

Dog-directed parenting: owners' influence on attachment and problem behavior in dogs (*Canis Familiaris*)



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Date: 05-03-2019

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**Master thesis Animal Science
Behavioural Ecology
March 2019**

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Abstract

Owner dog interactions are decisive in the success, or the failure, of the relationship and a disrupted relationships between owner and dog is often at the heart of problem behaviours in dogs. The owner dog relationship covers varying aspects including the mutual attachment bond and ways in which an owner raises and controls his/her dog. The latter refers to parenting styles, which in humans is known to affect a child's attachment and behavioural development. The aim of this study was to understand the influence of dog-directed parenting style of the owner on attachment and problem behaviour in dogs. Dog-directed parenting styles were assessed using the Dog-Directed Parenting Style Dimension Questionnaire (DD-PSDQ) (n=2,497). To validate the dog-directed parenting style scores based on owner-reports, three behaviour tests were performed in forty-two dog-owner dyads. Pearson correlations showed that owners' reported dog-directed parenting style corresponded with owner behaviour during owner and dog interactions, supporting the validity of dog-directed parenting style assessments. The authoritative trained way of parenting emerged as the most optimal dog-directed parenting style. One-way analysis of variance (ANOVA) showed that authoritative trained owners indicated that they spent more time with their dog and experience lower perceived costs of their relationship, and their dogs had less aggression and anxiety related problem behaviour compared to the other two dog-directed parenting style. Showing that shared activities and low perceived costs associated with secure dog to owner attachment and little problem behaviour like aggression and fear. The presently found relationships between (dog-directed) parenting styles and attachment or dog problem behaviour are similar to findings in humans and support the idea that dog-directed parenting styles influences problem behaviour in dogs. The findings of this study are currently used for the development of educational interventions to help owners better understand the impact of the way they handle their dog, as manifest in parenting styles, on the dog's attachment and (mis)behaviour.

key words: domestic dog, behaviour, attachment, dog-directed parenting, problem behaviour

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1. Introduction

Dogs have varying (behavioural) traits and features that favour and strengthen the bond we have with them. They communicate with humans via social cognitive abilities which are not found in their closest relatives, the wolf (Hare et al. 2002; Nagasawa et al. 2015). This ability facilitates strong bonding between dogs and humans and makes them ideally suited as companion animals (Hart and Yamamoto 2016). Dogs are the most common pets in western society (Bennett and Rohlf 2007). Typically, owners feel like their dog is a family member and raise it as they do their own child (Prato-Previde, Fallani, and Valsecchi 2006; German 2015). Ninety-three % of 14,004 respondents categorized their dog as being a “family member” (Kubinyi, Turcsán, and Miklósi 2009). Dogs provide emotional support to humans and can be a secure-base in difficult times (Zilcha-Mano, Mikulincer, and Shaver 2012). Owners state that their dog can feel their emotions and know when he/she is in distress (Vitulli 2006). So, owners tend to presume that dogs show empathy, which has been defined scientifically as “the cognitive ability to be affected by and share the emotional state of another” (de Waal 2008), with the stronger empathy occurring with stronger the emotional bond between two individuals (Cialdini et al. 1997). Dogs do show expressions of empathic concern, and a significant number of dogs (15 out of 18) approached the owner or a strange person when they pretended to cry (Custance and Mayer 2012). When the person hummed only 6 out of 18 dogs approached and none of the dogs approached during talking, meaning it was not merely purely curiosity that made dogs approach. Also, rather than approaching their usual source of comfort (the owner) the dogs sniffed, nuzzled and licked the “crying” stranger, suggesting that the dogs were empathic and offered comfort rather than showing egoistic comfort-seeking (Custance and Mayer 2012). For example by means of emotional support, dogs can have beneficial effects on humans psychology, physiology and sociality (Allen, Blascovich, and Mendes 2002; Cutt et al. 2007; Zilcha-Mano et al. 2012). Dog interactions are used as a stress management tool (Fiocco and Hunse 2017). Physiological stress responses were measured in 61 ungraduated university students, by electrodermal activity (EDA) in response to the Paced Auditory Serial Addition Test (PASAT, Fiocco and Hunse 2017). The PASAT is a stressful computerized audio task that sensitively measures information processing ability and assesses impaired attention (Holdwick and Wingenfeld 1999). Half of the students were randomly assigned to the therapy dog group. This group waited for 10 minutes in a room together with a therapy dog before taking the PASAT. They were allowed to interact and pet the dog while waiting. The no-dog control group waited for 10 minutes in a room without therapy dog. Exposure to therapy dog significantly buffered the stress response to a subsequent stressor, shown by reduced EDA responses in the therapy dog group compared to the control group. The aforementioned findings illustrate the mutual close relationship between humans and dogs. Owner dog interactions both mirror and determine the relationship and the general (mis)behaviour of dogs in daily life. Problem-related behaviour like separation related disorder (SRD) and aggression are influenced by the dog-owner interaction and reasons for relinquishment of the dog to a shelter (Marston, Bennett, and Coleman 2010). Understanding the mechanisms underlying human-dog interactions is therefore important as it can help improving dog behaviour and welfare.

Attachment of dogs to their owners is one of the outcomes of the way owners interact with their dog and may be defined as “an affectional bond between two individuals” (Cohen and J. 1974). Owners’ interactions with their dogs were analysed for 220 dyads during 8 different standardized situations (e.g. tug-of-war pay, execution of basic commands, put the dog a t-shirt on) (Cimarelli et al. 2016). In the last test, the dog was approached by a strange person in a threatening way. Results of the Exploratory Factor Analysis (EFA) showed that there were three behavioural factors, which related to “owner warmth”, “owners social support”, and “owner control”. Dogs were more likely to hide behind their owner in response to an unfamiliar person approaching when the owners showed a “warmer” and “enthusiastic” behaviour towards the dog (Cimarelli et al. 2016). This represents the “safe haven” phenomenon which is also seen in children, where they seek for proximity to their caretaker (attachment figure) in a stressful situation (Gácsi et al. 2013). Attachment behaviour of dogs towards their owner can be measured with a Ainsworth’s Strange Situation Procedure (ASSP), although it was originally made for testing the attachment of children towards their parents (Palmer and Custance 2008; Prato-Previde et al. 2003; Topál et al. 1998). In ASSP, a dog and the owner enter an unfamiliar room and are introduced to a stranger. Hereafter the dog is subject to three short episodes of separation and two reunions with either their owner or the stranger. Safe haven, proximity seeking, secure

base and separation distress are hallmarks of secure attachment and when compromised can negatively affected the development of children and dogs. Insecure attachment in dogs can be a risk factor for developing behavioural problems. Separation related-disorder, where dogs have excessive distress when separated from their owner (their attachment figure), might be one of those behavioural problems. To validate owner's report of their dogs' separation related disorder, 44 dog owners filled in a Separation Questionnaire and 15 of those, including both dogs with and without separation related disorder (as report by their owner), were tested in a behavioural test (Konok, Dóka, and Miklósi 2011). Thirty-four % of the owners reported SRD in their dog and complained about vocalisation, destructive behaviour or urinating when they left the dog at home alone. Dogs which were reported by the owner to have SRD showed indeed more distress (e.g. vocalisation and proximity behaviour as scratching the door) during ASSP separation and showed more affection (e.g. contact with the owner and tail-wagging) when they were reunited with their owner in comparison to dogs without owner-reported SRD (Konok et al. 2011). This suggests that the owner's attachment avoidance behaviour contributes to this problem behaviour. Insecurely attached dogs who experienced being ignored in stressful situations, when they sought for support from their owner (safe haven), may learn that they cannot be sure about the availability of their owner (Gácsi et al. 2013; Konok et al. 2015, 2011). Consequently, such 'avoidant' owners' dogs experience higher distress during stressful situations like separation. Insecurely attached children also are more prone to separation anxiety compared to securely attached children (Dallaire and Weinraub 2005; Edelstein et al. 2004). In order for children to feel confident about the availability of their mother (secure base, safe haven), the mother has to be responsive to the child's need. This means that interactions between parents and children, as expressed in parenting behaviour, influences the child's attachment (e.g. Leerkes 2011) and the same could be true for owner and dogs.

Parenting ways have an effect on the development and behaviour of off-spring both in humans and animals like birds (Wischhoff et al. 2018), macaques (Maestripieri 2001) and primates (Smith 2009). Parenting styles in humans are based on variation in the dimensions demandingness and responsiveness. Demandingness is the degree of monitoring and control of the parents on the child and responsiveness is related to which extent the parents listen to the needs and wishes of the child, and the supportiveness of the parents within those needs (Baumrind 1989; McCoby 1983) (Fig 1). Different combinations of these dimensions result in the parenting styles authoritarian, authoritative, permissive, and uninvolved (Maccoby and Martin, 1993). The authoritarian style is where parents exert strong control on their children, they set up strict rules without explanation and punishment will follow if rules are not been followed. The authoritative parents also demand from their children and set up rules, however, parents are more willing to negotiate about these rules and listen more to the needs of the child as well. In the permissive style there is more place to listen to the needs and wishes of a child, but there are a few rules and parents rarely monitor their children. The uninvolved style characterizes the parent who demands little and does not need the child's needs or wishes, making them neglectful. In human psychology, the Parenting Styles and Dimension Questionnaire (PSDQ) is used to determine the effect of parenting styles on children, consisting of 62 items (Robinson et al. 1995).

Inappropriate parenting might have a wide range of consequence for the behaviour, health and development of children (Chan and Koo, 2011). To examine the association between parenting style and health-related behaviour of children, 228 parents and their children were asked to fill in a Comprehensive General Parenting Questionnaire (parents) and a Dutch Eating Behaviour Questionnaire (children) (Philips et al. 2014). A small positive correlation between the frequency of sweet food consumption of children and the "coercive control" of the parents was found. On the other hand, a small negative correlation was found between fruit and vegetable consumption and overprotection. This suggests that parenting style plays an important role in the health-related behaviour of children. Examination of parenting styles also seems to be relevant in the understanding of the psychological well-being of youth (Clark and Virginia Commonwealth 2015). Prevalence of depressive symptoms among 989 college students was assessed via a self-report Symptom Checklist. Results showed that indeed parenting style predicts depression among college students, students who described their parents as "involved" and more "autonomous" reported fewer depression symptoms. These studies highlight the importance of understanding the effect of parenting on children namely to improve their development and well-being. This raises the question if this also applies to companion animals like dogs.

Parenting styles directed to children correspondent with, but are not identical to, dog-directed parenting (Herwijnen et al. 2018). Dutch dog owners (n=518) filled out the PSDQ for child-directed parenting and a similar questionnaire but now adapted for dog-directed parenting. Results of the Principal Component Analysis showed that indeed the 32-item PSDQ (shortened version of the 62-item PSDQ) is valid and that it re-constructs into a 20-item Dog-Directed Parenting Styles and Dimensions Questionnaire (DD-PSDQ) (Herwijnen et al. 2018). Three dog-directed parenting styles emerged, being authoritarian-corrected, authoritative-intrinsic value and, authoritative training oriented. The authoritarian-corrected dog-directed parenting style involves a high behavioural control and focussing on correcting dog behaviour verbally/physically. The authoritative-trained dog-directed parenting style focusing on manners in teaching a dog how to behave correctly, showing a high level of behavioural control but using a responsive way to accomplish this. The authoritative-intrinsic dog-directed parenting style is characterized being mainly oriented on the assumed needs and emotions of the dog (Herwijnen et al. 2018). Research on the effect of parenting style on the well-being of the dog is lacking, whereas it may be of considerable importance as in humans parenting related insecure attachment leads to problem behaviour in children. The aim of this study is to understand more about the influence of dog-directed parenting style of the owner on attachment bonds and problem behaviour in dogs. Since problem behaviour (like aggression and SRD) in dogs can have a huge influence on the welfare it is important to understand about the underlying mechanisms that play a role. If the influence of dog-directed parenting on attachment is indeed similar to child-directed parenting, it is expect that in-appropriate parenting (partly) causes these problem behaviours in dogs. Gaining knowledge on the influence of dog-directed parenting style on the mutual attachment between the owner and dog and the latter's (mis)behaviour, is an important first step in promoting appropriate parenting and improving dog welfare.

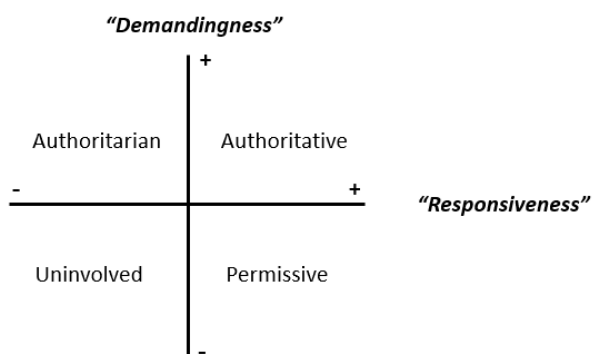


Figure 1 Parenting style matrix. On the axes "Demandingness" and "Responsiveness", resulting in four parenting styles: authoritarian, authoritative, uninvolved and permissive.

2. Material and Methods

2.1 Questionnaire

Dog-directed parenting styles were assessed using the Dog-Directed Parenting Style Dimension Questionnaire (DD-PSDQ, Herwijnen et al. 2018). This online survey (Appendix 1, Table 1.1) ran on *dierenwetenschap.com* from August 2017 until December 2018. General information on both dog and owner were also collected, including owner's gender and age, dog's age, neutered status and breed. The questionnaire included questions based on the 32-items Parenting Style and Dimension Questionnaire (PSDQ, Robinson et al. 1995), which is a shortened version of the original 64-item PSDQ. Questions were adapted for use with dogs (Herwijnen et al. 2018). The three dog-directed parenting styles as used for further analyses were authoritative-training (AUT) authoritative-intrinsic (AUI) and authoritarian-correction (AUN) oriented. Also included were questions about the dog owner relationship following the Monash Dog Owner Relationship Scale (MDORS, Dwyer, Bennett, and Coleman 2006), resulting in scores for the amount of dog-owner interaction, emotional closeness and the perceived costs of having a dog. This questionnaire can thus be used to assess the bond between the owner and the dog. Hundred % scores for all the three categories of MDORS, including (low) perceived costs, indicated a close bond between the owner and the dog. Additionally, information on (problem) behaviour of dogs in daily life, as reported by owners, were assessed with the Canine Assessment and Research Questionnaire (CBARQ, Hsu and Serpell 2003). This questionnaire is widely used in canine behaviour assessment and contains items regarding aggression, fear and anxiety, separation-related behaviour and, attachment to the owner. The surveys made it possible to assess the relationship between dog-directed parenting styles and problem-related behaviour in dogs.

2.2 Behaviour tests

Forty-two dog owners participated in behavioural tests at Carus research facility in Wageningen. These owners had at least one dog, which they owned from the dog's age of 16 weeks or younger and cared for at least 50% of the time. To validate the dog-directed parenting style scores, based on owner-reports, three behaviour tests were performed (for descriptions see below). Dogs participated also in a Strange Situation Test (SST) and the Theory of Mind test (ToM), but these were not part of the present study. Full test sessions took about 1.5 hours including walks and breaks. All behavioural experiments were recorded on video (Axis M10 network camera) and analysed afterward using Observer XT10.5. Behaviours of both owner and dog were recorded following ethograms presented in Appendix II (Tables 2.1 and 2.2).

Halfway the test session, there was a ten-minute break during which owners ($n=36$) were asked to first fill in a small questionnaire (State-Trait Anxiety Inventory, Spielberger et al. 1971). After filling out the questionnaire the owner and dog were free to move around the room and do whatever they wanted to for the rest of the time. The dog was allowed to be off leash, there was coffee or tea and some magazines were available for the owner and a water bowl, toys and a resting mat for the dog (Fig. 2). The owner was not informed about the purpose of this 'breakroom test', which was designed to assess spontaneous interactions between owner and dog from a perspective of the two parenting dimensions responsiveness and demandingness. The level of responsiveness was based on the time of interaction between owner and dog and the number of praises (verbal and physical). The level of demandingness was based on the numbers of instructions and reprimands (verbal and physical). For details on the ethogram see Appendix II (Table 2.1).

After the 'breakroom test', owners ($n=40$) were asked to teach their dog to score a goal. The owners got three minutes to make their dog do so. For this a Jolly "Push-n-Play ball (either 15cm or 25 cm) was available, or a softball if dogs were scared of the hardball. In the test room sized 49m² a goal (68x45x51cm) was placed against the wall. The owners were allowed to instruct, help and reward the dog the way they liked. This 'football test' lasted 3 minutes and assessed dog-owner interactions in the context of owners teaching their dogs. The owners' communication, as part of teaching a new behaviour, were noted down, like the number of verbal-, and physical instructions. Also, the number of non-verbal sounds used by the owner to attract the dogs' attention (e.g., whistle, clapping, pointing) were scored. Of further interest was how the owner learned the goal-scoring behaviour step by step (e.g. ball demonstrations and ball facilitation and using a trick to succeed), and if the owner rewarded (verbal-, and physical praises and giving food reward) the dog when showing successful behaviour or reprimanded (verbal-, and physical reprimand) the dog when not. Full details on the ethogram are in Appendix II (Table 2.1).

Finally, an obedience test was performed in which owner and dog ($n=40$) had to follow a track along food treats and small balls (Fig. 3), which the dog was not allowed to touch. Measurements focused on how owners prevented and corrected unwanted behaviours of their dog. In this ‘treat and ball test’, the owner was instructed that the dog was not allowed to eat the treats or take the balls which were equally distributed in the test room. The owner and leashed dog walked over a line that had been marked with tape on the floor. This walk was repeated 3 times with breaks of 30 seconds waiting outside the room. Again, the level of responsiveness was measured via scoring the number of praises (verbal and physical), and the level of demandingness was recorded by counting the numbers instructions and reprimands (verbal and physical). In addition, the number of pulling the leash, leash tension and, verbal and physical instructions were recorded to assess the demandingness of the owner. Full details on the ethogram are in Appendix II (Table 2.1). After the third time, the dog was allowed to eat the treats if the owner agreed to.

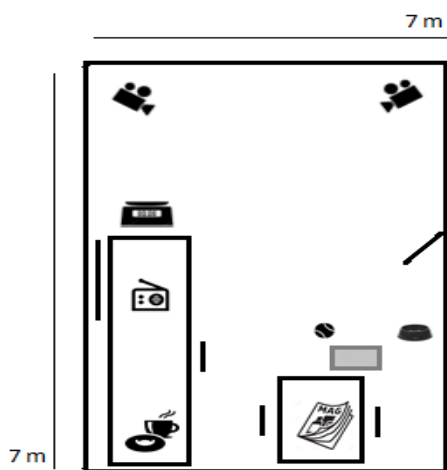


Figure 2 Map of dog testing facility (room 1) of Wageningen University. Test set-up for breakroom test

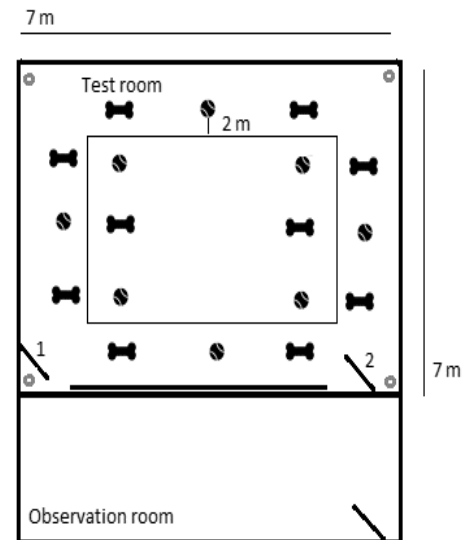


Figure 3 Map of dog testing facility (room 2) of Wageningen University. Test set-up for treat and ball test

2.3 Statistical analysis

During the three behavioural tests both point and state behaviours of owner and dog were scored (Appendix II, Tables 2.1 and 2.2). Point events were expressed as rate per minute (RPM) and states of behaviour as percentages of observation time (P). Statistical procedures tested for the link between dog-directed parenting scores and behaviour scores in the behaviour tests, to evaluate construct validity of the DD-PSDQ.

Behaviour tests produced a multitude of behavioural readout parameters and these were tested for associations in order to establish data reduction and identify underlying dimensions. A Principal components analyses (PCA, Jolliffe, 1986) was done following procedures described by Herwijnen et al. (2018). Only behaviours that were shown by the owner were included in the PCA (Appendix IV, Tables 4.1, 4.2 and, 4.3). Physical praise soft and hard were combined as ‘physical praise’, resulting in 11 owner behaviours left for PCA for the breakroom test, 19 owner behaviours for the football test and 12 owner behaviours for the treat and ball test. Principal components identified behaviours that co-varied, directly or inversely. Loadings higher than 0.4, on a scale of -1 to +1, were considered relevant. The relative importance of a component derived from the percentage of variation in the data set that it explained. Component scores integrated original scores for behaviours based on loadings as weighing factors. Components that explained significant variance and could be “biologically explained”, were used for further analyses. Next, Pearson correlation coefficients (r) were calculated to check whether the behavioural patterns, for example as expressed in PCA components, might be linked to one of the dog-directed parenting styles. Pearson correlations were also calculated for single owner behaviours and dog-directed parenting style percentage to check whether certain single owner behaviours were associated with dog-directed parenting styles. The summed scores of each participant, across the three trials during the treat and ball test, were used for calculating the Pearson correlation coefficients.

Owners were labelled by one of the three dog-directed parenting style (authoritative-trained (AUT), authoritative-intrinsic (AUI) and, authoritarian-corrected (AUN)). Within a study population of 2,497 dog owners, the participants were ranked for each of the three dog-directed parenting styles and were assigned the parenting style for which they ranked highest. This label was used for further analysis.

For the treat and ball test, a Linear Mixed Model (LMM) with restricted maximum likelihood (REML procedure in Genstat®) was used to analyse owner behaviours during the three different trials. REML takes the actual distribution of the data into account and the following statistical model was used:

$$Y_{pqr} = \mu + PS_p + Trial_q + (PS_p * Trial_q) + Owner_r + e_{pqr}$$

Where Y is a behaviour score for owner (n=40) with parenting style PS (AUT, AUI, AUN) during trial q (1,2 or 3). To account for the repeated measures on the same experimental unit the owner was included as a random factor in this statistical model. The number of trial did explain the variation in owner behaviour, with most of the time the first trial differing significantly from the subsequent (Appendix VI, Table 6.1). So in further analysis only the first trial was used. Next, one-way analysis of variance (ANOVA) was used to determine whether the independent variable parenting style explained variation in owner behaviours during the three behavioural tests. Post hoc student t-tests were used to evaluate contrasts and identify the significant differences between any two of the three dog-directed parenting styles. Results from the C-BARQ were used to assess associations between the dog-directed parenting styles and problem behaviour in dogs. A one-way analysis of variance (ANOVA) was conducted to determine whether there are any statistically significant differences of (problem) behaviour of the dogs amongst the three different dog-directed parenting styles (AUT, AUI or AUN). Also, the scores for the MDORS were statistically tested as dependent variables, in a one-way ANOVA, for possible associations with three different dog-directed parenting styles.

3. Results

3.1 Dog-Directed Parenting Style Questionnaire

Dog-directed parenting styles were assessed using the Dog-Directed Parenting Style Dimension Questionnaire (DD-PSDQ). The online questionnaire was filled in by a total of 2,497 owners. The majority of the respondent was female (85%, $N = 2,132$; male 14%, $N = 348$). Age of the respondents was categorized into seven age classes and most belonged to the age group 45-54 (29%, $N = 725$) (Appendix III, Table 3.1).

Of the dogs, 47% was female ($N = 1,128$) and 53% was male ($N = 1,254$, Appendix III, Table 3.2). The balance between neutered and not neutered dogs was almost equal (neutered 47%, $N = 1,186$; not neutered 48% $N = 1,196$). There were slightly more neutered females (59%, $N = 670$) than males (41%, $n = 516$, Appendix II, Table 3.2). Age of the dog was indicated in thirteen categories and the majority belonged to the age group of 1-2 years (16%, $N = 404$) and 2-3 years (14%, $N = 355$, Appendix III, Table 3.3). Also, most dogs had lived with their owner from an age of 7 to 9 weeks (70%, $N = 1,741$) and this current owner typically was the first and only owner they had (92%, $N = 2,300$).

Dog-directed parenting styles following the DD-PSDQ were scored on a scale of 0-100%. The majority of the respondent adopted an authoritative-training dog-directed parenting style (AUT, 83%). Followed by authoritative- intrinsic (AUI, 64%) and authoritarian-correction dog-directed parenting style (AUN, 23%, Table 1).

Table 1 Descriptive mean scores for the filled in online questionnaire. Dog owners ($n = 2,497$) reported about their dog-directed parenting by answering 32-items of the Dog-Directed Parenting Style Dimension Questionnaire (DD-PSDQ) on a five-point Likert scale. Dog-directed parenting style scores were calculated following standard procedures and expressed as a percentage. Next, dog owners reported about their dog-owner relationship ($n = 2,495$) by answering 26-items of the Monash Dog Owner Relationship Scale (MDORS) on a five-point Likert Scale. Dog owner relationship scores were calculated following standard procedures and expressed as a percentage. Presented are the calculated mean dog-directed parenting scores \pm s.d and the Monash Dog Owner Relationship items \pm s.d. Presented also are the dog owners reported dog-directed parenting style scores and Monash Dog Owner Relation scale scores for the owners who participated in the behaviour tests ($n = 42$). *Note that the perceived cost is reversed, meaning that 100% is the lowest perceived cost of having a dog.

Online Questionnaire	mean \pm s.d.	mean \pm s.d.
DD-PSDQ	n=2,497	n=42
Authoritative-intrinsic oriented (AUI)	63.63 \pm 18.21	65.76 \pm 17.36
Authoritarian-corrected oriented (AUN)	22.97 \pm 15.70	25.49 \pm 18.20
Authoritative-training oriented (AUT)	83.14 \pm 13.32	81.25 \pm 15.68
MDORS	n=2,495	n=42
Dog-owner interaction (Share)	72.15 \pm 11.03	69.78 \pm 10.21
Emotional closeness (Close)	76.23 \pm 16.21	75.04 \pm 13.89
Perceived Cost (Cost)	86.55 \pm 11.76	84.76 \pm 12.80

Owners were asked to participate in behaviour tests to validate their DD-PSDQ score with actual behaviour data. A total of 42 owners performed three behavioural tests with their dog (breakroom test $n = 36$, football test $n = 40$, and a treat and ball test $n = 40$). The majority of the participants of the behaviour tests adopted an AUT dog-directed parenting style (81%). Followed by AUI (66%) and AUN (25%, Table 1). These scores were comparable with those on the entire data set ($n = 2,497$), suggesting this test sub-population was representatives for the larger test population.

Results from the MDORS ($n = 42$), on a scale of 0-100%, showed that the perceived cost (85%) of having a dog was on average low (reversed score) and the owners scored moderately high for perceived emotional closeness (75%) and the time spend with their dog (70%, Table 1). Again these scores, were comparable with those on the entire data set ($n = 2,495$).

3.2 Construct validation of the DD-PSDQ using behavioural tests

3.2.1 Owner behaviour patterns and associations with reported dog-directed parenting styles

For each of the behavioural tests, a PCA was done to detect potential correlated owner behaviours in a certain behaviour pattern. Principal components with loading higher than 0.4 indicated that an item fitted into a component. The relative importance of a component derived from the percentage of variation in the data set that it explained.

In total 15 single owner behaviours were observed during the breakroom test (n=36, Appendix IV, Table 4.1). The owners spend most of their time sitting on a chair and they only paid attention towards their dog for about 25 percent of their time (Table 2). Eleven owner behaviours were left for PCA. We dropped 2 items from the first PCA, and retained the other 9 items with loadings more than |0.4| (Table 2). The PCA with the remaining owner behaviours resulted in two meaning full components “Attention” and “Inactivity” with a percentage of variation explained of 35% and 26%, respectively.

Table 2 Principal component analysis results on associations between owner behaviours during the breakroom test (n=36). Presented are the owner behaviours that were left over in the last PCA, the calculated mean of this behaviour \pm s.d. and, the main loading for the first two components with the explained variation in the top row.

	Rate per minute (RPM) or percentage of time (P)	Mean \pm s.d.	“Attention”	“Inactivity”
<i>Variation explained (%)</i>			35.11	25.89
Verbal Punishment	RPM	0.08 \pm 0.17	0.55	*
Verbal Instruction	RPM	0.95 \pm 1.30	0.87	*
Verbal Praises	RPM	0.40 \pm 0.58	0.85	*
Standing	P	7.13 \pm 9.08	*	-0.74
Walking	P	6.13 \pm 8.66	*	-0.61
Sitting	P	86.46 \pm 13.68	*	0.91
Attention Towards dog	P	26.74 \pm 22.43	0.90	*
Attention towards unknown	P	63.58 \pm 17.00	-0.68	*
Attention towards magazine	P	9.68 \pm 20.97	-0.08	0.60

In total 23 owner behaviours were observed during the football test (n=40, Appendix IV, Table 4.2). On average the owners touched the ball 6 times per minute and used 11 verbal instructions per minute (Table 3). Nineteen owner behaviours were left for PCA. We dropped 10 items from the first PCA, to retain the other 9 items with loadings over |0.4| (Table 3). Owner attention-getting parameters fitted in the first component as well as in the second component. Also, the second component explained little variation (17.41%) and it was unclear what it represented, indicating that only the first component was meaningful. Thus, the outcome was one meaning full component “Getting attention” with a percentage of variation explained of 32% (Table 3).

Table 3 Principal component analysis results on associations between owner behaviours during the football test (n=40). Presented are the owner behaviours that were left over in the last PCA, the calculated mean of this behaviour \pm s.d. and, the main loading for the first component with the explained variation in the top row.

	Rate per minute (RPM) or percentage of time (P)	Mean \pm s.d.	“Getting attention”
<i>Variation explained (%)</i>			32.19
Attention getting no name	RPM	0.36 \pm 0.73	0.64
Attention getting name	RPM	0.69 \pm 0.93	0.62
Demonstrating ball rolling in goal	RPM	0.42 \pm 0.57	0.45
Touching ball	RPM	6.16 \pm 4.01	0.67
Verbal punishment	RPM	0.78 \pm 1.15	0.57
Physical instruction	RPM	0.25 \pm 0.54	0.65
Verbal instruction	RPM	11.22 \pm 5.98	0.45
Giving treat reward	RPM	1.70 \pm 1.94	0.59
Standing	P	39.34 \pm 33.10	*

For the treat and ball test, 15 single owner behaviours (n=40) were observed in three trials, resulting in 120 records. The owners had on average 60 percent of the total test time tension on the leash and used 15 verbal instructions per minute (Table 4). Twelve owner behaviours were left for PCA (Appendix IV, Table 4.3). We dropped 6 items from the first PCA and retained the other 6 items. A PCA with the remaining owner behaviours resulted in two meaning full components “Controlling via leash” and “Instructing” with a percentage of variation explained of 41% and 27%, respectively (Table 4).

Table 4 Principal component analysis results on associations between owner behaviours during the treat and ball test (n=40). Presented are the owner behaviours that were left over in the last PCA, the calculated mean of this behaviour \pm s.d. and, the main loading for the first two components with the explained variation in the top row.

	Rate per minute (RPM) or percentage of time (P)	Mean \pm s.d.	“Controlling via leash”	“Instructing”
<i>Variation explained (%)</i>			40.80	27.32
Leash snap	RPM	2.26 \pm 2.98	*	0.78
Leash steady	RPM	8.03 \pm 3.26	0.75	*
Verbal punishment	RPM	3.97 \pm 4.04	*	0.78
Verbal instruction	RPM	14.66 \pm 7.89	*	0.57
Tension on leash	P	63.01 \pm 32.30	0.95	*
No tension on leash	P	35.39 \pm 31.61	-0.94	*

Pearson correlation coefficients were calculated to check whether the behavioural patterns, as these resulted from the PCA, might be linked to one of the dog-directed parenting styles. There were no significant correlations between the behaviour patterns of the breakroom, “Attention” or “Inactivity”, and the dog-directed parenting styles (Appendix V, Table 5.1). The behavioural pattern “Getting attention”, from football test, was positively correlated with the AUN dog-directed parenting style ($r=0.44$, $n=40$, $P=0.004$) (Appendix V, Table 5.2). The behaviour pattern “Controlling via leash”, from the treat and ball test, was positively correlated with the AUN dog-directed parenting style ($r=0.34$, $n=40$, $P=0.03$, Appendix V, Table 5.3). Owners who are more authoritarian-corrected oriented will display more controlling via leash behaviours. Results from the PCA showed that behavioural patterns emerged from the three behaviour tests. First, “Attention” and “Inactivity” from the breakroom test. Second, “Getting attention” from the football test and lastly “Controlling via leash” from the treat and ball test. Only the AUN dog-directed parenting style was significantly correlated, to “Getting attention” and “Controlling via leash”. Other behavioural patterns, i.e. PCA components, apparently represented something different and unrelated to dog-directed parenting style.

3.2.2 Owner single behaviours and associations with reported dog-directed parenting styles

Pearson correlations were calculated for single owner behaviours and dog-directed parenting style percentage to check whether certain single owner behaviours are associated with a dog-directed parenting style (Appendix V, Table 5.1, 5.2, and 5.3). Note that, the summed scores of each participant, across the three trials during the treat and ball test, were used for calculating Pearson correlation coefficients.

Authoritarian correction dog-directed parenting style

The AUN dog-directed parenting style was negatively correlated with verbal praises ($r=-0.35$, $n=40$, $P=0.029$, Fig. 3B) and using a treat reward ($r=-0.44$, $n=40$, $P=0.005$) during the football test. For the treat and ball test, this dog-directed parenting style was negatively correlated with the number of verbal praises ($r=-0.41$, $n=40$, $P=0.008$, Fig. 3D). On top of this, for the treat and ball test a positive correlation existed for verbal punishment ($r=0.43$, $n=40$, $P=0.006$, Fig. 3C), holding leash steady ($r=0.32$, $n=40$, $P=0.048$) and percentage of time tension on the leash ($r=0.32$, $n=40$, $P=0.044$). For the football test, this dog-directed parenting style was a positively correlation with using the name of the dog to get attention ($r=0.44$, $n=40$, $P=0.005$) and verbal instruction ($r=0.34$, $n=40$, $P=0.041$, Fig. 3A).

Authoritative-trained dog-directed parenting style

The AUT dog-directed parenting style was positively correlation with verbal praises during both the breakroom test ($r=0.37$, $n=36$, $P=0.027$) and the football test ($r=0.49$, $n=40$, $P=0.001$, Fig. 3B). Furthermore, for the football tests, this dog-directed parenting style was a negatively correlated with physical instruction ($r=-0.35$, $n=40$, $P=0.027$).

Authoritative-intrinsic dog-directed parenting style

The AUI dog-directed parenting style correlated negatively with pointing towards the goal ($r=-0.35$, $n=40$, $P=0.025$) and verbal instructions ($r=-0.43$, $n=40$, $P=0.006$, Fig. 3A), both during the football test. For treat and ball test, a negative correlation existed with for leash snap ($r=-0.39$, $n=40$, $P=0.012$) and verbal punishment ($r=-0.38$, $n=40$, $P=0.015$, Fig. 3C), but a positive correlation with verbal praises ($r=0.38$, $n=40$, $P=0.015$, Fig. 3D).

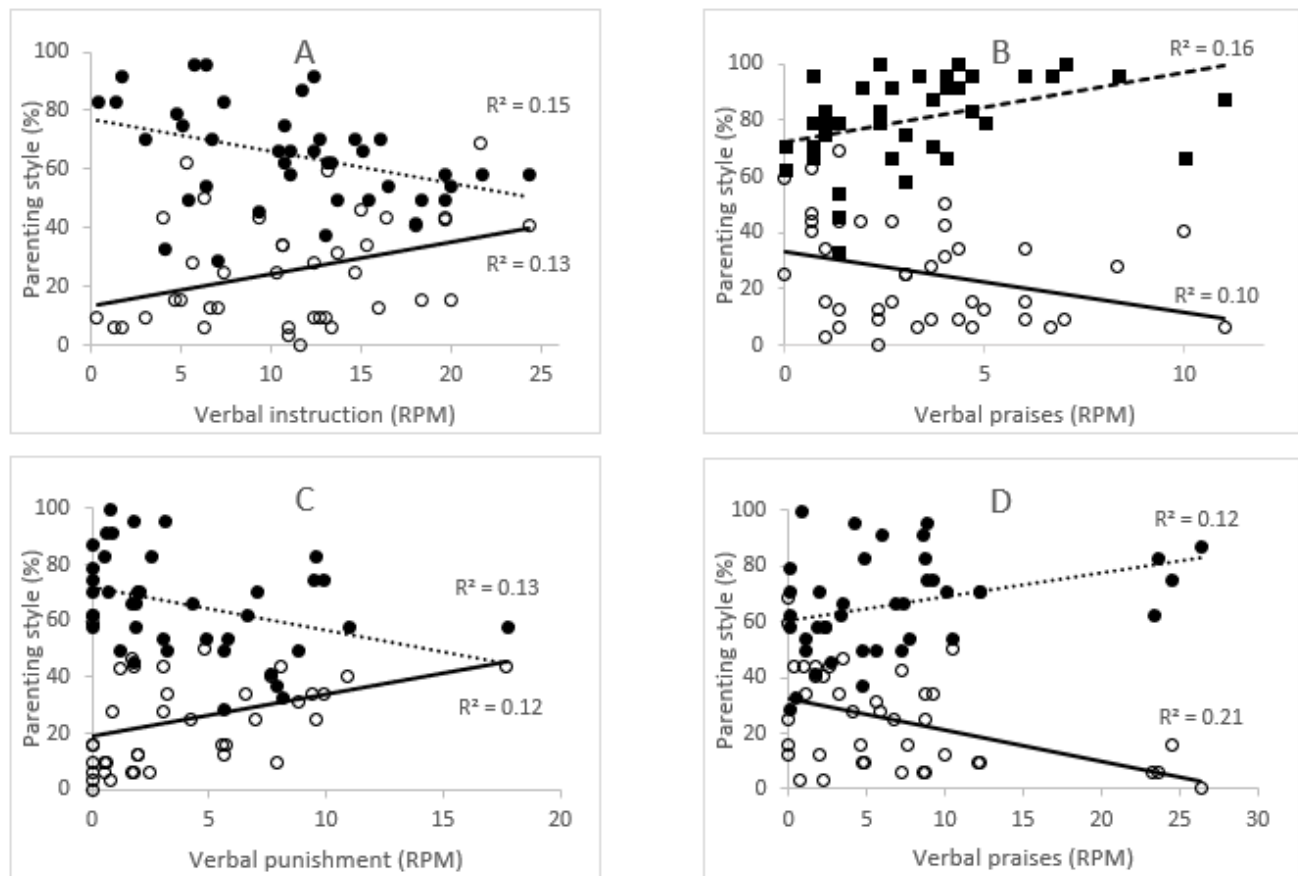


Figure 3 Dog owners ($n=40$) with different dog-directed parenting styles (authoritative-intrinsic oriented (AUI), authoritarian-corrected oriented (AUN) and, authoritative-trained (AUT)), measured with the dog-directed PSDQ, who give their dog either a A) verbal instruction or B) verbal praises during the football test and a C) verbal punishment or D) verbal praises during the treat and ball test. On the y-axis the dog-directed parenting style percentage and on the x-axis the rate per minute of either a A) verbal instruction, B) verbal praises, C) verbal punishment or D) verbal praises. The closed dots and dotted line represent the AUI dog-directed parenting style, the open dots and the continuous line represent AUN dog-directed parenting style, the closed squares and striped line represent the AUT dog-directed parenting style.

Results from the Pearson correlation coefficients showed that owners who adopt the AUT do reward (good) behaviour to reach success / good behaviour. Owners who adopt an AUN dog-directed parenting style used a more cold way, either verbal or physical, to instruct or correct their dog. Lastly, owners who adopt an AUI dog-directed parenting style were more willing to help and instruct the dog how to behave and using fewer corrections.

3.2.3 Influence of the dog-directed parenting style on single owner behaviour

A one-way ANOVA was conducted to test the effect of the owner's predominant dog-directed parenting style (expressed categorically) on the different single owner behaviours during the three tests. Since most of the time only the first trial of the treat and ball tests significantly differed from trial 2 and/or 3 (Appendix VI, Table 6.1), trial one scores were used to conduct one-way ANOVAs.

The dog-directed parenting style explained variation in the number of verbal praises (rate per minute, predicted means \pm se) the owner gave) during the football test ($F(2,37)=4.42$, $P=0.019$, Appendix VII, Table 7.2). Post hoc comparison indicated that number of verbal praises for the AUT dog-directed parenting style (4.9 ± 0.7) was significantly higher than for owners with an AUN dog-directed parenting style (2.1 ± 0.7 , $P=0.006$). The AUI dog-directed parenting style (3.8 ± 0.7) did not significantly differ from the other two dog-directed parenting styles (Appendix VII, Table 7.2). The dog-directed parenting style did not significantly explain the variation in owner behaviour during both the breakroom test (Appendix VII, Table 7.1) and the treat and ball test (Appendix VIII, Table 7.3). Taken together, these results suggest that dog-directed parenting styles adopted by the owner do not always explain the variation in owner behaviour.

3.3 Dog-directed parenting style and problem related behaviour in dogs

Results from the C-BARQ ($N=2,201$) showed that owners reported that their dog tended to be closely attached to them (attachment and attention seeking score of 50%). Average reported dog related-problem behaviour, like aggression, was notable lower ranging from 2% (owner-directed aggression) up to 20% (dog-directed aggression). Also, social fear (9%) and dog directed social fear (12%) was relatively low (Appendix VIII, Table 8.1).

Dog-directed parenting style as a discrete factor explained significant variation in the different problem-related behaviours of dogs as expressed in the C-BARQ score (ANOVA predicted mean percentages \pm se, Table 5). Owners who adopted an AUT dog-directed parenting style reported significant lower attachment scores (49%) and separation anxiety (7) for their dog compared to owners identified as AUN (resp. 51 and 9) or AUI (resp. 51 and 9). Owners who adopt an AUT dog-directed parenting style also report significantly lower aggression related problem behaviour for their dogs; stranger-directed aggression (9), owner-directed aggression (2) and, dog-directed aggression (17) compared to AUN owners (resp. 13, 3, and 20) or AUI owners (resp. 14, 3, and 22). Owners who adopted an AUT or an AUN dog-directed parenting style reported significantly lower social fear scores (AUT: 8, AUN: 8) and dog-directed social fear (AUT: 11, AUN: 11) compared to AUI owners (resp. 12 and 15, Table 5).

Table 5 One-way ANOVA of the results ($n=2,201$) from the Canine Assessment and Research Questionnaire (C-BARQ) and the three dog-directed parenting styles (authoritative-intrinsic oriented (AUI), authoritarian-corrected oriented (AUN) and authoritative-trained (AUT)). Presented are the different C-BARQ components on which there is a significant effect of dog-directed parenting styles; the F-value, the P-value (* $P<0.05$ ** $P<0.01$) and the predicted mean (%) per dog-directed parenting style with a significant sign (a,b and c)

C-BARQ	F	P-Value	Mean AUI	Mean AUN	Mean AUT
Attachment Score	4.059	0.017*	51.09 ^b	51.19 ^b	48.79 ^a
Separation Anxiety Score	4.059	0.011*	8.47 ^b	8.91 ^b	6.95 ^a
Stranger Directed Aggression	14.345	<0.001*	13.45 ^b	13.20 ^b	9.44 ^a
Owner Directed Aggression	8.513	<0.001*	2.59 ^b	3.20 ^b	1.73 ^a
Dog Directed Aggression	13.547	<0.001*	22.01 ^b	20.75 ^b	16.73 ^a
Social Fear	14.292	<0.001*	12.43 ^b	8.32 ^a	8.16 ^a
Dog Directed Social Fear	10.834	<0.001*	14.61 ^b	11.36 ^a	10.83 ^a

Dog-directed parenting style scores explained significant variation in the owner-dog relationship (MDORS) scores (ANOVA predicted mean percentages \pm se, Table 6). Owners who adopted an AUN dog-directed parenting style reported significant lower score for dog-owner interactions (70%) than owners who adopted an AUI (74) or an AUT (74) dog-directed parenting style. The perceived cost of having a dog (84) was significantly higher in owners who adopted an AUN dog-directed parenting style compared to owners who adopted an AUI (88) or an AUT (88) dog-directed parenting style (Table 6). Owners who adopted an AUI dog-directed parenting style had a significantly lower score for the perceived emotional closeness (80) with their dog followed by owners who adopted an AUT (76) or an AUN (73) dog-directed parenting style.

Table 6 One-way ANOVA of the results (n=2,495) from the Monash Dog Owner Relationship Scale (MDORS) and the three dog-directed parenting styles (authoritative-intrinsic oriented (AUI), authoritarian-corrected oriented (AUN) and, authoritative-trained (AUT)). Presented are the different dog owner relationship components on which there is a significant effect of dog-directed parenting styles; the F-value, the P-value (*P<0.05 **P=<0.1) and the predicted mean (%) per dog-directed parenting style with a significant sign (a,b and c). Note that the perceived cost is reversed, meaning 100% is perceiving the lowest cost of having a dog.

MDORS	F	P-Value	Mean AUI	Mean AUN	Mean AUT
Dog-owner interaction (Share)	39.537	<0.001*	73.636 ^b	69.616 ^a	73.616 ^b
Emotional closeness (Closeness)	27.429	<0.001*	79.085 ^c	73.298 ^a	76.964 ^b
Perceived Cost (Cost)	26.856	<0.001*	87.527 ^b	84.335 ^a	88.098 ^b

Thus, the dog-directed parenting style expressed categorically explained variation in problem-related behaviour in dogs. Interestingly, dogs from owners who adopted the AUT dog-directed parenting style had less aggression and anxiety related problem behaviour compared to the other two dog-directed parenting style. In the meantime, these owners indicated that they spent more time with their dog and experience lower perceived costs of their relationship compared to the other two dog-directed parenting style. Shared activities and low perceived costs associated with lower scores for aggression and anxiety problem behaviour in the dogs. Owners with an AUI dog-directed parenting style indicated a higher score for social related problems in their dog, compared to the other dog-directed parenting styles, whilst feeling most emotionally close to their dog.

4. Discussion

Dogs live in close contact with humans and understanding the factors influencing their problem behaviour will be beneficial for both humans and dogs. Disrupted relationships between owner and dogs may be at the heart of problem behaviours in dogs. The human-dog relationship is complex (Hart and Yamamoto 2016) and can be characterized as an attachment bond, just like in humans (Nagasawa et al., 2015; Prato-previde et al. 2003; Topál et al. 1998). For many, a dog is a real family member and owners raise them as if they are their own child (Prato-Previde, Fallani, and Valsecchi 2006; German 2015). The way children are raised, in terms of parenting styles, affects their development and possibly the same applies to the owner-dog relationship. The aim of this study was to understand the influence of dog-directed parenting style of the owner on attachment and problem behaviour in dogs. This study, revealed that the dog-directed parenting style adopted by the owner influences the attachment bond between the owner and their dog, which could result in either an secure or an insecure attached dog and can be related to problem behaviours in dogs.

There is a distinct pattern of dog-directed parenting but resemble parenting styles at children, three different dog-directed parenting styles are shown; authoritarian-corrected, authoritative-intrinsic value and, authoritative training oriented (Herwijnen et al. 2018). Here it was investigated if dog-directed parenting style scores based on self-reports match with the ways owners interact with their dog, either spontaneously during a 'break', when performing the task of making the dog 'score a goal' or when the dog had to perform an obedience task. The authoritarian-corrected dog-directed parenting style involves a high behavioural control using a relatively cold way of interaction, with high scores for "I yell or shout when my dog misbehave" or "I use physical punishment as a way to improve my dog's behaviour" (Herwijnen et al. 2018). Behavioural tests revealed their cold way of interactions (e.g. verbal punishments and controlling the dog via the leash). The authoritative-intrinsic owners, which is comparable to the permissive parenting style in children (Baumrind 1989), are characterized by being oriented on the assumed needs and emotions of their dog, with high scores for "I take my dog's desires into account before asking him to do something", I give praise when my dog is good" (Herwijnen et al. 2018). Behaviour tests revealed their the low level of behavioural control, but also an inability to correct dog misbehaviour in a cold way (e.g. leash snap or verbal punishment). Dogs from authoritative-intrinsic oriented owners tended to approach the treat more often (3.2 ± 0.7 rate per minute), during the first trial of the treat and ball test, compared to dogs from authoritative-trained oriented owners (1.0 ± 0.7). Authoritative-trained owners are expected to show a high level of behavioural control (Herwijnen et al. 2018), using a responsive way to accomplish this. Behaviour tests were in line with these expectations since these owners used significantly more verbal praises during the football test compared to authoritarian owners and, they tended to have less time tension on the leash when walking a track along distractions (balls and treats) that the dogs had to ignore. It seems that the verbal praises and tension on leash mirrored owner behaviour more than that of the dog as parenting style did not relate to the dog's misbehaviour (e.g. approaching food/ball or sniffing ground). Interestingly, dogs from authoritative trained oriented owners looked significantly more at their owner (6.9 ± 1.3 rate per minute), during the first trail of the treat and ball test, compared to dogs from authoritarian oriented owners (1.5 ± 1.1). Suggesting that these dogs were more oriented towards their owner, which is important for teaching a dog how to behave correctly. Owners who engaged in training activities reported that their dog was less disobedient (Jagoe & Serpell 1996; Kobelt et al. 2003) and the time that owners spent interacting with the dog associated with the latter's trainability (Kubinyi et al. 2009). Together, the findings show how owner reported dog-directed parenting styles are validated by observations on owner behaviour during owner dog interactions. Especially when owners have to perform a task with their dogs they reveal their dog-directed parenting style.

Attachment and affectional bonds in dependents (e.g. children or dogs) are emotional and grounded in receiving care, protection and/ or a source of security and comfort (Ainsworth 1989; Ainsworth and Bell 1970). Secure attachment has been designated by a relationship between two individuals where the caregiver (e.g. a parent) is able to be a protective and a predictable source in case of need for the other (e.g. a child) and they perceives the caregiver as a safe haven and a secure base. For this reason they feel free to explore the world, develop more confidence and are able to better regulate their own emotions (Colonnese et al. 2011;

Mikulincer, Shaver, and Pereg 2003). The attachment of children towards their parents is strongly influenced by the parenting style of the parent (Belsky, Steinberg, and Draper 1991; Main 2000; Skinner, Johnson, and Snyder 2005). Parenting styles directed to children correspondent, to some degree, with dog-directed parenting (Herwijnen et al. 2018). This made me predict that the attachment bond between a dog and its owner is influenced by the dog-directed parenting style of the owner, just like in child to parent attachment. Authoritative parents are both responsive to the child's needs, providing parental warmth and openness as well as setting limits and clear rules (Robinson et al. 1995) showing to be the most optimal parenting style with regard to children's development and being positively associated with secure attachment (Baumrind 1991; Fang 2000; Lamborn et al., 1991). The presently measured MDORS scores revealed that the degree of interacting with one's dogs is relatively high in owners with an authoritative-trained dog-directed parenting style. Authoritative-trained owners had significantly more shared activities with their dog, with high scores for "How often do you play games with your dog?", "How often do you give your dog food treats?" (MDORS, Dwyer, Bennett, and Coleman 2006). Next to this, these owners indicated a higher perceived emotional closeness of the relationship with their dog. Lastly, they had lower perceived costs of their relationship with high scores for "How often do you feel that looking after your dog is a chore?". These MDORS scores reveal the strong attachment bond that authoritative-trained owners have with their dog, which likely 'strengthens' the bond in opposite directions (Zilcha-Mano et al. 2012). If the owner has a strong attachment bond with its dog the dog is also more likely to have a strong attachment with their owner. In the present study, dog to owner attachment was assessed in part from owner-reports on dog behaviour using the C-BARQ (Hsu and Serpell 2003). The higher the C-BARQ 'attachment score' reported by the owner the more likely the dog solicited attention and stayed close to the owner in daily life (Hsu and Serpell 2003). Authoritative-trained owners reported significantly lower 'attachments scores' in their dogs, indicating that these dogs are more confidence and independent. This matched with the observation that during the break dogs from authoritative-trained owners were significantly more lying down with their head on the ground (25.9 ± 5.1 % of the observation time) compared to dogs from authoritarian-corrected (4.5 ± 3.9) and authoritative-intrinsic owners (6.3 ± 4.7). The former dogs seemed more relaxed and comfortable in a strange room, with the owner present, compared to the other dogs. This might reveal the secure attachment bond with their owner. So, an authoritative-trained way of parenting involves much interaction with the dog (e.g. verbal praise) and a close relationship, which leads to secure dog to owner attachment and obedience (no leas pulling).

Insecure attachment is a consequence of either carefree, inconsistent, and avoid punishment parenting (Ainsworth and Bell 1970; Ebrahimi and Amiri 2017; Edelstein et al. 2004). It develops when an caregiver is not providing a secure base (e.g. in children: Isabella 1993 or dogs: Konok et al. 2015; Konok, Dóka, and Miklósi 2011). Insecure attachment is both directly associated with the authoritarian (Ainsworth and Bell 1970; Edelstein et al. 2004; Isabella 1993) and permissive parenting style in child rearing (Ebrahimi and Amiri 2017). Because these parents are unable to self-regulate their emotional responses, they might, unintentionally, promote the more negative self-view in their children, resulting in less confidence and more dependency (Ebrahimi and Amiri 2017). Children whose mother have been observed to be more rejective of their child's attachment behaviours, show more averse to physical contact and tend to interact in a cold way (a component of the authoritarian parenting style), being more insecure (Ainsworth and Bell 1970; Isabella 1993). Next to this, a direct association existed between such children's overall reaction during a stressful situation, an inoculation, and self-reported parent attachment avoidance ($r=0.44$ $n=39$, $P=0.01$) (Edelstein et al. 2004). More avoidant parents showed lower responsiveness when the child reacted during this stressful procedure. Edelstein et al. (2004) suggested that these finding indicate that those parents miss the ability to serve as an attachment figure and that this will lead to higher distress in their children. The present study revealed that, just like in children, an authoritarian way of parenting involves more averse and cold way of interacting. It seems to derive from the less close relationship between the owner and dog, which contributes to insecurely attached dogs. However, warmth provided somewhat inconsistently may also facilitate insecure attachment. An authoritative-intrinsic way of parenting, corresponding with the permissive parenting style in child rearing, involves a warm way of interaction with the dog and strong emotional bond, but this related directly to dogs' insecure attachment.

Problem behaviour can develop more easily in the case of insecure attachment to the caregiver (e.g. parent or dog owner), as expressed in separation anxiety (Dallaire and Weinraub 2005; Edelstein et al. 2004), anxiety (Colonnesi et al. 2011; Wolfradt, Hempel, and Miles 2003) and, aggressive behaviour (Kawabata et al. 2011; Sagastizabal et al. 2014). A direct association existed between the insecure attachment of children at the age of 15 months, measured with the Strange Situation Procedure (Ainsworth and Bell 1970), and an increased level of separation anxiety at an age of six years (Dallaire and Weinraub 2005). Furthermore, assessment of mother's and father's perceived way of parenting was associated with self-reported anxiety related problems (Wolfradt et al. 2003). A direct association for parental control ($r=0.26$, $n=276$, $P<0.001$) and parental warmth ($r=-0.31$, $n=276$, $P<0.001$) between anxiety was found and, the authoritarian way of parenting was significant associated with high levels of anxiety (Wolfradt et al. 2003). For aggression related problem behaviour it was found that parental psychological control, including psychologically controlling and harsh parenting which are expected to be higher in authoritarian parenting, was associated with physical aggression (Kawabata et al. 2011; Sagastizabal et al. 2014) and proactive aggression (Rathert, Fite, and Gaertner 2011) in children. This reveals that child-parent attachment insecurity and the way of parenting contributes to development of problem behaviours. Just like in child rearing, a positive association between self-reported ($n=1,508$) owner attachment avoidance and owner reported separation-related disorder (SRD) in their dog was found (Konok et al. 2015). With owners' higher score on attachment avoidance the occurrence of SRD in the dog increases, which is suggested to be a result of owners failing to be a secure base for their dog (Gácsi et al. 2013; Konok et al. 2015, 2011). Furthermore, owners' 'controlling' interaction style showed to be positively associated with the dogs' likelihood to show aggressive behaviour ($r=0.15$, $n=220$, $P<0.05$) during a test where an unfamiliar person approaches the dog in a threatening manner, while the owner stood passively behind the dog (Cimarelli et al. 2016). Owners interactions with dogs, which are captured in dog-directed parenting styles, can contribute to the development of problem behaviour in dogs.

In the present study, dog problem behaviour was assessed in owner-reports on dog behaviour using the C-BARQ (Hsu and Serpell 2003). C-BARQ scores revealed that problem related dog behaviour can be explained by the dog-directed parenting style of the owner and the expression of problem behaviour is relative lowest in dogs from authoritative-trained owners. Dogs from authoritarian and authoritative intrinsic owners showed both high levels of anxiety and aggression-related problems. Interestingly, social related fear problems were the highest in dogs from authoritative-intrinsic owners. The emotionally close relationship of the owner might result in higher distress behaviour of their dog as these owners give their dog a lot of affection during stressful events leading to unintentionally enhancement of the problem behaviour (Schwartz 2003). So, the present study indicated that the authoritative-trained dog-directed parenting style is the most optimal to promote a secure attachment between the dog and its owner which results in less problem behaviour like aggression and fear. However, environmental factors like juvenile experience of the pup (including socialization) (Appleby, Bradshaw, and Casey 2002; Foyer, Wilsson, and Jensen 2016; Tiira and Lohi 2015), daily interaction with owner (Jagoe & Serpell 1996; Kobelt et al. 2003; Tiira and Lohi 2015), experience in owning a dog (Kobelt et al. 2003; Tiira and Lohi 2015), attendance of training (like puppy training) (Bennett and Rohlf 2007; Jagoe & Serpell 1996; Kobelt et al. 2003), and presence of other dogs (single- or multi-dog houses) (Tiira and Lohi 2015) will influence the tendency for problem related behaviour as well, especially for social related problems. Also, dog characteristics like heritability (Scott & Fuller 2012; Waaij, Wilsson, and Strandberg 2005), maternal care (Tiira and Lohi 2015), age (suggested by Mongillo et al. 2013) and, even body size (Mcgreevy et al. 2013) play a role. Using both questionnaires and behavioural tests is shown to be effective in unravelling the dog owner interactions and owners are capable of validly describing a dog's behaviour. Multiple factor studies, including parenting style and above-mentioned factors, could help in revealing which factors are the main contributors to the development of problem behaviour.

5. Conclusion

This study provides additional evidence that the owner-dog interactions, like the parenting style adopted by the owner, has welfare implications for both dogs and humans. Dogs live in close contact with humans and the presence of problem behaviour, like aggression, is not only dangerous to humans around them but indirectly also to themselves. Problem behaviour like aggression and separation related disorders are reasons for relinquishment of the dog to a shelter (Marston et al. 2010). The owners are responsible for their dog behaviour and should act to prevent problem behaviour. The authoritative-trained dog-directed parenting style seems the most optimal to promote a secure attachment between the dog and its owner resulting in less problem behaviour like aggression and fear. The findings of this study could be used as a basis for the development of interventions to help owners to better understand the impact of their interaction, like their parenting style, on the dog-owner relationship and eventually dog behaviour.

6. Acknowledgments

I would like to thank everyone who helped during the behavioural experiments test at Carus. First of all my student colleagues, who always supported, helped, and motivated me. Second, I would like to thank my supervisor Bonne Beerda, for brainstorm sessions, all his assistance in different processes of this thesis project, and giving me the opportunity to do this research related dog behaviour and welfare. Third, I would like to thank Ineke van Herwijnen, who helped us out during the set-up of the experiments together with Lydia Nieuwe Weme. Lastly, special thanks to all the owners, and their dogs, who participated in the behavioural experiments.

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Appendix I Dog-Directed Parenting Style And Dimension Questionnaire

Table 1.1 Dog-directed Parenting Styles and Dimensions Questionnaire (DD-PSDQ) as constructed from the adapted 32-PSDQ (van Herwijen et al., 2018) including the addition of two items from the 62-PSDQ (Robinson et al., 1995) <https://doi.org/10.1371/journal.pone.0193471.t003>. Presented also the dog-directed parenting style authoritative-intrinsic oriented (AUI), authoritarian-corrected oriented (AUN) and authoritarian-corrected oriented (AUT) related to the question.

Questions	Related to dog-directed parenting style
I yell or shout when my dog misbehaves	AUN
I scold or criticize when my dog's behaviour doesn't meet my expectations	AUN
I can explode in anger towards my dog when he does something he knows I don't want him to do	AUN
I raise my voice to make my dog improve	AUN
I use physical punishment (for instance a slap or a correction change) as a way to improve my dog's behaviour	AUN
I use a corrective slap when my dog misbehave	AUN
I grab my dog when he/she is being disobedient	AUN
I allow my dog to give input on decisions for instance with regard to the route we follow on walks	AUI
I take my dog's desires into account before asking him to do something	AUI
I am responsive to my dog's feeling or needs	AUI
I encourage my dog to show how it feels, it is allowed to growl for instance, when uncomfortable	AUI
I give comfort when my dog is upset	AUI
I take into account my dog's preference in making plans	AUI
I give praise when my dog is good	AUI
I practice behaviour step by step with my dog, so I am sure he understands what I ask of him	AUT
I use more or higher value reward (food or toy) when I believe my dog should really do something in a situation	AUT
I think about why rules should be obeyed by my dog	AUT
I practice certain behaviour with my dog before asking this behaviour in a more difficult situation	AUT
I channel my dog's misbehaviour into a more acceptable activity	AUT

Appendix II Ethogram for behavioural analysis

Table 2.1 Ethogram that is used for video analysis of the owner behaviour (either state and point event) during the three behaviour tests; the breakroom test (B), the football test (F) and the treat and ball test (T)

Class	Behaviour	Description	Used in test*
State locomotion owner	Standing	Two legs on the ground with body upright; the owner may move two steps from its original position	B,F
	Walking	Walking, standing upright and moving at least two steps from the original position	B
	Sitting	Hind quarters on the chair and bended legs	B,F
	Bending	Owner stands with straight legs (at least not bend more than 45 degrees) and only bend down/lean over by bending his/her back > 3sec	F
	Kneeling	Owner kneels to the ground, with knees fully bend, possibly rest one or both knees on the ground > 3sec	F
State owner attention	Dog	Owner has head pointed towards dog > 3sec	B
	Unknown	Owner does not have head pointed towards dog or magazine	B
	Magazine	Owner has head pointed toward magazine > 3sec	B
State leash tension	Floor	Leash held by owner and connected to dog lies/drag the floor >3 sec	T
	No tension (bow)	Leash held by owner and connected to dog does not lie/drag the floor of form a straight line, but is arched >3 sec	T
	Tension	Leash held by owner and connected to dog shows a straight line from owner to dog >3 sec	T
Point events owner	Leash snap	Upon interest shown by dog in object, person or location: owner strains or shortens the leash of the dog and/or takes one or more step(s) away from an object, person or location. Straining/shortening movement is started with an accelerated movement of the hand/arm of the owner.	T
	Leash steady	Upon interest shown by dog in object, person or location: owner strains or shortens the leash of the dog and/or takes one or more step(s) away from an object, person or location. Straining/shortening movement steadily increases pressure, without an accelerated start of the movement of the hand/arm of the owner.	T
	Collar snap	Upon interest shown by dog in object, person or location: owner holds the collar of the dog and/or moves the dog away from an object, person or location by its collar. Holding movement steadily increases pressure, without an accelerated start of the movement of the hand/arm of the owner.	T
	Collar steady	Upon interest shown by dog in object, person or location: owner holds the collar of the dog and/or moves the dog away from an object, person or location by its collar. Holding movement steadily increases pressure, without an accelerated start of the movement of the hand/arm of the owner.	T
	Hand punish	Owner uses (part of) the hand, or arm to touch the dog with certain degree of force, such as poking, slapping, hitting, pushing, jerking/ squeezing (skin).	B,T,F
	Foot punish	Owner uses (part of) the leg, or foot to touch the dog with certain degree of force, such as poking, pushing, kicking.	B,T,F
	Verbal punish	Harsh, sharp, intense voice lower frequency such as in 'Foei', 'Eh eh'.	B,T,F
	Verbal instruction	Neutral use of voice by owner towards dog, normal frequency, regarding command or instruction, no soft and/or high pitch manner uttering kind words as 'good dog', 'well done' and no harsh, sharp, intense voice lower frequency such as in 'Foei', 'Eh eh'. Only when the dog is already oriented at the owner.	B,T,F
	Physical instruction	Neutral use of body (hand, arm, foot, leg) in a steady way, applying limited pressure, with the objective to move dog and/or dog's position.	B,T,F
	Physical praise soft	Owner initiates contact using (part of) the hand to touch the dog with low levels of pressure/force, such as gently placing hand, patting, stroking. The body of the dog does not move more than two centimetres to the side upon the hand touch because of force applied and the dog is not put off balance because of force applied.	B,T,F

Attention getting	Physical praise hard	Owner initiates contact using (part of) the hand to touch the dog with some force applied through for instance patting, causing the dog to move more than two centimetres to the side upon the hand touch because of force applied. The dog may be put off balance because of force applied.	B,T,F
	Verbal praise	Owner uses voice in soft and/or high pitch manner uttering kind words as 'Braaf', 'Goed zo'.	B,T,F
	Solicit play owner	Any joyful, excited, accelerated movement towards dog, during which owner may extend hands and may or may not be holding toy/object <3 sec.	B
	Rewards praise	The owner gives the dog a food reward including eating a treat after "using treat for success" in the football test	F
	Attention getting non-verbal	Non-verbal signals used by the owner to attract the dogs' attention (e.g. whistle, clicking with tong, clapping on lap,) when the dos is not oriented at the owner	F
	Attention getting using name	Calling the name of the dog by the owner to attract the dogs' attention when the dos is not oriented at the owner	F
	Attention getting showing food	Owner uses a food treat to attract the dogs' attention when the dog is not oriented at the owner	F
	Attention getting verbal non-name	Verbal signals used by the owner to attract the dogs' attention when the dog is not oriented at the owner excluding using the dog's name (e.g. "Kijk eens hier", "Let eens op", "Kom hier" etc.)	F
	Attention gestures	Using gestures or pointing used by owner to attract dogs' attention and to direct in a certain place when the dog is not oriented at the owner	F
	Owner scored	Owner scored a goal by pushing ball passed goal line/pipes; without any ball touches (nose/paw) by dog before ball passes goal line/pipes	F
Training method	Pointing towards goal	Owner directs finger, hand, arm towards goal in a pointing gesture towards the goal	F
	Using treat for success	Owner uses a food treat to move the dog in a certain direction (goal or ball), and the dog looks at this treat and/or follows it with head and/or body. Or uses treat in other ways to let the dog succeed (moving the ball in the goal)	F
	Pointing towards ball	Owner directs finger, hand, arm towards goal in a pointing gesture towards the ball	F
	Touching ball	Owner touches the ball including tapping on it, with either finger, hand and/or foot. (if owner holds the ball in de hand or touches continuously, score every 3 seconds)	F

Table 2.2 Ethogram that is used for video analysis of the dog behaviour (either state and point event) during the three behaviour tests; the breakroom test (B), the football test (F) and the treat and ball test (T)

Class	Behaviour	Description	Used in test*
State locomotion dog	Walking	Walking, at least one step with each paw	B
	Sitting	Hind quarters on the ground and stretched forelegs supporting the front body	B
	Lying head not down	Lie down in ventral or lateral position, all four legs and belly makes contact with ground, head does not make contact with ground or forepaws	B
	Lying head down	Lie down in ventral or lateral position, all four legs and belly makes contact with ground, head does make contact with ground or forepaws	B
	Standing	All four paws on ground with legs upright and extended supporting the body; dog may move two steps from its original position	B
State dog attention	Owner	Dog has head pointed towards owner > 3sec	B,F
	Unknown	Dog does not have head pointed towards owner, object or door	B,F
	Door	Dog has head pointed towards door > 3sec	B,F
State dog play	Object/ball	Dog has head pointed in the direction of object such as toy > 3sec	B,F
	Self	Any vigorous or galloping gaited behaviour that is not directed toward a toy, other object or the owner.	B
	Object	Any vigorous or galloping gaited behaviour directed toward a toy or other object >3 sec; including chewing, biting, shaking from side to side, scratching or batting with the paw, chasing rolling balls and tossing using the mouth. These movements are not made in the direction of the owner, the owner is not holding or throwing an object. Although, the dog may take the objects into its mouth, destruction is not included in this category.	B
	Owner	Any vigorous or galloping gaited behaviour directed at the owner >3 sec. The dog may or may not have a toy or other object in its mouth or touch/move it with paws, in the direction of the owner. The owner may be holding the toy/object at the other end than the dog does. It may include chewing, biting, shaking from side to side, scratching or batting with the paw, chasing rolling balls and tossing using the mouth. Although, the dog may take the objects into its mouth, destruction is not included in this category.	B
State dog closeness to owner	Close contact	Dog body (any part of torso or paws) in contact with owner > 3sec	B
	Close meter	Dog < 1 meter of owner >3 sec	B
	Close far	Dog > 1 meter of owner >3 sec	B
State dog tail position dog	High	Position of the tail is higher than the neutral position of the tail	B,T
	Neutral	Natural position of tail according to the breed standards (www.fci.be); in cross breeds the natural position was estimated according to matching breeds	B,T
	Low	Position of the tail is lower than the neutral position of the tail	B,T
	Tail not visible	Tail movement not visible	B,T
State dog wagging tale	Yes	Regular sideward movements of the tail	B,T
	No	No regular sideward movement of the tail	B,T
	Tail movement not visible	Tail movement not visible	B,T
Point events dog	Dog look at owner	Dog directs nose towards owner <3 sec only when the dog is not oriented at the owner <3 sec	B,T,F
	Dog body to owner	Dog body (any part of torso or paws) in contact with owner <3 sec	B

Hand duck	Dog makes rapid movement with body towards floor, bending 2-4 legs <3 sec	B,T,F
Hand move	Dog makes slow movement with head only away from approaching hand of owner <3 sec	B,T,F
Bark	Loud and regular barking that is often repeated (1–2 barks per second)	B,T,F
High-pitched	Peeping, whining, yelling or howling (all vocalizations are characteristic of dogs)	B,T,F
Solicit play dog	Any vigorous or galloping gaited behaviour directed at the owner <3 sec. The dog may or may not have a toy or other object in its mouth or touch/move it with paws, in the direction of the owner.	B
Play bow	Lengthening of the body, at maximum length the forelegs are lowered creating a hollow back in or just before play state.	B
Sniffing ground	Dog is sniffing with nose pointed toward ground; sudden action and < 3 sec	B,T
Panting	Breathing in high frequency, which is mostly accompanied by the protrusion of the tongue	B,T
Dog at ball	Dog moves 2 steps or more in the direction of the ball (if continued score every 3 sec as 1 event)	T
Dog at food	Dog moves 2 steps or more in the direction of the food (if continued score every 3 sec as 1 event)	T
Dog contact ball	Dog makes contact with ball with nose or paw, (if dog holds the ball in the mouth or touches it continuously, score every 3 seconds)	T,F
Dog contact food	Dog makes contact with food with nose or paw	T

Appendix III General results of online questionnaire

Table 3.1 Reported ages of owners Respondents (n= 2,497) reported the age (in years) of themselves in the general information part of online questionnaire. Age of the respondents was categorized into seven age classes.

Age owner	< 17	18-24	25-34	35-44	45-54	55-64	>65	unknown
Number of owners	17	171	518	458	725	416	118	74

Table 3.2 Reported gender and neutered status of dogs

Owners (n= 2,497) reported the gender and neutered status of their dog in the general information part of online questionnaire. Presented the number of females, males, the number of neutered and, the intact dogs. Also percentage are presented (calculated for the dogs where the genders and neutered status was known)

	Neutered	Intact	Unknown	Total
Bitch (female)	670 (41%)	458 (59%)	-	1128 (47%)
Male	516 (59%)	738 (41%)	-	1254 (53%)
Unknown	-	-	115 (-)	115 (-)
Total	1186 (49.8%)	1196 (50.2%)	115 (-)	2497 (100%)

Table 3.3 Reported ages of dogs Owners (n= 2,497) reported the age (m=months, y=years) of their dog in the general information part of online questionnaire. Age of the dogs was categorized into thirteen age classes.

Age dog	< 6 m	6-12 m	1-2 y	2-3 y	3-4 y	4-5 y	5-6 y	6-7 y	7-8 y	8-9 y	9-10 y	10-12 y	>12 y	unknown
Number of dogs	114	194	404	355	266	232	183	161	136	123	92	125	108	4

Appendix IV Descriptive of the behavioural tests

Table 4.1 Descriptive of the 15 single owner behaviour during the breakroom test (n=36). Presented are the measure rate (rate per minute (RPM) and percentage of time (P)) and the calculated mean \pm s.d.

	Rate per minute (RPM) or percentage of time (P)	Mean \pm s.d.
Verbal Punishment	RPM	0.08 \pm 0.17
Foot punishment	RPM	0.00 \pm 0.00
Hand punishment	RPM	0.00 \pm 0.00
Verbal instruction	RPM	0.95 \pm 0.13
Physical instruction	RPM	0.03 \pm 0.06
Physical praise soft	RPM	1.13 \pm 1.86
Physical praise hard	RPM	0.0031 \pm 0.12
Verbal praise	RPM	0.40 \pm 0.58
Solicit play owner	RPM	0.00 \pm 0.00
Standing	P	7.13 \pm 9.09
Walking	P	6.12 \pm 8.66
Sitting	P	86.46 \pm 13.68
Attention towards dog	P	26.75 \pm 22.43
Attention towards unknown	P	63.58 \pm 27.02
Attention towards magazine	P	9.68 \pm 20.97

Table 4.2 Descriptive of the 23 single owner behaviour during the football test (n=40). Presented are the measure rate (rate per minute (RPM) and percentage of time (P)) and the calculated mean \pm s.d.

	Rate per minute (RPM) or percentage of time (P)	Mean \pm s.d.
Verbal punishment	RPM	0.78 \pm 0.12
Foot punishment	RPM	0.00 \pm 0.00
Hand punishment	RPM	0.00 \pm 0.00
Verbal instruction	RPM	11.22 \pm 5.98
Physical instruction	RPM	0.25 \pm 0.54
Physical praise soft	RPM	0.31 \pm 0.63
Physical praise hard	RPM	0.03 \pm 0.10
Verbal praise	RPM	3.45 \pm 2.64
Rewards praise	RPM	1.71 \pm 1.94
Attention getting non-verbal	RPM	0.21 \pm 0.33
Attention getting using name	RPM	0.69 \pm 0.93
Attention getting showing food	RPM	0.02 \pm 0.11
Attention getting verbal non-name	RPM	0.36 \pm 0.73
Attention gestures	RPM	0.00 \pm 0.00
Owner scored	RPM	0.42 \pm 0.57
Pointing towards goal	RPM	1.24 \pm 1.77
Using treat for success	RPM	0.73 \pm 1.31
Pointing towards ball	RPM	2.43 \pm 2.47
Touching ball	RPM	6.16 \pm 4.01
Standing	P	39.34 \pm 33.10
Sitting	P	1.16 \pm 7.32
Kneeling	P	22.18 \pm 32.97
Bending	P	36.99 \pm 31.97

Table 4.3 Descriptive of the 15 single owner behaviour during the treat and ball test (n=40). Presented are the measure rate (rate per minute (RPM) and percentage of time (P)) and the calculated mean \pm s.d.

	Rate per minute (RPM) or percentage of time (P)	Mean \pm s.d.
Verbal punishment	RPM	3.97 \pm 4.04
Foot punishment	RPM	0.00 \pm 0.00
Hand punishment	RPM	0.02 \pm 0.13
Verbal instruction	RPM	14.66 \pm 7.89
Physical instruction	RPM	0.32 \pm 0.61
Physical praise soft	RPM	0.03 \pm 0.02
Physical praise hard	RPM	0.02 \pm 0.12
Verbal praise	RPM	6.70 \pm 6.99
Collar snap	RPM	0.00 \pm 0.00
Collar steady	RPM	0.00 \pm 0.00
Leash snap	RPM	2.26 \pm 2.98
Leash steady	RPM	8.03 \pm 3.26
Leash on floor	P	0.11 \pm 0.69
No leash tension (bow)	P	35.39 \pm 31.61
Leash tension	P	63.01 \pm 32.30

Appendix V Pearson correlations between owner behaviour patterns *and* single owner behaviour and dog-directed parenting styles

Breakroom test

Table 5.1 Pearson correlation coefficients between owner behaviour patterns (resulted from PCA) *and* owner single owner behaviour and dog-directed parenting style of the owners (authoritative-intrinsic oriented (AUI), authoritarian-corrected oriented (AUN) and, authoritative-trained (AUT)) during the breakroom test. Presented are the Pearson correlation coefficients (P-value *P<0.05 **P<0.10)

	AUI	AUN	AUT
"Attention"	0.058	-0.041	0.165
"Inactivity"	-0.018	-0.0116	0.06
Verbal punishment	0.129	0.029	0.165
Verbal instruction	-0.024	0.038	0.156
Physical instruction	-0.071	0.32	0.143
Verbal praise	-0.023	-0.157	0.368*
Physical praise	0.238	0.106	0.106
Standing	-0.146	0.071	0.008
Walking	-0.028	0.038	0.1
Sitting	0.06	0.004	0.027
Attention towards dog	0.117	-0.046	0.239
Attention towards unknown	-0.039	0.102	-0.034
Attention towards magazine	-0.053	-0.15	-0.11

Football test

Table 5.2 Pearson correlation coefficients between owner behaviour patterns (resulted from PCA) and owner single owner behaviour and dog-directed parenting style of the owners (authoritative-intrinsic oriented (AUI), authoritarian-corrected oriented (AUN) and authoritative-trained (AUT)) during the football test. Presented are the Pearson correlation coefficients (P-value *P<0.05 **=P<0.10)

	AUI	AUN	AUT
"Getting attention"	-0.223	0.445*	-0.301**
Verbal punishment	-0.286	0.245	-0.29**
Verbal instruction	-0.43*	0.324*	-0.018
Physical instruction	-0.186	0.152	-0.349*
Physical praise	0.102	-0.256	0.066
Verbal praise	0.104	-0.346*	0.493*
Rewards praise	0.265	-0.438*	0.251
Attention getting non-verbal	-0.117	-0.295**	0.132
Attention getting using name	-0.185	0.436*	-0.107
Attention getting showing food	-0.028	0.007	-0.231
Attention getting verbal non-name	-0.007	-0.280**	0.208
Owner scored	-0.111	0.194	-0.352
Pointing towards goal	-0.354*	0.136	0.098
Using treat for success	0.027	-0.03	-0.177
Pointing towards ball	-0.294**	0.015	-0.061
Touching ball	0.212	0.047	-0.172
Standing	-0.078	-0.044	0.144
Sitting	0.028	0.007	-0.231
Kneeling	0.129	0.208	-0.084
Bending	0.026	-0.108	-0.134

Treat and ball test

Table 5.3 Pearson correlation coefficients between owner behaviour patterns (resulted from PCA) and owner single owner behaviour and dog-directed parenting style of the owners (authoritative-intrinsic oriented (AUI), authoritarian-corrected oriented (AUN) and authoritative-trained (AUT)) during the treat and ball test. Presented are the Pearson correlation coefficients (P-value *P<0.05 **=P<0.10)

	AUI	AUN	AUT
"Controlling via leash"	0.008	0.344*	-0.207
"Instructing"	-0.246	0.186	0.088
Verbal punishment	-0.381*	0.427*	-0.197
Verbal instruction	0.244	-0.138	0.296**
Physical instruction	0.193	-0.065	-0.14
Verbal praise	0.382*	-0.414*	0.298*
Leash snap	-0.393*	0.255	-0.103
Leash steady	0.109	0.315*	-0.104
No leash tension (bow)	-0.058	-0.311*	0.228
Leash tension	0.049	0.32*	-0.216

Appendix VI Results REML treat and ball tests

Table 6.1 REML Analysis on the treat and ball test (n=120). Presented are the results of the linear mixed model of all the scored behaviours of the owner during the treat and ball test. Also presented the Wald statistic, predicted mean \pm s.e (rate per minute or percentage of time) for the constant and the P-value (*=P<0.05, **=P<0.1) and, predicted means (rate per minute or percentage of time) for trail 1,2 and 3.

	Wald test	Wald/ df	Predicted mean \pm s.e.	P-value	Predicted means trail 1	Predicted means trail 2	Predicted means trail 3
Leash snap	8.49	4.25	2.304 \pm 0.4920	0.014*	3.314 ^b	2.032 ^a	1.566 ^a
Leash steady	30.88	15.44	7.979 \pm 0.5161	<0.001*	9.980 ^c	8.103 ^b	5.855 ^a
Verbal punishment	6.6	3.3	3.950 \pm 0.6492	0.037*	4.420 ^b	4.392 ^b	3.037 ^a
Verbal instruction	8.83	4.41	14.53 \pm 1.258	0.012*	16.20 ^b	14.19 ^{ab}	13.20 ^a
Physical instruction	2.4	1.2	0.302 \pm 0.0961	0.301	0.222	0.238	0.446
Verbal praises	9.7	4.85	6.957 \pm 1.1377	0.008*	5.523 ^a	6.712 ^{ab}	8.635 ^b
Tension on leash	17.08	8.54	62.62 \pm 5.130	<0.001*	72.67 ^b	56.89 ^a	58.29 ^a
No tension on leash	15.32	7.66	35.71 \pm 5.015	<0.001*	26.52 ^a	40.28 ^b	40.34 ^b

Appendix VII Results ANOVA of single owner behaviour

Breakroom test

Table 7.1 One-way ANOVA of single owner behaviours and the three dog-directed parenting styles (authoritative-intrinsic oriented (AUI), authoritarian-corrected oriented (AUN) authoritative-trained (AUT)) during breakroom test. Presented are the F-value, the P-value (*=P<0.05 **=P<0.1) and the predicted mean (rate per minute or percentage of time) per dog-directed parenting style of the single owner behaviour that were recorded. Note there is no variation in single owner behaviour that significantly can be explained by the dog directed parenting style.

	F	P-Value	Predicted mean AUI	Predicted Mean AUN	Predicted Mean AUT
Verbal Punishment	0.239	0.789	0.0545	0.0765	0.1086
Verbal instruction	1.270	0.294	0.990	0.627	1.484
Physical instruction	0.161	0.852	0.0366	0.0250	0.0219
Verbal Praise	0.981	0.386	0.554	0.250	0.472
Physical praise	0.815	0.451	1.688	1.010	0.647
Standing	0.122	0.885	7.93	7.28	5.89
Walking	0.084	0.920	6.94	6.00	5.33
Sitting	0.170	0.844	85.03	66.20	88.66
Attention towards dog	0.884	0.423	33.33	21.68	27.70
Attention towards unknown	2.023	0.148	51.25	71.93	63.78
Attention towards magazine	0.609	0.550	15.42	6.39	7.07

Football test

Table 7.2 One-way ANOVA of single owner behaviours and the three dog-directed parenting styles (authoritative-intrinsic oriented (AUI), authoritarian-corrected oriented (AUN) authoritative-trained (AUT)) during the football test. Presented are the F-value, the P-value (*= $P<0.05$ **= $P<0.1$) and the predicted mean (rate per minute or percentage of time) per dog-directed parenting style of the single owner behaviour that were recorded.

	F	P-Value	Mean AUI	Mean AUN	Mean AUT
Verbal punishment	2.425	0.102	0.277	1.206	0.721
Verbal instruction	1.783	0.182	8.56	12.74	12.22
Physical instruction	0.811	0.452	0.083	0.313	0.333
Physical praise	0.541	0.587	0.500	0.293	0.250
Verbal praise	4.422	0.019*	3.777 ^{ab}	2.141 ^a	4.860 ^b
Rewards praise	2.154	0.13	2.613	1.137	1.556
Attention getting non-verbal	0.522	0.598	0.138	0.267	0.193
Attention getting using name	0.970	0.389	0.388	0.774	0.888
Attention getting showing food	0.740	0.484	0.000	0.042	0.000
Attention getting verbal non-name	1.295	0.286	0.139	0.334	0.609
Owner scored	3.158	0.054**	0.33 ^{ab}	0.667 ^b	0.166 ^a
Pointing towards goal	0.458	0.636	0.833	1.342	1.499
Using treat for success	0.645	0.530	0.612	1.014	0.472
Pointing towards ball	0.142	0.868	2.111	2.603	2.528
Touching ball	0.851	0.435	7.19	6.21	5.05
Standing	1.623	0.211	10.61	35.51	53.17
Sitting	0.740	0.484	0.000	2.98	0.000
Kneeling	0.744	0.482	28.97	24.03	12.91
Bending	0.118	0.889	39.98	37.20	33.70

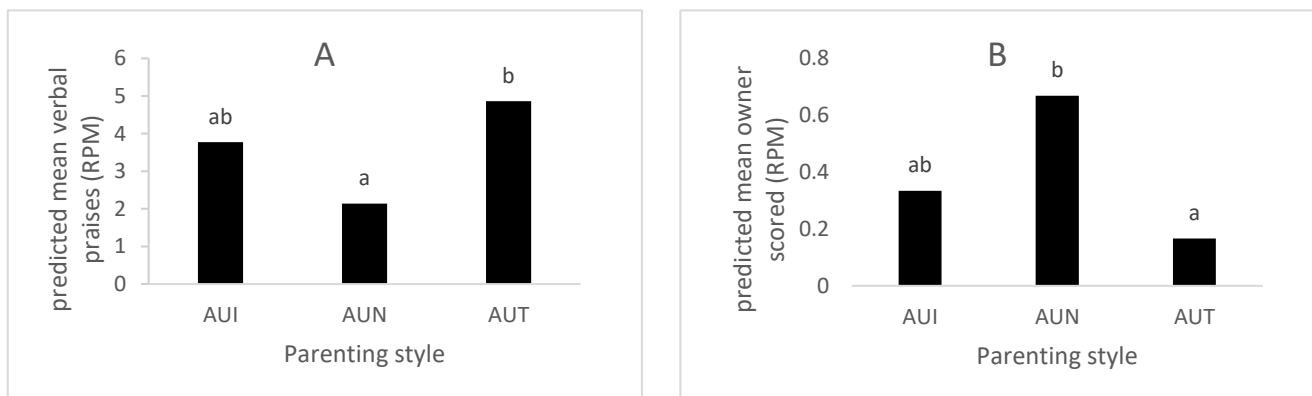


Figure 7.1 Graphical result of ANOVA of the single owner behaviours during the football test. On the x axis A) verbal praises (rate per minute (RPM)), B) owner scored (rate per minute (RPM)). On the y axis the three dog-directed parenting styles (authoritative-intrinsic oriented (AUI), authoritarian-corrected oriented (AUN) and authoritative-trained (AUT)). Note: presented are only the single owner behaviour that significantly ($P<0.05$ and $P<0.1$) can be explained by the dog directed parenting style.

Treat and ball test

Table 7.3 One-way ANOVA of single owner behaviours and the three dog-directed parenting styles (authoritative-intrinsic oriented (AUI), authoritarian-corrected oriented (AUN) and authoritative-trained (AUT)) during the first trail of the treat and ball test. Presented are the F-value, the P-value (*= $P<0.05$ **= $P<0.1$) and, the predicted mean (rate per minute or percentage of time) per dog-directed parenting style of the single owner behaviour that were recorded.

	F	P-Value	Mean AUI	Mean AUN	Mean AUT
Verbal Punishment	1.598	0.216	2.85	6.21	3.68
Verbal instruction	1.425	0.253	17.50	13.28	18.93
Physical instruction	0.237	0.790	0.292	0.128	0.275
Verbal Praise	3.043	0.06**	7.79 ^{ab}	1.69 ^a	8.42 ^b
Leash snap	1.647	0.206	1.40	1.26	1.52
Leash steady	1.363	0.268	11.01	10.53	7.97
No leash tension (bow)	2.91	0.067**	12.59 ^a	25.61 ^{ab}	44.21 ^b
Leash tension	2.856	0.07**	86.36 ^b	73.73 ^{ab}	54.97 ^a

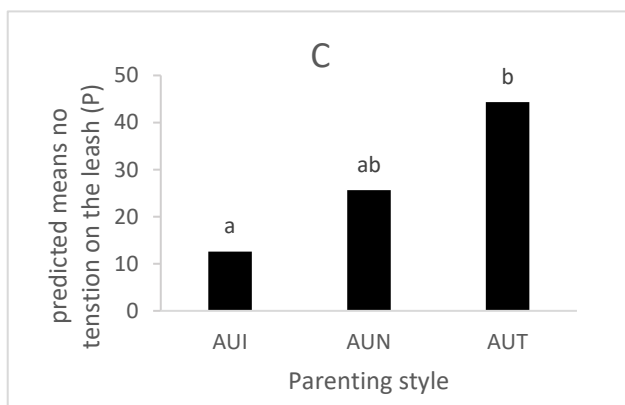
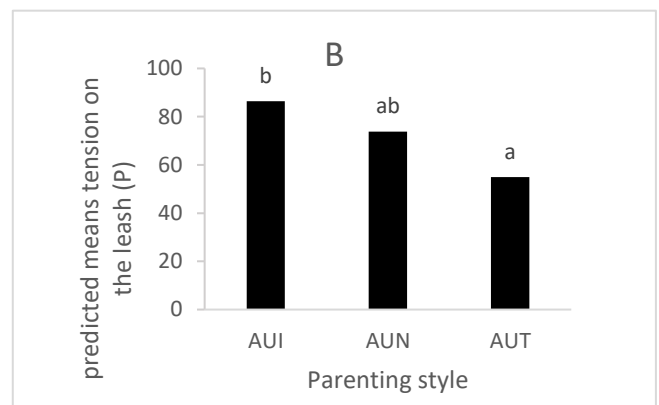
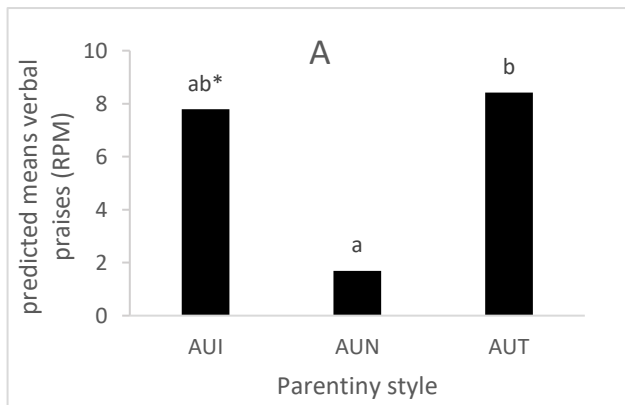


Figure 7.2 Graphical result of ANOVA of single owner behaviours during the first trail of the treat and ball test. On the x axis, A) verbal praises (rate per minute (RPM)), B) percentage of time there was leash tension (P) and, C) percentage of time there is no leash tension (P). On the y axis the three dog-directed parenting styles (authoritative-intrinsic oriented (AUI), authoritarian-corrected oriented (AUN) and authoritative-trained (AUT)). Note: presented are only the single owner behaviour that significantly ($P<0.05$ and $P<0.1$) can be explained by the dog directed parenting style.

Appendix VIII Pearson correlations between C-BARQ / MDORS and dog-directed parenting styles

Table 8.1 Descriptive mean scores for the filled in online questionnaire Dog owners (n=2,201) reported (problem) behaviour of their by filling out the Canine Assessment and Research Questionnaire (C-BARQ). Behaviour scores were calculated following standard procedures and expressed as percentage. Presented are the calculated mean dog (problem) behaviour scores (%) \pm s.d. Presented also are the Pearson correlation coefficient for the correlation between dog (problem) behaviour scores from the C-BARQ and the dog-directed parenting style (authoritative-intrinsic oriented (AUI), authoritarian-corrected oriented (AUN) and, authoritative-trained oriented (AUT)) (P-value *= P<0.05, **=P<0.1)

Online Questionnaire	mean \pm s.d.	AUI	AUN	AUT
C-BARQ (n=2,201)				
Attachment Score	50.30 \pm 18.69	0.092*	0.141*	-0.034
Separation Anxiety Score	8.09 \pm 13.56	0.005	0.109*	-0.106*
Stranger Directed Aggression	11.92 \pm 16.36	0.07*	0.122*	-0.081*
Owner Directed Aggression	2.49 \pm 7.17	-0.015	0.129*	-0.094*
Dog Directed Aggression	19.66 \pm 20.31	0.109*	0.094*	-0.061*
Social Fear	9.43 \pm 16.56	0.159*	-0.035	-0.012
Dog Directed Social Fear	12.11 \pm 16.08	0.131*	-0.039**	-0.013

Table 8.2 Descriptive mean scores for the filled in online questionnaire Dog owners (n=2,497) reported their relationship with their dog by filling out the Monash Dog Owner Relationship Scale (MDORS). Behaviour scores were calculated following standard procedures and expressed as percentage. Presented are the calculated mean dog owner relationship components scores (Share, Closeness and Cost) (%) \pm s.d. Presented also are the Pearson correlation coefficient for the correlation between the dog owner relationship component scores and the dog-directed parenting style (authoritative-intrinsic oriented (AUI), authoritarian-corrected oriented (AUN) and authoritative-trained oriented (AUT)) (P-value *= P<0.05, **=P<0.1)

Online Questionnaire	mean \pm s.d.	AUI	AUN	AUT
MDORS (n=2495)				
Dog-owner interaction (Share)	72.15 \pm 11.03	0.177*	-0.098*	0.168*
Emotional closeness (Closeness)	76.23 \pm 16.21	0.274*	-0.017	0.133*
Perceived Cost (Cost)	86.55 \pm 11.76	0.053*	-0.187*	0.125*

Appendix XI Dog behaviour during the treat and ball test and the breakroom test

Table 9.1 One-way ANOVA of single dog behaviours and the three dog-directed parenting styles of the owner (authoritative-intrinsic oriented (AUI), authoritarian-corrected oriented (AUN) authoritative-trained (AUT)) during the first trail of the treat and ball test. Presented are the F-value, the P-value (*= $P < 0.05$ **= $P < 0.1$) and the predicted mean (rate per minute or percentage of time) per dog-directed parenting style of the single dog behaviour that were recorded. Note that misbehaviours contact food and contact ball are not included in this analyses because those behaviours were only seen once or twice.

	F	P-Value	Mean AUI	Mean AUN	Mean AUT
Dog at ball	1.091	0.347	4.40	6.81	4.76
Dog at food	2.726	0.079**	3.237 ^b	1.741 ^{ab}	0.966 ^a
Dog looks at owner	4.876	0.013*	3.93 ^{ab}	1.54 ^a	6.93 ^b
Dog sniffs the ground	0.566	0.573	4.762	3.646	3.317

Table 9.2 One-way ANOVA of single dog behaviours and the three dog-directed parenting styles of the owner (authoritative-intrinsic oriented (AUI), authoritarian-corrected oriented (AUN) authoritative-trained (AUT)) during the breakroom. Presented are the F-value, the P-value (*= $P < 0.05$ **= $P < 0.1$) and the predicted mean (rate per minute or percentage of time) per dog-directed parenting style of the single dog behaviour that were recorded.

	F	P-Value	Mean AUI	Mean AUN	Mean AUT
Dog look at owner	0.071	0.932	0.544	0.521	0.473
Dog body contact owner	0.821	0.449	0.0091	0.1139	0.033
Dog close contact	1.347	0.274	17.09	5.92	2.83
Dog being near owner(meter)	0.665	0.521	69.67	58.16	71.05
Dog being far from owner (>meter)	2.166	0.137	13.04	33.89	25.85
Dog walking	0.386	0.683	17.21	22.56	18.04
Dog sitting	0.681	0.513	20.23	16.27	8.21
Dog standing	0.814	0.452	20.81	27.56	22.01
Dog lying head not down	1.237	0.303	35.79	22.28	21.41
Dog lying head down	6.260	0.005*	5.66 ^a	4.45 ^a	25.91 ^b
Dog oriented at owner	0.698	0.505	21.49	28.45	31.82
Dog oriented at door	0.254	0.777	9.86	7.36	5.79
Dog oriented at object	0.807	0.455	24.53	13.03	10.29
Dog at unknown	0.260	0.772	44.12	51.16	52.10