

37. OTDK Biology Section

Investigating the context dependency of dogs' separation behaviour

Eötvös Loránd University Faculty of Science, Institute of Biology

Written by:

Szigeti Balázs

Master's degree in biology, Graduated

Supervisor:

Dr. Faragó Tamás

Senior research fellow

Department of Ethology



Budapest, 2023

Contents

I.	Abstract	3
II.	Introduction	4
III.	Methods and materials	8
IV.	Results	14
V.	Discussion	18
VI.	Acknowledgement	23
VII.	References	24

I. Abstract

During domestication and breed selection, dogs became very dependent on humans. These companion animals can experience severe separation-related issues, causing poor welfare conditions and negatively affecting the dog-owner relationship. Separation behaviours have been studied before in lab or home settings, but to our knowledge, it has not been studied yet whether it differs between contexts within individuals. Thus, I compared family dogs' indoor and outdoor separation behaviour, assuming that despite contextual differences, dogs show similar behaviours in both situations due to the same underlying emotions. In the indoor setting, the owner left the dog in an unfamiliar room for 3 minutes. In the outdoor setting, first the owner tethered the dog to a tree, then throughout a 3-minute period the owner walked away and hid behind a building, after the 3 minute the owner walked back. I recorded the dogs' behaviours, and from their time percentages, I calculated PCA scores, which I compared between the two settings. In the results, though the predictions were not supported, certain results were consistent with previous studies, and the internal states underlying dogs' separation behaviour were further explored. The drawn conclusion is that different contexts with similar social settings (here is the separation) can activate emotions differently in the same dog, which are manifested in behaviour depending on the context. Also, the study sheds light on the importance of studying the context specificity of certain behaviours or phenomena. In conclusion, studying outdoor separation next to the indoor laboratory tests might provide important insight to the inner state behind separation behaviours in dogs, leading to new ways to improve their welfare status. Furthermore, this approach can provide a broader overview of the dogs' behaviour leading to more certain and appropriate diagnosis of abnormal separation behaviours.

II. Introduction

In the relationship between an infant and a caregiver, separation stress occurs when the caregiver leaves the infant (Ainsworth 1989). A mild level of separation stress is adaptive for individuals (e.g., infants), as it provokes an approach from the attachment figure (e.g., caregiver) (Bowlby 1969). Family dogs (*Canis familiaris*) depend on their owners in many aspects (Meyer et al. 2022), and they also exhibit an infant-like attachment relationship towards their owners (Topál et al. 1998). Therefore, during the separation from the owner, dogs can experience intense separation stress (Ogata 2016). Most of the elicited behaviours during separation are considered undesired for the owners and the environment; also, in some more severe or extreme cases, we can even talk about separation anxiety (Ogata 2016). Family dogs' separation-related behaviours ('separation behaviour' from now on) have become one of the most common owner-reported behavioural problems in veterinary practice (Simpson 2000; Sherman and Mills 2008). These separation behaviour-related problems can create poor welfare conditions for the dogs and harm the dog-owner relationship (Salman et al. 2000), therefore dogs' separation behaviour represents an important research topic.

The "mechanism" behind separation behaviour is the attachment (McCrave 1991; Bowlby 1979). Dogs' developed attachment towards humans during domestication (Nagasawa, Mogi, and Kikusui 2009; Topál et al. 1998). Attachment is an asymmetrical social relationship from the attached individual (in the current situation is the dog) towards the attachment figure (in the current situation is the owner) (Ainsworth 1969; Ainsworth, Bell, and Stayton 1971; Topál et al. 1998). In a separation situation from the attachment figure, two main behaviours are present in the attached individual: proximity-seeking and proximity-maintaining, which aim to recreate and maintain the closeness of the attachment figure (Bowlby 1969). Attachment relationship usually appears between the infant and mother (Bowlby 1979), thus what is the most interesting between dogs and humans, that it is an interspecific relationship.

The Strange Situation Test, or SST has been developed to study the attachment behaviour of infants (Ainsworth 1969), and it also has been applied to examine dog-owner relationship (Topál et al. 1998), which proved that dogs display attachment behaviour functionally analogue to human infants (Topál et al. 1998; Konok, Dóka, and Miklósi 2011). Also, dogs exhibit the "secure base" (Horn, Huber, and Range 2013) and "safe haven" (Gácsi et al. 2013) effects which are important elements of the attachment behaviour system (Bowlby 1969; 1979). The SST itself consist of 8 episodes (Ainsworth 1969; Topál et al. 1998): first an introductory episode of the testing room, then the test happens trough 7 episodes, during which there are 2 separations

from and 2 reunions with the attachment figure, also interactions with the stranger. During these, the attachment pattern of an individual can be assessed, but in this current research the focus is on only the behaviours showed during separation, therefore from now I would like to look at what has been done in the past in terms of studying dogs' behaviour in a separation situation.

Dogs' separation behaviour can be very diverse (Ogata 2016; Overall, Dunham, and Drank 2001) including intensive vocalisations (e.g.: barking, yelping, whining, howling), destructive behaviours (e.g.: scratching, chewing), lip licking, increased salivation, change in activity, in appetite, inappropriate elimination (urination, defecation, vomiting) and aggression. Assessing information about dogs' separation behaviour is mostly done via questionnaires, or with behavioural tests, or the combination of the two. It is a plausible approach to make questionnaires for the dog owners, as they are the ones experiencing the separation behaviours, but meanwhile some of these studies suggest that owners may have an indicative knowledge of their dog's behaviour during separation (Konok, Dóka, and Miklósi 2011; van Rooy et al. 2018), they still can be subjective, also the owners are not necessarily fully aware of all behaviours as they are absent in the separation situation (Konok, Marx, and Faragó 2019). 'At home' settings are another possibility to observe separation behaviour (Palestrini et al. 2010; van Rooy et al. 2018; Stephan, Leidhold, and Hammerschmidt 2021; Lund and Jørgensen 1999), but they are usually complicated to set up, and as an uncontrolled environment, they are not completely reliable. So, these previous assessment approaches can serve as rich information sources, but their reliability can be questionable in some respects, therefore it is important to validate the gained information with behavioural test in a controlled environment.

Indoor laboratory settings provide a great opportunity for that, which has been used successfully in the past many times (van der Borg, Netto, and Planta 1991; Konok, Dóka, and Miklósi 2011; Gácsi et al. 2013; Lenkei et al. 2021; Marx, Lenkei, Pérez Fraga, Bakos, et al. 2021; Marx, Lenkei, Pérez Fraga, Wallis, et al. 2021). With this approach the paradigm is to experimentally induce separation-related stress in the dog by separating it from its owner for a given period of time in a controlled and possibly novel environment (van der Borg, Netto, and Planta 1991; Konok, Dóka, and Miklósi 2011). Many important discoveries related to separation behaviour in dogs have emerged from the above referred studies, couple of examples:

- owners can have realistic idea about their dog's behaviour during separation (Konok, Dóka, and Miklósi 2011) and dogs are not hyper-attached to them, but the owner's attachment style affects this behaviour (Konok, Dóka, and Miklósi 2011; Konok et al. 2015; Konok, Marx, and Faragó 2019)

- separation behaviour patterns change with age (Marx, Lenkei, Pérez Fraga, Wallis, et al. 2021; Mongillo et al. 2013)
- separation behaviour responses of dogs might be triggered by different inner states (Lenkei et al. 2021).

What we can concluded here, is the importance of the usage of multiple approaches in the investigation of dog's separation behaviour, as it can be affected by many factors and represents a complex system (Sherman and Mills 2008).

Outdoor experimental settings also has been used before to study the separation behaviour of dogs (Pongrácz et al. 2017; Pongrácz, Gómez, and Lenkei 2020; Lenkei, Alvarez Gomez, and Pongrácz 2018). These 3 studies had the same experimental setup: during daylight, on a flat, grassy area, with minimal to no disturbance from people passing by in the distance, the owner tethered the dog to a tree with its leash, then said good bye to the dog and walked away in a straight line until he/she disappeared behind the corner of a building 45 m away from the tree. The owner had a stopwatch which was started when he/she started walking away, and after 3 minutes elapsed the owner walked back from the building to the dog. Here the aim again is to induce separation-related stress in the dog by separating it from its owner, but the difference that the test has 3 stages: the (1.) departure (owner walking away); (2.) absence (owner hide at the building); and (3.) return of the owner (owner walking back) (Pongrácz et al. 2017). Therefore, the advantage of this approach will be that we can observe the different stages of separation in longer periods. Though this outdoor setting doesn't provide a fully controlled environment, there can be distracting factors, also the dog's movement is somewhat limited, still it gives a good opportunity to study the underlying emotional states during separation.

Dogs show high individual diversity in their behaviour during separation, as it can be affected by many factors (Sherman and Mills 2008; Ogata 2016). Though its risk factors are well investigated, still there are some uncertainties about what the underlying emotions of the behaviours are. There are several underlying emotions or inner states which could relate to separation behaviour in dogs, anxiety, fear, and phobia are probably the most accountable for them (Sherman and Mills 2008). All of them cause physiological and behavioural signs. Based on Sherman és Mills, 2008, anxiety is a reaction to a prospective or imagined danger or uncertainty; fear is an emotion of alarm caused by the presence or proximity of an object, individual, or social situation; and phobia is a marked, persistent, and excessive fear of clearly discernible circumscribed objects or situations. Also, frustration is a fourth possible inner state behind separation (Lenkei, Alvarez Gomez, and Pongrácz 2018; Lenkei et al. 2021), which

negative inner state occurs when the individual's expectations are violated (e.g.: when needed resource is inaccessible, like the owner during separation). In previous studies it has been shown that dog barks are context dependent (Pongrácz, Molnár, and Miklósi 2006; Molnár et al. 2009), also dogs show different vocal behaviour depending on the possible underlying inner state between fear and frustration during separation from the owner (Pongrácz et al. 2017; Lenkei, Alvarez Gomez, and Pongrácz 2018; Lenkei et al. 2021; Lund and Jørgensen 1999). Lenkei et al. 2021, 2018 and Pongrácz et al. 2017 investigated dogs' vocal behaviour (which is a good indicator to assess individuals inner states (Briefer 2020)) during separation from the owner, and the short conclusion is that dogs' whining more likely to indicate fear (and probably panic) during separation, meanwhile barking more likely to indicate a frustrated inner state. Also, both represent a negative inner state, though only whining is present in the same situation in dog's close relatives, barking is more complex as it is present in dogs in many other contexts with other underlying emotions. Furthermore, these inner states can be characterised by valance (positive or negative inner state) and arousal (intensity of the inner state) (Kuppens et al. 2013; Russell 1980). Frustration, fear, and panic all negative inner states by these characteristics, and frustration thought to have a lower intensity than fear and panic, also the latter two have similar underlying mechanism (Lenkei et al. 2021). Perhaps during separation, the change of these inner states can elicit the diverse behaviours, as they are not necessarily discrete and can overlap or change over time (Lenkei et al. 2021).

As it has been shown, dogs' separation behaviour represents an important issue regarding dogs' welfare conditions and the dog-owner relationship, it is a complex system affected by many factors and can be very diverse individually, also it is dependent on the given inner state of the dog. In the current study the aim was to investigate the context dependency of dogs' separation behaviour (not only the vocalisations as in previous studies) with comparing it between an indoor and an outdoor setting, assuming that despite contextual differences, individuals show similar or functionally analogue behaviours in both situations due to the same underlying emotions. Based on this hypothesis the predictions are:

- dogs show the same type of vocalisation both indoors and outdoors
- dogs that try to escape the separation situation would show behaviours indicating these behaviours in both contexts (scratch and jump on the door inside and pull the leash more in the outside)
- dogs that indoors spend more time near the owner's exit, outdoors also orient themselves towards the direction where the owner walked away

- dogs who behave calmly or not so active indoors, would be calm or not so active outdoors
- dogs who would be more active and explore around indoors, would do the same outdoors.

Separation behaviour of family dogs have been studied before with questionnaires, at home, in lab or outdoor settings, but to our knowledge, it has not been studied yet whether it differs or not between contexts within individuals.

III. Methods and materials

Subjects

The study was advertised via a Facebook post, the criteria for the participation was that the dog should be older than 1 year. I have tested 78 participating family dogs. From the indoor test recordings 8 dogs and from the outdoor test recordings 13 dogs were excluded because of technical issues with the recordings, or because the test had to be interrupted (e.g. dog got out of the room or the leash). Therefore, in the final analysis 59 dogs' indoor and outdoor recordings were included (Table 1.). The owners filled out a questionnaire before the behaviour tests, which contained questions related to demographic data and the owners' previous experiences of their dog's separation behaviour. With the questionnaire, I aim to control for ontogenetic and environmental factors, but it is not part of the current thesis, it will be included in the future study.

Indoor separation test

The indoor separation tests were conducted in the laboratory of ELTE Department of Ethology in Budapest. The layout of the test room was similar to that in Konok et al. 2011, with the difference that only one chair was placed in the room, no other objects. Figure 1. shows the layout of the test room. The owners came in with their dog through the green door visible in the right side, and then the owner sat on the chair 1.5 meters away from that door for 1 minute before the separation. The white door on the left side corner was closed, it had no role in the test, I considered it part of the wall during coding, not a door. Video and audio recordings were made with the help of 5 cameras (5 different angles to see the lab, Figure 1. shows only 3 angles) and 2 microphones (1 shotgun microphone directed towards the chair and an omnidirectional microphone in the middle of the ceiling) placed in the room.

Table 1.: List of the tested dogs, their name, breed, age (in years), sex, and neuter status

	Name	Breed	Age	Sex	Neuter status
1.	Abu	Cavalier King Charles Spaniel	M	2	intact
2.	Alfi	Tervueren	M	9	neutered
3.	Archie	Boston terrier	M	11	intact
4.	Arwen	Border collie	F	10	neutered
5.	Audrey	Mix	F	4	neutered
6.	Azúr	Dachshund	M	2	neutered
7.	Berci	Shiba Inu	M	4	intact
8.	Bogyó	Bichon Havanese	M	7	neutered
9.	Buci	Shiba Inu	F	2	neutered
10.	Chili	Jack Russell terrier	F	9	neutered
11.	Coco	Bichon Havanese	F	9	neutered
12.	Cukor	Chihuahua	M	1	neutered
13.	Daisy	Bichon Havanese	F	5	neutered
14.	Dante	French bulldog	M	2	neutered
15.	Dotti	Shih-tzu	F	3	neutered
16.	Drazsé	French bulldog	M	5	neutered
17.	Fahéj	Pug	M	5	intact
18.	Faust	Italian greyhound	F	2	neutered
19.	Gimli	Shiba Inu	M	3	neutered
20.	Hetty	Cavalier King Charles Spaniel	F	13	neutered
21.	Hiba Mraja	Italian greyhound	F	7	neutered
22.	Hirohito	Shiba Inu	M	7	neutered
23.	Kara	Shiba Inu	F	2	neutered
24.	Kex	Pug	F	6	neutered
25.	Kindli	Bichon Havanese	F	3	neutered
26.	Kinga	Mix	F	14	intact
27.	Kismaszat	Bolognese	F	4	neutered
28.	Ködmön	Mudi	M	9	neutered
29.	Köles	Bichon Havanese	M	2	neutered
30.	Kona	Miniature dachshund	M	3	neutered
31.	Lily	Mix	F	8	neutered
32.	Loki	English cocker spaniel	M	8	intact
33.	Lujzi	Jack Russel terrier	F	2	neutered
34.	Lulu	Shiba Inu	F	1	neutered
35.	Málna	Miniature schnauzer	F	6	neutered
36.	Maya	Greyhound Mix	F	2	neutered
37.	Mázli	Mix	M	4	neutered
38.	Mex	Foxterrier	M	1	neutered
39.	Milka	Bichon Havanese	M	1	neutered
40.	Monty	Pug	M	1	neutered
41.	Nala	Border collie	F	1	intact
42.	Nasi	Mix	F	4	neutered
43.	Papucs	Mix	M	1	neutered
44.	Polly	Cavalier King Charles Spaniel	F	2	neutered
45.	Puszedli	Dachshund	F	1	neutered
46.	Rimi	Mix	F	1	neutered
47.	Samu	Miniature schnauzer	M	2	neutered
48.	Schopenhauer	Miniature poodle	M	7	neutered
49.	Sophie	Border collie	F	2	neutered
50.	Szellő	Mix	F	11	neutered
51.	Szofi	Dachshund	F	4	neutered
52.	Thessa	Cavalier King Charles Spaniel	F	1	neutered
53.	Tito	Mix	M	5	neutered
54.	Wechat	German shepherd	M	1	neutered
55.	Simi	Cavalier King Charles Spaniel	M	1	intact
56.	Zeusz	American staffordshire terrier	M	3	intact
57.	Zira	Miniature schnauzer	F	2	neutered
58.	Zoé	Bull type mix	F	4	neutered
59.	Zorró	Husky	M	1	neutered

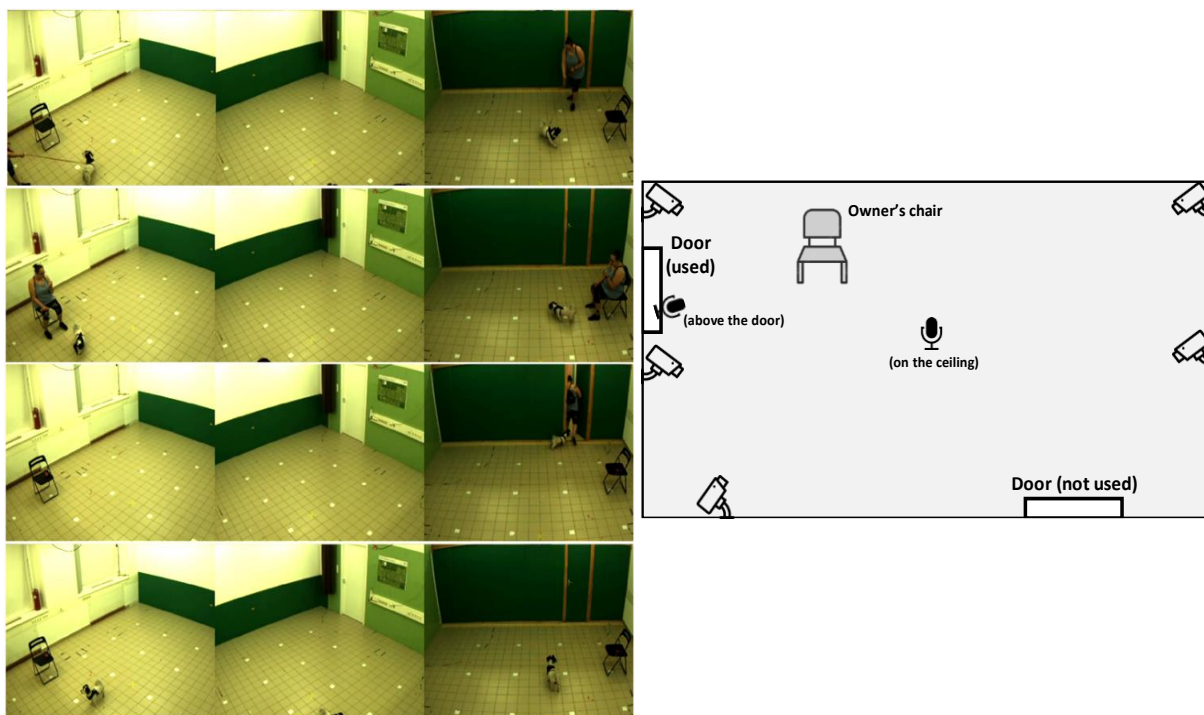


Figure 1.: Schematic picture about the layout of the indoor separation behavioural test on the right, and the episodes from top to down on the left: the owner and the dog enter the room; the owner sits on the chair for 1 minute and the dog off the leash freely moving; the owner is leaving the room without the dog; the separation tests starts with the dog alone in the room.

Before starting the separation test, the experimenter explained the instructions to the owner and gave them a stopwatch, then they entered the test room with the dog on a leash. The owner first had to take the leash off the dog and then put it on the back of the chair placed in the room. After that, the owner sat down on the chair and started the stopwatch, which measured 1 minute. During this 1 minute, the owner was not allowed to interact with the dog in any way (touching, looking at, or talking to the dog). After 1 minute, the owner stood up, left the leash on the chair, and left the room through the same door, then went to the operator's room to the experimenter. The 3-minute separation began after the owner entered the operator's room, during which the dog was alone in the test room. After the 3 minutes the test ended, and the owner went back to the test room to the dog.

Outdoor separation test

After the indoor separations on the same occasion, the outdoor separation test was conducted at Eötvös Loránd University Lágymányosi Campus in Budapest next to the Southern building in the park area. The tests were done during daylight, on a flat, grassy area, with minimal to no disturbance from people passing by in the distance. The setup of the outdoor test was based on Pongrácz et al. 2017. Figure 2. shows the setup: the owner tethered the dog to a tree with its leash, then the owner left the dog, after saying goodbye in a form of a brief sentence (e.g.: “Szia

/dog's name/!" or etc.; the purpose of this is to draw the attention of the dog to the owner as the test happens in a stimuli rich environment) and walked away in a straight line, until the owner disappeared behind the corner of the building 45 m away. The owner was given a stopwatch that they started when they left the dog. When 3 min had elapsed, the owner reappeared from behind the building and walked back to the dog. When the owner arrived, they greeted and unleashed the dog. The test was over when the owner petted the dog, or the dog somehow touched the owner. Video and audio recordings were made with the help of 1 camera (ca. 3 m away from the tree) and 2 microphones (2 shotgun microphone directed towards the dog in line with the owner's path, one closer for the quieter and one further for the louder vocalisations). The experimenter who handled the devices avoided any kind of interactions with the dog. Verbal indications were made at the start of the experiment, at the time of the owner's disappearance behind the building, and the owner's reappearance at the building. Based on these, the test consisted of 3 stages: the (1.) departure of the owner; (2.) absence of the owner; and (3.) return of the owner; from which only the first two is used in the current study.

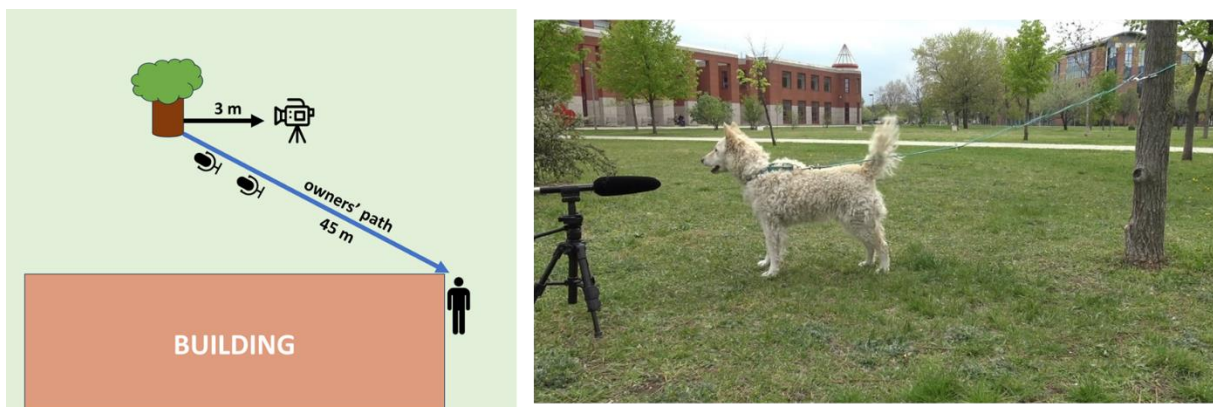


Figure 2.: Schematic picture about the outdoor setup on the left, and a moment cut out from one of the outdoor separation tests during the absence of the owner on the right.

Behaviour coding

The recordings of the tests were coded using Solomon Coder beta 19.08.02. software, with which I coded the duration of behaviours shown in the 3-minute separation period indoors, and in the first 2 stages ((1.) departure and (2.) absence of the owner) outdoors. Table 2. (indoor) and Table 3. (outdoor) are showing the behaviours coded from the recordings.

Table 2.: List of the behaviours coded in the indoor separation test, and their explanations.

Indoor behaviour labels	Explanation
Distance (Door; Chair)	The dog stays close to the door or chair in proportion to its body length.
Orientation (Door; Chair)	The dog's head is in the direction of the door or chair.
State of motion (Sit; Stand; Lay; Move)	The dog is sitting / standing / lying down / moving.
Vocalisations (Barking/Yelping; Whining; Panting; Other)	The dog is barking or yelping / whining / panting / produces other vocalizations.
Exploration (Door; Chair; General)	The dog exhibits exploratory behaviour at the door/chair/ in any other part of room (e.g. showing active interest; smelling, looking at something closely).
Rearing (Door; Chair; Wall)	Standing on its two hind legs, the dog puts its forelegs onto the door / chair / wall.
Scratching (Door; Other)	The dog scratches the door / other walls of the room.
Self-grooming/-scratching	The dog scratches itself with its legs / cleans itself with its tongue.
Lip licking	The dog licks its mouth with its tongue.
Tail wagging	The dog wags its tail because of aroused inner state, not because of its movement.

Table 3.: List of the behaviours coded in the outdoor separation test, and their explanations.

Outdoor behaviour labels	Explanation
State of motion (Sit; Stand; Lay; Move)	The dog is sitting / standing / lying down / moving.
Vocalisations (Barking/Yelping; Whining; Panting; Other)	The dog is barking or yelping / whining / panting / produces other vocalizations.
Owner orientation	The dog's head is in the direction of the owner's path.
Exploration	The dog exhibits exploratory behaviour (e.g. showing active interest; smelling, looking at something closely).
Leash pulling	The dog pulls the leash and the leash restricts the movement of the dog.
Tense leash	The leash is tense (i.e.: the dog constantly pulls it).
Lip licking	The dog licks its mouth with its tongue.
Tail wagging	The dog wags its tail because of aroused inner state, not because of its movement.

Statistical analysis

The statistical analysis was done in R and R-studio. With principal component analysis (PCA; psych package, principal function, oblimin rotation) behavioural components (see Table 4., 5., 6.) were created based on the durations of the observed behaviours from the indoor separation test and from the first 2 stages ((1.) departure; (2.) absence) of the outdoor separation test. Afterwards, a pairwise correlation analysis (cor function) was performed on the behavioural components, from which a correlation matrix was created. Based on this correlation matrix the correlation network was plotted using qgraph package. In these networks, the nodes represents the scales, edges are the correlations between scales. Edges are weighted based on the direction and strength of the correlation coefficient. Only significant connections are present on the networks. Both the uncorrected (Figure 4.) and corrected (Figure 5.) version of the network are presented. Benjamini-Hochberg correction for multiple comparisons was applied in the latter. The aim with the correlation matrix and networks was to get an overview of the possible connections between the behaviour components, which from the meaning of the correlating behaviours can be interpreted. During the analysis, the “Tense leash” observed outdoor

behaviour was separated into “Tense leash while exploring” and “Tense leash while not exploring” (Table 5. and 6.). This decision was made as I observed during the tests that dogs might have a tense leash both because they explore the area without trying to go after the owner, but also just because they try to go after the owner only.

Table 4.: PCA table of the indoor separation tests' behavioural component.

PCA - Indoor (I)		I - Escape	I - Chair	I - Activity/Exploration	I - Whining at door	I - Sit
Observed behaviours	Rearing	0,727	-0,224	0,232	-0,036	0,141
	Barking/Yelping	0,724	0,073	-0,160	-0,111	-0,072
	Tail wagging	0,702	0,218	-0,105	0,071	-0,122
	Scratching	0,581	-0,277	0,122	0,202	0,171
	Near chair	0,021	0,777	-0,242	-0,163	-0,002
	Near door	-0,009	-0,705	-0,197	0,244	0,095
	Chair exploration	-0,071	0,687	0,149	0,301	0,090
	Chair orientation	-0,073	0,592	0,315	0,207	0,277
	Door orientation	0,237	-0,142	-0,614	0,196	0,052
	Moving	0,278	0,160	0,609	0,322	-0,153
	Panting	0,241	0,067	0,605	-0,140	0,046
	General exploration	-0,266	-0,023	0,511	0,346	-0,096
	Other vocalization	0,242	0,223	-0,333	0,149	0,020
	Door exploration	-0,063	-0,154	0,052	0,723	-0,050
	Whining	0,147	0,124	-0,350	0,535	-0,054
	Lay	-0,189	-0,020	-0,022	-0,509	0,365
	Stand	-0,051	-0,058	-0,095	0,142	-0,903
	Sit	-0,033	-0,017	-0,323	0,177	0,729

Table 5.: PCA table of behavioural components from the outdoor separation test, departure stage.

PCA - Outdoor, Departure stage (D)		D - Attention seeking	D - Escape	D - Explore
Observed behaviours	Barking / Yelping	0,784	0,030	-0,079
	Whining	0,691	-0,025	0,198
	Panting	-0,635	0,255	0,023
	Tail wagging	0,683	0,216	0,013
	Sit	0,101	-0,745	0,073
	Move	0,444	0,641	0,129
	Owner orientation	0,251	-0,550	-0,395
	Tense leash while not exploring	0,125	0,669	-0,155
	Tense leash while exploring	0,055	-0,161	0,811
	Explore	0,007	0,088	0,833

Table 6.: PCA table of behavioural components from the outdoor separation test, absence stage.

PCA - Outdoor, Absence stage (A)		A - Tense leash	A - Frustration	A - Stress, exploration
Observed behaviours	Sit	-0,834	-0,130	0,066
	Stand	0,854	0,044	-0,083
	Tense leash while not exploring	0,668	-0,057	0,299
	Barking / Yelping	-0,094	0,795	0,126
	Other vocalisation	0,053	0,716	-0,165
	Move	0,483	0,532	0,162
	Tail wagging	0,084	0,849	-0,009
	Whining	0,194	-0,048	0,774
	Panting	0,135	-0,079	-0,770
	Owner orientation	-0,446	0,238	0,547
	Tense leash while exploring	0,458	-0,262	0,428

IV. Results

Overall, there were 8 correlations between the behavioural components (Figure 3.), but after the applied correction for multiple comparisons, two of them with low correlation coefficient values were eliminated (Figure 4.): a negative correlation between the indoor Activity/Exploration and the outdoor, departure stage Attention seeking components, and a negative correlation between the indoor Activity/Exploration and the indoor Sit components.

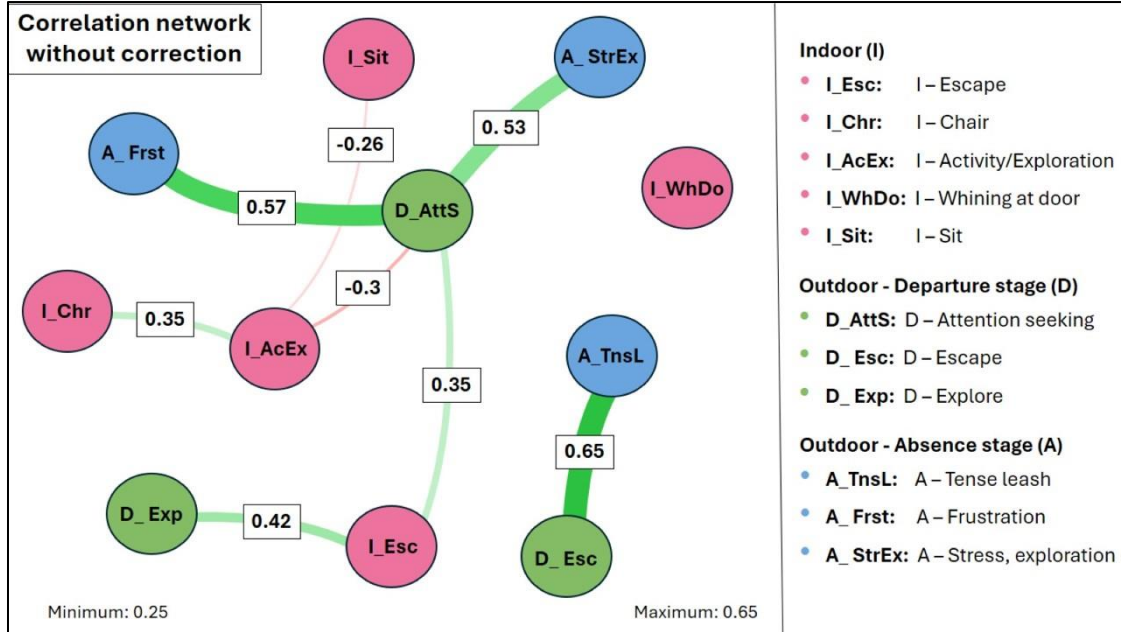


Figure 3.: The correlation matrix of the behavioural components as a network without correction. Behavioural components: indoor test - red dots; outdoor test, departure stage - green dots; outdoor test, absence stage - blue dots. Correlations: positive– green lines; negative - red lines.

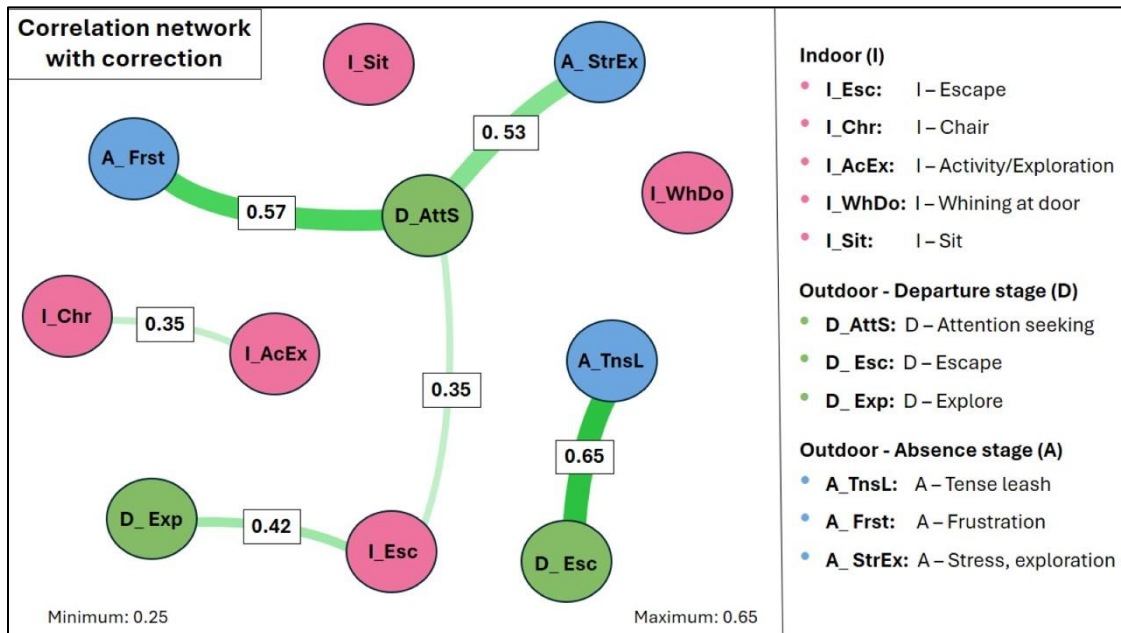


Figure 4.: The correlation matrix of the behavioural components as a network with correction. Behavioural components: indoor test - red dots; outdoor test, departure stage - green dots; outdoor test, absence stage - blue dots. Correlations: positive– green lines; negative - red lines.

The network showed 3 correlations, which were between indoor and outdoor behavioural components, so considered as between the two contexts (Figure 3., Table 7.). There was a positive correlation between the indoor Escape and the outdoor, departure stage Explore components. After examining the created scatter plot of this correlation (Figure 5.), I decided to exclude the data point that seemed to be an influential point. Without this data point the correlation was not significant anymore (Figure 6.).

Table 7.: Correlations of Indoor and Outdoor (Departure stage) behavioural components. Under the names of the given behavioural components are the related behaviours. The negative correlation is coloured differently.

Correlations of Indoor and Outdoor (Departure stage) behavioural components		
I - Escape	Correlation coefficient	D – Explore
More time spent barking, tail wagging, scratching and rearing at the door	0,42	More time spent exploring, having a tense leash while exploring, and less time spent orienting towards the owner's path
I - Escape	Correlation coefficient	D – Attention seeking
More time spent barking, tail wagging, scratching and rearing at the door	0,35	More time spent barking, whining, tail wagging, moving, and less time spent panting
I – Activity/Exploration	Correlation coefficient	D – Attention seeking
More time spent moving around, panting, exploring the room, and less time spent orienting towards the door	-0,3	Less time spent barking, whining, tail wagging, moving, and more time spent panting

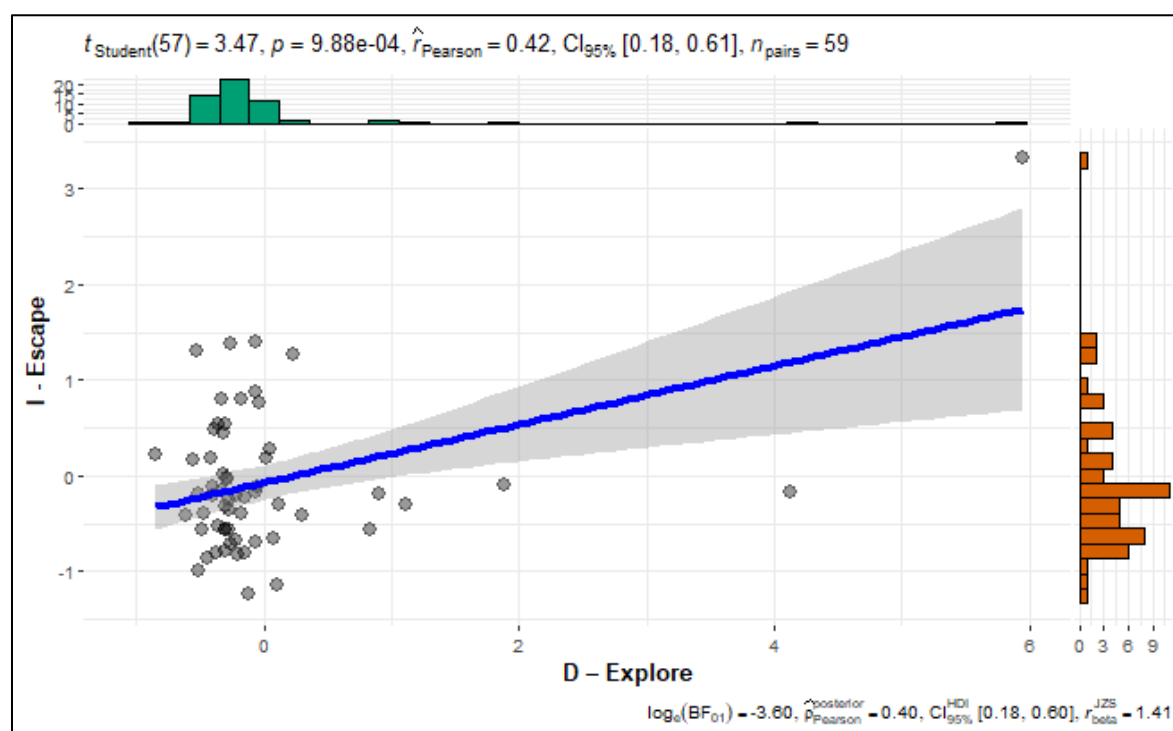


Figure 5.: Scatterplot of the relation of the indoor Escape and the outdoor, departure stage Explore components.

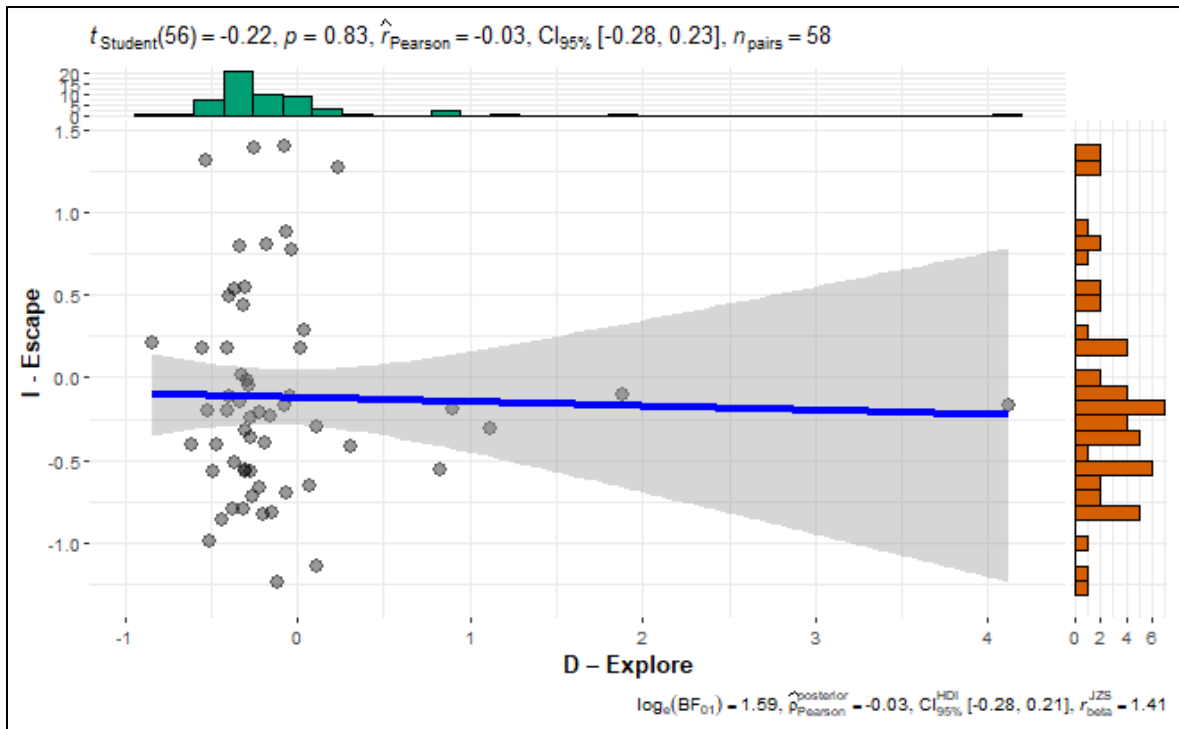


Figure 6.: Scatterplot of the relation of the indoor Escape and the outdoor, departure stage Explore components after excluding the outlier.

Another positive correlation was between the indoor Escape and outdoor, departure stage Attention seeking components (Figure 7.). I found the third correlation between the indoor Activity/Exploration and the outdoor Attention seeking components, which was negative (Figure 8.).

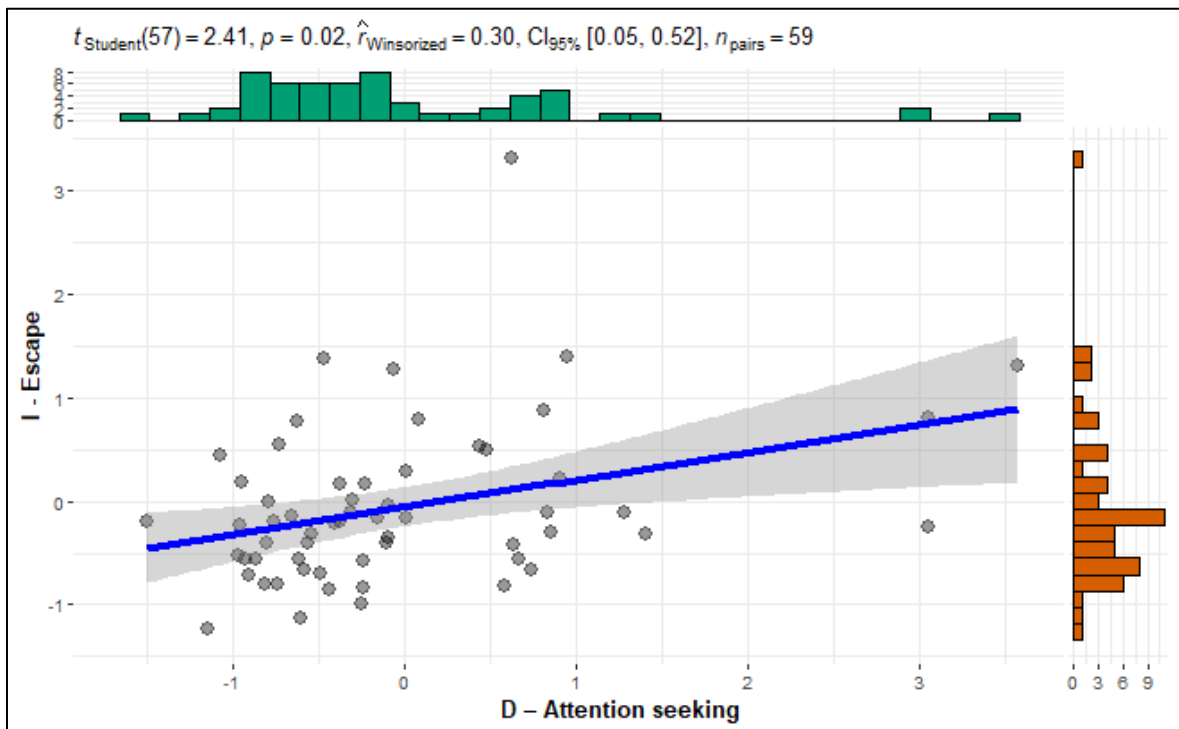


Figure 7.: Scatterplot of the relation of the indoor Escape and the outdoor, departure stage Attention seeking components.

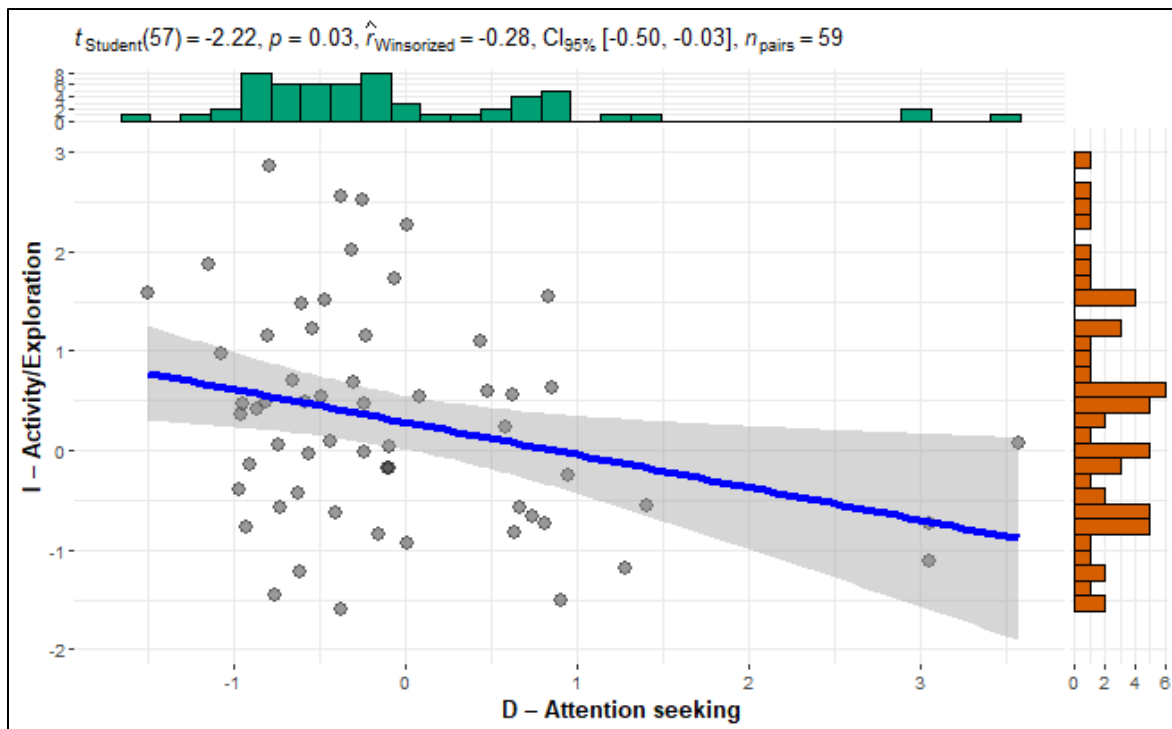


Figure 8.: Scatterplot of the relation of the indoor Activity/Exploration and the outdoor, departure stage Attention seeking components.

In the network, I found two correlations which were between the indoor behavioural components (Table 8.): a positive correlation between the Activity/Exploration and the Chair components, and a negative correlation between the Activity/Exploration and Sit components.

Table 8.: Correlations of Indoor behavioural components. Under the names of given behavioural components are the related behaviours. The negative correlation is coloured differently.

Correlations of Indoor behavioural components		
I – Activity/Exploration	Correlation coefficient	I - Chair
More time spent moving around, panting, exploring the room, and less time spent orienting towards the door	0,35	More time spent not near the door, but near the chair, orienting towards the chair and exploring it longer
I – Activity/Exploration	Correlation coefficient	I - Sit
More time spent moving around, panting, exploring the room, and less time spent orienting towards the door	-0,26	Less time spent sitting and more time spent standing

Lastly, there were three positive correlations which were between the outdoor behavioural components (Table 9.). One was between the departure stage Escape and the absence stage Tense leash components. The departure stage Attention seeking component had two correlations: one with the absence stage Frustration component, and another with the absence stage Stress, exploration component.

Table 9.: Correlations of Indoor and Outdoor (Departure stage) behavioural components. Under the names of the given behavioural components are the related behaviours.

Correlations of Outdoor (Departure stage an Absence stage) behavioural components		
D - Escape	Correlation coefficient	A - Tense leash
More time spent moving, having a tense leash while not exploring, and less time spent sitting, orienting towards the owner's path	0,65	More time spent standing, moving, having a tense leash while exploring and not exploring, and less time spent sitting, orienting towards the owner's path
D – Attention seeking	Correlation coefficient	A - Frustration
More time spent barking, whining, tail wagging, moving, and less time spent panting	0,57	More time spent barking, emitting other vocalisations, moving, and tail wagging
D – Attention seeking	Correlation coefficient	A - Stress, exploration
More time spent barking, whining, tail wagging, moving, and less time spent panting	0,53	More time spent whining, orienting towards the owner's path, having a tense leash while exploring, and less time spent panting

V. Discussion

Dogs' separation-related behaviours can be central problems in their welfare and in the dog-owner relationship. Most probably the attachment bond towards the owner and the high dependency on the owner as a resource provide the bases of these behaviours. Separation behaviours are affected by many factors, also the underlying emotions in dogs during separation are still not fully understood. The aim of the current study was to investigate the context dependency of not just the vocalisations as in previous studies, but dogs' behaviour as a whole during separation from the owner. Dogs were tested in an indoor and an outdoor setting, and their displayed behaviours were compared between the two contexts. The assumption was that despite contextual differences, individuals show similar or functionally analogue behaviours in both situations due to the same underlying emotions. The results showed only 3 correlating behaviour components between the two contexts, the rest of the correlations were either within the indoor, or the outdoor components. Although the predictions were not supported, certain results were consistent with previous studies, and the internal states underlying dogs' separation behaviour were further explored. The drawn conclusion is that different contexts with similar social settings (here is the separation) can activate emotions differently in the same dog, which are manifested in behaviour depending on the context. Also, it might be difficult to directly infer inner states from behaviours apart from vocalisations that can be considered more reliable

(Briefer 2020). Furthermore, acoustic analysis would be necessary, as certain acoustic parameters covary within a vocalisation type with the inner state (Marx, Lenkei, Pérez Fraga, Bakos, et al. 2021).

The results showed three correlations between the behavioural components of the two separation contexts (Figure 3.). One of these correlations, which were between the indoor Escape and the outdoor, departure stage Explore components, turned out to be only significant because of an outlier. So, one subject got high scores for both the indoor Escape and the outdoor, departure stage Explore components, causing a seemingly significant connection between the two (Figure 5.). This correlation would have meant that dogs who spent more time barking, tail wagging, scratching and rearing at the door indoors, outdoors also spent more time exploring, having a tense leash while exploring, and spent less time orienting towards the owner's path which would seem to be contradictory. After the exclusion of the outlier, the significant effect disappeared (Figure 6.), therefore there is probably no actual correlation between these components.

The second between contexts correlation was between the indoor Escape and the outdoor, departure stage Attention seeking components. This means that those dogs who spent more time barking, tail wagging, scratching and rearing at the door indoors, outdoors while the owner was walking away spent more time barking, whining, tail wagging, moving, and spent less time panting. This finding didn't give support for the prediction, as I expected that dogs who would try to get out of the separation situation indoors (e.g. scratching the door), also would do the same outdoors (e.g.: pulling the leash). Regarding the vocalisations, although both components contained barking (an indicator of a frustrated inner state) supporting the predictions, but the outdoor, departure stage Attention seeking component included whining as well (an indicator of a fearful inner state). In previous studies based on vocal behaviour it has been suggested that the indoor context (physical barrier from the owner/resource) might rather elicit frustration (Lenkei et al. 2021), meanwhile the outdoor context rather elicit fear (seeing the owner walking away for a long time) (Lenkei, Alvarez Gomez, and Pongrácz 2018; Pongrácz et al. 2017). This might seemingly contradict the hypothesis, however we have to take into consideration the contextual differences. While indoors the owner's departure is sudden, and the owner's absence is relatively long probably having a higher impact, in the outdoor setting the owner's departure is comparably long as the owner's absence, thus it could impact the dog's behaviour differently. In accordance, the results showed that the indoor setting rather elicited barking in the dogs suggesting to cause a frustrated inner state, meanwhile the departure stage of the outdoor setting elicited both barking and whining suggesting the presence of both frustration and fear.

Although, another explanation for this later phenomenon could be that occasionally fear might elicit barking in dogs too, which would give support for the findings of former studies (Pongrácz et al. 2017; Lenkei et al. 2021)

The third between contexts correlation was between the indoor Activity/Exploration and the outdoor, departure stage Attention seeking components. The correlation was negative, so those dogs who indoors spent more time moving around, panting, exploring the room, and less time orienting towards the door, outdoors while the owner was walking away spent less time barking, whining, tail wagging, moving, and more time spent panting. This finding could be interpreted as that dogs who seemed to be less stressed about the absence of the owner and were more occupied with exploration of the room, also were less stressed outdoors (e.g. showing less barking and whining), as well as the other way around, This could give support for some of the hypotheses, but as this correlation was eliminated after the applied correction (excluding the weaker correlations), therefore we should be careful making assumptions.

The results showed correlations, which were either within the indoor or the outdoor behavioural components. These were not in the focus of the study, though they might represent some interesting findings. In case of the indoor context, the Activity/Exploration component had two correlations. One with the Chair component, meaning that dogs who were more active, explored around the room more, also spent more time near the chair exploring it. Possibly dogs who move around the room were more likely to get to the proximity of the chair as well, causing the found correlation. Interestingly, it seems they didn't care about the door where the owner left the room (less time spent being near the door and orienting towards it). The other correlation was with the Sit component. Not surprisingly, this correlation was negative, meaning that indoors dogs were either active and explored more, or spent more time sitting, being not so active during the separation from the owner. It is a plausible explanation that those dogs who spent most of the time sitting are habituated to this situation (e.g. staying alone in an unfamiliar room), or they could be well-trained and might perceive it as a kind of exercise with the owner. This explanation could be confirmed with the questionnaire the owners filled out before the tests in future analysis. Also, the owners of these trained dogs might be more consistent and less lenient in their behaviour with the dog, which can give the dogs a sense of security (Lenkei, Alvarez Gomez, and Pongrácz 2018). On the other hand, the more active and explorative dogs might have been mildly upset but not in panic, as there were no related vocal indicators of the stressed inner state present. Yet again, this negative correlation with the Sit component was eliminated after the applied correction, so we must be cautious about making assumptions.

The last three correlations were between components of the two stages (departure and absence stages) of the outdoor separation test. The departure stage Escape and the absence stage Tense leash components had a correlation, meaning that dogs who tried going after the owner during the departure, did the same in the absence stage. Also, in the absence stage, as both tense leash while exploring and not exploring was included in the Tense leash component, dogs had a generally tense leash for a longer time and explored more. However, though the dogs seem to try to get out of the leash and go after the owner, they didn't seem to direct towards the owner's path through the two stages. An explanation for this could be that while the dogs were moving around, trying to get off the leash, exploring the area, they were not necessarily always facing the direction of the owner's path.

The departure stage Attention seeking component had the other two correlations, one with the absence stage Frustration component, and one with the absence stage Stress, exploration component. As I mentioned it before, the departure stage Attention seeking component contained both barking and whining. Thus, dogs showed both fear and frustration indicating vocalisations during the owner's departure, but they showed only either barks linked with frustration (absence stage Frustration component), or whines linked with fear (absence stage Stress, exploration component) during the stage of the owner's absence. This could mean two things, which are not mutually exclusive. One explanation, which was mentioned before, that perhaps fear can elicit barking as well in some cases, as fear is rather expected in the outdoor situation, which again would reinforce previous experiences (Lenkei et al. 2021; Pongrácz et al. 2017). Secondly, maybe the underlying emotional states (fear and frustration) changed between the two stages, and they are probably not exclusive with each other (Lenkei et al. 2021).

One limitation of the outdoor separation test is the uncontrolled environment, the dog's behaviour can be affected by noises, smells, visible events, but this might even be advantageous using this situation as a diagnostic tool as these disturbances might raise the dogs' sensitivity threshold, thus trigger only the more burdened, problematic dogs. Another limitation to be considered outdoors is that the dog's movement is restrained with the leash. This approach was used in the original protocol, it prevents the dog from running after the owner or running away. Indoors due to the closed room, this is not necessary, the physical barriers prevent this. However, the dog's movement was not restricted to an extreme extent, it was able to move in a radius of approximately 1.5-1 m. An interesting set up could be an unfamiliar and closed terrain. For example, to build an arena next to the university with a fence and it would function as an "unfamiliar garden", where the dog could freely move around, still it would be a foreign terrain

(as the laboratory is unfamiliar as well). But to be able to compare the results with previous studies, the approach where the dog is tethered to the tree by the leash was used. Furthermore, differences or similarities between breeds are a common question raised in dog-related research. However, in the present case, I was looking for a kind of consistency or inconsistency in the behaviour of the individuals between the two situations. Therefore, I didn't aim to find differences between breeds, but differences within individuals.

In summary, the results suggest that the two contexts, though they not necessarily trigger similar set of behaviours, they might be suitable for activating different underlying emotions in the same dog, and this can be a very important in the research of separation-related problems. Also, the study sheds light on the importance of studying the context specificity of certain behaviours or phenomena. In conclusion, studying outdoor separation next to the indoor laboratory tests might provide important insight to the inner state behind separation behaviours in dogs, leading to new ways to improve their welfare status. Furthermore, this approach can provide a broader overview of the dogs' behaviour leading to more certain and appropriate diagnosis of abnormal separation behaviours.

VI. Acknowledgment

I would like to say thank you to Dr. Tamás Faragó, my supervisor and mentor, for all your hard work, help, encouragement and perseverance! I would like to thank my family for their support and their help in pursuing my career! I would also like to thank all the owners and their dogs who participated in the test for their contribution to my research, to the creation of this thesis, and to the further enrichment of the science of ethology!

VII. References

- Ainsworth, Mary S. 1969. "Attachment and Expolatory Behavior of One-Year-Olds in Strange Situation." *Determinants of Infant Behavior*, 111–36.
- . 1989. "Attachments beyond Infancy." *American Psychologist* 44 (4): 709–16. <https://doi.org/10.1037/0003-066X.44.4.709>.
- Ainsworth, Mary S., S M Bell, and D J Stayton. 1971. "Attachment and Exploratory Behavior of One Year Olds." *The Origins of Human Social Relations*, 17–52.
- Borg, Joanne A.M. van der, Willem J. Netto, and Doreen J.U. Planta. 1991. "Behavioural Testing of Dogs in Animal Shelters to Predict Problem Behaviour." *Applied Animal Behaviour Science* 32 (2–3): 237–51. [https://doi.org/10.1016/S0168-1591\(05\)80047-4](https://doi.org/10.1016/S0168-1591(05)80047-4).
- Bowlby, John. 1969. "Attachment and Loss: Attachment, Vol. 1 New York." NY: *Basic Books* [Google Scholar].
- . 1979. "The Bowlby-Ainsworth Attachment Theory." *Behavioral and Brain Sciences* 2 (4): 637–38. <https://doi.org/10.1017/S0140525X00064955>.
- Briefer, Elodie F. 2020. "Coding for 'Dynamic' Information: Vocal Expression of Emotional Arousal and Valence in Non-Human Animals." In *Coding Strategies in Vertebrate Acoustic Communication*, edited by T. Aubin and N. Mathevon, 1st ed., 137–62. Cham: Springer International Publishing. https://doi.org/10.1007/978-3-030-39200-0_6.
- Gácsi, Márta, Katalin Maros, Sofie Sernkvist, Tamás Faragó, and Ádám Miklósi. 2013. "Human Analogue Safe Haven Effect of the Owner: Behavioural and Heart Rate Response to Stressful Social Stimuli in Dogs." *PLoS ONE* 8 (3). <https://doi.org/10.1371/journal.pone.0058475>.
- Horn, Lisa, Ludwig Huber, and Friederike Range. 2013. "The Importance of the Secure Base Effect for Domestic Dogs - Evidence from a Manipulative Problem-Solving Task." *PLoS ONE* 8 (5). <https://doi.org/10.1371/journal.pone.0065296>.
- Konok, Veronika, Antal Dóka, and Ádám Miklósi. 2011. "The Behavior of the Domestic Dog (Canis Familiaris) during Separation from and Reunion with the Owner: A Questionnaire and an Experimental Study." *Applied Animal Behaviour Science* 135 (4): 300–308. <https://doi.org/10.1016/j.applanim.2011.10.011>.

- Konok, Veronika, András Kosztolányi, Wohlfarth Rainer, Bettina Mutschler, Ulrike Halsband, and Ádám Miklósi. 2015. “Influence of Owners’ Attachment Style and Personality on Their Dogs’ (Canis Familiaris) Separation-Related Disorder.” Edited by Juliane Kaminski. *PLOS ONE* 10 (2): e0118375. <https://doi.org/10.1371/journal.pone.0118375>.
- Konok, Veronika, András Marx, and Tamás Faragó. 2019. “Attachment Styles in Dogs and Their Relationship with Separation-Related Disorder – A Questionnaire Based Clustering.” *Applied Animal Behaviour Science* 213 (March): 81–90. <https://doi.org/10.1016/j.applanim.2019.02.014>.
- Kuppens, Peter, Francis Tuerlinckx, James A. Russell, and Lisa Feldman Barrett. 2013. “The Relation between Valence and Arousal in Subjective Experience.” *Psychological Bulletin* 139 (4): 917–40. <https://doi.org/10.1037/a0030811>.
- Lenkei, Rita, Sara Alvarez Gomez, and Péter Pongrácz. 2018. “Fear vs. Frustration – Possible Factors behind Canine Separation Related Behaviour.” *Behavioural Processes* 157 (September): 115–24. <https://doi.org/10.1016/j.beproc.2018.08.002>.
- Lenkei, Rita, Tamás Faragó, Viktória Bakos, and Péter Pongrácz. 2021. “Separation-Related Behavior of Dogs Shows Association with Their Reactions to Everyday Situations That May Elicit Frustration or Fear.” *Scientific Reports* 11 (1): 1–13. <https://doi.org/10.1038/s41598-021-98526-3>.
- Lund, Jørgen Damkjær, and Mads Chr Jørgensen. 1999. “Behaviour Patterns and Time Course of Activity in Dogs with Separation Problems.” *Applied Animal Behaviour Science* 63 (3): 219–36. [https://doi.org/10.1016/S0168-1591\(99\)00011-8](https://doi.org/10.1016/S0168-1591(99)00011-8).
- Marx, András, Rita Lenkei, Paula Pérez Fraga, Viktória Bakos, Enikő Kubinyi, and Tamás Faragó. 2021. “Occurrences of Non-Linear Phenomena and Vocal Harshness in Dog Whines as Indicators of Stress and Ageing.” *Scientific Reports* 11 (1). <https://doi.org/10.1038/s41598-021-83614-1>.
- Marx, András, Rita Lenkei, Paula Pérez Fraga, Lisa Wallis, Enikő Kubinyi, and Tamás Faragó. 2021. “Age-Dependent Changes in Dogs’ (Canis Familiaris) Separation-Related Behaviours in a Longitudinal Study.” *Applied Animal Behaviour Science* 242 (September). <https://doi.org/10.1016/j.applanim.2021.105422>.
- McCrave, Elizabeth A. 1991. “Diagnostic Criteria for Separation Anxiety in the Dog.”

- Veterinary Clinics of North America: Small Animal Practice* 21 (2): 247–55.
[https://doi.org/10.1016/S0195-5616\(91\)50030-9](https://doi.org/10.1016/S0195-5616(91)50030-9).
- Meyer, Iben, Björn Forkman, Merete Fredholm, Carmen Glanville, Bernt Guldbrandtsen, Eliza Ruiz Izaguirre, Clare Palmer, and Peter Sandøe. 2022. “Pampered Pets or Poor Bastards? The Welfare of Dogs Kept as Companion Animals.” *Applied Animal Behaviour Science* 251 (December 2021).
<https://doi.org/10.1016/j.applanim.2022.105640>.
- Molnár, Csaba, Péter Pongrácz, Tamás Faragó, Antal Dóka, and Ádám Miklósi. 2009. “Dogs Discriminate between Barks: The Effect of Context and Identity of the Caller.” *Behavioural Processes* 82 (2): 198–201. <https://doi.org/10.1016/j.beproc.2009.06.011>.
- Mongillo, Paolo, Elisa Pitteri, Paolo Carnier, Gianfranco Gabai, Serena Adamelli, and Lieta Marinelli. 2013. “Does the Attachment System towards Owners Change in Aged Dogs?” *Physiology and Behavior* 120: 64–69. <https://doi.org/10.1016/j.physbeh.2013.07.011>.
- Nagasawa, Miho, Kazutaka Mogi, and Takefumi Kikusui. 2009. “Attachment between Humans and Dogs.” *Japanese Psychological Research* 51 (3): 209–21.
<https://doi.org/10.1111/j.1468-5884.2009.00402.x>.
- Ogata, Niwako. 2016. “Separation Anxiety in Dogs: What Progress Has Been Made in Our Understanding of the Most Common Behavioral Problems in Dogs?” *Journal of Veterinary Behavior: Clinical Applications and Research* 16: 28–35.
<https://doi.org/10.1016/j.jveb.2016.02.005>.
- Overall, Karen L., Arthur E. Dunham, and Diane Drank. 2001. “Specific Criteria for the Diagnosis of Noise Phobia.” *Journal of the American Veterinary Medical Association* 219 (4): 417–560.
<http://avmajournals.avma.org.ezproxy.is.ed.ac.uk/doi/pdf/10.2460/javma.2001.219.467>.
- Palestrini, Clara, Michela Minero, Simona Cannas, Emanuela Rossi, and Diane Frank. 2010. “Video Analysis of Dogs with Separation-Related Behaviors.” *Applied Animal Behaviour Science* 124 (1–2): 61–67. <https://doi.org/10.1016/j.applanim.2010.01.014>.
- Pongrácz, Péter, Sara Alvarez Gómez, and Rita Lenkei. 2020. “Separation-Related Behaviour Indicates the Effect of Functional Breed Selection in Dogs (Canis Familiaris).” *Applied Animal Behaviour Science* 222 (September 2019): 104884.
<https://doi.org/10.1016/j.applanim.2019.104884>.

- Pongrácz, Péter, Rita Lenkei, András Marx, and Tamás Faragó. 2017. "Should I Whine or Should I Bark? Qualitative and Quantitative Differences between the Vocalizations of Dogs with and without Separation-Related Symptoms." *Applied Animal Behaviour Science* 196 (July): 61–68. <https://doi.org/10.1016/j.applanim.2017.07.002>.
- Pongrácz, Péter, Csaba Molnár, and Ádám Miklósi. 2006. "Acoustic Parameters of Dog Barks Carry Emotional Information for Humans." *Applied Animal Behaviour Science* 100 (3–4): 228–40. <https://doi.org/10.1016/j.applanim.2005.12.004>.
- Rooy, Diane van, Elizabeth R. Arnott, Peter C. Thomson, Paul D. McGreevy, and Claire M. Wade. 2018. "Using an Owner-Based Questionnaire to Phenotype Dogs with Separation-Related Distress: Do Owners Know What Their Dogs Do When They Are Absent?" *Journal of Veterinary Behavior: Clinical Applications and Research* 23: 58–65. <https://doi.org/10.1016/j.jveb.2017.10.009>.
- Russell, James A. 1980. "A Circumplex Model of Affect." *Journal of Personality and Social Psychology* 39 (6): 1161–78. <https://doi.org/10.1037/h0077714>.
- Salman, Mo D., Jennifer Hutchison, Rebecca Ruch-Gallie, Lori Kogan, John C. New, Phillip H. Kass, and Janet M. Scarlett. 2000. "Behavioral Reasons for Relinquishment of Dogs and Cats to 12 Shelters." *Journal of Applied Animal Welfare Science* 3 (2): 93–106. https://doi.org/10.1207/S15327604JAWS0302_2.
- Sherman, Barbara L., and Daniel S. Mills. 2008. "Canine Anxieties and Phobias: An Update on Separation Anxiety and Noise Aversions." *Veterinary Clinics of North America - Small Animal Practice* 38 (5): 1081–1106. <https://doi.org/10.1016/j.cvsm.2008.04.012>.
- Simpson, Barbara S. 2000. "Canine Separation Anxiety." *COMPENDIUM ON CONTINUING EDUCATION FOR THE PRACTISING VETERINARIAN-NORTH AMERICAN EDITION* 22 (4): 328–39.
- Stephan, Gerrit, Joachim Leidhold, and Kurt Hammerschmidt. 2021. "Pet Dogs Home Alone: A Video-Based Study." *Applied Animal Behaviour Science* 244: 105463. <https://doi.org/10.1016/j.applanim.2021.105463>.
- Topál, József, Ádám Miklósi, Vilmos Csányi, and Antal Dóka. 1998. "Attachment Behavior in Dogs (*Canis Familiaris*): A New Application of Ainsworth's (1969) Strange Situation Test." *Journal of Comparative Psychology* 112 (3): 219–29. <https://doi.org/10.1037//0735-7036.112.3.219>.

