

ARTICLE

Effects of Thyroidal Disturbance on the Behavior of Domestic Dogs (Canis lupus familiaris)

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ABSTRACT

Hypothyroidism is not uncommon in dogs, but it is actually very often diagnosed in elderly dogs. When and how does the disease start? What are the first recognizable signs? The first symptoms are usually changes in the behavior. First, these changes are quite subtle, but as the illness progresses, they can get very grave. We do often hear from the worried owners, that their report of a behavioral change to their vet is often ignored, not taken seriously or simply interpreted as unsteady or insufficient dog training/education. This not taking seriously of the first signs is very concerning and a big problem in many ways. It is delaying the finding of the right diagnosis and treatment, which leads to suffering of the animal and the owner. In some cases, it leads to giving the dog up as an unbearable danger to the family. So the dog, who is only ill and could be back to normal with the right medical treatment, finally ends up in a dog shelter or a new family. The common understanding is, that hypothyroidism is an illness solely occurring in the elderly dog. In contrast to this, the authors found out, that thyroidal problems occur already at relatively young ages. This is a very important finding, considering that many clinically practising veterinarians expect hypothyroidism only in the aged or elderly dog and will not run any diagnostics in relatively young or middle-aged animals. The authors also found significant differences in the personality traits of emotional stability and extraversion. Therefore, we would like to expand the existing studies, so that this widely underestimated topic finally comes to the fore and hopefully, in the future the right diagnostic steps can be taken at an early stage of the disease.

1. Introduction

The connection between thyroid diseases and behavioral changes has been sufficiently documented in human medicine and should be ruled out in all cases of seemingly

problematic or unusual behavior before starting behavioral therapy^[1].

Unfortunately, our experience showed us, that the situation is still different in veterinary medicine: many veterinary colleagues only think of a thyroid problem

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when the clinical picture is already more than obvious and clear.

Hypothyroidism is not uncommon in dogs (*Canis lupus familiaris*). We therefore think it should be mandatory that the clinically active veterinary colleagues start diagnostics much earlier in order to recognize the beginning of hypothyroidism. This is the only way that the animal (and also the owner) can be spared a lot of suffering at an early stage, and that is exactly what we should expect from clinical veterinarians.

Also, as connections to brain metabolism have already been investigated in other species (see below), and the Domestic dog is getting more and more common as a model for human psychiatry as Overall found out ^[2], investigations in this regard should also lead to a better understanding of brain mechanisms and behavioral physiology in general.

In the BSAVA Manual of Canine and Feline Behavioral Medicine by Horwitz and Mills ^[3], hypothyroid aggression has been presented as a separate form of aggression, which appears to be similar to the aggression in social conflict or fear. The authors point out that the clinical signs of hypothyroidism can be mild or absent.

Fatjo and Bowen ^[4] report that hypothyroidism lowers the threshold for aggressive behavior. It is seen as a multifactorial event, an influence on the serotonin metabolism is also mentioned.

The effects on behavior can be explained physiologically by the effects of TSH, which acts as a neurotransmitter ^[5]. Panic attacks have been reported in human psychiatry at elevated levels ^[6]. TRH has an antidepressant effect and is known for the following interactions in human psychiatry: poor concentration and anxiety with a reduced thyroxine alpha 1 receptor level, in the case of depression in humans, T4 is increasingly converted to the non-functioning kT3 ^[7].

Findings from gynecology also support our concern: Interactions between TRH and prolactin are known: an increased TRH level leads not only to an increase in the TSH level, but also to an increase in the amount of prolactin in the body. This in turn results in a drop in LH and FSH, which slows cycle activity. Estrogens also increase the amount of thyroglobulin, which in turn increases T4 levels ^[8].

Interactions with other neurotransmitters have been demonstrated in laboratory animal studies: in the case of hypothyroidism, the serotonin and dopamine receptors are broken down more quickly. Furthermore, it was found that thyroxine also directly increases serotonin levels and increases the activity of dopamine receptors ^[9,10].

In cases of rats with hypothyroidism, the number of

norepinephrine receptors in the brain increases. T3 and T4 prevent the re-uptake of GABA, one of the most important transmitters in the brain's arousal-cushioning circuits. Therefore, GABA remains longer in the synaptic cleft at higher levels of thyroxine. Thyroid hormones also affect gene expressions of behavioral receptors. A reduced thyroxine level leads to reduced metabolism and therefore to a protracted presence of cortisol. This explains why the behavioral symptoms of the hypothyroid dog are similar to those of a dog under stress, loss of control or cortisone treatment ^[11,12].

Well balanced or increased serotonin levels lead to a reduction in/ of aggressiveness ^[13].

Studies by Aronson, Dodmann and Doddser showed that in a sample of 200 dogs (*Canis lupus familiaris*) with behavioral problems, 61% of the animals were hypothyroid or at least had a suboptimal thyroid parameters ^[11,12].

Neutered dogs (male and female) had at significantly higher risk of hypothyroidism ^[14].

Huber recognized an increased level of T3 in dioestrous female dogs and an increase of T4 during estrus ^[8].

Unfortunately, in our experience, the first signs of incipient thyroid disease usually went unnoticed for a very long time.

Most dogs get the diagnosis of a thyroidal disease, when they already show unmistakable clinical symptoms like obesity, lethargy, coat and skin changes, further weight gain despite small or normal amounts of food and the so-called "sad face". The first symptoms usually appear as changes in behavior. We do often hear from the worried owners, that their report of a behavioral change to their vet is often not taken seriously or interpreted as unsteady dog training/education.

In our behavioral pet consultancy in Germany, Austria and Switzerland we have lately seen some cases of a new and very disturbing tendency in some vets – supplying these dogs without further diagnostics with unneeded pharmacotherapeutic drugs like fluoxetine. Fluoxetine is an antidepressant that increases serotonin levels in the brain. The most common side effects of fluoxetine in the body are lethargy, change in appetite, weight changes, runny nose, dry mouth, drowsiness, weakness, sore throat, nausea or diarrhea. The biggest problems in our case are the behavioral side effects of the drug: Behavioral side effects of fluoxetine include anxiety, panic attacks, trouble sleeping, irritability, agitation, hostility, aggression, restlessness, hyperactivity, or increased depression. These side effects are often the problems, which the drug was administered to decrease in the first place. Dogs with changes in their behavior due to a thyroidal illness will of course not respond well to this medical treatment. In some

cases, the animals experience dramatic side effects.

Therefore, we would like to expand the existing studies with further relevant data collection, so that this widely underestimated topic finally comes to the fore.

2. Material and Methods

We evaluated all cases from our consultancy in Germany, Austria and Switzerland in which there was a thyroid problem in the processed cases from 2010 to 2018. There are a total of 559 dogs (*Canis lupus familiaris*) with thyroid problems or hypothyroidism.

In order to be able to create an individual report and recommendations for an animal with behavioral problems, we work with 4 different questionnaires and ask for current blood values, which the owners provide.

The first questionnaire was created by us to collect general information on anamnesis, signalement, living conditions etc., in which we ask about the individual life and the current living conditions of the animal: We ask for information about origin, breed, age, other animals and persons in the household, living environment, such as the daily routine including occupation of the animal, the living situation, feeding, handling, rules for the animal, upbringing, sleeping habits, fears, unwarranted hunting behavior, aggression towards other dogs, towards familiar and/or unfamiliar humans, noise sensitivity etc.

A detailed behavioral anamnesis is also carried out, which clarifies at what age and in what situations the unwelcome behavior first occurred and what the possible causes are. We inquire about previous measures and their effects.

In this connection, a detailed medical history is also taken, for which we also request current blood values and medical findings that have already been collected. This is absolutely essential so that we can rule out “euthyroid sick syndrome”. Not every change in the thyroid levels has its cause in the thyroid itself. Very often, there is a secondary change in the thyroid levels because of another primary serious or chronic disease. The thyroid reacts to that condition. A precise definition is important here so that no misdiagnosis is made. That is why we look into all existing medical data of the dog. If the report of the owner or the medical data requires further diagnostics or treatments, we ask to do and deliver us those. Very common reasons to a change in the behavior can be pain. This can be pain resulting from old injuries, skeleton problems, joint diseases and so on. Sometimes it is necessary to rule this out by asking the owner to see a physiotherapists with their dog. But also other chronic diseases can lead to a general feeling of being unwell in the animal, which can lead to unexpected reactions of

the dogs. So the medical history is very important in our research.

The 2nd questionnaire we use was developed by Turcsan et al. [15], who intended by using owner reported assessments to characterize dog breeds on 4 complex behavioral traits: Trainability, boldness, calmness and dog sociability [15]. Instead of the terms “boldness” and “calmness” we used the terms “extraversion” and “stability” to distinguish these qualities from the supertrait model of shy vs bold [16,17].

In this questionnaire, emotional stability and sociality to dogs both score from zero to eight, openness (= trainability) scores between zero and ten, and extraversion between zero and six points. For details see Turcsan et al. [15].

The 3rd questionnaire relates to the emotional disposition and is a translation of Sheppard & Mills’ questionnaire [18].

The 4th questionnaire assesses impulsivity based on the work of Wright et al. [19].

After evaluating the data collected from 2010 to 2018 we found a total of 559 animals with possible thyroidal cause versus non diseased animals.

Data were analysed by Excel and SPSS, by means of X²-test. All tests were two-tailed, and the significance level is set at < 0.05.

3. Results

There are castrated and uncastrated males and females of different age groups, see Figures 1, 2 and 3:

In Figure 1, we see that thyroidal problems occur already at relatively young ages, in the mean in about 3 year old dogs, partly already with the beginning of their youth. Nevertheless there is a significant difference ($p=0,0003 \chi^2$).

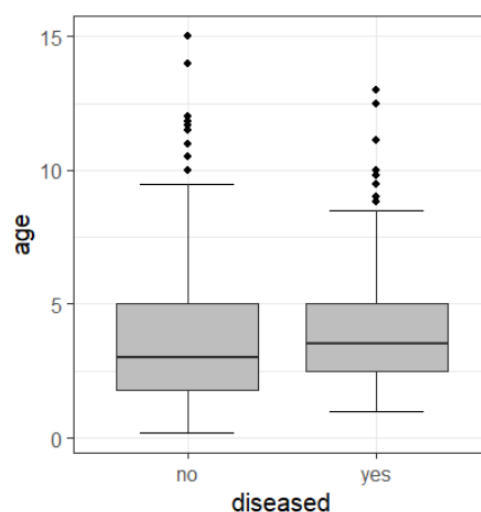


Figure 1. Age groups (Age distribution of diseased vs. healthy dogs (*Canis lupus familiaris*) in a sample of behavioral consultancy clients)

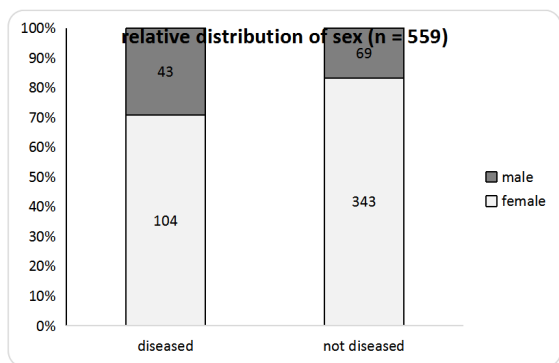


Figure 2. Sex (Sex distribution of diseased vs. healthy dogs (*Canis lupus familiaris*) in a sample of behavioral consultancy clients)

In Figure 2, we see that thyroidal problems occur both in female and male dogs, but in a significant difference ($p=0,017 x^2$). Relatively more males than females seem to have thyroid problems.

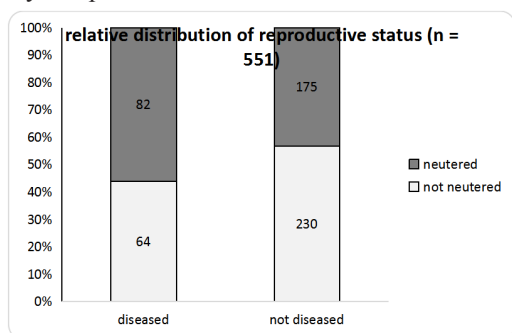


Figure 3. Reproduction status (Reproduction status distribution of diseased vs. healthy dogs (*Canis lupus familiaris*) in a sample of behavioral consultancy clients)

Thyroidal problems occur more often in neutered dogs than in intact ones ($p=0,0095 x^2$).

In Figures 4-7 our results on the effect of disease on the behavior, evaluated on the basis of a questionnaire by Turcsan et al. [1], are shown:

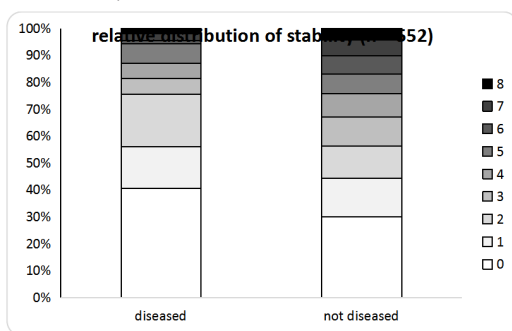


Figure 4. Emotional stability (Emotional stability distribution of diseased vs. healthy dogs (*Canis lupus familiaris*) in a sample of behavioral consultancy clients):

We found out, that the thyroid disease seems to have a significant effect on the emotional stability of the dog. The scores for emotional stability are lower for diseased dogs ($p=0,0001 x^2$).

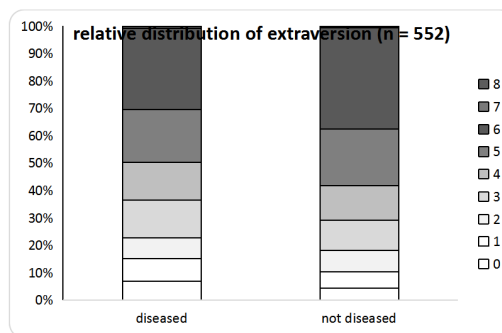


Figure 5. Extraversion (extraversion distribution of diseased vs. healthy dogs (*Canis lupus familiaris*) in a sample of behavioral consultancy clients)

In the area of extraversion, a tendency can be seen in animals with thyroid disease. Diseased dogs have lower scores and more non-diseased than diseased are found in the categories with higher scores ($p=0,0539 x^2$).

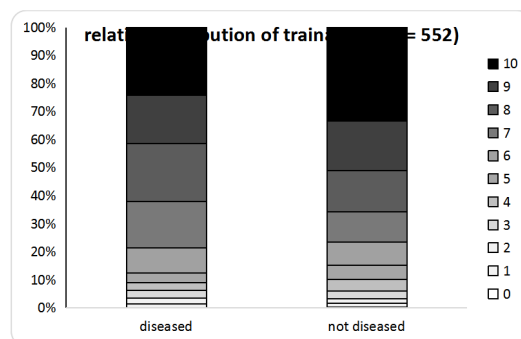


Figure 6. Trainability (=openness) (trainability (=openness) distribution of diseased vs. healthy dogs (*Canis lupus familiaris*) in a sample of behavioral consultancy clients)

No obvious differences can be seen in the area of trainability (=openness) ($p=0,1439 x^2$).

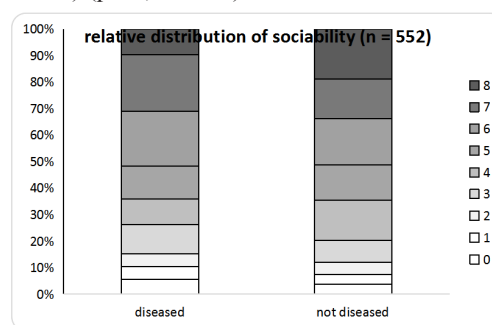


Figure 7. Sociability (sociability distribution of diseased vs. healthy dogs (*Canis lupus familiaris*) in a sample of behavioral consultancy clients)

No statistical significance can be seen in the area of sociability ($0,02735 x^2$).

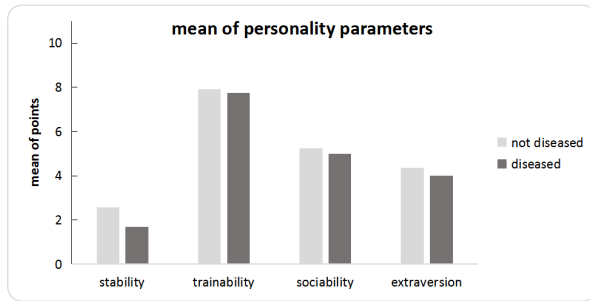


Figure 8. Mean of personality parameters (Mean of personality parameters distribution of diseased vs healthy dogs (*Canis lupus familiaris*) in a sample of behavioral consultancy clients)

Figure 8 shows a comparison of the “super-traits”: shy and bold did not find a significance ($p= 0,1813x^2$); both shy and bold type dogs seem to have thyroid problems at similar rates.

4. Discussion

We see, that in all 4 areas of stability, trainability, sociability and extraversion the non diseased group is ahead of the dogs with thyroidal disease.

In figure 1, we see that thyroidal problems occur already at relatively young ages, in the median in about 3-year-old dogs. This is a very important finding, considering that many clinically practising veterinarians expect hypothyroidism only in the aged or elderly dog!

The occurrence of behavioral signs of hypothyroidism at rather early age may be the result of the necessity of sufficient levels of thyroidal hormones for the development of the brain ^[20].

In Figure 3, we see that thyroidal problems occur more in neutered dogs. This may be, because the reproductive cycle and thyroid hormones are connected ^[8]. An increased frequency of thyroidal problems was also found e.g. by Sundburg et al. ^[21].

We found, that the thyroid disease has a significant effect on the emotional stability of the dog.

In the area of extraversion, a clear tendency can be seen in animals with thyroid disease. We can conclude that a reduction of thyroid hormones seems to lead to lower scores in this personality trait.

No statistical significance can be seen in the area of trainability. This differs from our personal experience, which showed that the ability to concentrate and to be inventive in finding solutions on their own and also process learning units is significantly higher in non diseased dogs.

No statistical significance can be seen in the area of sociability. This also differs from our personal experience, which seems to show that a non diseased dog is friendlier and more open towards previously unknown conspecifics and also shows less aggressivity.

Considering all of this, it would make sense to initiate appropriate thyroidal diagnostics at the first signs of behavioral change. If a dog, that has been completely well-behaved to date, suddenly shows unusual behavior, this should be taken seriously and should lead to further diagnostic. This could avoid a lot of suffering and grief, for the animal as well as for the owner. Often the one who suspects correctly an existing hypothyroidism is the animal trainer, not the vet! Only when the animal trainer gives the advise, the vet then examines on the owners wish. In our opinion, the goal of our veterinary work should be to think in the right direction before medical laymen recognize the correct diagnosis.

There are thousands of family dogs in many countries whose behavior, as well as veterinary data, are routinely observed, collected, evaluated and treated. Using them in comprehensive and comparative studies not only for curative medical purposes but also as a data pool for basic research could lead to a better understanding. Brain metabolism and behavioral physiology researchers could thus create and analyze a huge data pool from non- or minimally invasive studies for mammalian behavioral physiology and perhaps (see Overall 2000) ^[2] also as a model for human psychiatry, The Domestic dog due to life history, cognitive and social capabilities is much easier to compare to humans than e.g. laboratory rodents are.

5. Conclusions

Future research plans: In the second step of our work, we want to continue to investigate the consequence of a low thyroxine for animals with behavioural problems that are adjusted to medication. For this purpose, after the medication has been correctly adjusted, which has to be tested in a blood sample, regular inquiries are made about the change in behavior since the therapy. We will report about it in a second part of the publication.

Conflict of Interest

There is no conflict of interest.

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