Behavioural Correlates of Neutering Male Dogs—a Question of Breed?

Keywords: Castration; Retriever; Shepherds; Hunting Dogs; Terrier; Personality traits; Panic; Aggression

Abstract
Castration of dogs is often conducted as a preventive measure against diseases and undesirable behaviour. While female dogs are preferably neutered for medical reasons, owners of male dogs hope for an improvement in behavior. Although there is a lack of scientific knowledge on this subject, neutering is often conducted to get a more trainable and less aggressive dog.

The aim of this study is to examine castration from an ethological perspective and to reveal possible behavioural changes after castration related to breed.

An online study was conducted consisting of two different questionnaires about the dog’s personality. A total of 242 dog owners participated in the study concerning specific behaviour problems (n = 130 intact and 112 neutered males). Another 211 owners of males (n = 115 intact, 96 neutered) completed the questionnaire about personality traits (dog sociability, trainability, emotional stability and extraversion) based on Turcsán et al. 2011.

Four breed categories were formed following Parker et al. (2017): shepherds, retrievers, terriers, and hunting Dogs. Our study reveals that intact males are bolder than neutered males. Intact males have lower aggression scores than neutered ones. Castrated males show significantly more panic behavior (multinomial logistic Regression, p = 0.04).

Intact shepherds are bolder than neutered ones (Mann-Whitney-U-Test: p = 0.03) and intact terriers are bolder than neutered ones (Mann-Whitney-U-Test: p = 0.04). Intact terriers scored lower for aggression than neutered ones. With these results and the data of previous studies, we question castration to modify behavior, as a measure for reproductive control and as a preventive measure against diseases.

Introducing
At the beginning of industrialization, breeding goals changed from pure specialists, such as hunting and retrieving dogs, to companion dogs, which should rather take on the function of social partners [1]. Today, classic working dogs such as the Magyar Vizsla (hunting dog) or the Australian Shepherd (herding dog) are increasingly found in the home as family members. Today’s requirements for breeders include that dogs can adjust to urban living conditions and that they meet the social needs of humans as family members [32,42].

Although the number of dog breeds has increased significantly over the past century and a half, relatively little empirical research has focused on the behavioral characteristics of breeds. However, it is generally accepted that different breeds exhibit different behavioral repertoires due to selective pressures exerted by humans [5,18,41]. Brewer et al. (2002) define a dog breed as a group of individuals within the C. lupus familiaris subspecies that are very similar on the basis of a number of characteristics that have been shown to differ from other groups [6].

The more traditional and widely used methods of categorizing breeds have been promoted by various national and international cynological associations, where dog breeds are divided into groups based on the type of task dogs must perform. Empirical studies examining breed differences in behavior have largely focused on the categorizations established by the American Kennel Club (AKC) and the Fédération Cynologique Internationale (FCI) (n = 365 breeds, 10 breed groups).

While the FCI classifies the breeds based on their function and phenotype, there is a more modern approach. A study viewed on the geographic origin and molecular relations of dog breeds with the aim to investigate how migration, geographical separation and remixing contributed to the emergence of the dog breeds that exist today [38]. They examined the gene sequences of a total of 1,346 dogs from 161 breeds. The dogs came from all parts of the world, with the exception of Antarctica, and all had different breeding histories. The resulting breed groups were summarized as clades and the researchers were able to identify 23 clades in total. In this study four breed clades are examined: "shepherds", "retrievers", "terriers" and “hunting Dogs”. Within these breed clades, differences in social behavior between neutered and non-neutered males are to be analyzed.

The topic of neutering dogs is always controversial [39,40,43,21,46] and almost all dog owners are confronted with this question at some point. Despite new scientific findings on various health side effects of castration, this surgical procedure is still the method of choice for reproductive control, to remove undesirable behavior and as a preventive measure against some diseases like e.g. testicular cancer in males or pyometra in females [35].

Behavioral reasons relate to problem behavior such as urine marking or, from the point of view of dog owners, inappropriate aggressive behavior. A large-scale Questionnaire study by Niepel (2007; n = 1010) in Germany showed that the reasons vary depending on the dog’s gender. According to the study of Niepel male dogs are neutered to 74% for behavioral and only 21% for medical reasons. The study by Mertens & Unshelm (1997) also in Germany revealed similar results [31]. As a reason for castration in males, 69% stated behavioral problems and only 24% stated medical causes.

A very important hormone in connection with consequences of castration is cortisol. It is dependent on some neurotransmitters
behavior and a more peaceful communication with conspecifics.

**Emotional Stability**

Is related to the dog’s behavior in stressful situations. Low scores indicate anxious and stressful behavior (=neuroticism). High scores indicate a calm and emotional stable dog.

**Trainability = openness**

Low scores in this trait indicate a less playful and inventive character. Dogs with low scores are considered less open and inquisitive.

**Statistical Analyses**

The statistical evaluation and some graphical representation of the results were carried out in SPSS software (by IBM, version 27). The data were tested for normal distribution using the Kolmogorov-Smirnov test [22]. Since all data are not normally distributed, non-parametric tests were used for the analysis. Independent data, e.g., comparisons of intact and castrated males were calculated using the Mann-Whitney U test [30], comparisons with k-samples, e.g., comparisons of personality traits between breed categories examined by the Kruskal-Wallis H test (H test) [25]. In the second case, if statistical significance was recognized, an adapted post-hoc test was carried out after the Kruskal-Wallis-test. This test includes a comparison of the individual groups including a Bonferroni correction to adjust the level of significance (Dunn-Bonferroni test). In general, the level of significance was set at \( \alpha = 0.05 \). The nominal data of the case studies were statistically analyzed using a multinominal logistic regression to test the differences in dog behavior on a multivariable level.

**Results**

**BUDAPEST Questionnaires**

Figure 1 shows the differences between the intact and castrated breed clades and between the intact and castrated dogs in the personality traits. Significant differences could be calculated for both

![Figure 1: Boxplot of the respective breed categories shepherds (n = 36 intact and n = 27 neutered), retrievers (n = 35 intact and n = 15 neutered), terriers (n = 26 intact and n = 37 neutered) and hunting dogs (n = 18 intact and 17 = neutered), separated into intact and neutered males. A) extraversion, B) sociability, C) emotional stability, D) trainability. * = p≤0.05, ** = p≤0.01, *** = p≤0.001 (Mann-Whitney U test).](image)
the shepherds (U-Test: p = 0.03) and the terriers (U-Test: p = 0.04). The intact shepherds show higher scores for extraversion (Mdn = 6, SD = 1.2) than the castrated shepherds (Mdn = 5, SD = 2). The data also reveal that the intact terriers have higher extraversion values (Mdn = 6, SD = 1.3) than neutered ones (Mdn = 5, SD = 1.6). No significant differences could be found for the personality traits of sociability (B), emotional stability (C) and trainability (D) (U-test: p > 0.05).

Case Studies

There are noticeably high scores for stress and insecurity in all four breed categories in comparison to the other behavior problems see (Figure 2).

Aggressive behavior occurred in all breed classes, with the exception of the hunting dogs, more frequently in the castrated than the intact males.

Panic was recorded among shepherds, hunting dogs and retrievers only among neutered dogs. The differences for the castration status are statistically significant for the trait panic (multinomial logistic regression, p = 0.04). When the effect sizes are considered individually, it is noticeable that the significant value is mainly due to differences in castration status and not due to differences in breed.

No significant differences could be found for the stress/uncertainty axis, although the shepherds run upwards here and the retrievers comparatively have low values (Figure 2).

Discussion

Possible explanations for the results can be found in the evaluation of the dog owners as well as in the current research on castration and modern dog breeds.

Using the questionnaire about the dog’s personality, differences in extraversion could be determined. Although no major differences between the breed categories of retrievers and hunting dogs could be found, there were significant differences between the shepherds and the terriers. The intact shepherds differ from the neutered shepherds and likewise the intact terriers differ from the neutered terriers. Intact males have higher values in extraversion and are therefore considered to be more open-minded and less fearful than neutered dogs.

This agrees with the results of Hakanen et al. (2020) that intact males are less anxious than neutered males [14]. Kaufmann et al. (2017) also found out on the basis of questionnaire and video analyses that intact males are more likely to perform social behavior than castrated males [21]. The latter often appeared to be more stressed and nervous and consequently stayed more out of the social situation. One explanation for this lies in the abovementioned elimination of the stress-relieving sex hormones and the associated increase of the stress hormone cortisol [16].

Figure 2: Results of the case studies. Comparison of behavioral problems between neutered (n=112) and Intact (n=130) male dogs (n=242 dogs) related to the breeds: shepherds (n = 36 intact and 26 neutered), hunting Dogs (n = 26 intact and 21 neutered), retrievers (n = 41 intact and 26 neutered), terriers (n = 27 intact, 39 neutered).
Why the clades of the shepherds and the terriers show significant differences in extraversion can only be speculated at this point. Terriers were bred for independent work such as finding rats and killing prey. They are considered as fearless and impulsive [24]. The higher values of extraversion in non castrated males could therefore be the result of typical breeding effects.

Turcsán et al. (2011) found that terriers received high scores for extraversion and differ significantly from other breeds [44]. While herding dogs (such as Australian Shepherd or Border Collie) could be classified as low calm, high trainable, low sociable and low bold, (i.e. introverted in the five factor terminology) hunting dog breeds (such as Irish Setters or Pointer) and retrievers (such as Golden or Labrador Retrievers) turned out to be low calm, medium trainable, high sociable and high bold. These data partly coincide with our results. The retrievers had the higher scores for sociability and the hunting dogs were high bold here too. The latter, however, did not turn out to be highly sociable, but achieved lower scores. It must be noted that some representatives of the clade hunting dogs (e.g. German Wirehaired Pointer or Vizsla) can also be found in Turcsán et al (2011) in cluster 2 (low sociable), which in turn corresponds to our results.

The Australian Shepherd was the most frequent breed within this study in the clade of the shepherds. The Australian Shepherd is considered (if kept correctly!) as a balanced, rarely contentious and active herding dog, who is very eager to work [24]. The high extraversion of the Australian Shepherds can also be seen here as the breeding result of a highly motivated working breed [42].

The overall low panic and aggression scores for retrievers and hunting dogs are one of the reasons that both Golden and Labrador Retrievers are among the most popular assistance dog breeds [3]. Hunting dogs are selected to pay more attention to their environment still remaining calm or obedient. In this study, the hunting dogs consisted mainly of Weimaraners, which are considered spirited and sometimes impetuous hunting dogs with a reliable pointing. They are highly vigilant and are therefore not suitable for beginners or people who tend to be a bit casual [24].

The higher values for aggressive behavior in the neutered dogs coincide with the results from Kaufmann et al. (2017). Here the researchers also found by means of questionnaire and video analyses that neutered males are more likely to aggression than intact males, which in turn supports the assumption that aggressive behavior cannot be influenced positively by castration per se (Niegel, 2007) [21,35].

Regarding aggression control, it should also not be disregarded that only types of aggression can be influenced by castration that are dependent on sex hormones.

So from a behavioral point of view, it is controversial to what extent neutering affects social or especially aggressive behavior since dogs may become more aggressive due to the lack of sex hormones [17]. Feddersen-Petersen (2008) writes that aggressive behavior can also indicate a disturbed organism-environment relationship [10]. Nelson et al. 1997, Huntingford & Turner

Above all, the different types of aggression must be taken into account.

For example, there is also serotonin-dependent aggressive behavior. If the serotonin level is too low, aggressive behavior can be favored. Conversely, however, high serotonin levels can also lead to aggression. The dog breeds Cocker Spaniel and Golden Retriever in particular can have a certain genetic defect, which disrupts the build-up and breakdown of serotonin. As a result, these dogs are prone to aggressive attacks [20].

In partner protection, jealousy behavior and in pair bonding, it is also not the sex hormones that play a role, but two other hormones: oxytocin and vasopressin [29,2]. The latter evokes the aggressive behaviors occurring in partner protection and in jealousy. Oxytocin is important above all for a positive, social bonding with a conspecific. In order for developing a bond, however, vasopressin must be produced as a preliminary stage before oxytocin production. Accordingly, in general terms, every bond also includes a certain degree of jealousy. Consequently, partner protection and jealous behavior cannot be eliminated by castration, as Bielsky & Young (2004) were able to show in mice and rats.

In addition to the hormone-related behaviors, there are also some that are influenced by transmitters. Aggressive behavior that occurs in the course of self-defense is controlled, for example, by norepinephrine. This catecholamine, also known as the fighting hormone, is preferred in a stressful situation when it comes to protecting or defending yourself. The norepinephrine acts primarily in a self-rewarding learning effect, which means that successful courses of action are learned and saved (an example would be the learned leash aggression). Again, even with this type of aggressive behavior, castration is not very promising, as there is no connection between the sex hormones and self-defense [1,34]. In our study, aggressive behavior also occurs among neuters and there were no significant differences, i.e. neutering does not seem to have a positive effect on aggressive behavior. This is an important aspect considering aggression as a common reason for castration.

The increased panic with more neutered animals again provides an indication of the behavioral consequences of neutering, which was also found by Zink et al. (2014) in castrated Vizslas [45]. Our results show only significance for the castration status, not for the breeds, which could be an indication that panic behavior occurs more frequently in neutered males regardless of the breed. If the stress hormone cortisol is included again, as already described in the introduction, it becomes clear that anxiety-related aggressions are controlled by cortisol and that testosterone as an inhibitor is no longer present as a result of castration [16].

Serpell & Hsu (2005) and also Kubinyi et al. (2009) as well as Starling et al. (2013) showed that the neutered males and females were the most insecure dogs in comparison to the intact ones. In addition, the neutered dogs of both sexes were also the less sociable dogs [41,26,42].

In Müllers study (2017), the representatives of the shepherds clade showed fewer distance-keeping signals than the retriever clade. The herding dogs seem to be generally more open-minded and open towards conspecifics, so that they are often assessed by their dog...
owners as more excitable. This less developed distancing tendency can possibly due to the breeding effects of shepherds for herding work [33].

However, the results regarding the terriers were surprising. These are considered fearless energetic and proactive dogs with low self-protective behavior and a high tendency to react with aggression when threatened [24]. The fact that the terriers do not distinguish themselves significantly from the other breed categories in any emotional characteristic was therefore an unexpected result.

Beside the genetic and morphological aspects, the experiences and handling of the dog certainly play a major role in how castration affects a dog, because each animal tends to coping strategies [9,10]. Likewise, when it comes to castration, placebo effect should always be taken into account [47], which is based on a certain expectation of dog owners to improve or remove specific behaviors through castration.

Our results once again show the importance of individual-based informed decision-making processes regarding this ever-present topic.

References


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