Dominance Aggression In Young Female Dogs: What Does This Suggest About The Heterogeneity Of the Disorder?

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Introduction:
Clients frequently associate the onset of aggression in bitches with ovariectomy (Borchelt, 1983). Since most forms of aggression usually have an onset coincident with social maturity (18-36 months of age in dogs), if bitches are spayed after 1-2 heats, the timing of social maturity and spaying is confounded (Borchelt, 1983; Borchelt and Voith, 1986; Voith and Borchelt, 1982). To attribute the onset of aggression to the latter is not parsimonious, but is understandable, given that the client can clearly recognize the time of the spaying procedure, but may have difficulty in recognizing early signs of aggression in the absence of serious outcomes. Many bitches are spayed at 6 months of age and clients still feel that the bitch became aggressive around the time of the spay. Is there any biological basis to these fears?

Overview of behavioural associations:
Early data collected by Voith and Borchelt (1982) hinted that spaying bitches that had problem aggressions rendered them more aggressive, while Borchelt (1983) asserted that bitches became more aggressive post-spaying in certain contexts based on data calculated from percentages of patients in a population with aggressive diagnoses. A re-analysis of Borchelt’s data demonstrates that when using pair-wise comparisons of sex and reproductive status (intact male, intact female, castrated male, spayed female) and comparing them for dominance, fear, protective, predatory, and possessive aggression, the only category for which spayed females are more aggressive than intact females is that of possessive aggression ($p < 0.05$; $G = 8.23$ (re-analysed from Borchelt, 1983)). Other statistically significant results are found in Table 1.

Because the animals in Borchelt’s study were not followed through time, it is still possible that individual females, with known behavioural profiles, could become more aggressive after spaying. Following individuals through time is a tremendous undertaking. In an excellent first step O’Farrell and Peachey (1990) looked at 3 age groups of bitches through time: ≤ 11 months of age, 12-24 months of age, and < 2 years of age. A control group of unspayed bitches was matched for age and breed with a group of spayed bitches. Unfortunately, these groups were not identical in terms of age acquired, exposure to synthetic oestrogens, and early experiences. Regardless, and despite a modest sample size, this study produced some intriguing results, for which I have provided a more in-depth statistical analysis than was included in the original paper. When examining the individuals within in each age and outcome group (level of aggression increased, level of aggression stayed the same, level of aggression decreased), there was no significant difference in the frequencies of spayed and unspayed dogs ($G$ statistics, all $p > 0.05$).

When looking at the group of dogs for which aggression increased there were two significant results. When the 12-24 month old spayed group was compared with the 2 year and
older spayed group, the 2 year and older spayed group showed a statistically significant increase in aggression ($p < 0.05; G_{adj} = 4.56$). When the $\leq 11$ months of age unspayed group was compared with the 2 years and older unspayed group, the 2 years and older unspayed group showed significantly more of an increase in aggression ($p < 0.05; G_{adj} = 5.03$). Both of these differences can be attributed to changes concomitant with attainment of social maturity; however, it is interesting that the results were not symmetrical. There were no similar findings when comparing the $\leq 11$ months of age spayed group with the 2 years and older spayed group, nor was there a statistical difference between the 12-24 months unspayed group when compared with the 2 years and older unspayed group. Were social maturity the only factor driving the development of aggression these results should mirror those for which a positive association with age was found. A summary of these results is found in Table 2.

These results are particularly puzzling given the results for the groups in which aggression decreased. When dogs $\leq 11$ months of age were compared with those 2 years of age or older, dogs 2 years of age or older were over-represented for both the spayed and unspayed groups ($p < 0.05; G_{adj} = 5.172$ and $G_{adj} = 7.33$, respectively). When comparing dogs 12-24 months of age with those 2 years of age or older for whom aggression decreased with time, dogs 2 years of age and older were significantly over-represented only for the unspayed group ($p < 0.05; G_{adj} = 5.80$). A summary of these results is found in Table 3.

The above two sets of results suggest that social maturity is a behaviourally labile time where aggression can decrease or increase. This is a logical result. Is it possible to glean any more information about specific changes within ages and treatment (spayed v. unspayed) groups?

O'Farrell and Peachey looked within age groups and compared spayed v. unspayed females for 3 categories of dogs: those that experienced an increase in aggression v. those with no change, dogs with an increase in aggression v. those with a decrease in aggression, and dogs with no change in aggression v. those with decreased aggression. For the comparisons of increased or decreased aggression and no change in aggression level, dogs experiencing no change in aggression were over-represented when compared with those experiencing a change within age groups for both the spayed and unspayed groups (G-tests, all $p > 0.05$). The interesting finding is that for dogs in the $\leq 11$ months of age group that were spayed, aggression increased more frequently than it decreased ($p < 0.05; G_{adj} = 5.95$), suggesting that for some subpopulation of early-spayed females, spaying facilitates the worsening of aggression. Note that this is not universally true for all populations or comparisons of early spayed females. Still, this is a result that warrants further examination since for all comparisons for other groups (increased aggression v. no change in aggression, increased aggression v. decreased aggression, no change in aggression v. decreased aggression for spayed and unspayed females in both the 12-24 month age group and the 2 years and older age group) there are no statistically significant difference between behavioural categories within treatment and age groups. A summary of these results is found in Table 4.

Despite the small sample size (4-43 individuals in each of 18 groups, reflected in the statistical analysis), the finding that some sub-population of females in the $\leq 11$ months of age group that were showing aggression prior to spaying, became more aggressive after spaying, is an interesting one. Can we postulate an underlying mechanism for this?

Pattern of dominance aggression and sex at VHUP: About 4-5 years ago in the Behaviour Clinic at VHUP, I began to notice that when my patients were dominantly aggressive females, the dominance aggression had started at a very early age - usually less than 6 months of age (Tables 5 & 6). In fact, one of the most severely dominantly aggressive dogs I
have seen was an 8 week old female Cocker Spaniel. Dominance aggression is best defined as aggression manifest towards people in situations where dogs perceive a challenge to control or to access to control. By definition, these are abnormal, out-of-context behaviours that may be exaggerated reactions to abnormal perceptions in status-affiliated situations. Status is generally defined by the ease of frequency of engendering deferential behaviours from others. Unwittingly, many clients defer to their pets in the context of interacting with the animal in friendly, loving situations because the humans do not perceive that the behaviours exhibited by the dog are - in canine signalling - challenges. Dominance aggression has long been believed to be sexually dimorphic: approximately 90% of dominantly aggressive dogs are male. While testosterone does not cause the condition (most intact males are not dominantly aggressive), testosterone can act as a behavioural modulator or facilitator, rendering an animal with aggressive propensities more reactive. Accordingly, it is commonly recommended that dominantly aggressive male dogs are castrated as part of their treatment. In addition to a desire to not perpetuate such genes in the environment, the hope is that the removal of testosterone will act as an adjuvant for behavioural treatment and the render the dog more malleable. Castration does decrease many of the behaviours seen in dominantly aggressive dogs, including mounting and marking, so this is not an unreasonable assumption (Hopkins, et al., 1976). What of the young female that's dominantly aggressive? Unlike males, for whom dominance aggression is most prevalent at social maturity (age of onset generally between 18-24 months of age), females exhibiting dominance aggression as defined above are usually less than 6 months of age at the onset of the problem. This suggests that while dominance aggression in older dogs who are in the midst of social maturity may be affected about anxiety about changing social status, this behavioural/social mechanism may not be operating for young females. In utero androgenization has been postulated as one mechanism for the engendering of aggressive young females. Furthermore, it has been well documented for rodents that females having an intrauterine position between two males are "masculinized" at birth: they are more aggressive to their littermates and their patterns of aggression more closely resemble those of males than of females (vom Saal, 1989; Brain and Haug, 1992). Accordingly, for some of my patients in this category I have asked the clients to not spay them until they have had a heat cycle. For a few of these dogs this first heat cycle is delayed, not appearing until after a year of age. The data are too few for statistical analysis and the young, female, dominantly aggressive dogs are not sufficiently common in my patient pool to conduct a systematic study, but the finding is intriguing. Female puppies that are treated with testosterone before birth in utero were more successful at competing for a bone than were non-treated females, but less so than males (Beech et al., 1982). Could these females puppies that show early and profound dominance aggression be masculinized in utero? Could an in utero masculinization effect account for the findings of O'Farrell and Peachten, that the only group that became more aggressive when spayed was the one with pups 11 months of age or younger that had already shown aggression? The frequency with which female pups will be surrounded by males in utero depends on the sorting of the puppies in the bicornuate uterus and on the number of models. Probability models demonstrate that at a litter size of approximately 12 the probability that any one female is nestled between two males asymptotes at 0.16. For a litter size of 4 the probability that this occurs is 0.05. The number of females less than 6 months of age in the VHUP population of dominantly aggressive dogs falls within the parameters predicted by the model, and this does not assume that all females would experience equal hormonal effects (Tables 5 & 6). That any hormonal effect would not have to be experienced identically by every pup, perhaps accounting for some of O'Farrell's other findings. When I first noticed the effect we were seeing in young,
dominantly aggressive bitches I wrote to most university affiliated veterinary reproductive specialists to ask if they had ever encountered laboratory data that could shed some light on this. The response was universally negative. Data on birth order and sex could be obtained through caesarean sections or ultrasound. Given the relatively uncommon occurrence of the pattern, many litters would be needed, but if lines with large numbers of aggressive females are identifiable (there are a few within the VHUP population pool), the extent to which young females are affected may tell us something about the underlying neurochemistry of the condition.

Conclusions:

The necessary and sufficient conditions for the phenotypic diagnosis of dominance aggression to be made include abnormal, inappropriate, out-of-context aggression (threat, challenge, or attack) consistently exhibited towards people under any circumstance involving passive or active control of the dog's behaviour or the dog's access to the behaviour. This response will intensify upon any active or passive correction of the dog's behaviour or it's access to the behaviour. This discrete definition of dominance aggression does not couple the behaviour to food, toys, or space. When dominance aggression is apparent in older dogs it most commonly first appears as the dog is entering social maturity or is in the midst of social maturity. The majority of dogs exhibiting dominance aggression do so out of anxiety, not because they are confident in their ability to control the situation, and they require that control. The more common presentation hints at a neurochemical basis that involves anxiety, and most of these dogs will respond to treatment with tricyclic antidepressants or selective serotonin reuptake inhibitors in conjunction with behavioural and environmental modification that provides the dogs with a rule structure that relieves their anxiety. In these dogs, most challenges and aggression function to provide information about the human with whom the dog is interacting; the challenges function within a default rule structure where the dog's actions are determined by each individual or each cluster of individual responses. Hence, this form of dominance aggression is very variable, and responds to treatment that provides a consistent and generalized rule structure, and that treats the underlying anxiety. The dominance aggression exhibited by young female dogs is much more consistent between patients with the condition, and is uncoupled from social maturity and the conflicts posed them. The young female pups with dominance aggression react in the same phenotypic circumstances as do others with the disorder, but react more consistently and in a more overtly controlling manner. This is more similar to the rare group of males exhibiting dominance aggression - those that must control the social environment. For all three groups - males that must control the environment, young females, and those at social maturity who are anxious about social "rules" - familial patterns have been noted. There are not currently sufficient data to evaluate whether the mode of inheritance is the same for all groups, when the condition is heritable. While similar phenotypically, these patterns suggest that there are, minimally, 2 or 3 underlying neurochemical or molecular mechanisms for the disorder. This would certainly account for variability in presentation, and in success at treatment. Only when we elucidate the interaction of all mechanistic levels for such conditions will we understand the tableau presented by clinical signs.

Table 1: Statistically significant pair-wise comparisons after Borchelt, 1983
Dominance Aggression:
intact males > castrated males (p<0.05; Gadj=6.505)
intact males > intact females (p<0.05; Gadj=13.836)
intact males > spayed females (p<0.05; Gadj=23.376)
Fear Aggression:
intact females > intact males (p<0.05; Gadj=7.581)
Protective Aggression:
castrated males > spayed females (p<0.05; Gadj=5.223)
Possessive Aggression:
intact males > intact females (p<0.05; Gadj=3.902)
castrated males > intact females (p<0.05; Gadj=6.424)
spayed females > intact females (p<0.05; Gadj=8.23)
Predatory Aggression:
no significant pair-wise comparisons at the 0.05 level

Table 2: Dogs for which aggression increased (O'Farrell and Peachey, 1990)

<table>
<thead>
<tr>
<th>spayed</th>
<th>unspayed</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤11 months v. 12-24 months</td>
<td>ns</td>
</tr>
<tr>
<td>12-24 months v. 2 + years</td>
<td>***</td>
</tr>
<tr>
<td>2 + years v. &lt;11 months</td>
<td>ns</td>
</tr>
</tbody>
</table>

*** significant difference at 0.05 level - see text

Table 3. Dogs for which aggression decreased (O'Farrell and Peachey, 1990)

<table>
<thead>
<tr>
<th>spayed</th>
<th>unspayed</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤11 months v. 12-24 months</td>
<td>ns</td>
</tr>
<tr>
<td>12-24 months v. 2 + years</td>
<td>ns</td>
</tr>
<tr>
<td>2 + years v. &lt;11 months</td>
<td>***</td>
</tr>
</tbody>
</table>

*** significant difference at 0.05 level - see text

Table 4: Dogs with changes in aggression within age groups (O'Farrell and Peachey, 1990)

<table>
<thead>
<tr>
<th>spayed</th>
<th>unspayed</th>
</tr>
</thead>
<tbody>
<tr>
<td>increased aggression v. no change</td>
<td>***</td>
</tr>
<tr>
<td>increased aggression v. decreased aggression</td>
<td>+++</td>
</tr>
<tr>
<td>no change v. decreased aggression</td>
<td>***</td>
</tr>
</tbody>
</table>

*** significant difference at 0.05 level - see text; no change over-represented for all groups
+++significant difference at 0.05 level; aggression increased more frequently than decreased for the
≤11 months of age group, only

Table 5. Demographic Profile of Dogs with Dominance Aggression VHUP 1989-1996

<table>
<thead>
<tr>
<th>Age</th>
<th>F</th>
<th>FS</th>
<th>M</th>
<th>MC</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1 year</td>
<td>15</td>
<td>11</td>
<td>18</td>
<td>24</td>
<td>68</td>
</tr>
<tr>
<td>≥1 year</td>
<td>14</td>
<td>119</td>
<td>67</td>
<td>233</td>
<td>433</td>
</tr>
<tr>
<td>Totals-Behaviour Clinic</td>
<td>29</td>
<td>130</td>
<td>85</td>
<td>257</td>
<td>501</td>
</tr>
<tr>
<td>VHUP Population</td>
<td>8930</td>
<td>13737</td>
<td>15822</td>
<td>8184</td>
<td>47473</td>
</tr>
</tbody>
</table>

Table 6: Statistics for the demographics of dominance aggression: Comparisons for VHUP behaviour clinic patients with dominance aggression [all ages] with overall
hospital population [all ages]:
VHUP F >> Behaviour Clinic F; p <0.05, Gadj = 71.30502
VHUP FS Behaviour Clinic FS; NS
VHUP M > Behaviour Clinic M; p < 0.05; Gadj = 63.98711
VHUP MC < Behaviour Clinic MC; p < 0.05; Gadj = 251.1799

Females that are unspayed (intact) and under 1 year are over-represented compared with other
groups in a comparison of patients with dominance aggression:
DA - F < 1 year >> DA - FS, M, MC < 1 year; p < 0.05; Gadj = 25.06971
    DA - FS   p < 0.05; Gadj = 25.16583
    DA - M    p < 0.05; Gadj = 9.028676
    DA - MC   p < 0.05; Gadj = 26.99373

Females that are unspayed (intact) and under 1 year are over-represented compared with other
intact females with dominance aggression and all other females with dominance aggression:
DA - F < 1 year >> DA - F >/= 1 year; p < 0.05; Gadj = 15.9346
DA - F < 1 year >> all other DA females, p < 0.05; Gadj = 6.19377

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