to bite and tear it, when it was removed. About 1 year before he had already undergone surgery to remove a foreign body of cloth in the intestine.

The dog manifested attention seeking with jumps to the owners and mounting attempts towards the dog trainer who was trying to interact with.

The mother of the wife referred that when her daughter and son-in-law were away, the dog began to howl after a few minutes; if he was ignored, he continued for hours and if he was recalled and put in the house with her, he calmed down for a few minutes and then he scratched the door to go back out and he started to howl.

Diagnosis and therapeutic program

The dog showed signs related to environmental and social anxiety, inability to cope with stress and frustration, attachment disorder, ritualistic / compulsive behaviors with alteration of the somesthesic behavior and foreign body ingestion.

It is quite common that dogs adopted from shelter (because they may have already lost the attachment figure once or more times) develop anxiety states when separated from the "new" attachment figure with vocalizations, hyperkinetic, mastication of objects (Landsberg et al., 2013).

There are environmental situations that can provoke ritualistic behaviors (boredom, separation anxiety, attention request) as well as diseases transmitted by ticks and psychomotor epilepsy (Overall, 2001).

Since the dog had not been diagnosed with any skin disease and had a negative neurological examination, the diagnosis and the treatment were directed towards an attachment disorder and environmental anxiety with substitutive and ritualistic behaviors.

Initially a nutraceutical (Calmex) for 2 weeks was prescribed and, in the meantime, the behavior modification program with the dog trainer began with bi-weekly sessions at the owner's home.

The work of the dog trainer was set on learning with mental activation exercises able to allow the dog to reach a greater emotional and cognitive autonomy even in the absence of the owners.

The co-operation of the owner's mother was also requested: it was ask to avoid punishments and to recall the dog when he vocalized after the owners left.

Following this, the extinction of ritualized behaviors was sought.

For what concerns the chewing and ingestion of tissues, games or food, that could be chewed

without danger, were provided to the dog, encouraging him to use them in times of frustration.

It was tried to encourage greater autonomy, even physical with a gradual habituation to sleep and take meals in a large enclosure next to the house without the presence of the owners.

The owner's mother said she was absolutely opposed to letting the dog sleep inside her part of the house during the night when her daughter would be abroad.

It was also suggested to prevent the dog from sleeping in the owners' room when they would be back with the adopted children.

After the first 2 weeks the dog began to interact with the dog trainer without mounting behaviors and he diminished the vocalizations in the absence of the owners but he continued to injure his skin during the night and to destroy the objects of cloth when frustrated.

In association with the meetings with the dog trainer, the owners accepted to start the drug therapy and Clomipramine was prescribed in increasing doses starting from 1 mg/kg bid in increments every 15 days up to the dose of 3 mg/kg bid (Overall, 2001).

When the dose of Clomipramine reached 2 mg/kg bid the skin lesion started to improve significantly, the vocalizations were very reduced and the interactions with the owners appeared less hyperkinetic. For this reason, this dose of the drug was maintained, always associated with weekly behavioral modification session.

The dog started to consume his meals in the enclosure without problems and during the day he often picked up the chewable toys in his mouth and took them inside the fence, remaining calm for a few hours during the working hours of the owners. They did not yet want to make him sleep at night in the enclosure.

At this point the owners had to be away for 1 month (which will become 2 actually) and the dog stayed with the mother of the owner (sleeping in her house) continuing his medication and behavioural modification sessions every 2 weeks. During the period of absence of the owners, the regularity of the meetings with the dog trainer was not respected but the use of the fence during the meal's consumption was regular. The dog had no longer licking lesions and there was the extinction of the behaviors of mounting, theft, destruction and ingestion of objects. The therapy was continued with Clomipramine 2mg/kg bid.

Follow up

The return of the owners with the adopted children took place at night and the dog met the whole family group. After a few minutes of excitement, the dog was put to sleep in the house of the owner's mother. In the following days the dog appeared again hyperkinetic and showed again behaviors of mounting and destruction of fabrics and objects.

A new program of intervention was set up with the dog trainer based on weekly sessions, with the gradual involvement of the children, and the use of the external enclosure also as a "private area" in which children did not have access. The interaction between the dog and the owners were also planned, both at home and outside.

In the subsequent checks it was highlighted that the dog was returning to a more stable emotional state: in fact, he appreciated the use of the enclosure to consume meals, sleep and take shelter when the environmental stimulations exceed his level of safety. The relationship with the owners was rebuilt, based on greater autonomy and self-determination of the dog who can choose to "take refuge" in the enclosure when they were absent but also when the children "exceeded" with the interactions.

After about 10 months the dog showed no longer compulsive licking; he learned how to manage interactions with the child and to move away and relax in his enclosure when frustrated.

Clomipramine administration was discontinued gradually.

Conclusions

In Veterinary Medicine the use of the term "obsessive-compulsive disorder" is still controversial in the case of repetitive and ritualized behaviors, also if they can compromise the relationship with the owners. Some authors prefer the term "abnormal repetitive behaviors" (Overall, 2001).

In this case the dog showed a strong anxiety both environmental and social, probably reinforced by the long stay in the shelter. The dog adopted coping strategies both to manage the frustration of the absence of the owners and when his social needs and attention were not satisfied.

The stimulation of the chewing suitable objects, different from those initially chosen by the dog, allowed to safeguard the physical health of the animal without eliminating this behavior so functional to cope with stress.

The use of the enclosure as a safe zone initially facilitated a greater emotional autonomy of the dog during meals and in the hours of separation from the owners, allowing him to manage independently the interactions with the children.

The anxiolytic drug TCA (Clomipramine) in increasing doses allowed to establish the minimum effective dose to control the anxiety of the animal. The dog reactivity was modulated, and the dog started to interact with his trainer and his owners in a quiet and relaxed way.

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Un caso di dermatite acrale compulsiva in un cane meticcio

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Sintesi

Un cane meticcio, incrocio labrador, maschio di 6 anni circa, è inviato, dopo varie terapie, alla consulenza comportamentale da altri colleghi per una dermatite da leccamento a livello del carpo sinistro.

Il cane è stato in canile dal 2009 (anno ipotizzato di nascita) al gennaio 2012 quando è stato adottato dagli attuali proprietari.

Durante il primo colloquio i proprietari riferiscono anche che il cane ha l'abitudine di succhiare, masticare e strappare qualunque tipo di stoffa abbia a disposizione. Il cane ulula quando i proprietari sono fuori casa e ciò avviene spesso poiché entrambi i proprietari lavorano la mattina. Inoltre, il cane ruba oggetti, in particolare ciabatte di stoffa, quando tornano a casa. Molto spesso il cane manifesta comportamenti di "monta" sia verso i membri della famiglia (coniugi giovani e madre della proprietaria) sia verso gli estranei in visita.

Il cane di solito ha comportamenti di evitamento se viene avvicinato da bambini (senza aggressività) e questo comportamento preoccupa i proprietari che sono in procinto di adottare, entro poche settimane, tre bambini di 7, 8 e 10 anni. Per tale motivo i proprietari si assenteranno da casa per 2 mesi per recarsi all'estero.

L'animale mostra segni riferibili ad ansia ambientale e sociale, incapacità nel gestire le frustrazioni, disturbo di attaccamento, comportamenti ritualistici/compulsivi con alterazione del comportamento somestesico ed ingestione di corpi estranei.

Nella prima visita è prescritto un nutraceutico (Calmex) per 2 settimane e nel frattempo è iniziato il programma di gestione comportamentale con l'educatrice cinofila con incontri bi-settimanali presso il domicilio dei clienti.

Il lavoro dell'educatrice cinofila è stato impostato sugli apprendimenti con esercizi di attivazione mentale in grado di permettere al cane una maggiore autonomia emotiva e cognitiva anche in assenza dei proprietari.

Dopo le prime 2 settimane il cane ha iniziato ad interagire con la educatrice senza comportamenti di monta ed ha diminuito le vocalizzazioni in assenza dei proprietari ma ha continuato a lesionarsi la pelle durante la notte e a distruggere gli oggetti di stoffa nei momenti di frustrazione.

I proprietari accettano di iniziare la terapia farmacologica e viene prescritta clomipramina a dosi crescenti partendo da 1 mg/kg bid con incrementi ogni 15 giorni fino ad arrivare alla dose di 3 mg/kg bid (1).

Alla dose di 2 mg/kg bid la lesione da leccamento comincia a migliorare sensibilmente, i vocalizzi sono molto ridotti e le interazioni con i proprietari appaiono meno ipercinetiche per cui questa dose del farmaco è mantenuta, sempre associata agli incontri settimanali con l'educatrice cinofila.

Dopo circa 10 mesi il cane non ha più manifestato leccamento compulsivo, ha imparato a gestire le interazioni con i bambini e ad allontanarsi e rilassarsi nel suo recinto quando entra in frustrazione invece di manifestare "monta" ed ipercinesi.

La somministrazione di Clomipramina è stata interrotta gradualmente secondo le consuetudini.

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