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Title: Intraspecific relationships in adult domestic dogs (Canis familiaris) living in the same household: a comparison of the relationship with the mother and an unrelated older female dog

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Corresponding Author: Dr. chiara mariti, DVM, Ph.D., Dipl. ECAWBM (AWSEL)

Corresponding Author's Institution: università di pisa

First Author: chiara mariti, DVM, Ph.D., Dipl. ECAWBM (AWSEL)

Order of Authors: chiara mariti, DVM, Ph.D., Dipl. ECAWBM (AWSEL); beatrice carlone; emilia votta; eva ricci; Claudio Sighieri, full professor; angelo gazzano, dvm, PhD, Dipl. ECAWBM (BM)

Abstract: There is scientific evidence that adult dogs establish attachment bonds towards human beings. Attachment as behavioural system exists in the puppy-mother relationship, but adult dogs tested with the Ainsworth Strange Situation Test (ASST) have been found to show a preference for the stranger over a conspecific living in the same household.
In the current study, 50 adult dogs were tested with an intraspecific version of the ASST where the role of the presumed attachment figure was played by an older female dog living in the same household, 18 being their own mother and 32 being an unrelated older dog. The two groups did not show remarkable differences when compared one to the other. However, the within-group analysis revealed that dogs tested with an household older female dog other than the mother showed a preference for the human stranger, who had a higher ameliorative effect than the companion dog. Dogs tested with their mother instead displayed both social and non-social behaviours in a very similar manner when in the company of the stranger or of the mother after being reunited with them.
Considering the peculiar appeal that human beings have to dogs and the differences observed in the current study, it can be concluded that adult dogs showed a stronger bond for the mother. Future research may clarify if this depends on the maternal care and/or on the time spent with the mother since birth.

Revision Note

Comments:

I am pleased to inform you that this manuscript may now be acceptable following a satisfactory minor revision. The enclosed reviews explain the topics you need to consider and revise. I look forward to seeing your revised manuscript.

Yours sincerely,
Per Jensen
Editor-in-chief

Reviewer #1: The new version of the manuscript shows a very careful revision done by Authors. I am thankful for the detailed answers and explanations. I am glad to recommend the manuscript for acceptance - Authors made great efforts to make their introduction and conclusions clearer, and they performed a much more appropriate analysis at this time.

WE WISH TO THANK YOU REVIEWER #1 FOR THE POSITIVE COMMENTS AND FEEDBACKS.

Reviewer #2: The manuscript has been greatly improved. The current title "Intraspecific relationships in adult domestic dogs (Canis familiaris) living in the same household: a comparison of the relationship with the mother and an unrelated older female dog" summarizes relevant information to the reader, who can make a more appropriate choice about whether the manuscript is of interest or not. The Introduction has been shortened and it focuses on relevant information. The M&M, the Results and the Discussion are greatly improved too and, in general, easier to read than in the previous draft. However, I find that some parts are still difficult to easily read and understand. For example, in M&M, l.125, the Author presents "the first step of the statistical analysis" when a first step of the statistical analysis had been already introduced in the previous paragraph. I understand what the Author wants to say, i.e. that what explained in the first paragraph is a preliminary statistical analysis to make sure that there were not difference between groups; but at first I thought that the second paragraph was giving more information about what was summarized in the first. I think that, in the second paragraph of M&M, it may help to have an introductory part like "Once we studied the potential differences in factors between the two groups, we proceeded to analyze the differences between and within groups for the factor "test with the mother"... or something similar. In the Discussion I found the paragraph in ll.167-171 difficult to read; could it be rewarded for clarity? Maybe these minor changes can be also done during the editing process, since I found the manuscript almost ready to be accepted for publication.

WE WISH TO THANK ALSO REVIEWER #2. WE MODIFIED THE MANUSCRIPT ACCORDING TO HIS/HER SUGGESTIONS.

Highlights

- ~~Research on intraspecific attachment bonds in dogs is scarce.~~
- Eighteen adult dogs were tested with the mother and 3~~2~~9 with an older ~~cohabitant~~ female dog
- A human stranger had a higher ameliorative effect than the unrelated cohabitant dog
- Dogs behaved similarly towards/in the company of their mother and of the stranger
- Adult dogs show a stronger bond for the mother than for another cohabitant dog

Intraspecific relationships in adult domestic dogs (*Canis familiaris*) living in the same household: a comparison of the relationship with the mother and an unrelated older female dog

Chiara Mariti*[1,2], Beatrice Carlone[1], Emilia Votta[1], Eva Ricci[1], Claudio Sighieri[1, 2], Angelo Gazzano[1, 2]

[1] Dipartimento di Scienze Veterinarie – Università di Pisa, viale delle Piagge 2 – 56124 Pisa, Italy

[2] ETOVET – Group of Research in Veterinary Ethology and Physiology, Pisa, Italy

**Corresponding author*: chiara.mariti@unipi.it

ABSTRACT

There is scientific evidence that adult dogs establish attachment bonds towards human beings. Attachment as behavioural system exists in the puppy-mother relationship, but adult dogs tested with the Ainsworth Strange Situation Test (ASST) have been found to show a preference for the stranger over a conspecific living in the same household.

In the current study, 50 adult dogs were tested with an intraspecific version of the ASST where the role of the presumed attachment figure was played by an older female dog living in the same household, 18 being their own mother and 32 being an unrelated older dog. The two groups did not show remarkable differences when compared one to the other. However, the within-group analysis revealed that dogs tested with an household older female dog other than the mother showed a preference for the human stranger, who had a higher ameliorative effect than the companion dog. Dogs tested with their mother instead displayed both social and non-social behaviours in a very similar manner when in the company of the stranger or of the mother after being reunited with them.

Considering the peculiar appeal that human beings have to dogs and the differences observed in the current study, it can be concluded that adult dogs showed a stronger bond for the mother. Future

research may clarify if this depends on the maternal care and/or on the time spent with the mother since birth.

Keywords: Ainsworth Strange Situation Test; Attachment; Behaviour; Bond; Dog; Mother.

INTRODUCTION

Attachment theory regards the propensity to make intimate emotional bonds to particular individuals (Bowlby, 1988). Initially studied in the 1960s and 1970s primarily in the context of children and parents, since the 1980's there has been an explosion of research examining attachment processes beyond the parent-child dyad (Cassidy et al., 2013), which has supported Bowlby's belief that attachment is a process that characterizes humans "from the cradle to the grave" (Bowlby, 1979).

Bowlby's theory of attachment is indeed largely connected to animal ethology (Bowlby, 1982; van der Horst et al., 2007). Bowlby's postulated an inborn behavioural system that emerged as an adaptation over the course of mammalian evolution. The presence of an attachment system is therefore genetically determined, but the individual to which the attachment bond is formed depends on experience (Bowlby, 1982). Maternal care takes on great importance for the establishment of the bond (Bowlby, 1982), and a major role is played by the caregiver acting as a secure base and safe haven (Bowlby, 1982; Ainsworth, 1989). However, secure base use and support demand are present across the span of adulthood (Waters and Cummings, 2000). The attachment bond is usually maintained between adult children and their parents (see e.g. Carpenter, 2001), and in adult humans other attachment bonds can be created, e.g. between partners, friends, and intimates (Ainsworth, 1989).

There is scientific evidence that adult dogs establish attachment bonds towards human beings (for a review see Payne et al., 2016). Adult dogs can use their owner as a secure base (Mariti et al., 2013),

and they can form new interspecific attachment bonds even after the breaking of previous ones (Gácsi et al., 2001).

The presence of an attachment bond to conspecifics have instead received scant attention from researchers. Studies on separation from conspecifics (Pettijohn et al., 1977; Tuber et al., 1996; Walker et al., 2014) seem to point to a difference in the nature of the social relationships of dogs with humans and with conspecifics. Attachment as behavioural system exists in puppy-mother relationship (Prato-Previde et al., 2009), but there is no evidence of it in intraspecific relationships between adult dogs living in the same household (Mariti et al., 2014). It can be hypothesized that the attachment bond of puppies towards their mother is maintained, provided the possibility to live together also in adulthood.

The aim of this study was to test this hypothesis, through the analysis of the behaviour of adult dogs in the Ainsworth Strange Situation Test where the role of the presumed attachment figure was played by an older female dog living in the same household, being their own mother or an unrelated older female dog.

MATERIALS AND METHODS

Subjects

Fifty dyads of dogs were involved in this study. Dyads were divided into two groups: the mother-offspring (MO) and the older female dogs (OF) group. The two groups were matched as much as possible for factors which may have affected results, such as female/male ratio, age of the tested dogs, age of the other dog, breed, number of dogs in the household, time spent together, and environment in which they lived. More details are provided below and in the results section.

In the MO sub-sample each dyad was formed by the tested dog and his/her own mother living in the same household since birth. Eighteen dogs (10 females and 8 males; 4 mixed-breed, 2 Labrador

Retrievers, 2 German Shepherd Dogs, 2 Border Collies, 2 Bearded Collies, 2 Welsh Corgi Pembrokes, 1 English Springer Spaniel, 1 Australian Kelpie, 1 Flat Coated Retriever, and 1 Boxer; mean age = 37.8 ± 13.7 months old) took part at the study as tested subjects. Each of these 18 dogs were tested with his/her own mother (mean age = 75.1 ± 27.3 months old) as the presumed attachment figure. The mean time spent living together with the mother was 37.8 ± 13.7 months. The number of dogs living in the same household varied from 2-7, the mean being 3.7 ± 1.8 dogs/household.

In the OF sub-sample, the dyads consisted in dogs living in the same household but not related by blood. Dogs had been adopted around 8-10 weeks of age; before that age puppies had lived with their mother and littermates in a home environment and, after adoption, they had been living in the same household until the testing time. Thirty-two dogs (18 females and 14 males; 8 mixed-breed, 7 Labrador Retrievers, 2 German Shepherd Dogs, 2 Border Collies, 2 English Setters, 2 Belgian Shepherd Dogs, 1 Scotch Collie, 1 Flat Coated Retriever, 1 Bernese Mountain Dog, 1 English Springer Spaniel, 1 Australian Kelpie, 1 Pug, 1 Beagle, 1 Shetland Sheepdod, and 1 Toy Poodle; mean age = 46.7 ± 32.3 months old) participated in the study as tested subjects. Each dog was tested with an unrelated older female dog living in the same household (mean age = 70.7 ± 30.5 months old) playing the role of the presumed attachment figure. The time spent living together with the other dog was 38.7 ± 25.0 months. The number of dogs living in the same household varied from 2-8, the mean being 3.6 ± 1.7 dogs/household.

Each dog was tested in one condition only, but owners could participate with more than one dog. As a result, part of the MO sub-sample (10 out of 18 dogs) was living in the same household of part of the OF sub-sample (15 out of 39 dogs). This allowed the researchers to match as much as possible the living environment of the two groups.

None of the female dogs were in estrus, nor were they pregnant at or around the time of testing.

99 The inclusion criteria for tested dogs were the same used in a previous paper about intraspecific
100 attachment in adult dogs (Mariti et al., 2014).
101 Dog owners were all volunteers recruited by personal contacts. The stranger (Stranger 1) was
102 played by five 25-35 year old women, unfamiliar to all the dogs; each of them performed the
103 stranger for some dogs of both the MO and OF groups. A second person (Stranger 2) helped
104 Stranger 1 for the entrance and exit of the dog acting as the presumed attachment figure.
105 The involvement of an unknown dog playing the role of the stranger was avoided for ethical
106 reasons, due to the high risk of intraspecific aggression.
107 This study did not require approval of an Ethical committee because it was observational in nature.
108
109 Experimental setting and procedure
110 The procedure was the same described in Mariti et al. (2014). The procedure was as faithful as
111 possible to the Ainsworth Strange Situation Test (Ainsworth and Bell, 1970). Seven 2-min episodes
112 were carried out in an experimental room, unfamiliar to all dogs. As recommended in the ASST, the
113 procedure included two separations from the presumed attachment figure (episode 3, dog with
114 stranger; episode 5, dog in complete isolation; and episode 6, dog with stranger) and two reunions
115 with him/her (episode 4 and 7). A more detailed description of the procedure is reported in table 1.
116 Dogs were videotaped throughout the test and their behaviour was analysed using a continuous
117 sampling method in order to measure the duration (in seconds) of dogs' social and non-social
118 behaviours. The complete list of analysed behaviours is reported in Mariti et al. (2014).
119
120 Statistical analysis
121 In order to exclude the possible impact of factors other than being tested with the mother, a
122 statistical analysis was performed on factors assessed through a quantitative measure: X^2 test ($p <$

123 0.05) for the female/male ratio and t test ($p < 0.05$) for age of the tested dog, age of the other dog,
124 time spent in the same household, and number of dogs in the household.
125 Once we studied the potential differences in factors between the two groups, we proceeded to
126 analyze the differences between and within groups for the factor "test with the mother". The first
127 step of the statistical analysis consisted in comparing the MO and the OF groups for all the episodes
128 using a U-Mann Whitney test (multiple comparison corrections were performed using the
129 Benjamini-Hochberg procedure).
130 The second step was a within-group comparison for both MO and OF groups. The Kruskall-Wallis
131 test was applied to each behaviour in all the seven episodes, and behaviours resulted statistically
132 different ($p < 0.05$) with that test were re-analysed with the Wilcoxon paired-sample test. Due to the
133 results of the first analysis and to previous literature (Mariti et al., 2013, 2014), such analysis was
134 performed on episodes 5 (isolation), 6 (reunion with the stranger) and 7 (reunion with the presumed
135 attachment figure: mother or older female dog). A Bonferroni correction for multiple comparisons
136 was applied, considering the three possible combinations: episode 5 versus 6, episode 5 versus 7,
137 and episode 6 versus 7. The significance level was therefore $\alpha = 0.0167$.
138
139 **RESULTS**
140 The statistical analysis revealed no difference between the two groups for any of the analysed
141 factors: female/male ratio ($X^2 = 0.062$, $p = 0.803$), age of the tested dog ($t = -1.110$, $p = 0.272$), age
142 of the other dog ($t = 0.508$, $p = 0.614$), time spent in the same household ($t = -0.141$, $p= 0.889$), and
143 number of dogs in the household ($t = 0.196$, $p = 0.846$).
144 The behaviour of dogs belonging to the two groups was then compared. The first statistical analysis
145 revealed no significant differences between MO and OF for episodes 1, 2, 3, 4, and 6. In episodes 5,
146 dogs of the OF group spent more time close to the door compared to dogs tested with their own
147 mother (range: 26-120 versus 9-120; median: 93.50 versus 77.00; $U = 177.00$; $p = 0.025$). In

episode 7, dogs of the MO group spent more time oriented to the door (range: 37-111 versus 11-111; median: 77.00 versus 60.23; U = 168.00; p = 0.015).

The second step of the statistical analysis gave the results summarized in table 2 and 3. In the tables, only analysed behaviours for which a comparison led to any statistically significant differences are reported.

Figures 1 shows, as example, the results concerning the duration of behaviours against the door in both groups in the three analysed episodes.

DISCUSSION

The analysis of dogs' behaviour during the ASST clearly showed that, when isolated in an unfamiliar room, dogs of both groups displayed behaviours indicative of distress and attempt to regain proximity (e.g. behaviours against the door, staying close to the door, and vocalisations) for longer time compared to their display in the presence of a social stimulus. However, behaviours indicative of distress (i.e. behaviours against the door and staying close to the door) were observed for longer time in the presence of the older female dog than in the presence of the human stranger, whilst such difference did not emerge for the group tested with the canine mother. In addition, the comparison between episode 6 (reunion with the stranger) and episode 7 (reunion with the presumed attachment figure, i.e. the mother or the older female dog), resulted in different findings depending on the group: dogs looked more at the mother than at the stranger, but dogs displayed more affiliative behaviours (following and seeking attention) to the stranger than to the unrelated older female dog.

In the MO group it was found that the longer proximity far from the door towards the stranger was likely due to the fact that the stranger had to stay seated, whilst the mother dog was free to move, so she could stay close to the door together with the tested dog. In the OF group, proximity at first glance could seem to be higher towards the older female dog, but the longer total proximity was

actually due to the higher time spent close to the door by both the tested and the older female dog. In fact, proximity far from the door did not differ between episodes 6 and 7.

The results of the OF group are in line with findings previously described by Mariti et al. (2014), where dogs, after separation, showed a preference for a stranger over another dog living in the same household. However, from the current study it emerged that the characteristics of the relationship between the two dogs involved in the Ainsworth Strange Situation Test affected dogs' behaviour during the procedure. More in detail, the ameliorative effect of the mother dog was comparable to the ameliorative effect of a human stranger (no difference between episodes 6 and 7, except longer visual orientation to the mother); whilst dogs preferred the human stranger (longer following and seeking attention behaviours) in case they were tested with an older female dog other than the mother.

Contrary to what expected from previous literature on children-mother and dog-human bond, dogs of neither group showed a preference for the presumed attachment figure over the stranger. Mariti et al. (2014) explained this appeal of dogs to humans as a result of the special relationship linking these species, which has strong peculiarities both in the phylogenesis and in the ontogenesis of the domestic dog. Mariti et al. (2014) also hypothesized that intraspecific relationships in adult dogs may have very different features: e.g. owners may represent the main figure of attachment for their dogs, while cohabitant dogs may be secondary figures; or adult dogs, among them, may establish a relationship that is more similar to that of peers, as found in human children towards siblings (e.g. see Trouple-Cremel and Zauche-Gaudron, 2006) or between human partners (e.g. see Feeny, 1999).

The findings of the current study suggest that, given the possibility to keep it into adulthood, adult offspring-mother relationship in dogs differ from the relationship between an adult domestic dog and an unrelated older female dog. Interestingly, such difference is not due to sharing everyday life, as whole our sample was composed by dogs living in the same household with the presumed canine attachment figure since a long time. The relationship with the mother seems to have characteristics

198 that predispose it to be somehow maintained. In fact, 2 years old dogs are able to recognise their
199 mother even if they have been separated from them from 8-12 weeks after birth (Hepper, 1994).
200 The stronger bond with the mother is probably maintained from puppyhood (Prato-Previde et al.,
201 2009), and it is likely due to the relevance of maternal care in domestic dogs' social relationships,
202 as suggested by Guardini et al. (2016) and Foyer et al. (2016). However, also the possibility to
203 socialize and interact in the very first weeks of life may be responsible of it. Future studies may test
204 dogs living in the same households since birth without being linked by a mother-offspring
205 relationship, in order to clarify which are the effects of maternal care and of the familiarity in the
206 first weeks of life.
207 As this study was carried out using two independent groups of dogs, individual differences may be
208 regarded as responsible of the observed differences. Some measures were taken in order to reduce
209 that risk. For instance, an early weaning (Mogi et al., 2011), an early separation from littermates
210 (Pierantoni et al., 2011), and a disruption of the bond with owners (Prato-Previde and Valsecchi,
211 2007) are all factors known to affect the development of social and emotional behaviours of dogs.
212 For this reason, dogs included in this study were born at home or acquired at 2 months of age, living
213 with the mother before acquisition and with the same owner later on. In addition, the two groups
214 were as matched as possible for the age of tested dogs, the age of mother/older female dogs, the
215 time spent in the same household, the number of dogs living in the same household, and the
216 environment in which tested dogs were living. The fact that MO and OF dogs provided the same
217 response to the novel environment and to the human stranger at the first meeting (episode 1, 2 and
218 3) allowed us to consider the two groups basically equivalent for their "base" behaviour, and to
219 attribute the statistically significant differences to the kind of relationship that tested dogs have with
220 the other dog.
221 In this study, the gender of tested dogs was not considered as a factor possibly affecting the results,
222 based on previous findings of Tuber et al. (1996) and Mariti et al. (2014). It is desirable that future

studies will investigate the possible impact of the gender of both the tested dog and the dog playing the role of the presumed attachment figure. However, the gender is not *per se* a variable related to the care provided by adult dogs to younger ones (Pal, 2005).

Summarizing, the presence of a human stranger had a stronger ameliorative effect when compared to the presence of an older female dog living in the same household, but the ameliorative effect was almost identical when the stranger was compared to the canine mother. Considering the peculiar appeal that human beings have to dogs (Mariti et al., 2014), these findings suggest that the bond of adult dogs towards conspecifics sharing their daily life is stronger in case the conspecific is their own mother rather than an unrelated older female dog. However, such bond does not fit all the characteristics of an attachment bond as intended in a child-caregiver or in a dog-human bond (Mariti et al., 2013).

CONCLUSIONS

Dogs are linked to conspecifics living in the same household by a bond that does not completely correspond to the attachment bond in human children towards caregivers, nor to the attachment bond in adult dogs towards their owners. However, the bond of adult dogs towards their own mothers, when living together, seems to be stronger than the bond towards unrelated older female conspecifics living together but not being the mother.

Future research should investigate more in depth this kind of bond, its features and its connection with canine behaviour and social life.

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Casini. Preliminary data of this study have been presented in abstract form at the Canine Science Forum in Padua, Italy, 28th June-1st July 2016.

The idea for the article was conceived by C. Mariti and A. Gazzano. The experiments were designed by C. Mariti, C. Sighieri and A. Gazzano. The experiments were performed by C. Mariti, E. Votta, E. Ricci and B. Carlone. The data were analyzed by C. Mariti. The article was written by C. Mariti and B. Carlone. All authors have approved the final article.

Ethical considerations

This research was an observational study involving owned dogs, thus it did not require the approval by an ethical committee. Owner informed consent and authorization to video record were obtained before testing each dog.

Conflict of interest

We have read and understood this journal's policy on declaration of interests and declare that we have no competing interests.

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316

317 Tab. 1: procedure of the ASST as adapted for the study of intraspecific attachment bond.

Episodes	Subjects involved	Description
1	Dog1+ Dog2	dogs were free to move and explore the room
2	Dog1+ Dog2 + Stranger	Stranger 1 entered the room and she could greet the dogs if they were seeking attention. Then she sat on the chair and had to ignore the dogs, but she could not move them away if they approached her
3	Dog1+ Stranger	Dog2 is taken in another room 20 m away from the experimental room. Stranger 1 sat on the chair.
4	Dog1+ Dog2	Dog2 is led into the experimental room; in the meanwhile, Stranger left the room
5	Dog1	Dog2 is taken in another room 20 m away from the experimental room. Dog1 is in complete isolation.
6	Dog1+ Stranger	Stranger 1 entered the room and could greet the dog, then she sat
7	Dog1+ Dog2	Dog2 is led into the experimental room; in the meanwhile, Stranger left the room

318 Dog1 = dog tested. Dog2 = dog acting as the presumed attachment figure. Stranger = unfamiliar person.

319 Tab. 2: summary of the remarkable results raising from the comparison between episodes 5
320 (isolation), 6 (with stranger) and 7 (with the familiar dog) for the dogs tested with their own mother.
321

	Comparison (median values)	Min-max range	Results	Summary
Socially oriented	Ep. 6 vs 7 (17.0 vs 9.5)	6-83 vs 0-45	W=94.50, p=0.032	$7>6^{+}$
Following	Ep. 6 vs 7 (2.0 vs 0.0)	0-70 vs 0-9	W=112.00, p=0.099	≈
Seeking attention	Ep. 6 vs 7 (0.0 vs 0.0)	0-58 vs 0-2	W=122.00, p=0.121	≈
Proximity far from door	Ep. 6 vs 7 (37.0 vs 5.1)	0-120 vs 0-119	W=73.50, p=0.005	6>7*
Total proximity	Ep. 6 vs 7 (37.0 vs 52.0)	0-120 vs 0-119	W=157.00, p=0.874	≈
Close to door	Ep. 5 vs 6 (77.0 vs 10.5)	9-120 vs 0-100	W=233.50, p=0.002	5>6*
	Ep. 5 vs 7 (77.0 vs 52.0)	9-120 vs 0-116	W=113.50, p=0.125	≈
	Ep. 6 vs 7 (10.5 vs 52.0)	0-100 vs 0-116	W=106.00, p=0.076	≈
Oriented to door	Ep. 5 vs 6 (90.5 vs 75.0)	38-117 vs 32-110	W=90.00, p=0.023	$5>6^{+}$
	Ep. 5 vs 7 (90.5 vs 77.0)	38-117 vs 37-111	W=92.00, p=0.027	$5>7^{+}$
	Ep. 6 vs 7 (75.0 vs 77.0)	32-110 vs 37-111	W=145.50, p=0.601	≈
Behaviours against door	Ep. 5 vs 6 (7.0 vs 0.0)	0-47 vs 0-101	W=57.00, p=0.001	5>6*
	Ep. 5 vs 7 (7.0 vs 0.0)	0-47 vs 0-26	W=67.00, p=0.001	5>7*
	Ep. 6 vs 7 (0.0 vs 0.0)	0-101 vs 0-26	W=150.50, p=0.645	≈
Whining	Ep. 5 vs 6 (13.0 vs 8.5)	0-62 vs 0-47	W=128.50, p=0.287	≈
	Ep. 5 vs 7 (13.0 vs 5.4)	0-62 vs 0-34	W=105.00, p=0.068	≈
	Ep. 6 vs 7 (8.5 vs 5.4)	0-47 vs 0-34	W=143.00, p=0.542	≈
Barking	Ep. 5 vs 6 (0.0 vs 0.0)	0-19 vs 0-4	W=108.00, p=0.016	5>6*
	Ep. 5 vs 7 (0.0 vs 0.0)	0-19 vs 0-1	W=105.00, p=0.013	5>7*
	Ep. 6 vs 7 (0.0 vs 0.0)	0-4 vs 0-1	W=161.50, p=0.968	≈

322 ≈=no statistically significant differences; *= statistically significant, $p<0.0167$; $^{+}= 0.0167<p<0.005$
323

Tab. 3: summary of the remarkable results raising from the comparison between episodes 5 (isolation), 6 (with stranger) and 7 (with the familiar dog) for the dogs tested with an older female dog living in the same household.

	Comparison (median values)	Min-max range	Results	Summary
Socially oriented	Ep. 6 vs 7 (15.5 vs 12.5)	0-75 vs 2-86	W=1031.50, p=0.909	≈
Following	Ep. 6 vs 7 (1.1 vs 0.0)	0-6 vs 0-9	W=879.50, p=0.014	6>7*
Seeking attention	Ep. 6 vs 7 (0.5 vs 0.0)	0-105 vs 0-16	W=888.00, p=0.019	$6>7^{+}$
Proximity far from door	Ep. 6 vs 7 (23.0 vs 11.5)	0-120 vs 0-119	W=963.00, p=0.299	≈
Total proximity	Ep. 6 vs 7 (23.0 vs 48.0)	0-120 vs 0-120	W=888.00, p=0.041	$7>6^{+}$
Close to door	Ep. 5 vs 6 (93.5 vs 10.0)	26-120 vs 0-120	W=638.00, p<0.001	5>6*
	Ep. 5 vs 7 (93.5 vs 46.0)	26-120 vs 0-120	W=471.00, p=0.004	5>7*
	Ep. 6 vs 7 (10.0 vs 46.0)	0-120 vs 0-120	W=813.00, p=0.002	7>6*
Oriented to door	Ep. 5 vs 6 (82.0 vs 64.5)	9-120 vs 0-106	W=856.00, p=0.013	5>6*
	Ep. 5 vs 7 (82.0 vs 60.2)	9-120 vs 11-111	W=858.50, p=0.015	5>7*
	Ep. 6 vs 7 (64.5 vs 60.2)	0-106 vs 11-111	W=1032.00, p=0.914	≈
Behaviours against door	Ep. 5 vs 6 (5.2 vs 0.0)	0-56 vs 0-82	W=753.00, p<0.01	5>6*
	Ep. 5 vs 7 (5.2 vs 0.0)	0-56 vs 0-26	W=847.50, p=0.007	5>7*
	Ep. 6 vs 7 (0.0 vs 0.0)	0-82 vs 0-26	W=904.00, p=0.024	$7>6^{+}$
Whining	Ep. 5 vs 6 (19.0 vs 9.0)	0-66 vs 0-63	W=854.50, p=0.012	5>6*
	Ep. 5 vs 7 (19.0 vs 2.2)	0-66 vs 0-70	W=798.00, p=0.001	5>7*
	Ep. 6 vs 7 (9.0 vs 2.2)	0-63 vs 0-70	W=992.50, p=0.518	≈
Barking	Ep. 5 vs 6 (0.0 vs 0.0)	0-50 vs 0-42	W=943.50, p=0.109	≈
	Ep. 5 vs 7 (0.0 vs 0.0)	0-50 vs 0-74	W=904.50, p=0.014	5>7*
	Ep. 6 vs 7 (0.0 vs 0.0)	0-42 vs 0-74	W=082.50, p=0.222	≈

≈=no statistically significant differences; *= statistically significant, p<0.0167; $^{+}$= 0.0167<p<0.005

Fig. 1: results concerning the duration of behaviours against the door in episode 5 (isolation), 6 (with stranger) and 7 (with the familiar dog) in both the MO (dogs tested with mother) and the FO (dogs tested with an older female dog living in the same household) groups. For each box, the bottom and top horizontal lines represent the lowest and highest values, the lowest and top edge of the grey/white box represent the lower and upper quartile, the horizontal line within the grey/white box represents the median, and the stars represent the outliers.

Figure

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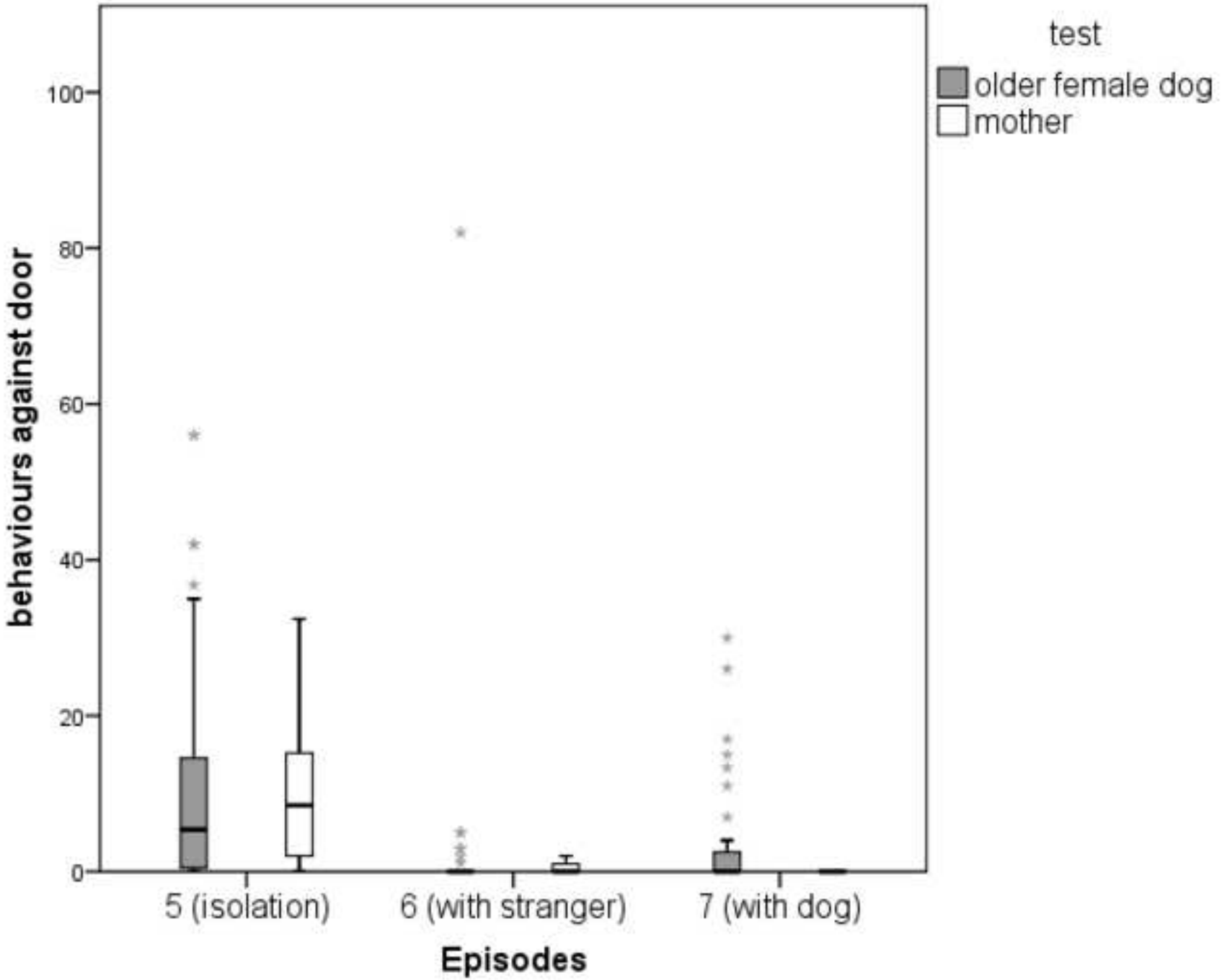

*Conflict of Interest

AUTHOR DECLARATION TEMPLATE

We wish to confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome.

We confirm that the manuscript has been read and approved by all named authors and that there are no other persons who satisfied the criteria for authorship but are not listed. We further confirm that the order of authors listed in the manuscript has been approved by all of us.

We confirm that we have given due consideration to the protection of intellectual property associated with this work and that there are no impediments to publication, including the timing of publication, with respect to intellectual property. In so doing we confirm that we have followed the regulations of our institutions concerning intellectual property.

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Signed by all authors as follows:

CHIARA MARITI 12/08/2016

BEATRICE CARLONE 12/08/2016

EMILIA VOTTA 12/08/2016

EVA RICCI 12/08/2016

CLAUDIO SIGHIERI 12/08/2016

ANGELO GAZZANO 12/08/2016