

Original Research

Do they Play or Flirt? 'Pawsitive' Correlations of Castration Status and Social Behaviour of Male Dogs (*Canis lupus familiaris*): Video Analyses and Questionnaires

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| ABSTRACT |

Introduction

In the current research, there are already many reports on the effects of castration on the behavior of dogs. However, most studies are based on questionnaires, interviews, or medical archives.

Objectives

In our study, the aim was to observe the dogs' behavior directly in social contact, so we carried out video analyses in addition to questionnaires.

Methods

Therefore, 44 male dogs were filmed in groups of four (n=2 intact and 2=neutered), and their behavior was analyzed using an ethogram. In addition to the video analyses, the personalities of the 44 dogs were evaluated using the Budapest questionnaire.

Results

The neutered dogs were very intensively sexually harassed by the intact dogs (e.g., sniffing of the anal region; randomization test, $p^*=0.01$, OD=2.59; sniffing of the genitals; randomization test, $p^*=0.0008$, OD=4.09; and lick genitals; randomization test, $p^*=0.001$). Accordingly, the castrates appeared stressed ("ears sideways", randomization test, $p=0.005$, OD=2.24). They also showed more aggression, such as attacks (randomization test $p^*\leq 0.001$, OD=1.55) and threats (randomization test $p^*=0.002$, OD=1.74). The Budapest questionnaire revealed significantly higher values for intact dogs for the traits of emotional stability (Mann-Whitney-U-test, $p<0.0005$; OD=9.27) and socioability (Mann-Whitney-U-test, $p=0.004$; OD=5.78).

Conclusion

The above results suggest that, on the one hand, castration can have a significant influence on the dog's character, social compatibility, and emotional state, which could be due to the testosterone-cortisol imbalance. On the other hand, neutering also seems to change the way neuters are perceived by other intact dogs. They may appear more sexually attractive and, therefore, be harassed more. The reason for this could lie in hormonal changes. Many factors must therefore be considered when neutering a dog. Decisions must be made on an individual basis, and the time of neutering should also be considered depending on seasonality.

Keywords

Castration; Videos; Questionnaire; Social Behavior; Sexual Harassment.

| INTRODUCTION |

The reasons for neutering dogs range from health prevention and reproduction control to the avoidance or elimination of

unwanted dog behavior, which is the reason the topic of neutering remains current.¹ It is difficult to determine what changes occur in a dog's behavior due to the hormonal changes caused by neutering, as the effects of neutering can vary.²

The entire behavioral repertoire of dogs must be considered, especially when attempting to understand their supposedly sexual and social systems. The dog does not focus solely on reproduction. Rather, the dog strives for positive (pair) bonds that are formed on a social and non-sexual level.³ So instead of sex hormones, oxytocin is primarily involved in social bonding. Oxytocin, also known as the ‘cuddle or love hormone’,⁴ is produced in both male and female mammals and is essential for building social relationships with conspecifics. Partner-protective behavior (when an individual bonds) can therefore not be eliminated by castration, as Bielsky et al⁵ demonstrated in mice and rats, for example.

In relation to the sex hormones, the oxytocin receptors are particularly important. Their stimulation is dependent on the sex hormones testosterone, progesterone, and estrogen, among others. They are activated, in particular, when the hormones are present.⁶ In a neutered dog, sex hormones are no longer produced to a significant extent, and this can lead to a decrease in these receptors as found in castrated rats.⁷ Furthermore, given that female neutered Golden and Labrador Retrievers were less receptive to human pointing than intact dogs, there might be an interaction between neuter status and oxytocin stimulation.⁸

There are many studies studying the influence of neutering on aggression. In order to avoid surprises, decisions should always be made individually, as this topic is extremely multifaceted and there are different forms of aggression. According to an American study,⁹ neutered female dogs show more aggression and biting towards other dogs than intact female dogs. According to a questionnaire study by Hsu et al,¹⁰ neutered female and male dogs are more aggressive towards their owners than intact dogs.

The results of the study by Podberscek et al¹¹ also confirm this: with a *p* value of less than 0.001, significantly more neutered dogs than intact ones show aggression towards children from the same household. Guy et al¹² discovered that neutered female dogs bite humans twice as often as intact ones. Kim et al¹³ showed that female dogs that had not shown aggression towards children before neutering did so after castration.

One hormone that plays a major role in aggression and anxiety is cortisol. This stress hormone competes with the sexual hormones.¹⁴ Because they originate from the same precursor, cortisol and testosterone share a lot of structural similarities, and the two hormones compete for binding sites with their carrier proteins.¹⁵

Therefore, neutering can cause more stress, panic, insecurity, and excitement in dogs, as the sex hormones that dampen the effects of cortisol are no longer present. In the studies by Kubinyi et al¹⁶ and Zink et al¹⁷ it was found that neutered female and male dogs were the most insecure. Kaufmann et al¹⁸ also found more panic and stress as well as emotional instability in neutered dogs. McGreevy et al¹⁹ showed a significant correlation between the percentage lifetime exposure to gonadal hormones and the occurrence of behavioral problems such as aggression and anxiety in male dogs. The earlier castration was performed, the more likely the negative effects were. Starling et al²⁰ found similar results in

female dogs.

Kustritz²¹ is also of the opinion that neutering cannot improve trainability. Furthermore, the questionnaire study by Farhoo et al²² showed that neutered dogs were less trainable than intact dogs. Neutering can also reduce the dog’s overall activity level, possibly due to a reduction in the dog’s metabolism and an increased tendency to become overweight.^{2,23}

In contrast to studies in which neutering had a negative effect on aggressive behavior in dogs,^{24,25} there are also a number of studies that found either no effect²⁶ or even a positive effect of neutering.^{27,28} However, in one of these studies,²⁶ the neutered dogs were more sensitive to noise or exhibited a more intense fear response overall.

As our video study also includes two chemically castrated dogs in addition to the surgically castrated dogs, the GnRH implant should be briefly discussed. With this method, the dog is not surgically castrated but chemically castrated. As a result, the dog becomes infertile, and castration-related side effects can occur (for detailed information see: Günzel-Apel et al²⁹).

Although the comparability of the exact effects of chemical and surgical castration has not yet been sufficiently studied, the chip offers an opportunity to assess the dog’s behavior after the production of sex hormones has stopped and to make a decision for or against castration on this basis. So far, only a few studies have analyzed the influence of GnRH implants on behavior. Goericke-Pesch³⁰ summarizes that there has been no improvement in the reduction of aggression towards humans, suggesting that behavioral therapy is necessary to manage this issue. This is consistent with the above findings on the influence of surgical castration.^{11,17,18,31}

In general, it is important to wait for the exact time for castration if a dog owner has decided to neuter the dog. While female dogs should only be neutered during the hormonal resting phase, male dogs should also preferentially be neutered in certain months. There are reports from dog owners that their male dog is sexually harassed by other males after neutering. These harassments occur frequently and have already been confirmed by Wörner et al.³²

The aim of our study is to establish a comparison between neutered and intact male dogs and to uncover differences or peculiarities in their behavior and personalities. In order to observe the behavior of the dogs in as much detail as possible, questionnaires and video analyses were carried out in this study.

The first question is about whether the neutered dogs differ from the intact dogs in certain behaviors (e.g., threatening, attacking). The second question is whether sexual harassment occurs between neutered and intact dogs, and the third question asks if there is a difference in the four personality traits of emotional stability, trainability, sociability, and extraversion¹ between the neutered and intact male dogs.

MATERIALS AND METHODS

Research Design

Within this study, videos of 11 different groups of dogs were recorded. A dog group always consisted of 2 neutered and 2 intact male dogs. A total of 44 male dogs (n=22 neutered and n=22

intact dogs) took part in the study. Twenty (20) of the castrated males were surgically castrated, 2 males were chemically castrated *via* suprelorin® Virbac. The dogs were between 10 months and 10.5 years old. They included both mixed-breed and pure-breed dogs, although no direct pedigree was requested. The composition of the dog groups with all participating dogs is shown in Table 1.

Table 1. All 44 Participating Dogs in the Video Recordings. In Addition to Age and Breed, Neutering Status and the Age or Date of Neutering or Neutering Chip were Recorded (where possible)

Group No.	Dog No.	Neuter Status	Breed	Age	Age/Date of Neutering
1	D1	Neutered	Mixed breed	10 years	at 3-4 years
1	D2	Intact	German Wirehaired Pointer	-	-
1	D3	Intact	Dalmatian	-	-
1	D4	Neutered	Galgo Español-Mix	10.5 years	unknown
2	D5	Neutered	Galgo Español	4.5 years	unknown
2	D6	Neutered	Mixed breed	4 years	at 3 years (in May)
2	D7	Intact	Ratenero Bodeguero Andaluze	-	-
2	D8	Intact	Beagle	2.9 years	-
3	D9	Neutered	Samojede-Medium Spitz	1.5 years	unknown
3	D10	Intact	Jack Russell Terrier	4 years	-
3	D11	Intact	American Bully	1.5 years	-
3	D12	Neutered	Golden Retriever - Mix	5 years	unknown
4	D13	Neutered	Bernese Mountain Dog-Mix	4 years	at 2 years
4	D14	Intact	Malinois-Mix	13-14 months	-
4	D15	Intact	unknown	2 years	-
4	D16	Neutered	Labrador-Bernese Mountain Dog	3 years	at 1 year
5	D17	Intact	Giant Schnauzer	1 year	-
5	D18	Neutered	German Shorthaired Pointer-Great Swiss Mountain Dog	2.5 years	at 2 years
5	D19	Neutered	Labrador-Boxer-Mix	2 years	at 1.5 years
5	D20	Intact	French Bulldog	2 years	-
6	D21	Neutered	Miniature Spitz	5 years	< 1 year
6	D22	Neutered	Miniature Spitz	2 years	unknown
6	D23	Intact	Miniature Spitz	2 years	-
6	D24	Intact	Miniature Spitz	1 year	-
7	D25	Intact	Husky-Mix	2 years	-
7	D26	Neutered	Shih-Tzu-Mix	3 years	unknown
7	D27	Neutered	Bearded Collie	7 years	unknown
7	D28	Intact	Border Terrier	2.5 years	-
8	D29	Neutered	Irish Wolfhound	5 years	unknown
8	D30	Neutered	Mixed Breed	4 years	unknown
8	D31	Intact	Small Münsterländer	1 year	-
8	D32	Intact	Elo	1 year	-
9	D33	Chip	Mixed Breed	10 years	at 9.5 years (April)
9	D34	Chip	Mixed Breed	2 years	at 1.5 years (Feb)
9	D35	Intact	Weimaraner	10 months	-
9	D36	Intact	Australian Shepherd	1 year	-
10	D37	Neutered	Dalmatian	4 years	unknown
10	D38	Neutered	Mixed Breed	2 years	unknown
10	D39	Intact	Labrador Retriever	2.5 years	-
10	D40	Intact	Mixed Breed	2 years	-
11	D41	Neutered	Mixed Breed	6 years	unknown
11	D42	Neutered	Mixed Breed	1.5 years	unknown
11	D43	Intact	Australian Shepherd	3 years	-
11	D44	Intact	Mixed Breed	4 years	-

The groups of dogs were each filmed at one of four meetings. The focal-animal sampling method³³ was used so that every dog was filmed for 5 minutes as a focused animal. To ensure that each dog was filmed once at the beginning of a meeting, the order of the dogs was rotated for the four meetings. A random selection was made on the first date.

The video recordings took place in a fenced-in area of a dog school. The dog keepers, at least one dog trainer, and one or two people with cameras were always present. In order to prevent violent conflicts, the dog trainer or the dog keepers intervened as soon as the situation demanded it. One of the dogs wore a muzzle from the start, to which he was already accustomed through his everyday life before this study.

Budapest Questionnaire

In addition to the video recordings, questionnaires were completed by the dog keepers about their dogs. The questionnaires are based on the study by Turcsán et al¹ and provide information about the dog's personality. The Budapest questionnaire, which can be found in the appendix, contains various items that can be answered using a three-point scale. The scale ranges from "applies" to "partially applies" and "does not apply" and the respective answer is ticked to achieve a certain score. The results of the questionnaire are summarized into the following four personality categories:

Extraversion: Extraversion (also called boldness), but we prefer the first term to avoid confusion with the behavioral supertrait as in the shy-bold-system Taborsky et al³⁴. A character with low scores is likely anxious and insecure. High scores point to an outgoing, extrovert personality.

Sociability: A high propensity for bullying or fighting with conspecifics is indicated by low scores. A higher score denotes less suspicious behavior and more peaceful interactions with conspecifics.

Emotional stability: Emotional stability refers to the reaction of a dog to stressful situations. Reduced scores are indicative of nervous and tense behavior (neuroticism). A dog with high scores is calm and emotionally stable.

Trainability: A character that scores low on this attribute is less imaginative and playful. Dogs that score low are thought to be less open and curious.

Statistical Analyses

The video analyses were carried out using an ethogram created by Goodman et al³⁵ and modified by Spitzley et al³⁶ and Feddersen-Petersen³⁷ (for detailed information on the individual behaviors, see Appendix, Ethogram).

All behaviors were recorded *via* focal-animal sampling, recording sender and receiver. Data were recorded in seconds for states and as frequencies for events (such as yawning or body shaking). As a total of 44 dogs were filmed at each of the 4 meetings,

the sample size totaled an N of 176 individual data points.

Due to this data size and the data level, a two-sided randomization test based on a one-way analysis of variance (ANOVA) was used. The program used for this is the statistical program SsS 8.2c (full version, copyright 2009-2023 Zoolution; www.zoolution.de). A Kruskal-Wallis test was also used to differentiate the castration status with regard to the sender and receiver of the behavior. This made it possible to differentiate whether an intact male dog sends an intact or neutered male dog, and vice versa.

This multiple testing led to an adjustment of the data according to the Bonferroni correction. A standard adjustment, according to Engel,³⁸ was performed by multiplying the *p* values by the number of tests performed (*n*=2). The corrected *p* values were labeled with an asterisk (*).

The non-parametric, two-sided Mann-Whitney U-test was applied to the data from the BUDAPEST questionnaires.¹ The statistical program IBM statistical package for social sciences (SPSS) Statistics (Version 29.0) was used for this. All tables and graphics were created using Microsoft Excel or SPSS 29.

The effect size was determined to assess the extent of the relationship between the variables.³⁹ The odds ratio was applied with the following bandwidth by Chen et al⁴⁰:

Exp(B)<1.68	Very small
1.68≤Exp(B)<3.47	Small
3.47≤Exp(B)<6.71	Medium
Exp(B)≥6.71	Large

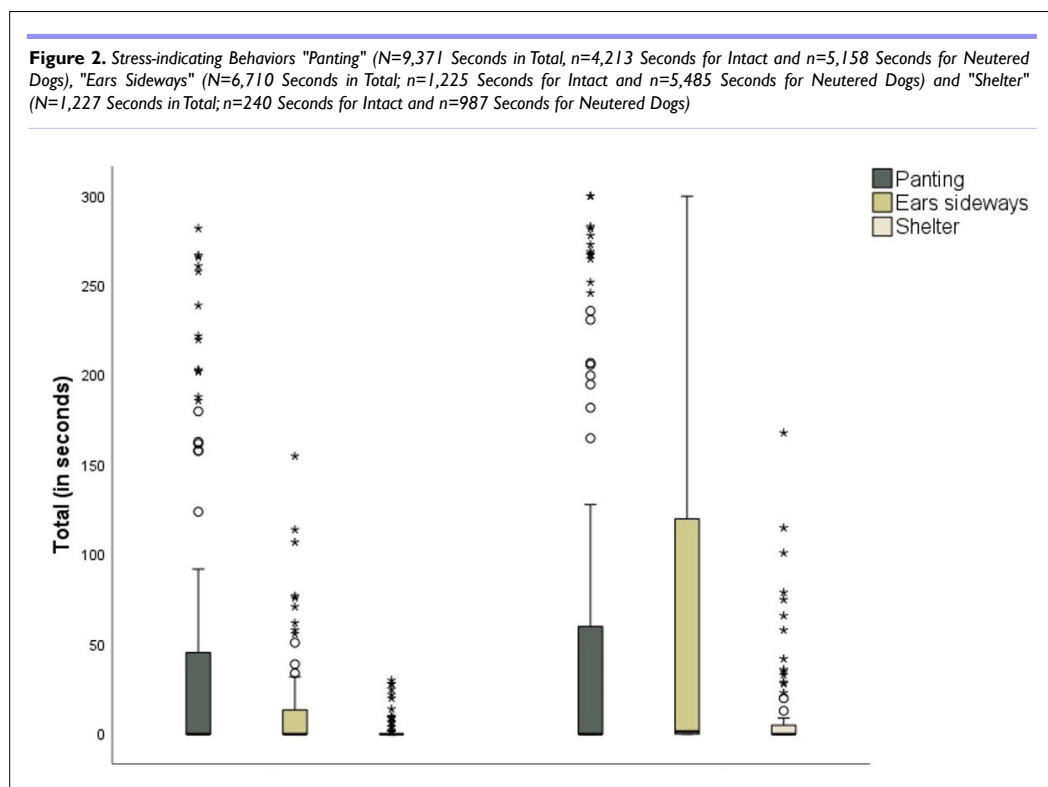
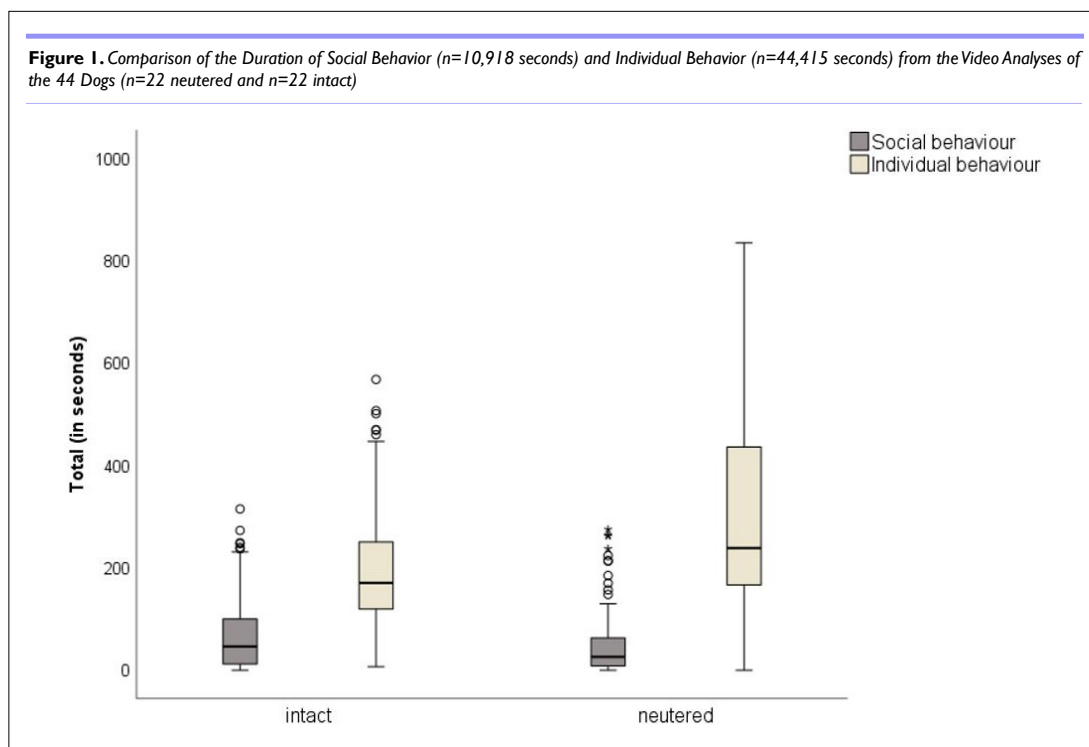
RESULTS

The dogs displayed a total of 10,918 seconds of social behavior, of which 6,328 seconds were displayed by the intact dogs and 4,590 seconds by the neutered dogs. The individual behavior was 44,415 seconds in total (of which *n*=17,767 seconds for the intact dogs and *n*=26,648 seconds for the neutered dogs).

If individual behavior is compared with social behavior (Figure 1), it is noticeable that the neutered males showed more individual behavior (median=238.5) than social behavior (median=26). They also showed more individual behavior than the intact males. In intact males, social behavior (median=46.5) was also lower than individual behavior (median=170.5).

Regarding stress-indicating behavior within the individual behavior, it can be seen that "Ears sideways", "Panting" and seeking "Shelter" occurred in more neutered than intact males (Figure 2). The results were highly significant for the behavior "Ears sideways" (randomization test, *p*=0.005; OD=2.24).

Comparing "countermarking" and "tooth chattering" (Figure 3), there were large differences between the neutered and



intact males, with intact dogs marking significantly more than the neutered dogs (randomization test, $p < 0.0005$; OD=2.59). The tooth chattering only occurred in intact dogs and not in neutered dogs (randomization test, $p = 0.04$; OD=13.5 e8).

With regard to sexual harassment, it was found that there were certain behaviors that were exhibited more by the intact males

than by the neutered males. These were in particular “sniffing of anal region” (randomization test, $p^* = 0.01$, OD=2.59), “huddle” (randomization test, $p^* = 0.06$; OD=3.02), “threaten” (randomization test, $p^* = 0.012$; OD=3.36), “follow” (randomization test, $p^* = 0.06$; OD=1.56), “sniff genitals” (randomization test, $p^* = 0.0008$; OD=4.09), “lick genitals” (randomization test, $p^* = 0.001$; OD=1.6 e8), “sniffing of inguinal region” (randomization test, $p^* = 0.004$;

OD=2.65), “chinrest” (randomization test, $p^*=0.01$; OD=4.57) and “T-formation” (randomization test, $p^*=0.002$; OD=3.28) (Table 2). Almost all harassing behaviors were largely directed from the intact males to the neutered males, which can be seen in Figure 4. Only

“Mount” was mainly sent by the neutered males to other neutered males. The neutered and intact dogs differed significantly from each other in almost all harassing behaviors when it comes to distinguishing who sends them to whom (Table 3).

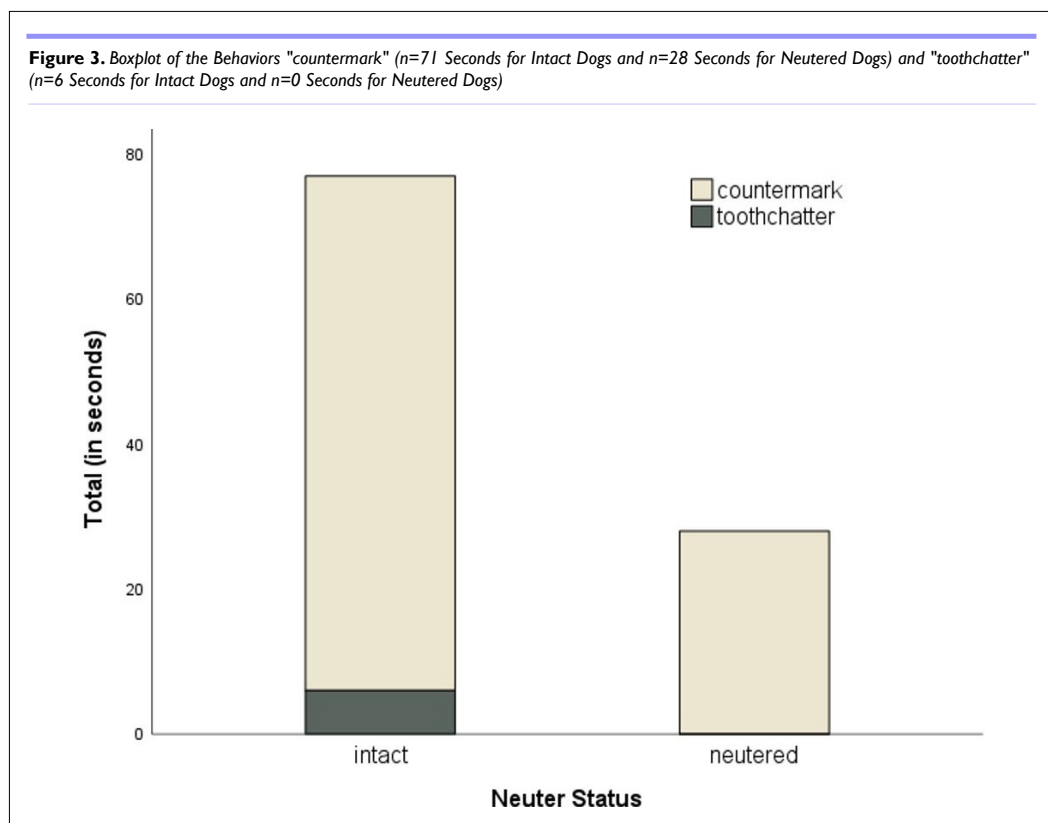


Table 2. The Statistical Results of the Randomization Test of Social and Individual Behavior of Neutered (n=22) and Intact (n=22) Males

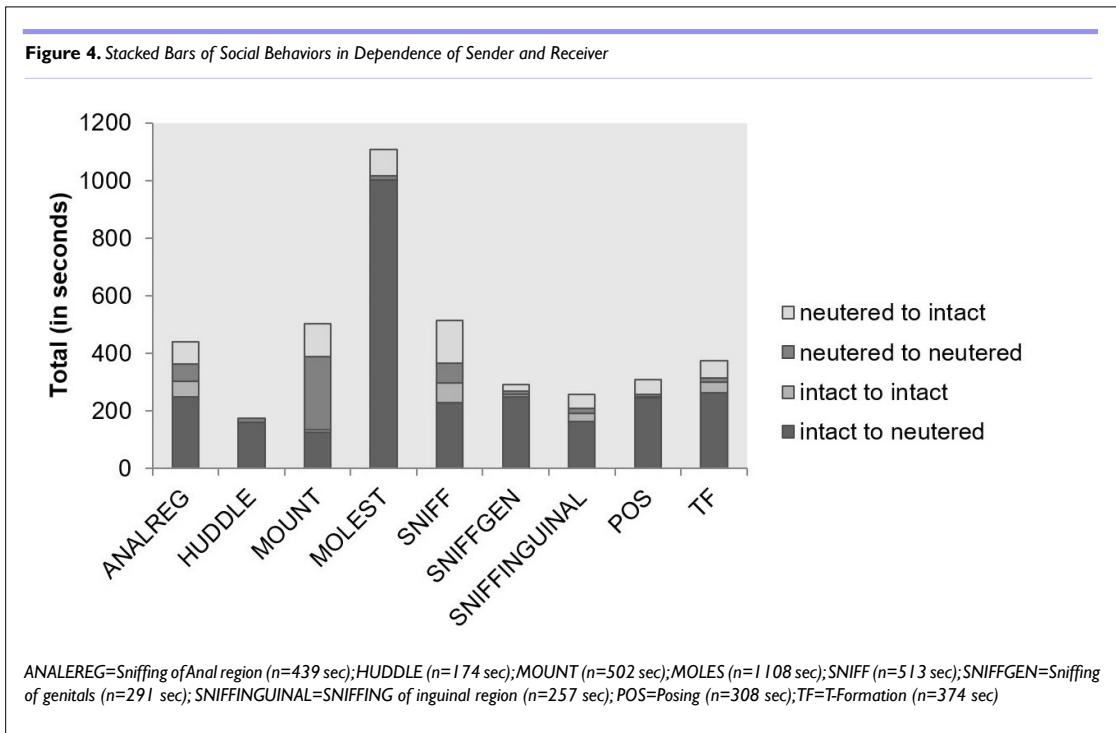
Variable	p value	OD	Bandwidth
Social Behavior			
Sniffing of anal region	0.01*	2.59	Small
Huddle	0.06*	3.02	Small
Molest	0.12*	2.06	Small
Threaten	0.012*	3.36	Medium
Follow	0.06*	1.84	Small
Sniff genitals	0.0008*	4.09	Medium
Lick genitals	0.001*	1.6 e8	Large
Sniffing of inguinal region	0.004*	2.65	Small
Bickering	0.06*	1.00	Very small
Chinrest	0.01*	4.57	Medium
T-formation	0.002*	3.28	Small
Individual Behavior			
Active looking	0.004	2.13	Small
Ears side	0.005	2.24	Small
Overmark	<0.0005	2.59	Small

The Bonferroni-corrected p values are marked with an asterisk (*). The effect sizes were calculated using the odds ratio (OD; by Cohen³⁹ and estimated according to the range by Chen et al⁴⁰ (see material and methods section above).

Table 3. Results of the Kruskal-Wallis-Test of Harassments and Aggressive Patterns by the Neutered (n=22) and Intact (n=22) Males Depending on Sender and Receiver of the Behaviors

Variable	p value	OD	Bandwidth
Harrassments			
Sniffing of anal region	<0.001*	1.67	Very small
Huddle	<0.001*	2.63	Small
Mount	0.1*	1.05	Very small
Molest	<0.001*	1.61	Very small
Sniffing	<0.001*	1.32	Very small
Mount	0.1*	1.31	Very small
Follow	<0.001*	1.27	Very small
Sniff genitals	<0.001*	2.13	Small
Lick genitals	<0.001*	66,666.66	Large
Sniffing of inguinal region	<0.001*	1.67	Very small
Pose	<0.001*	2.17	Small
T-Formation	<0.001*	1.79	Small
Aggression			
Attacks	<0.001*	1.55	Very small
Threaten	0.002*	1.74	Small
Dodge	<0.001*	1.15	Very small

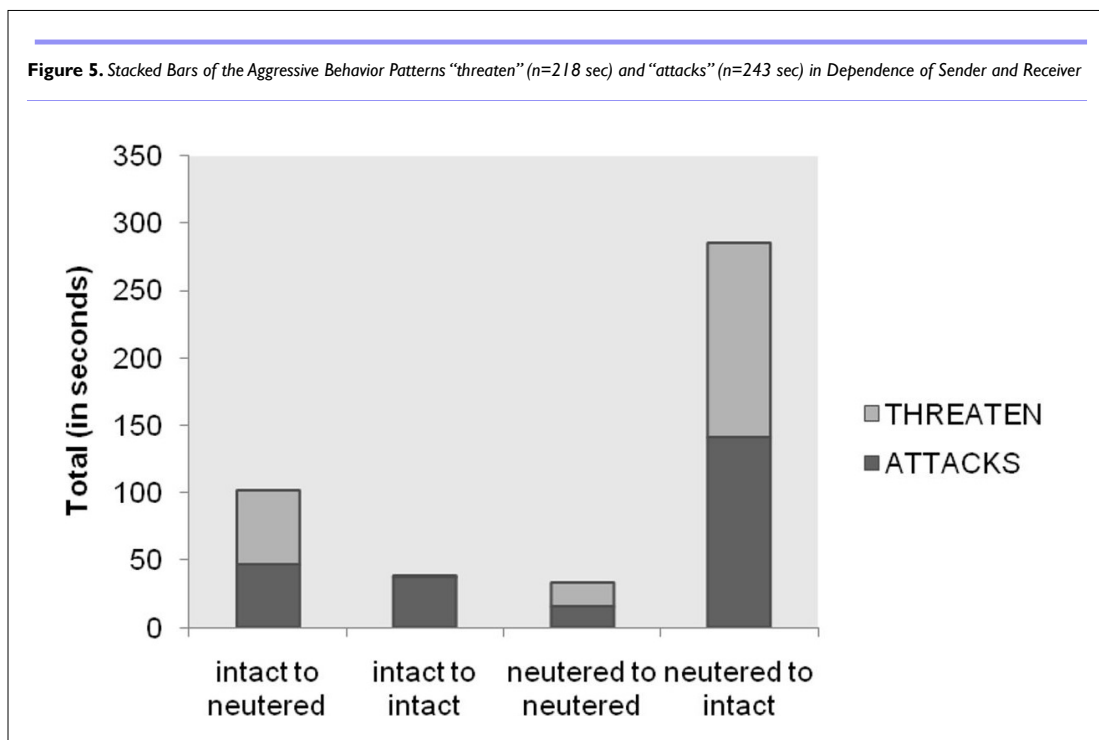
The Bonferroni-corrected p values are marked with an asterisk (*). Effect sizes were calculated using the odds ratio (OD; by Cohen³⁹ and estimated according to the range by Chen et al⁴⁰ (see material and methods section above).



In terms of social behavior, differences in aggressive behavior were particularly evident. Here, the neutered males showed a higher proportion of attacks (randomization test, $p^* < 0.001$, $OD = 1.55$) and threatening behavior (randomization test, $p^* = 0.002$, $OD = 1.74$). The corresponding statistical results can be found in Table 3. A comparison of the sexual harassment of the two chipped males in relation to their estimated hormone levels can be found in the supplementary material (Figure 5).

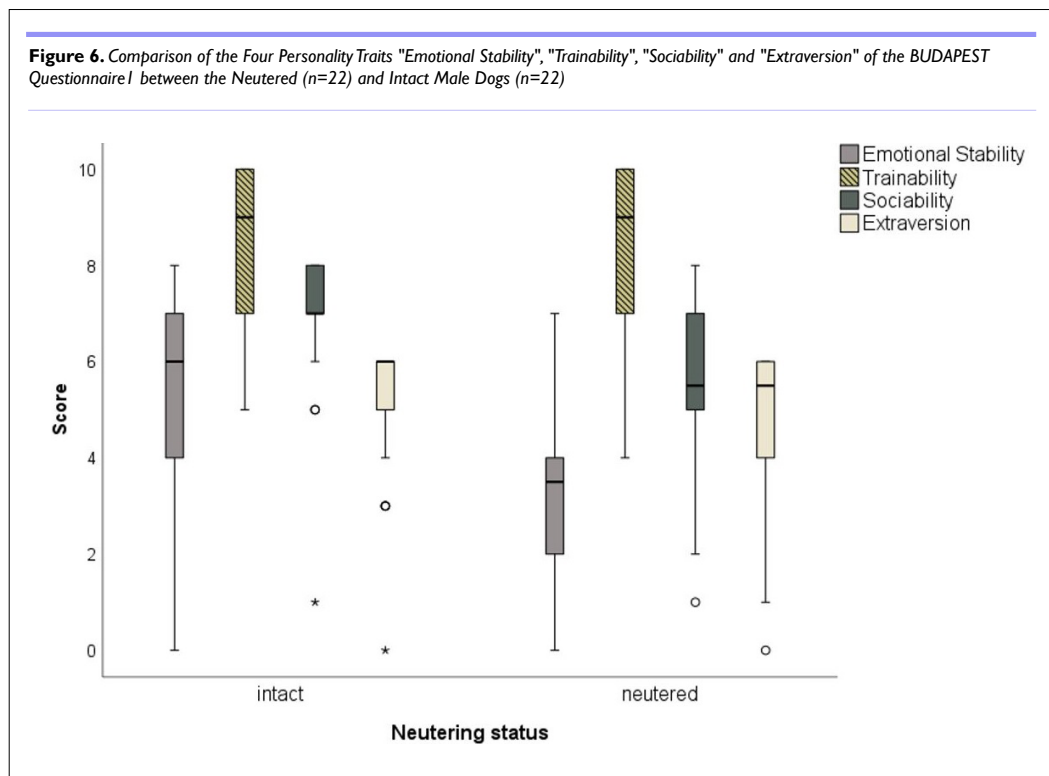
The results of the BUDAPEST questionnaire show differences between the neutered and intact dogs. Significant differences and a large effect size were observed for the personality trait emotional stability (Mann-Whitney U-test, $p < 0.0005$; $OD = 9.27$), with higher scores in the intact (median=6) than in the neutered dogs (median=3.5).

Similarly, the score for sociability was significantly high-



er in the intact than in the neutered dogs (Mann-Whitney U-test, $p=0.004$) with a medium effect size (OD=5.78). There were no major differences in the trainability category. The median was 7 for both the neuters and intact, but the minimum value was slightly

lower for the neuters. Extraversion also showed no significant differences, although the ranges of the whiskers differed. The scores of the intact dogs were slightly higher (median=6) than those of the neutered dogs (median=5.5), but the latter had stronger down-



ward outliers (Figure 6).

DISCUSSION

The results of our study indicate that neutered dogs show more insecurity in their interactions with conspecifics and display less social behavior and more individual behavior. This change in behavior might be attributed to the absence of sex hormones, which play a role in regulating oxytocin levels. Oxytocin plays a crucial role in modulating social anxiety,⁴¹ and it also increases self-confidence.⁴² The oxytocin receptors, in particular, depend on the amount of testosterone. Consequently, they become less active when the amount of testosterone decreases.^{6,7} It has been shown in rats that oxytocin-receptor binding and messenger ribonucleic acid (mRNA) levels in the brain increase with estrogen and testosterone treatment and decrease with castration.^{43,44} It would therefore be expected that neutered dogs could also be more excitable and emotionally unstable due to the lack of oxytocin.

Also, the loss of sexual hormones after castration causes cortisol levels to rise due to the lack of testosterone,^{14,45} which can lead to increased stress in male dogs. A possible increased stress level was also detected in the neutered dogs in the video analyses. They showed behaviors such as “ears sideways”, “panting” and “shelter”, all of which indicate that the dogs felt uncomfortable

and were exposed to a stress stimulus. The “ears sideways” behavior in particular indicates a conflicting inner state.⁴⁶

This increased stress can cause the dogs to avoid potentially challenging situations. Additionally, it can change their odor in the urine and anal glands, which in turn affects how they are perceived by others.^{32,47,48} Certain odorants are released from the glands, which are primarily used for social communication.⁴⁹

The chemical composition of this secretion can vary from season to season. For example, female canines are considered particularly attractive for a certain period before mating (in March) due to specific peaks in their odor composition. Similar seasonal variations in odor composition have also been observed in male dogs.^{47,48} If a male dog is castrated during these months (especially February, March, and April), he may remain at this odor level and thus appear extremely attractive to other males,³² (based on questionnaires).

A series of studies by Raymer et al^{47,48} describe the chemical composition of odorants in the anal gland secretions and urine of canids. For example, trimethylamine, indoles, butanoic acid, and propanoic acid are found in anal gland secretions, as well as alcohols, aldehydes, and ketones as volatile components. Some of these are typical for sex and reproductive status.

Raymer et al^{47,48} found that the chemical components in wolf urine varied based on reproductive state. When testosterone was given to castrated male wolves or ovariectomized females, the concentration of acetophenone, which was high in females and castrated males, decreased. Females showed two peaks of acetophenone concentration in early June and early August. Testosterone administration also led to an increase in male urine components in females. Methyl propyl sulfide concentrations, low in castrated males and females, rose to intact male levels with testosterone. Benzaldehyde levels were higher in intact female wolves in February but lower in castrated males in August. Haase⁵⁰ observed seasonal changes in testosterone concentrations and testicle size in domestic male dogs, with a decrease in April–May. Otherwise, modern dog breeds show less clear seasonal patterns compared to wolves.

The above-mentioned findings led to the hypothesis of possible increased sexual harassment of neutered male dogs. This can be confirmed by our video analysis. Sexual harassment behaviors such as increased anal-genital and inguinal sniffing, intrusive sniffing, and following were exhibited by many intact males and were most frequently sent to neutered males. Behaviors such as chin resting, mounting, and teeth chattering also occurred, which are usually sent by an intact male to a sexually intact female to show interest.^{51,52} These behavioral elements may all be part of courting behavior and serve to test the female's willingness to mate and to assess whether mating would be possible (see ethogram in the appendix).^{53,54}

In our video analyses, the neutered males were mostly the recipients of this sexual courting. This made them even more stressed, and they consequently tried even harder to avoid these situations.

The extent to which the month of castration of the males is directly related to the intensity of harassment³² can only be vaguely surmised from our study, as the time of castration was not known exactly or at all for most of the castrated males. In the case of one male dog, who was one of the males with a high rate of being harassed, it was known that he was castrated in May, i.e., close to the sensitive months mentioned above. For two other males, it was possible to calculate back approximately to the time of neutering based on their age, and April or May was found for both. This suggests, at least for these three males, that their neutering in the first half of the year could have resulted in increased attractiveness.

The neutered males sometimes reacted with strong agonistic behavior by making offensive and defensive threats. There were even attacks that were not causing injury but did not respect distance. These included snapping, lunging at each other, or threatening barks. The neutered dogs showed aggression in response to the sexual harassment, but the aggressive behavior was also sent to other males (including neuters) who did not harass them. Aggressiveness must always be considered multicausal, as there are different forms of aggression that are dependent on different hormones.⁵⁵⁻⁵⁷ The overall higher aggressiveness of the neutered males could also be due to the loss of hormones. On the one hand, the

calming oxytocin is missing, and, on the other hand, the increased cortisol level can lead to more insecurity and inadequate behavior.^{58,59} Other studies also confirm that neutered male dogs can exhibit more aggression^{18,31,60,61} or that aggression in particular does not decrease as a result of neutering.⁶² In particular, fear-related and territorial aggressions do not decrease as a result of castration.⁶² Neutering can also lead to a significant decrease in serotonin levels,⁴⁵ which also leads to a tendency towards aggressive behavior.⁶³⁻⁶⁵

An important aspect of our study is that there were different dog breeds and weight classes. It must be considered that there can be both size- and breed-dependent aggression in dogs.^{66,67} While some authors indicate a higher-risk in smaller dogs,^{66,67} others find no correlation between body size and aggressiveness.⁶⁸ Tira et al,⁶⁹ Salonen et al,⁷⁰ Hsu et al¹⁰ and Duffy et al⁷¹ also found breed-specific variations in aggressive dog behavior. Two studies by Kolkmeier et al^{31,60} have already investigated breed-specific correlations between dog behavior and neutering status. On the one hand, it was found that neutered dogs were more aggressive than intact dogs, regardless of breed. On the other hand, the group of 'Bulldogs' were significantly more aggressive than the clade of 'Huskies'.⁶⁰ However, Kolkmeier et al³¹ found no correlation between dog breed and aggressiveness and found that neutered dogs were more aggressive than intact dogs, regardless of breed. Consequently, breed-dependent aggression or a higher-risk of aggression in certain breeds due to gonadectomy cannot be ruled out in our study, either. A comparison of aggressive behavior in relation to dog breeds can be found in the appendix (Table X; Figure Y).

In contrast to the studies that assume increased aggression problems in neutered dogs,^{18,24,25,60,61} there are also studies in which no negative effect on aggressive behavior was found,²⁶ but in which sensitivity to noise or a more intense fear response was higher in neutered dogs.²⁶ Conversely, positive effects of neutering on aggression have also been reported.^{27,28} The online survey by Kriese et al² found that the prevalence of aggressive behavior towards humans was not changed by gonadectomy, but aggressive behavior towards dogs and other animals decreased. However, in the study by Hart et al,⁷² neither territorial nor fear aggression decreased in the dogs after castration. In addition, aggression increased more in dogs that were already aggressive after neutering than in intact dogs.

Neutering did not lead to a reduction in fearful behavior in fearful dogs. Neutering led to an increase in the number of dogs that were afraid of strange dogs or people and an increase in the number of dogs with noise phobias. At the same time, the frequency of hiding behavior decreased.²

According to McGreevy et al,¹⁹ urine marking was the only undesirable behavior that was reduced by castration. On the one hand, Lisberg et al⁷³ found that castration did not lead to any significant difference in countermarking, except for direct overmarking towards the urine of intact other sexes. McGreevy et al¹⁹ also stated that mounting behavior increased after castration. This has not been confirmed by other studies.

It was clearly noticeable that the neutered males also mounted a lot in our videos, especially with other neuters. A courtship behavior can probably be ruled out here, as this behavioral element mostly took place independently of the context and no other flirting elements were present. Therefore, there must be another reason for the increased mounting behavior of the neuters. Mounting also occurs in other contexts in addition to courtship behavior. For example, it can arise from insecurity and stress and can occasionally be a sign of stress that can be triggered by frustration.^{74,75} It also occurs in a playful context.⁷⁶

Another possibility would be a connection with dominant or sovereign behavior. In wolves and dogs, these behaviors are usually considered signs of dominance.^{52,77,78} However, Van Hooff et al⁷⁹ found that mounting and “head-tucking” (equivalent to chin-resting) were associated with affiliative behavior rather than behavior related to status communication in their study of dominance in captive wolves. In Trisko,⁵¹ the wolves were mounted exclusively in one direction, with subordinates often mounting the dominants. Dopfer⁵⁴ also found no clear correlation between mounting behavior (outside the heat of a female dog) and dominance structure in foxhounds. In our video study, there was also a lack of other dominant behavior patterns and the submissive behavior of the recipient dog.

In addition, significant differences in countermarking were also observed. The intact males in particular marked more on the urine of other males than the neutered dogs. Marking behavior is a means of communication between dogs. However, a clear distinction must be made as to whether the marking behavior takes place on another dog’s urine or directly next to it. Marking next to another dog’s urine can either occur in a competitive context or can serve and present the social bond to each other and therefore come from a completely different social context than direct over-marking.⁷⁹

Direct over-marking occurs in a sexual context toward the urine of an intact female and is intended to mask the scent for other rivals.⁸⁰ In our video analyses, the intact males marked over other intact males on the one hand, and, in the case of known males (=“friends”), even just next to them. If it was the urine of a neutered male, the intact male urinated directly on the mark. This emphasizes the above assumption that the castrated males are sexually attractive to the intact males.

Lisberg et al⁷³ investigated the marking behavior of dogs in relation to their castration status and found that the subjects’ counter markings had no significant correlation with their gonadal status. There were no significant differences between intact and gonadectomized males with regard to counter markings, over markings, and adjacent markings.

However, countermarking may also be related to rank order. In African wild dogs, it has been shown that high-ranking males mark particularly frequently and that all animals communicate with other pack members *via* the scent marks they leave behind. They exchange information with each other by marking the

same places.⁸¹ Anecdotal evidence suggests that it may be common in the family.^{82,83}

Similar to a high-ranking wolf, a sovereign male usually marks more frequently than a low-ranking male.⁷³ Consequently, the intact males would also be the higher-ranking males in our video analyses. This finding is not very surprising when one considers that the hierarchy could be influenced by testosterone,⁸⁴ which is lower in castrates.

In contrast, Beach⁸⁵ showed that female dogs that were treated with testosterone both prenatally and postnatally did not differ from males that were castrated in adulthood. The conclusion of the study was that the hormones released prenatally have the greatest influence on social behavior and hierarchy. Neonatally and postnatally, the effects are much smaller, so it can be assumed that a neutered dog does not change its rank due to the loss of testosterone.

However, Beehner et al⁸⁶ emphasize that in a stable male dominance hierarchy, there appears to be no correlation between aggression and testosterone levels. Similarly, rank and testosterone levels in primates appeared to be unrelated, whereas changes in rank were positively related to testosterone, meaning that males that rise in rank have higher testosterone levels than males that fall in rank.

Olfactory communication itself, which plays a major role in over-marking,⁸⁷ would also be of interest here. Berthoud⁸⁸ found that signal reception behavior *via* the vomeronasal organ is impaired by castration in male dogs. This could prevent some dogs from getting the maximum information from urine markings.

When comparing the personality traits of the BUDA-PEST questionnaire (Turcsán et al¹) it was observed that the intact males were more emotionally stable and more sociable than the neuters. These results are consistent with the video recordings, as here too, the neuters appeared emotionally unbalanced and less social. They showed more threats, attacks, and stress-indicating behavior. As with the videos, the results of the personality questionnaire could also be explained by the hormonal changes. The loss of sex hormones leads to an imbalance between the sex hormones and cortisol^{14,45,58} and oxytocin.^{6,7}

A study of this kind could have a number of issues. The first barrier was the selection of the dogs, as only males that generally got along well with each other were allowed to run together. The individual group composition was certainly a decisive factor in the results. In addition, a different picture could have emerged if no pre-selection had taken place. This way, it was possible to avoid major conflict situations and injuries. However, it made it even more difficult to find suitable dogs, causing the sample to be very heterogeneous. Although the distribution of breeds was purposely chosen randomly, as this also corresponds to the situation of daily dog walks, an even distribution of breeds would possibly be statistically more meaningful. Unfortunately, it was also not possible to provide information on the time of neutering for each dog.

In addition, the behavior of the dogs could have been influenced by the presence of their keepers, as they intervened in certain cases and communicated with their dogs.

CONCLUSION

In conclusion, our results show that there can be clear differences between neutered and intact dogs and that there may be complex hormonal changes and correlations behind this. Therefore, neutering should be decided on an individual basis, particularly due to the changes in behavior after neutering and the associated increase in stressed behavior or other behavioral problems. This can minimize possible negative effects and avoid unpleasant surprises.

RESEARCH WITH ANIMALS AND ETHICS APPROVAL

Our video and questionnaire study involved participants who completed a questionnaire about their dogs and who took part in four meetings with their dogs. On these dates, the dogs were filmed for a total of 20 minutes.

The participating dogs were either neutered or intact before taking part in our study. None of the dogs were neutered for our study, but the sample was taken from a selection of already neutered and intact dogs. All dogs are treated anonymously, and their owners agree to take part in the survey with their dogs. All subjects gave their informed consent to participate before taking part in the questionnaire study. As no data was collected from humans but only from dogs, no ethical authorization is required under German law (DSGVO).

None of the dogs were injured during the video recordings. At least one dog trainer, the dog keepers, and at least one person with a camera were always present. Before the first video recording was started, the dogs were pre-selected so that only dogs that were compatible with each other were allowed to run and serious conflicts could be avoided. The dog trainers or dog keepers were always able to intervene if the situation required it.

AUTHORS' CONTRIBUTIONS

Conceptualization, U.G. and C.K.; methodology, U.G., C.K.; software, C.K.; validation, U.G., C.K.; formal analysis, U.G. and C.K.; investigation, C.K.; resources, U.G. and C.K.; data curation, C.K.; writing—original draft preparation, C.K.; writing—review and editing, U.G., C.K.; visualization, C.K.; supervision, U.G.; project administration, U.G.

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STATEMENT OF SUPPLEMENTARY MATERIALS

The data collected in the questionnaire can be found in anonymised form in the electronic Appendix.

EXPLANATION OF DATA AVAILABILITY

The raw data presented in this study is also available on request from the corresponding author.

PARTICIPANTS' CONSENT STATEMENT

The dog schools have signed a declaration of consent that the results of the video analyses may be published.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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APPENDICES

DOGS WITH CHIP

Two of the castrated dogs were hormonal castrated. As the sample of two animals was too small to carry out meaningful comparative analyses, this was left out. The extent to which the castration chip affects the receiving of sexual harassment can therefore only be assumed. Nevertheless, it is noticeable in the graph (Figure X) that the male dog that was chipped in February probably had his testosterone low level in March/April. This male dog was also massively sexually harassed and this would correspond to the thesis about the seasonal dependence of the month of castration.

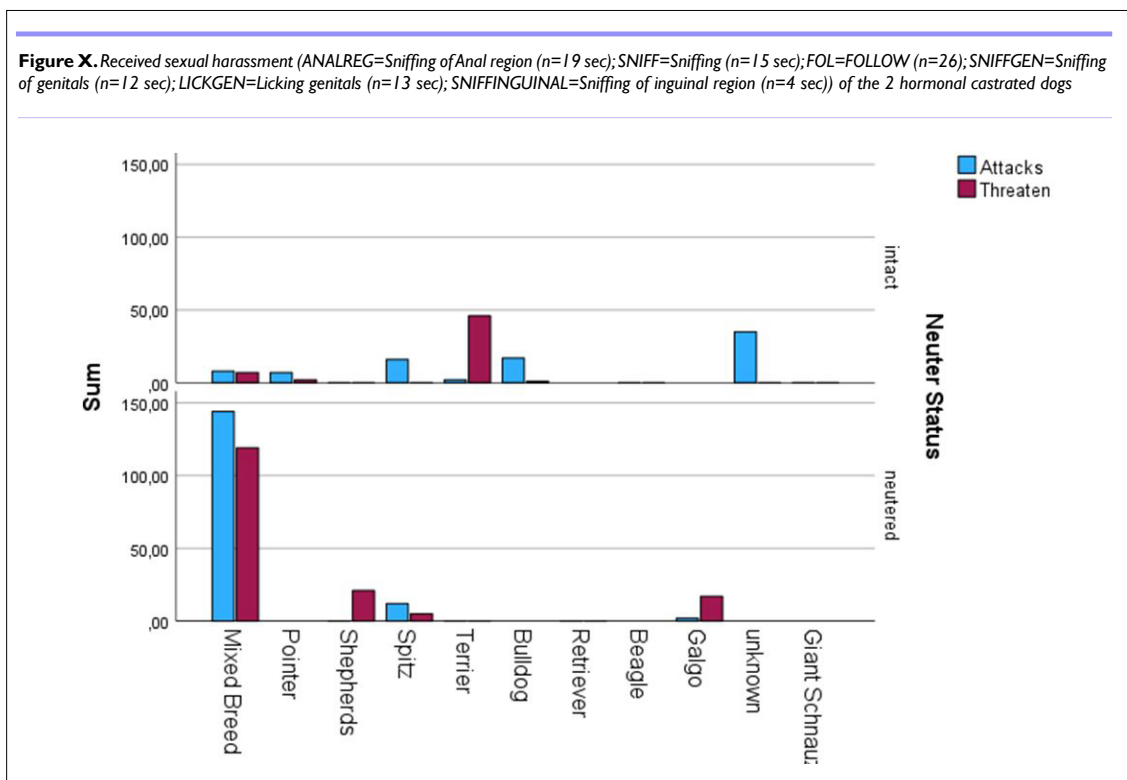


Table. Ethogram

Neutering Status	Emotional Stability	Trainability	Sociability	Extraversion
Intact	8	6	8	6
Intact	0	9	6	6
Intact	4	10	8	0
Intact	5	9	7	5
Intact	7	8	8	6
Intact	7	7	7	3
Intact	4	9	8	5
Intact	6	7	8	6
Intact	6	10	7	6
Intact	6	7	7	6
Intact	8	7	8	6
Intact	3	10	5	5
Intact	5	5	1	6
Intact	7	8	8	6
Intact	4	10	6	5
Intact	4	10	8	3
Intact	3	10	7	6
Intact	7	9	7	5
Intact	6	10	7	6
Intact	6	7	8	4
Intact	7	7	5	6
Intact	5	10	7	3
Neutered	3	7	6	1
Neutered	1	6	2	4
Neutered	2	7	6	6
Neutered	5	9	5	6
Neutered	2	9	6	6
Neutered	1	4	3	0
Neutered	4	9	7	6
Neutered	4	9	7	6
Neutered	4	10	6	6
Neutered	7	10	7	2
Neutered	0	10	5	5
Neutered	3	9	8	6
Neutered	4	10	4	6
Neutered	3	7	5	4
Neutered	4	6	5	2
Neutered	2	10	1	3
Neutered	4	9	4	4
Neutered	5	5	7	5
Neutered	5	5	5	6
Neutered	3	8	8	6
Neutered	4	8	8	5
Neutered	3	10	5	6
Median	3,5	9	5,5	5,5

Social Behaviour																						
Day	Neuter	Analr	Attack	Huddl	Rideup	Avoid	Moles	Snif-fin	Mount	Threat	Follow	Genita	Lick_G	Press	Ignore	In-Guin	Naggin	Chinre	Pose	Play	T-Form	Total
Day 1	Intact	20	0	0	2	19	3	0	2	0	2	8	0	0	0	0	0	0	1	13	1	71
Day 2	Intact	22	0	0	2	2	0	5	0	0	0	0	0	0	0	7	0	0	0	39	0	75
Day 3	Intact	12	0	0	0	0	8	18	0	0	2	2	2	0	0	0	0	0	4	0	0	48
Day 4	Intact	1	0	0	0	0	1	5	0	0	0	0	0	0	0	4	0	0	0	12	0	23
Day 1	Intact	1	0	0	0	0	3	0	0	0	10	0	0	0	0	2	0	0	0	22	0	38
Day 2	Intact	10	0	0	0	0	1	1	0	0	24	0	0	0	0	4	0	0	0	15	0	55
Day 3	Intact	11	0	0	0	1	0	5	0	0	2	6	0	0	0	9	0	0	4	29	5	72
Day 4	Intact	4	0	0	0	0	0	4	0	0	0	1	0	0	0	0	0	1	117	0	0	127
Day 1	Intact	4	1	0	0	2	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	9
Day 2	Intact	12	0	0	0	1	35	6	0	1	18	5	0	0	0	8	0	0	13	0	0	99
Day 3	Intact	4	0	0	0	0	0	1	0	0	6	11	0	0	0	0	0	0	3	0	0	25
Day 4	Intact	0	0	0	0	1	0	0	0	0	30	0	0	0	0	0	0	0	0	52	0	83
Day 1	Intact	7	0	0	0	2	0	0	0	0	68	4	0	0	0	0	0	0	0	0	0	81
Day 2	Intact	33	0	0	0	3	7	1	0	0	4	4	4	0	0	8	0	0	6	0	12	82
Day 3	Intact	5	0	0	0	1	33	3	0	0	2	10	0	0	0	5	0	0	0	6	2	67
Day 4	Intact	2	0	0	0	1	57	13	0	0	64	33	9	0	0	0	0	0	0	0	17	196
Day 1	Intact	5	2	2	2	8	0	0	0	46	19	11	7	17	21	9	0	0	0	0	0	149
Day 2	Intact	0	0	10	0	0	0	4	0	0	23	0	0	108	0	0	0	0	0	0	0	145
Day 3	Intact	4	0	8	0	6	0	7	0	0	30	6	4	0	0	6	0	0	0	0	0	71
Day 4	Intact	17	0	10	0	0	0	5	0	0	63	0	0	22	0	0	0	14	0	0	0	131
Day 1	Intact	2	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	7
Day 2	Intact	2	0	0	0	0	0	0	0	0	8	0	0	0	8	0	0	0	0	0	0	18
Day 3	Intact	0	0	0	0	2	0	0	0	0	3	8	0	0	4	4	0	0	0	0	0	21
Day 4	Intact	6	0	0	0	3	0	8	0	0	5	0	0	0	0	3	0	0	0	0	0	25
Day 1	Intact	0	0	33	4	0	0	0	0	0	9	0	0	4	40	3	14	0	8	65	45	225
Day 2	Intact	5	0	66	16	4	0	0	0	0	14	6	1	0	3	2	0	0	5	96	22	240
Day 3	Intact	3	0	16	2	52	0	1	0	0	0	4	0	0	143	1	2	0	0	28	63	315
Day 4	Intact	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Day 1	Intact	2	28	0	0	0	0	0	0	0	60	0	0	0	6	0	38	0	0	0	5	139
Day 2	Intact	5	0	0	0	0	0	1	0	0	67	0	0	0	6	0	5	0	19	0	0	103
Day 3	Intact	0	0	1	0	0	0	0	0	0	85	0	0	0	0	0	15	0	0	0	0	101
Day 4	Intact	0	7	0	0	0	0	0	0	0	30	0	0	0	69	0	72	0	3	0	5	186
Day 1	Intact	2	0	0	0	18	20	0	0	0	67	9	3	0	0	22	0	4	59	1	4	209
Day 2	Intact	1	0	2	79	2	7	0	0	0	30	3	0	0	11	6	0	1	23	84	0	249
Day 3	Intact	0	0	0	0	2	0	4	0	0	51	0	0	0	0	4	0	0	25	0	1	87
Day 4	Intact	2	0	0	0	3	77	4	1	0	100	1	0	0	0	13	1	43	2	0	247	

Continue...

...Continued		6	0	3	2	1	195	0	0	0	25	23	0	0	0	16	0	0	2	0	0	273
Day 1	Intact	1	3	0	4	0	148	3	6	0	35	12	0	0	2	2	0	0	0	0	15	231
Day 2	Intact	0	2	0	8	0	157	3	1	0	56	4	0	0	0	2	0	0	0	0	4	237
Day 3	Intact	1	12	3	5	0	103	0	0	1	24	1	0	0	2	2	0	0	0	3	0	160
Day 4	Intact	0	0	0	0	0	0	0	0	0	18	1	0	0	0	0	0	0	0	0	0	27
Day 1	Intact	0	0	0	0	1	0	0	0	0	3	0	0	0	0	0	0	0	0	0	2	6
Day 2	Intact	0	0	0	0	2	0	6	0	0	33	11	0	0	10	1	0	0	0	8	0	81
Day 3	Intact	0	16	0	0	2	0	4	0	0	35	0	0	0	0	0	0	0	0	0	0	57
Day 4	Intact	0	0	0	0	1	8	0	0	0	40	0	0	0	2	0	0	0	0	0	7	69
Day 1	Intact	0	0	0	0	0	64	11	0	0	11	34	0	0	5	1	0	0	0	4	14	144
Day 2	Intact	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	10	0
Day 3	Intact	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12
Day 4	Intact	0	0	2	0	1	62	0	0	0	3	36	0	0	0	1	0	0	0	0	0	105
Day 1	Intact	3	0	0	0	0	0	0	0	0	19	0	0	0	0	0	0	0	0	3	0	25
Day 2	Intact	6	0	0	0	0	0	4	0	0	9	0	0	0	0	0	0	0	0	0	0	19
Day 3	Intact	6	0	0	0	0	0	0	0	0	51	0	0	0	0	0	0	0	0	0	0	57
Day 4	Intact	5	0	0	0	0	0	15	0	0	15	0	0	0	0	5	0	0	0	0	0	40
Day 1	Intact	8	0	0	0	0	9	0	0	0	15	0	0	0	0	0	0	0	0	0	0	32
Day 2	Intact	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
Day 3	Intact	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Day 4	Intact	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Day 1	Intact	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Day 2	Intact	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Day 3	Intact	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
Day 4	Intact	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	13
Day 1	Intact	1	0	0	0	4	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	12
Day 2	Intact	4	0	0	0	0	0	1	0	0	29	0	0	0	0	1	0	0	0	0	5	40
Day 3	Intact	2	0	0	10	2	0	0	0	3	13	0	0	0	0	0	0	0	0	0	26	61
Day 4	Intact	4	0	0	0	0	0	0	0	0	28	0	0	0	0	1	0	0	0	0	12	45
Day 1	Intact	4	0	0	0	16	0	1	0	0	6	0	0	0	0	1	0	0	0	0	3	31
Day 2	Intact	7	0	0	0	5	2	2	0	0	7	0	3	0	0	7	0	0	0	0	12	45
Day 3	Intact	2	5	0	0	74	2	2	1	0	23	0	1	0	0	2	0	0	0	0	5	117
Day 4	Intact	4	2	0	0	31	0	4	0	0	0	0	1	0	0	1	0	0	0	0	9	52
Day 1	Intact	2	0	0	0	20	0	1	0	0	0	0	0	0	0	15	0	0	0	0	1	39
Day 2	Intact	0	0	0	0	3	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	12
Day 3	Intact	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
Day 4	Intact	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Day 1	Intact	3	0	0	0	10	0	2	0	0	4	0	0	0	0	0	0	0	0	0	0	19
Day 2	Intact	0	0	4	0	1	0	0	0	2	0	2	2	3	8	0	0	0	0	0	64	86

Continue...

..Continued

Day 3 Neutered	9	3	0	0	0	13	0	0	0	24	0	0	0	0	0	0	0	0	0	21	70
Day 4 Neutered	1	0	0	0	0	0	0	0	0	24	0	0	0	0	0	0	0	0	0	1	26
Day 1 Neutered	0	0	0	0	0	0	0	3	40	0	0	0	0	1	0	0	0	0	0	0	44
Day 2 Neutered	2	2	0	0	0	26	5	0	0	21	4	0	0	0	5	0	0	0	0	21	86
Day 3 Neutered	3	0	0	0	0	13	0	0	0	45	0	0	0	3	0	0	0	0	0	6	70
Day 4 Neutered	4	1	0	0	0	0	1	0	0	5	5	0	0	0	0	0	0	0	0	4	20
Day 1 Neutered	3	1	0	0	0	0	5	0	0	3	0	0	0	0	0	0	0	0	0	4	16
Day 2 Neutered	0	31	0	0	0	5	1	0	3	20	0	0	0	0	0	0	0	0	0	7	67
Day 3 Neutered	0	1	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	8
Day 4 Neutered	0	2	0	0	1	0	0	0	0	10	0	0	0	0	0	0	0	0	0	1	14
Day 1 Neutered	1	0	0	0	0	0	12	0	0	22	0	0	0	4	0	0	0	0	34	0	73
Day 2 Neutered	1	0	0	0	5	0	4	0	0	11	0	0	0	5	0	0	0	0	3	0	29
Day 3 Neutered	0	0	0	0	5	0	0	0	0	0	0	0	0	7	0	0	0	0	47	0	59
Day 4 Neutered	0	0	0	0	8	0	11	0	0	22	0	0	0	10	0	2	0	0	9	0	62
Day 1 Neutered	3	0	0	0	0	0	13	4	0	0	0	0	0	3	0	0	0	0	0	0	23
Day 2 Neutered	1	0	0	0	0	0	11	0	0	0	2	0	0	2	0	2	0	0	34	0	57
Day 3 Neutered	0	0	0	0	0	0	3	0	0	0	0	0	1	3	0	0	0	0	48	0	55
Day 4 Neutered	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	3	0	0	5
Day 1 Neutered	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	9
Day 2 Neutered	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	14
Day 3 Neutered	0	0	0	0	3	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	9
Day 4 Neutered	0	0	0	0	4	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	5
Day 1 Neutered	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Day 2 Neutered	0	0	0	0	0	0	0	0	0	7	0	0	0	1	0	0	1	0	2	0	11
Day 3 Neutered	4	0	0	0	0	0	4	0	0	14	0	0	0	0	0	0	0	0	4	0	26
Day 4 Neutered	0	0	0	1	14	0	0	1	0	65	0	0	0	0	0	1	0	0	0	0	82
Total	439	243	174	502	753	1108	348	188	218	2404	291	37	168	509	257	146	218	308	2233	374	
Intact	302	85	160	134	373	1002	195	11	56	1451	256	37	156	365	190	146	6	248	855	300	
Neutered	137	158	14	368	380	106	153	177	162	953	35	0	12	144	67	0	212	60	1378	74	

Individual Behaviour													
Neuter Status	Activewatc	Bark	Yawn	Pantin	Walkin	Ears_S	Shakin	Urinat	Urine_	Overm	ToothC	Shelte	Total
Intact	6	0	0	0	10	4	2	0	7	0	0	0	29
Intact	0	0	0	0	26	24	1	0	12	0	0	0	63
Intact	40	0	0	0	100	62	0	0	7	0	0	0	209
Intact	0	0	0	0	99	6	1	0	9	0	0	0	115
Intact	5	0	0	0	10	18	1	0	1	0	0	25	60
Intact	9	0	0	0	0	6	1	0	1	0	0	0	17
Intact	16	0	0	0	15	3	1	0	7	2	0	0	44
Intact	5	0	0	0	0	0	2	0	0	0	0	0	7
Intact	8	0	0	0	64	56	0	0	7	0	0	30	165
Intact	5	0	0	0	98	14	2	0	0	0	0	0	119
Intact	15	0	0	0	146	0	2	0	2	0	0	0	165
Intact	16	0	0	0	86	107	1	0	4	0	0	14	228
Intact	9	0	0	0	35	0	0	0	4	0	0	0	48
Intact	8	0	0	0	107	0	0	0	5	0	0	0	120
Intact	0	0	0	0	70	0	0	0	11	0	0	0	81
Intact	3	20	0	0	36	5	1	0	9	0	0	0	74
Intact	7	3	0	0	0	0	1	0	0	0	0	0	11
Intact	62	0	0	0	31	0	0	0	0	0	0	0	93
Intact	38	11	0	0	74	0	0	0	3	0	0	0	126
Intact	40	0	0	0	39	0	0	0	2	0	0	0	81
Intact	94	2	0	0	71	0	0	0	15	0	0	0	182
Intact	75	0	0	0	66	0	0	0	10	0	0	0	151
Intact	88	0	0	0	61	0	0	0	6	0	0	0	155
Intact	80	0	0	0	60	0	0	0	4	0	0	0	144
Intact	9	0	0	0	18	0	2	0	0	0	0	4	33
Intact	14	0	0	188	12	0	1	0	5	4	0	7	231
Intact	16	0	0	69	7	0	2	0	2	0	0	0	96
Intact	0	0	0	0	0	21	0	0	0	0	0	0	21
Intact	73	0	0	92	9	1	0	0	0	5	0	0	180
Intact	97	0	1	88	14	0	0	0	0	5	0	9	214
Intact	74	0	0	0	54	1	4	0	12	8	0	0	153
Intact	84	0	0	0	17	0	0	0	0	6	0	0	107
Intact	42	4	0	202	50	32	0	2	7	0	0	0	339
Intact	26	1	0	282	11	7	0	1	7	0	0	9	344
Intact	46	0	0	266	135	39	0	0	6	9	0	0	501
Intact	17	0	0	267	9	13	0	3	7	9	0	0	325
Intact	20	0	0	239	7	8	0	0	6	0	0	10	290
Intact	32	0	0	222	3	17	1	0	6	0	0	20	301
Intact	39	0	0	261	3	51	0	0	7	3	0	4	368
Intact	38	0	0	220	37	76	1	0	15	0	0	28	415
Intact	49	0	0	0	215	77	3	0	9	0	0	0	353
Intact	75	26	0	186	203	58	0	0	11	0	0	9	568
Intact	74	25	0	158	152	24	1	0	19	7	0	0	460
Intact	136	15	0	162	114	10	0	0	10	0	0	0	447
Intact	58	0	0	22	52	1	4	0	0	0	0	0	137
Intact	98	17	0	203	107	0	0	0	0	0	0	9	434
Intact	210	26	0	158	61	12	0	2	0	0	0	1	470
Intact	155	3	0	180	156	13	0	0	0	0	0	0	507
Intact	118	0	0	0	184	155	0	0	7	0	5	0	469
Intact	58	0	0	0	176	34	0	0	9	0	1	0	278

Continue...

...Continued													
Intact	79	0	0	0	14	71	0	0	0	0	0	0	164
Intact	31	0	0	0	115	18	0	0	4	0	0	2	170
Intact	89	0	0	0	96	114	0	0	27	0	0	0	326
Intact	125	0	0	0	188	0	0	2	21	0	0	0	336
Intact	24	0	0	0	85	0	0	0	13	0	0	0	122
Intact	26	0	0	0	76	0	1	0	8	0	0	0	111
Intact	16	0	0	163	0	0	0	5	0	0	0	6	190
Intact	0	0	0	203	0	0	0	8	0	0	0	22	233
Intact	19	0	0	258	0	0	0	9	0	0	0	1	287
Intact	9	0	0	124	0	0	0	13	0	0	0	28	174
Intact	23	0	0	0	199	4	1	0	5	0	0	0	232
Intact	37	0	0	0	164	23	0	0	2	0	0	0	226
Intact	94	0	0	0	81	28	0	0	1	0	0	0	204
Intact	0	0	0	0	126	12	1	0	16	0	0	0	155
Intact	17	0	0	0	179	0	0	0	7	0	0	0	203
Intact	4	0	0	0	56	0	0	0	9	0	0	0	69
Intact	3	0	0	0	144	0	0	0	3	0	0	0	150
Intact	20	0	0	0	111	0	0	0	5	0	0	0	136
Intact	25	0	0	0	116	0	2	0	6	0	0	0	149
Intact	31	0	0	0	195	0	0	0	5	0	0	0	231
Intact	29	0	0	0	212	0	0	0	2	0	0	0	243
Intact	19	0	0	0	264	0	0	0	7	0	0	0	290
Intact	128	0	2	0	92	0	0	0	7	0	0	0	229
Intact	49	0	1	0	103	0	0	0	4	1	0	0	158
Intact	95	0	2	0	24	0	0	0	7	0	0	0	128
Intact	48	0	1	0	5	0	0	0	3	4	0	0	61
Intact	130	1	0	0	56	0	1	0	3	0	0	2	193
Intact	117	0	0	0	127	0	0	0	7	0	0	0	251
Intact	138	0	0	0	82	0	2	0	5	0	0	0	227
Intact	41	0	0	0	66	0	1	0	3	1	0	0	112
Intact	136	0	0	0	27	0	3	0	2	3	0	0	171
Intact	154	0	3	0	0	0	2	0	2	0	0	0	161
Intact	96	0	2	0	68	0	0	0	0	2	0	0	168
Intact	130	0	2	0	97	0	1	0	2	0	0	0	232
Intact	60	24	0	0	77	0	0	0	4	0	0	0	165
Intact	59	59	0	0	22	0	0	0	1	2	0	0	143
Intact	181	15	0	0	52	0	0	0	2	0	0	0	250
Intact	82	23	0	0	81	0	2	0	1	0	0	0	189
Neutered	42	0	0	0	0	122	0	0	6	0	0	0	170
Neutered	90	0	2	0	0	122	0	0	0	0	0	23	237
Neutered	167	0	0	0	77	21	0	0	2	0	0	0	267
Neutered	154	2	1	0	22	61	0	0	0	0	0	0	240
Neutered	64	0	0	0	60	217	0	0	5	0	0	0	346
Neutered	24	0	0	0	135	41	0	0	2	0	0	2	204
Neutered	75	0	0	0	130	233	0	1	4	0	0	0	443
Neutered	27	0	0	0	161	125	1	0	16	0	0	0	330
Neutered	7	0	0	0	0	300	1	0	2	0	0	0	310
Neutered	6	19	0	0	20	293	0	0	0	0	0	29	367
Neutered	8	8	0	0	6	236	0	0	0	0	0	115	373
Neutered	2	4	0	0	62	300	1	0	2	0	0	58	429
Neutered	13	31	0	0	0	50	0	0	0	0	0	0	94
Neutered	8	29	0	0	83	43	0	0	10	0	0	0	173

Continue...

...Continued													
Neutered	0	39	0	0	234	9	0	0	3	0	0	0	285
Neutered	79	1	0	0	57	0	0	0	0	0	0	42	179
Neutered	3	0	0	0	232	0	1	0	7	0	0	0	243
Neutered	0	8	0	0	62	0	1	0	0	0	0	0	71
Neutered	0	0	0	0	204	0	0	0	3	0	0	0	207
Neutered	50	0	0	0	120	0	0	0	0	0	0	0	170
Neutered	89	0	0	0	59	0	0	0	0	0	0	28	176
Neutered	152	0	0	0	43	0	0	0	0	0	0	0	195
Neutered	107	0	0	0	35	0	1	0	0	0	0	20	163
Neutered	92	0	0	0	54	0	1	0	0	0	0	0	147
Neutered	8	0	0	104	2	2	0	0	4	0	0	0	120
Neutered	42	0	0	278	0	225	0	0	0	0	0	9	554
Neutered	11	0	0	269	0	228	0	0	0	0	0	0	508
Neutered	39	0	0	283	0	262	0	0	0	0	0	0	584
Neutered	181	36	0	273	27	150	0	0	0	0	0	168	835
Neutered	68	3	0	182	113	83	0	0	1	0	0	66	516
Neutered	62	0	0	206	162	93	0	0	3	0	0	75	601
Neutered	59	15	0	246	140	155	2	0	17	0	0	33	667
Neutered	76	0	0	282	6	150	1	0	0	0	0	0	515
Neutered	95	0	0	195	0	111	0	68	0	0	0	9	478
Neutered	96	0	0	267	12	210	0	0	6	0	0	35	626
Neutered	74	0	0	252	12	280	1	0	0	0	0	36	655
Neutered	18	0	0	268	0	48	1	0	0	0	0	0	335
Neutered	65	0	0	200	0	21	1	0	3	0	0	9	299
Neutered	33	0	0	236	0	49	2	0	0	0	0	1	321
Neutered	51	0	0	265	22	71	4	0	2	0	0	5	420
Neutered	74	0	0	5	205	104	1	0	9	0	0	0	398
Neutered	138	45	0	300	105	4	0	0	4	0	0	9	605
Neutered	103	20	1	16	58	20	0	0	0	0	0	0	218
Neutered	74	5	0	165	117	92	0	0	2	0	0	0	455
Neutered	88	0	0	128	113	118	1	0	4	0	0	9	461
Neutered	113	0	0	300	77	138	1	0	5	0	0	79	713
Neutered	166	0	0	231	99	60	0	0	1	0	0	101	658
Neutered	101	0	0	207	111	131	0	0	3	0	0	0	553
Neutered	218	170	0	0	183	0	0	0	0	0	0	0	571
Neutered	273	184	0	0	127	0	0	0	0	0	0	0	584
Neutered	159	199	0	0	19	0	1	0	0	0	0	4	382
Neutered	147	152	0	0	60	0	0	0	0	0	0	4	363
Neutered	228	0	0	0	152	140	0	0	4	10	0	0	534
Neutered	95	0	0	0	181	189	0	0	4	0	0	13	482
Neutered	50	31	0	0	52	43	0	0	2	0	0	5	183
Neutered	87	0	0	0	127	129	1	0	0	0	0	0	344
Neutered	208	0	1	0	90	0	0	0	0	0	0	0	299
Neutered	171	0	1	0	162	0	0	0	2	0	0	0	336
Neutered	60	0	0	0	132	0	1	0	5	0	0	0	198
Neutered	25	0	1	0	50	0	0	0	1	0	0	0	77
Neutered	55	0	0	0	170	4	0	0	0	0	0	0	229
Neutered	2	0	0	0	110	1	5	0	0	0	0	0	118
Neutered	2	0	0	0	150	1	2	0	0	0	0	0	155
Neutered	16	0	0	0	142	0	0	0	1	0	0	0	159
Chip	66	0	0	0	174	0	0	0	4	0	0	0	244
Chip	7	0	0	0	101	0	0	0	5	0	0	0	113

Continue...

...Continued														
Chip	18	0	0	0	238	0	0	0	4	0	0	0	260	
Chip	0	0	0	0	0	0	0	0	0	0	0	0	0	
Chip	20	0	0	0	194	0	0	0	3	0	0	0	217	
Chip	1	0	0	0	86	0	0	1	2	0	0	0	90	
Chip	69	0	0	0	128	0	0	2	0	0	0	0	199	
Chip	97	0	1	0	108	0	1	0	0	0	0	0	207	
Neutered	32	0	0	222	3	17	1	0	6	0	0	20	301	
Neutered	104	9	0	0	0	0	0	0	0	0	0	0	113	
Neutered	99	39	0	0	27	0	0	0	4	2	0	0	171	
Neutered	78	0	2	0	32	0	0	0	1	4	0	0	117	
Neutered	37	12	0	0	22	0	0	0	5	0	0	0	76	
Neutered	97	0	0	0	32	0	2	0	0	3	0	0	134	
Neutered	115	0	0	0	7	0	2	0	0	0	0	0	124	
Neutered	146	0	0	0	0	0	0	0	0	3	0	0	149	
Neutered	160	0	0	0	47	0	4	0	2	0	0	0	213	
Neutered	120	0	7	0	0	0	0	0	0	0	0	0	127	
Neutered	172	0	2	0	30	0	0	0	2	0	0	0	206	
Neutered	132	0	1	0	4	0	0	0	0	0	0	0	137	
Neutered	87	0	0	0	51	0	3	0	8	0	0	0	149	
Neutered	164	0	0	0	28	0	0	0	6	4	0	0	202	
Neutered	103	0	0	0	72	0	0	0	2	2	0	0	179	
Neutered	181	0	0	0	26	0	0	0	2	0	0	0	209	
Neutered	71	0	0	0	9	0	0	4	0	0	0	0	84	
Total					9371	13070	6710	96	121	660	99	6	1227	44115
Intact					4213	6510	1225	52	45	465	71	6	240	
Neutered					5158	6560	5485	44	76	195	28	0	987	

Sender to whom	Analreg	Atack	Huddle	Rideup	Molest	Sniffin	Mount	Threat	Follow	Genita	Lick_G	Presentation	Ignore	Inguin	Naggin	Chinre
Intact to neutere	247	47	159	124	1002	227	11	55	1187	247	37	156	274	162	3	6
Intact to intact	55	38	1	10	0	69	0	1	264	9	0	0	91	28	143	0
Neutered to neut	59	16	14	253	13	68	3	18	235	13	0	3	23	18	0	10
Neutered to intac	78	142	0	115	93	149	174	144	718	22	0	9	121	49	0	202

Pose	Play	T-Formation
245	543	261
3	312	39
8	1076	15
52	302	59

Dogs with Chip	Dog No.	Day	Low Test	Osteronne	Analreg	Sniff	Follow	Genital_Snif	Genita_Lick	Inguinal
Received social behaviour of intact dogs	D33	Day 1	March-April	5	4	7	0	0	0	
		Day 2	March-April	1	11	10	0	2	4	
		Day 3	March-April	13	0	9	12	11	0	
		Day 4	March-April	0	0	0	0	0	0	
	D34	Day 1	May/June	0	0	0	0	0	0	
		Day 2	May/June	0	0	0	0	0	0	
		Day 3	May/June	0	0	0	0	0	0	
		Day 4	May/June	0	0	0	0	0	0	
TOTAL			19	15	26	12	13	4		

ETHOGRAM

Attacks

A direct rapid approach to a human or another dog. It can occur with a wrinkling of the nose with snarling, snapping, sometimes in conjunction with an inhibited bite. It can be shown with a short jump and/or a few quick steps.

Avoid

In the sense of an active verb. The dog that evades goes out of the way of another dog or a situation. If faster steps are used for this process, then one speaks of fleeing. Evading can also be associated with crawling.

Barking

Barking is very pronounced in dogs compared to wolves and can be shown in a wide variety of situations with the appropriate intonation. The individual vocalisations of barking can merge seamlessly into one another. The situation in which the barking is shown allows conclusions to be drawn about the meaning of the barking.

Chin Rest

Chin Rest Placing of the head on another dog's back or shoulders, sometimes observed as confident behaviour, but can also be used in a socio-positive context as well as in preparation of mounting.

Ears Pricked Sideways (Ears Side)

Ears are lifted upright and turned in a way that the inner part is pointed to the sides, sometimes to a point where the backs of the ears are almost touching.

Follow (FOL)

Following another dog and changing directions with him, sometimes keeping a constant distance.

Huddle

Seeking of close physical contact to a conspecific or a human by sliding and rubbing up against the social partner's body.

Ignore

Do not show any observable reaction, although the other dogs can still be observed closely.

Inguinal Presentaion (INGPRES)

Lifting of one back leg to facilitate the sniffing of the area of the inner thigh.

Molest

Repeated and unrequited seeking of contact to a conspecific, threatening and aggressive behaviour. The molesting dog tries to prevent the other one escaping.

Mounting (MOUNT)

Grasping another dog between the front legs, normally from behind but sometimes from the front.

Lick Genitals (LICKGEN)

Licking of genitals, sometimes also done to puppies to stimulate digestion or to females in heat.

Nagging

It is an exaggerated form of barking with a very high and dominant frequency and amplitude oscillation. Barking is an atonal sound that is uttered in varying lengths, as a single sound or in combination with growling, hissing and barking. Whining occurs exclusively in an agonistic context.

Nosing/Sniffing (NOSE)

Slow and intense nosing of another dog, sometimes circular movements of the nose along the other dog's body.

Over Mark (O-MARK)

One dog urinates over the urine marking of another.

Panting

Panting is increased breathing with an open muzzle. Panting allows the dog to evaporate water and thus regulate its body temperature. Panting occurs with: heat, exertion, joyful excitement, overheating, fever, inner restlessness or pain.

Play

Summarised as an overall category, includes various game types such as game face, game begging, game racing and others.

Pose

The dog is standing upright with bent neck and his ears typically pricked upright or turned sideways.

Raised Leg Urination (RAISEDLEG)

Urinating by lifting one leg and holding it at right angles to the body.

Ride Up

Often standing in a right angle to another dog, the front paws are laid onto or over its back.

Shake

The whole body is shaken, often starting from the snout, along the longitudinal axis.

Shelter

The dog draws back and finds shelter, sometimes if he is the goal of molesting or an attack, but also if a conspecific is attacked.

Sniffing of Anal Region (ANREG)

Sniffing of the anal region of another individual. This is thought to serve the establishment of social contact between dogs.

Sniff Genitals (SNIFFGEN)

Sniffing of the genital region and around the genitals, often seen during first contact. Can be avoided by the dog being sniffed by tucking in his tail and bending his back legs.

Sniff Inguinal Region (SNIFFING)

Sniffing of the area of the inner thighs as well as of the belly between and behind the knees.

Tail Avert (TAILAV)

The tail is bet sideways at the root to hang alongside the hip. This is a signal of females ready for mating.

T-Formation (TFORM)

One dog places himself at right angles to another, which looks like the letter “T” from above.

THREATEN

Threa Ten-Aggressive

Characteristic signs of aggressive threatening are bared teeth, with the corners of the mouth pulled forward and only the fangs visible, erect ears, ruffled hair and tail position SP1 (SP1 = tail higher than the back).

ThreaT-Defensive

In the defensive threat, the teeth are often bared, but the corners of the mouth are pulled back so that the premolars are also visible. The ears are usually laid back and the tail in position SP5 to SP7 (SP5=tail lower than the back; SP6=tail resting against the testicles; SP7=tail between the legs, can even touch the belly). Defensive threatening also includes opening the mouth.

AGGRESSION IN RELATION TO BREED

Table X. Dog Breeds Categorized sensú Parker et al²⁹

Dog Breed	Number of Dogs
Mixed breed	22
“Pointer”	5
“UK rural; Shepherds”	4
“Spitz”	4
“Terrier”	2
“Bulldog”	2
“Retriever”	1
“Beagle”	1
“Galgo”	1
Giant Schnauzer	1
Unknown	1
TOTAL	44

