# Assessing the relationship between personality and behavioural responses of domestic dogs during novel object tests

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## ABSTRACT

In nature, differences in factors relating to personality traits and response to novelty will produce varied competitive strategies, therefore resulting in differential survival between individuals. Personality is believed to remain stable across time and within different contexts. Currently, the rise in literature on personality in domestic dogs (*Canis familiaris*) has led to a number of questions as to how differences in personality will affect behaviours displayed during variable situations. I examined the responses of individuals to novelty by scoring the behaviours of 62 dogs from 31 households during two novel object tests (NOTs). The relationships between the behaviours displayed during the NOTs, personality traits as determined using the Monash Canine Personality Questionnaire- Revised (MCPQ-R), the proportion of wins during toy possession tests (TPTs), and age were compared in order to characterize any relationships between these measures. Certain behaviours during the NOTs were found to correlate with each other and many were found to decrease between the two NOTs, most likely due to habituation. The number of times that dogs directly approached the novel object correlated with the MCPQ-R scores of Extraversion and Motivation during the first NOT but not the second test, suggesting that the dog's initial reactions to novelty can be predictive of personality traits. Younger dogs scored higher on Extraversion and performed more exploratory and bold behaviours overall compared to older dogs, including direct approaches. The proportion of TPT wins was highly correlated with Extraversion but not with any NOT behaviours, with the exception of biting the novel object. This study shows that the responses of dogs to novelty may be applicable in assessing the personality traits of individuals, which likely reflect the importance of individual dog experiences.

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# INTRODUCTION

Individual differences occur among members of a species and result in variation among individuals in the characteristic behavioural traits that they display (Ley et al., 2008). Some individuals may be more energetic, intelligent, or shy than others, which often results in a variation of competitive strategies used in activities such as obtaining food, finding mates, and interaction with conspecifics. These traits are believed to sum up into a larger picture of 'personality' (Ley et al., 2008). As animals age and experience new situations personality is thought to remain stable, suggesting that an individual's reactions in one context may be indicative of its reactions in another (Ley et al., 2008). Wolf and Krause (2014) suggested that there are several major factors affected by differences in personality: 1) social structure, 2) problem-solving ability, and 3) social responsiveness, behavioural coordination and social competition. Social responsiveness is particularly interesting as differences in personality will prompt selection on socially responsive individuals when in cooperative situations (Wolf & Krause, 2014). They also suggest that differences in problem-solving ability exist, with proactive or "motivated" individuals having increased problem-solving skills compared to reactive individuals, as seen in a variety of different animals including mammals, birds, and fish (Wolf & Krause, 2014). Montiglio et al. (2012) examined the consistency of individuals across the normally correlated measures of 'docility', 'boldness', and 'exploration' in wild populations of eastern chipmunks and their stress reactivity. They did this through open field tests using reactions to novelty and trappability to determine whether behavioural differences among individuals were predictors of autonomic response (Montiglio et al., 2012). They found that fast explorer chipmunks were trapped more often and were not as docile, with nervous systems that were more reactive than slower explorers (Montiglio et al., 2012). They concluded that together,

these differences in personality factors may result in variable survivability of individuals in the wild (Montiglio et al., 2012).

In domestic dogs (*Canis familiaris*), measures of personality traits assessed through questionnaires have been found to correlate with behaviours typical of these traits as also assessed by objective tests (Rayment et al., 2016). For example, owner-based personality assessments of activity levels in their dogs correlate strongly with the dog's activity in a dog park (Ottenheimer Carrier et al., 2013). Interestingly, canine personality assessments, whether based on questionnaire or behavioural data do not entirely agree concerning the personality traits or dimensions that reflect dog personality (Rayment et al., 2016; Posluns et al., 2017). Regardless of the specific test, canine personality assessments are subjected to the same standards as measurements for human personality and are likely just as accurate (Posluns et al., 2017)

The Monash Canine Personality Questionnaire (MCPQ-R) assesses dog personality along five personality dimensions: Amicability, Training Focus, Extraversion, Neuroticism, and Motivation (Ley et al., 2009a). It has been shown to be both reliable and valid (Ley et al., 2009a; Ley et al., 2009b), and some dimensions correlate with personality traits measured by other questionnaire-based personality assessments (Posluns et al., 2017). These dimensions may also be used to describe the personalities of other animals but one may be entirely unique to the domestic dog (Ley et al., 2008). "Amicability" has been described as being somewhat related to the human Five Factor Model factor "Agreeableness" and is overall similar to traits that express social interaction such as "non-aggressive" and "friendly". "Training focus" deals with factors that are heavily associated with the responsiveness of the dog to being trained such as "obedient", "intelligent", and "clever" (Ley et al., 2008). "Extraversion" is the personality dimension most indicative of the activity level of the dog. Extraversion deals with factors such as

"sociable", "outgoing", and "playfulness". In a study by Ley et al. (2009a), they found that younger dogs score higher on Extraversion than older dogs, consistent with findings in humans using the Five Factor Model. "Neuroticism" is a measure of nervous sensitivity and is described as being similar to the neuroticism factor also used as a personality dimension in the study of hyenas and humans (Ley et al., 2008). Neuroticism includes traits such as "fearful", "nervous", and "timid". The last personality dimension used to describe the personality of dogs is "Motivation", described by factors such as "persevering", "independent", and "eager". It deals with the amount of internal motivation that is recognized in the dog and is made up of traits involved in several of personality dimensions of humans (Ley et al., 2008). This is the only dimension that is entirely unique to dogs and may be the result of the selective pressures placed on dogs by domestication (Ley et al., 2008).

During novel object tests (NOTs) one or more animals are presented with an entirely novel object and the behaviours displayed by the animal during these tests are measured in a variety of ways. Visser and colleagues (2002) used NOTs to quantity temperamental traits in immature horses (Visser et al., 2002). The researchers quantified these traits by measuring heart rate during the test. They found a correlation between these results and personality assessments indicating emotional reactivity made by the riders (Visser et al., 2002). Fox, Ladage, Roth II, and Pravosudov (2009) used NOTs to study the relationships between behavioural profiles based on boldness in exploratory behaviour (how quickly they explore a room/object) and social rank or dominance behaviours in Mountain Chickadees (*Poecile gambeli*). They used two tests involving the exploration of a novel room and the exploration of a novel object and related the amount of time spent exploring to the observed dominance behaviours of the individual birds during dyadic interactions (Fox et al., 2009). They discovered that when tested in a novel room, birds that did

not explore the room very much were much more likely to display dominant behaviours in interactions with a bird that explored more areas within the room. However, they did not find a relationship between the exploration of novel objects and displays of dominance (Fox et al., 2009).

Chamove (1983) measured dominance behaviours in a resource possession test using water as the resource in laboratory-born macaques (*Macaca mulatta*, *Macaca nemestrina*, and *Macaca arctoides*). In this study, results of possession tests were compared with the results of NOTs. During the possession test, a water bottle was given to a group of macaques and the amount of time with possession of the bottle was correlated with dominance for each individual. It was found that during peer-group testing, when the novel object was only slightly novel, the more dominant macaques approached first but this was not the case when the object was highly novel (Chamove, 1983).

Bray and colleagues (2017) used NOTs, in addition to other tests, as a way to measure temperament in puppies undergoing guide dog selection (Bray et al., 2017). During the NOT, in which the dog was presented with a novel object (animatronic kitten), the researchers measured latency to vocalization in addition to other behaviours. Shorter latencies to vocalization were correlated with high anxiety levels measured through personality assessments as well as failure of the training program (Bray et al., 2017).

Possession tests have been traditionally used to test dominance in animals, particularly wolves (MacDonald, 1987) and dogs (Fox, 1972). An individual may be considered dominant when they have acquired a high rank within a dominance hierarchy established by individuals that are "dominant" when there is aggression present. These behaviours may consist of one individual displaying agonistic behaviours toward the other, and/or one displaying submissive

behaviours. In both of these cases, the other animal does not reciprocate this behaviour, making the behaviour unidirectional (Cafazzo et al., 2016). The agonistic individual can ultimately limit the ability of the submissive individual to obtain resources, which will further cement their elevated social status (Boogert et al., 2006; Lisberg & Snowden, 2009). These tests measure the ability, or lack of ability, of each individual animal to maintain possession of a desirable resource in the presence of conspecifics. The validity of this test to measure dominance has been recently called into question. It has been suggested that these tests may actually be a way of measuring competitive performance and associated traits such as motivation (Bradshaw et al., 2016). Originally in bone-in-pen tests, a bone was presented to two or more littermates, and the individual that held possession of the bone the longest was considered the most "dominant" of the group (Serpell et al., 2016). Fox (1972) found a correlation between possession of the bone and increased skill at capturing prey as well as higher rates of exploratory behaviour during NOTs in wolf pups (*Canis lupus*). MacDonald (1987) found that after six weeks of age, the outcome of the bone-in-pen test for litters of wolf pups became consistent with certain pups losing to the same littermates, indicating that these traits are stable throughout the lifetime of the individual (Serpell et al., 2016). Later, bone-in-pen tests were replaced by toy possession tests (TPTs). Lisberg and Snowden (2009) scored TPT outcomes and mean tail base position in dogs who lived in a single household in order to determine the social status of individuals (Lisberg & Snowden, 2009). During the TPT, the toy was thrown to the dogs three times. One of the dogs would receive a score of 1 when they held onto the toy for either 30 seconds or brought the toy to their owner (Lisberg & Snowden, 2009). There was a significant correlation between TPT "wins" and a high tail base position, which was interpreted as corroborating measures of social status in dogs (Lisberg & Snowden, 2009). Castro (2017) studied the relationship between

personality, TPT outcomes, potential behavioural indicators of social dominance and hormones in multi-dog homes. She found that dogs that had been rated as more extraverted and motivated, using the MCPQ-R, had more TPT successful outcomes as well as higher levels of testosterone combined with lower levels of cortisol. However, other potential measures of social dominance were unrelated to these outcomes, suggesting that TPT is a measure of competitive performance that does not necessarily reflect dominance.

**Thesis Objectives**

There were several goals for this study. The first goal was to characterize the novel object test (NOT) behaviours in dogs across two short exposures to a novel toy, which might be somewhat aversive to some dogs. I predicted that there would be differences in the number of times dogs performed some of the behaviours between NOT 1 and NOT 2 as well as differences in some of the relationships between different behaviours. The second goal was to examine the relationships between NOT behaviours and the MCPQ-R personality dimensions. I predicted that the quantity of stress behaviours, such as "retreat", displayed during the NOT would correlate positively with the score of "Neuroticism" and negatively with "Motivation" and "Extraversion" scores from the MCPQ-R. Factors such as age were also evaluated, which I predicted would have an inverse relationship with "Extraversion" as seen in previous studies, as well as more energetic behaviour during the NOT such as "direct approach". The third goal was to examine whether NOT behaviours correlated with TPT outcomes. I predicted that that higher proportion of TPT wins would be related to bold and exploratory behaviours such as "direct approach" as well as "Extraversion" and "Motivation" as seen in previous studies (Castro et al., 2017).

# MATERIALS AND METHODS

## Participants:

In this study, a total of 62 dogs from 31 different households were observed and tested by University of Oulu/Memorial University MSc student Mari Kinnunen. The households were each home to two dogs (dyads). There were 28 males and 34 females in total (7 male-male, 10 female-female, and 14 female-male dyads). The dogs were various breeds and ages (62.8 ± 35.8 months; mean ± SD). The majority of the dogs tested were either spayed or neutered, with only two males left intact.

The dogs were all volunteered by their owners. These participants were recruited through ads on social media, specifically on the "Canine Research Unit at Memorial University" Facebook page. Posters were also posted at local pet stores and some volunteers were recruited via word of mouth. The participants were required to own two dogs that had lived together for at least 6 months, be over the age of 18, and live on the Avalon Peninsula to volunteer. The advertisement outlined the requirements of the study including answering questionnaires about both dogs, taking saliva samples, and allowing the dogs to be observed during behavioural tests during a visit by the researchers that would last approximately 60 minutes.

The behavioural tests took place within each of the dyads households in an open area of the home. These areas were different sizes in each of the households.

## Materials and General Procedure:

The novel object used during the NOT was one of two Kid Connection Light & Sound Battery Operated Walking Dinosaur/Dragon (Wal-Mart Canada Corp., St. John's, NL). The video was recorded using a Sanyo VPC-HD1010 digital camera and videos were saved in .mp4

file format. In order to code the relevant behavioural events from the videos, VSW.app (© A. Earle, Memorial University), a behavioural event recorder, was used. Before and after the NOT took place, saliva samples were collected using Salimetrics Children's Swabs (hydrocellulose sponges, 8 × 125 mm; State College, Pennsylvania, USA). The Monash Canine Personality Questionnaire-Revised (MCPQ-R) was completed by owners prior to the visit to assess the personalities of each dog. Prior to the NOT, owners answered a series of questionnaires with the experimenter. Following the NOT, a competitive toy possession test (TPT) was conducted as described in Castro (2017).

**Novel Object Test:**

In order to conduct the NOT, the experimenter entered each household and determined an area that would be spacious enough to capture the reactions of the dogs on camera with the least amount of obstruction. The experimenter had the owner sit on either a chair or a couch and instructed them to hold onto the two dogs at a distance of approximately 1.5 meters from the experimenter. Before the test could begin, the experimenter would call to the dogs to get their attention while the novel object was removed from a bag that had been completely concealed up to this point. The novel object was an animatronic dinosaur/dragon that could walk, make noise, and light up. The owner was instructed hold onto their dogs as the experimenter stepped back and waited for 1 minute. The novel object was placed on the floor and turned on. The dogs were released for 20 seconds and allowed to interact with the toy; this is referred to as NOT 1. The toy was turned off and placed back within the bag to remove it from the dog's sight. After a 1 minute break the test was repeated following the same protocol (NOT 2). Specific behaviours of each dog toward the novel object were examined.

**Table 1: Ethogram of dog-to-novel object behaviours**

| Behaviour: | Description: |
|---|---|
| **Direct Approach** | Dog moves forward in a straight line toward the novel object |
| **Indirect Approach** | Dog moves nearer to the novel object but not in a straight line (e.g., curved approach) |
| **Retreat** | Dog moves away slowly away from the novel object turning head and body away from the object |
| **Exaggerated Retreat** | Dog moves away from the object quickly without turning back toward the object/ pushes forelegs back |
| **Orientation (Duration)** | Dog turns head towards novel object with or without moving the rest of its body towards it (not mutually exclusive with other behaviours) |
| **Bark** | A sharp, sudden vocalization produced by the dog |
| **Growl** | A low grumbling vocalization |
| **Latency to Vocalization** | Time from start of test for the dog to begin barking or growling |
| **Lunge** | A sudden leap toward the novel object while the head is pushed forward. Dog will often snap or vocalize toward the novel object |
| **Sniffing (Duration)** | Dog positions muzzle on or near the novel object (within 10cm)<br>*Location on object annotated during coding |
| **Bite** | Firm mouth contact on the novel object |

**Table 2: Ethogram of dog-to-dog behaviours**

| Behaviour: | Description: |
|---|---|
| **Approach** | Dog moves forward toward the other dog |
| **Orientation (Duration)** | Dog turns head towards the other dog with or without moving the rest of its body towards it (not mutually exclusive with other behaviours) |
| **Retreat** | Dog moves away from the other dog turning head and body away from the dog |
| **Sniffing (Duration)** | Dog positions muzzle on or near the other dog (within 10cm)<br>*Location on object annotated during coding |
| **Bump** | Dog uses a part of its body to knock into the other dog |
| **Touch (Duration)** | Contact between the body of the dog and body of the other dog |
| **Play bow** | Dog's forelimbs are outstretched and parallel or angled to the floor, oriented toward conspecific. The dog's hind end is raised while the tail is either erect or wagging |
| **Bite** | Firm mouth contact on the other dog |

**Table 3: Ethogram of dog-to-owner behaviours**

| Behaviour: | Description: |
|---|---|
| **Approach** | Dog moves forward toward the owner |
| **Retreat** | Dog moves away from the owner turning head and body away from the owner |
| **Orientation** | Dog turns head towards the owner with or without moving the rest of its body towards them (not mutually exclusive with other behaviours) |
| **Sniffing** | Dog positions muzzle on or near the owner (within 10cm)<br>*Location on object annotated during coding |
| **Bump** | Dog uses a part of its body to knock into owner |
| **Touch (Duration)** | Contact between the body of the dog and the body of the owner |
| **Play bow** | Dog's forelimbs are outstretched and parallel or angled to the floor, oriented toward owner. The dog's hind end is raised while the tail is either erect or wagging |

**The Monash Canine Personality Questionnaire-Revised:**

This questionnaire consists of 26 adjective-based questions to be answered on a graded scale from 1 (really does not describe my dog) to 6 (really describes my dog) on five dimensions (Extraversion, Neuroticism, Amicability, Training Focus, and Motivation) outlined in Table 4 (Ley et al., 2008). This questionnaire has been tested for both validity (Ley et al., 2009a) and reliability (Ley et al., 2009b). In order to score the results of the test, the scores of each of the adjectives traits that comprise within each of the five personality dimension factors are added together and then divided by the maximum score for each dimension of the factors. Finally, the number is multiplied by 100 to get the percentage score of each dimension factor.

**Table 4: Scoring Rubric for the Monash Canine Personality Questionnaire (Revised)**

| **Extraversion** | **Motivation** | **Training Focus** | **Amicability** | **Neuroticism** |
|---|---|---|---|---|
| Active<br>Energetic<br>Excitable<br>Hyperactive<br>Lively<br>Restless | Assertive<br>Determined<br>Independent<br>Persevering<br>Tenacious | Attentive<br>Biddable<br>Intelligent<br>Obedient<br>Reliable<br>Trainable | Easy-going<br>Friendly<br>Non-aggressive<br>Relaxed<br>Sociable | Fearful<br>Nervous<br>Submissive<br>Timid |
| Max Score: 36 | Max Score: 30 | Max Score: 36 | Max Score: 30 | Max Score: 24 |
| Score* | Score* | Score* | Score* | Score* |

* Scores for each of the five dimensions are added together then divided by the maximum score for each dimension (see above). The number is then multiplied by 100 to give the percentage score for each dimension

**Toy Possession Test:**

The TPTs were conducted using two different toys. The toys were alternated back and forth between three trials for a total of six trials. Both were rubber with one being filled with a treat and the other having the ability to squeak. The first toy to be used at each household was also alternated. At the beginning of each trial the owner called the dogs to them, gave each a chance to sniff the toy so that they were aware of it, and then threw at an equal distance away from both dogs. The dogs that went after the toy were filmed and then coded afterwards to obtain the results of the TPTs. The dog that held possession of the toy won the point. The number of wins of all trials in which one dogs participated were scored and added together to get the total portion of TPT wins (0-6).

**Statistical Analyses**

Non-parametric statistical analyses were run on the data collected in this study include Spearman's rho correlations as well as Wilcoxon W tests, as both the personality and

behavioural data were not normally distributed, using Jamovi version 0.9.6.1. All of the probabilities reported were two-tailed with an alpha level that was set at 0.05. No corrections were made using measures such as the Bonferroni correction due to the formula decreasing the likelihood of finding relationships that might be further explored in the future (Eichstaedt et al., 2013).

## RESULTS

The behaviours of dogs, tested in pairs, during two Novel Object Tests (NOTs) are described in Table 5. Specifically, Table 5 shows the number and percentages of dogs displaying each behaviour, as well as the range of each measure across dogs. Orientation and sniffing were recorded as duration in seconds while the rest of the behaviours were recorded as frequencies.

**Table 5: The number and percentage of dogs performing each behaviour during each novel object test with the range of the number of times the behaviour was produced**

| Behaviour | Novel Object Test 1 | | Novel Object Test 2 | |
|---|---|---|---|---|
| | Number of Dogs (%) | Range | Number of Dogs (%) | Range |
| Orientation | 62 (100%) | 1.02- 20 s | 60 (96.8%) | 0.48-20 s |
| Sniffing | 50 (80.6%) | 0.26-15.17 s | 29 (46.8%) | 0.57-14.85 s |
| Direct Approach | 56 (90.3%) | 1-3 | 41 (66.1%) | 1-4 |
| Indirect Approach | 27 (43.5%) | 1-2 | 24 (38.7%) | 1-3 |
| Retreat | 53 (85.5%) | 1-6 | 56 (90.3%) | 1-3 |
| Exaggerated Retreat | 26 (41.9%) | 1-4 | 11 (17.7%) | 1-3 |
| Bark | 11 (17.7%) | 1-22 | 12 (19.4%) | 1-38 |
| Lunge | 1 (0.02%) | 1 | 1 (0.02%) | 1 |
| Growl | 3 (0.05%) | 1-3 | 6 (0.1%) | 1-3 |
| Bite | 2 (0.03%) | 1 | 2 (0.03%) | 1-4 |

**Behaviours during the NOT:**

To investigate the relationships between the behaviours displayed during the NOTs Spearman's rank-order correlations ($r_s$) were conducted, as the data were not normally distributed. As seen in Table 6, during NOT 1, sniffing was correlated with latency to vocalization [$r_s(62) = 0.745$, $p = 0.012$] indicating that the longer the dog spent sniffing the novel object, the longer it took for the dog to bark or growl. Dogs that barked at the novel object also had more direct approaches [$r_s(62) = 0.275$, $p = 0.030$]. When comparing the relationships

between the two different approach and retreat types it was found that dogs showing more indirect approaches had more retreats [$r_s(62) = 0.403$, $p = 0.001$] and dogs with more direct approaches showed more exaggerated retreats [$r_s(62) = 0.503$, $p < 0.001$]. Exaggerated retreat was also associated with barking [$r_s(62) = 0.370$, $p = 0.015$]. Although there were significant correlations between bark, growl, lunge, and bite, very few dogs displayed these behaviours (Table 5).

**Table 6: Spearman's rank order correlations ($r_s$) for dog-to-novel object behaviours coded during NOT 1**

Correlation Matrix

| | NO1 Sniffing (s) | NO1 Direct Approach | NO1 Indirect Approach | NO1 Retreat | NO1 Exaggerated Retreat | NO1 Latency to Vocalization | NO1 Bark | NO1 Growl | NO1 Lunge | NO1 Bite |
|---|---|---|---|---|---|---|---|---|---|---|
| NO1 Sniffing (s) | — | 0.000 | 0.137 | -0.031 | 0.099 | 0.745* | -0.178 | 0.020 | 0.004 | 0.102 |
| NO1 Direct Approach | | — | 0.054 | 0.172 | 0.503*** | -0.381 | 0.275* | 0.244 | 0.104 | 0.019 |
| NO1 Indirect Approach | | | — | 0.403** | 0.115 | -0.115 | -0.033 | -0.060 | -0.109 | 0.078 |
| NO1 Retreat | | | | — | -0.320* | 0.191 | -0.222 | 0.024 | -0.047 | 0.113 |
| NO1 Exaggerated Retreat | | | | | — | -0.447 | 0.307* | 0.130 | -0.105 | -0.150 |
| NO1 Latency to Vocalization | | | | | | — | -0.583 | 0.006 | 0.000 | 0.000 |
| NO1 Bark | | | | | | | — | 0.287* | 0.279* | 0.157 |
| NO1 Growl | | | | | | | | — | 0.558*** | 0.377** |
| NO1 Lunge | | | | | | | | | — | 0.701*** |
| NO1 Bite | | | | | | | | | | — |

Note. * p < .05, ** p < .01, *** p < .001

During NOT 2, there were slight differences in the correlations found previously between NOT 1 and the approach/retreat behaviours. While indirect approach and retreat ($r_s(62) = 0.414$, $p < 0.001$) and direct approach and exaggerated retreat ($r_s(62) = 0.437$, $p < 0.001$) were still

significantly correlated in NOT 2, direct approaches were also correlated with retreat ($r_s(62) = 0.611$, $p < 0.001$). Direct approach remained correlated with bark ($r_s(62) = 0.283$, $p = 0.026$) and became correlated with growl ($r_s(62) = 0.361$, $p = 0.004$) during NOT 2. Interestingly, twice as many dogs growled during NOT 2 compared to NOT 1 (6 vs. 3). In NOT 2, only exaggerated retreat was correlated with more aggressive behaviours including bark ($r_s(62) = 0.316$, $p = 0.012$), growl ($r_s(62) = 0.310$, $p = 0.014$), and lunge ($r_s(62) = 0.323$, $p = 0.010$). There was still a strong correlation between lunge and growl, as well as between lunge and bite, but the correlations from NOT 1 between growl and bite (Table 6) were lost during NOT 2. However, the number of dogs displaying these behaviours remained low, as seen in Table 5.

**Table 7: Spearman's rank order correlations ($r_s$) for dog-to-novel object behaviours coded during NOT 2**

Correlation Matrix

| | NO2 Sniffing (s) | NO2 Direct Approach | NO2 Indirect Approach | NO2 Retreat | NO2 Exaggerated Retreat | NO2 Bark | NO2 Growl | NO2 Lunge | NO2 Bite |
|---|---|---|---|---|---|---|---|---|---|
| NO2 Sniffing (s) | — | 0.528*** | 0.014 | 0.408*** | 0.238 | 0.074 | 0.015 | 0.159 | 0.129 |
| NO2 Direct Approach | | — | -0.008 | 0.611*** | 0.437*** | 0.283* | 0.361** | 0.236 | 0.195 |
| NO2 Indirect Approach | | | — | 0.414*** | 0.013 | 0.010 | 0.105 | -0.099 | -0.142 |
| NO2 Retreat | | | | — | 0.046 | -0.064 | 0.083 | 0.163 | -0.007 |
| NO2 Exaggerated Retreat | | | | | — | 0.316* | 0.310* | 0.323* | 0.192 |
| NO2 Bark | | | | | | — | 0.512*** | 0.202 | 0.103 |
| NO2 Growl | | | | | | | — | 0.363** | 0.233 |
| NO2 Lunge | | | | | | | | — | 0.713*** |
| NO2 Bite | | | | | | | | | — |

Note. * p < .05, ** p < .01, *** p < .001

Comparison of behaviours between NOT 1 and NOT 2 revealed that four behaviours significantly decreased between tests (Figure 1). Specifically, dogs spent less time oriented toward the novel object in NOT 2 vs. NOT 1 (Wilcoxon W=1354.00, $p < 0.001$, Cohen's d= 0.5024). They also spent less time sniffing the novel object (Wilcoxon W=1183.00, $p < 0.001$, Cohen's d= 0.6698). The frequency of direct approaches towards the novel object was significantly lower in NOT2 compared to NOT1 (Wilcoxon W=661.00, $p < 0.001$, Cohen's d= 0.5141) with the percentage of dogs which showed at least one direct approach towards the novel object dropping from 90.3% in NOT 1 to NOT 2. The frequency of exaggerated retreats was also lower in NOT 2 compared to NOT 1 (Wilcoxon W=229.50, p= 0.004, Cohen's d= 0.4078). The percentage of dogs performing exaggerated retreats dropped from 41.9% in NOT 1 to 17.7% in NOT 2.

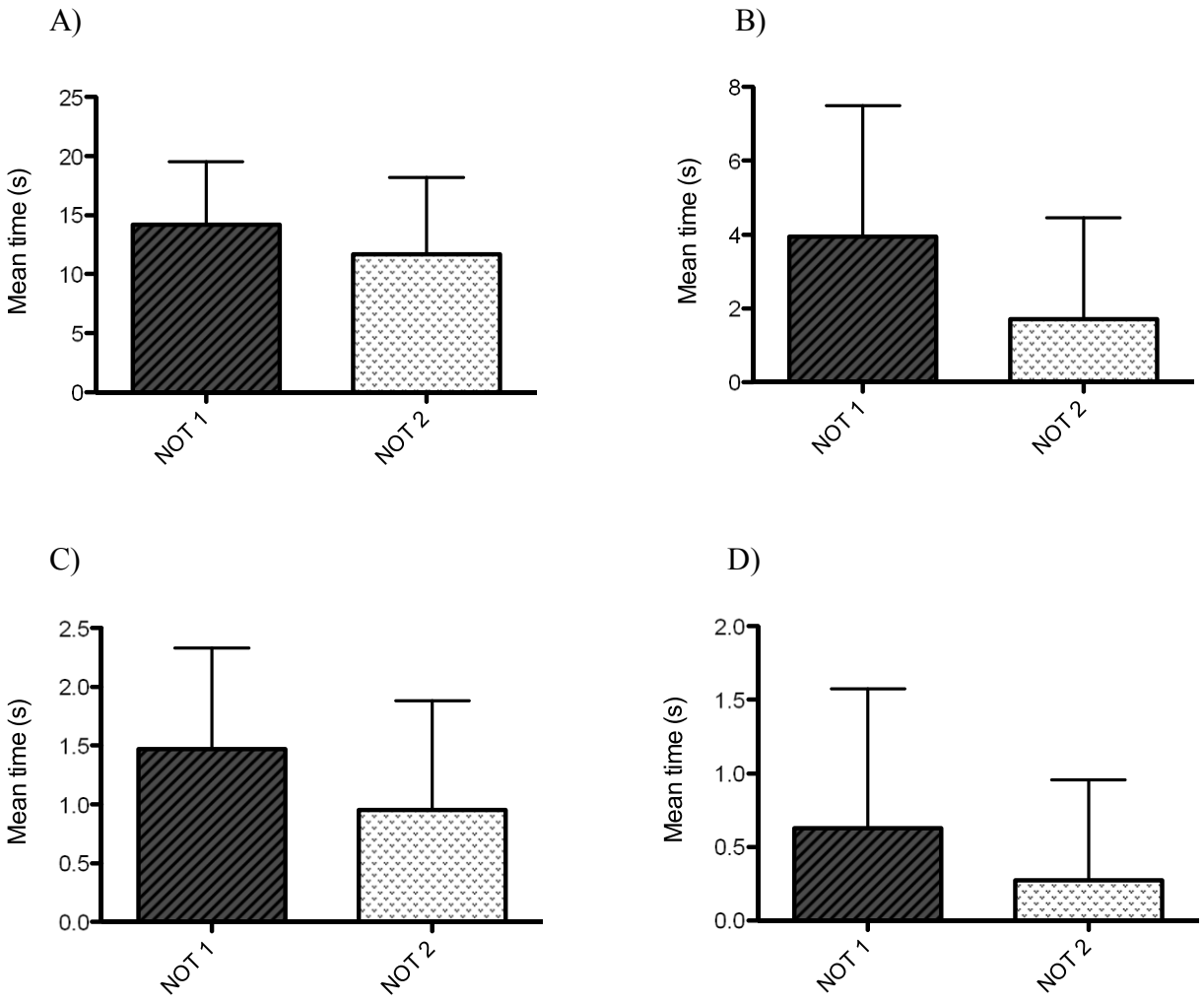


**Figure 1: The differences in behaviours observed between NOT 1 and NOT 2.** A) Differences in mean duration of orientation. B) Differences in mean duration of sniffing. C) Differences in mean frequency of direct approaches. D) Differences in mean frequency of exaggerated retreat. Error bars indicate standard deviation. A, B, C: $p<0.001$; D: $p=0.004$.

**NOT behaviours, personality, age, and toy possession test (TPT) wins:**

In order to explore the relationships among the behaviours displayed during the NOT, MCPQ-R personality dimensions, dog age (months), and the proportion of Toy Possession Test (TPT) wins, Spearman's rank-order correlations ($r_s$) were examined. For NOT 1, there were significant correlations between the number of direct approaches by the dogs and two MCPQ-R personality traits: Extraversion [$r_s(62) = 0.380$, $p = 0.002$] and Motivation [$r_s(62) = 0.255$, $p = 0.045$]. It was also found that the more times the dog bit the novel object, the higher the dog scored on Extraversion [$r_s(62) = 0.265$, $p = 0.038$]. Younger dogs performed more direct approaches [$r_s(62) = -0.347$, $p = 0.006$], indirect approaches [$r_s(62) = -0.279$, $p = 0.028$], exaggerated retreats [$r_s(62) = -0.374$, $p = 0.003$], and generally spent more time oriented towards the novel object [$r_s(62) = -0.316$, $p = 0.012$]. Younger dogs also scored significantly higher on Extraversion [$r_s(62) = -0.409$, $p < 0.001$]. The proportion of TPT wins seemed to be highly related to the number of times the dog bit the novel object [$r_s(62) = 0.259$, $p = 0.042$].

**Table 8: Spearman's rank order correlations ($r_s$) for dog-to-novel object behaviours coded during NOT 1, measures of personality, age at time of visit, and proportion of TPT wins**

Correlation Matrix

| | NO1 Orientation (s) | NO1 Direct Approach | NO1 Indirect Approach | NO1 Exaggerated Retreat | NO1 Bite | Extraversion | Motivation | Age at time of visit (months) | Proportion of TPT Wins |
|---|---|---|---|---|---|---|---|---|---|
| NO1 Orientation (s) | — | 0.249 | 0.072 | 0.468*** | -0.010 | 0.173 | -0.155 | -0.316* | 0.229 |
| NO1 Direct Approach | | — | 0.054 | 0.503*** | 0.019 | 0.380** | 0.255* | -0.347** | 0.140 |
| NO1 Indirect Approach | | | — | 0.115 | 0.078 | 0.158 | 0.044 | -0.279* | -0.015 |
| NO1 Exaggerated Retreat | | | | — | -0.150 | 0.200 | 0.057 | -0.374** | 0.043 |
| NO1 Bite | | | | | — | 0.092 | 0.084 | 0.130 | 0.259* |
| Extraversion | | | | | | — | 0.367** | -0.409*** | 0.265* |
| Motivation | | | | | | | — | -0.172 | 0.142 |
| Age at time of visit (months) | | | | | | | | — | -0.125 |
| Proportion of TPT Wins | | | | | | | | | — |

Note. * p < .05, ** p < .01, *** p < .001

During NOT 2, there were some differences in the correlations found previously for NOT 1. The number of times of dogs directly approached the novel object no longer had a relationship with the personality measures of extraversion or motivation. Instead, the number of exaggerated retreats of the dog away from the novel object was negatively correlated with the MCPQ-R personality dimension training focus [$r_s(62) = -0.272$, $p = 0.033$]. Similar to the first test, during NOT 2, younger dogs had more direct approaches to the novel object [$r_s(62) = -0.320$, $p = 0.011$] and performed more exaggerated retreats [$r_s(62) = -0.337$, $p = 0.007$].

**Table 9: Spearman's rank order correlations ($r_s$) for dog-to-novel object behaviours coded during NOT 2, measures of personality, age at time of visit, and proportion of TPT wins**

Correlation Matrix

| | NO2 Direct Approach | NO2 Exaggerated Retreat | Extraversion | Training Focus | Age at time of visit (months) | Proportion of TPT Wins |
|---|---|---|---|---|---|---|
| NO2 Direct Approach | — | 0.437*** | 0.171 | 0.001 | -0.320* | -0.014 |
| NO2 Exaggerated Retreat | | — | -0.018 | -0.272* | -0.337** | 0.056 |
| Extraversion | | | — | 0.234 | -0.409*** | 0.265* |
| Training Focus | | | | — | 0.002 | 0.159 |
| Age at time of visit (months) | | | | | — | -0.125 |
| Proportion of TPT Wins | | | | | | — |

Note. * p < .05, ** p < .01, *** p < .001

## DISCUSSION

In this study, we presented dyads of dogs living in the same household with a novel object over two NOTs and recorded the specific behaviours of each dog toward the novel object. During testing, which took place in the dogs' homes, the dogs were also given TPTs, with the proportion of "wins" for each dog recorded. Prior to the home visit by experimenters, owners completed the MCPQ-R for each dog. The variables for each of these tests were examined and relationships among them were explored. The goal of this study was to determine whether the results of the NOT could be related to the owner-report personality dimensions of the MCPQ-R and the outcome of a competition between the two dogs for a resource.

During the NOTs, there were many interesting and significant relationships found between the behaviours that were measured. By looking at how these behaviour correlate with

each other, we can explore the patterns and relationships with how dogs will react when presented with a novel object. During NOT 1, sniffing was correlated with latency to vocalization, suggesting that the longer the dog spent sniffing the novel object, the longer it took for the dog to bark or growl. Barking may be indicative of a high level of arousal, particularly in the presence of novelty. A nervous dog may be quicker to start barking than a dog that is willing to approach a novel object to sniff it.

When exploring the relationships between bold types of behaviours, it was also found that approach and retreat behaviours that would be considered quicker or 'bold' are correlated with one another while the less intense, slower movements of indirect approach and retreat are also correlated. Bold behaviours refer to behaviours that are potentially risky to perform such as walking straight toward a novel object to explore it. Indirect approaches, or getting closer to the novel object by 'circling', may be a behaviour more typically seen in dogs that are cautious and less energetic and therefore they will not head straight toward the object when approaching it. Similarly, retreating away from the object by turning around and walking away rather than jumping back (exaggerated retreat) is a much more cautious way to move away from the object. The data suggest that dogs that boldly approach the object will react with more energetic movements away while dogs that cautiously approach will move away carefully. Direct approaches toward and exaggerated retreats away from the novel object were also related to the number of times the dog barked during NOT 1. This would suggest that bolder dogs were more likely to bark during the test, rather than shy or cautious dogs. Rather than sneaking around the object, some of these dogs moved straight towards it and vocalized towards the object. In a study by Bray et al. (2017), it was found that guide dogs in training had shorter latencies to vocalization in the presence of a novel object, and this was predictive of future program success.

Dogs that were quicker to bark at the object may have been more reactive toward novelty and would not be able to focus and meet the demands of training (Bray et al., 2017). There were significant relationships between the more aggressive behaviours measures. Bark, growl, bite, and lunge all significantly correlated with each other, suggesting that dogs that vocalized were more likely to also act aggressively toward the novel object. However, only a very small number of dogs lunged (1 out of 62), growled (3-6 out of 62), and bit (2 out of 62) during either of the NOTs, and as a result there were not enough data to fully support the correlations between the behaviours.

There were several significant differences found between the data collected for NOT 1 and NOT 2. The correlations found between direct approach and exaggerated retreat and indirect approach and retreat were stable between the two tests, but the number of direct approaches toward the novel object was also significantly related to the number retreats performed by the dogs. There was a relationship between growl and the number of direct approaches during NOT 2. This change may have occurred due to the increase in dogs that growled during NOT 2. Twice the number of dogs growled at the novel object during the second test as compared to the first, suggesting that this behaviour may have been subjected to sensitization as the dogs spent more time in the presence of the novel object. Increased familiarity after NOT 1 likely resulted in the object no longer being truly novel to the dogs, and behaviours like growl may have become more likely during continued testing.

Four of the dogs' behaviours coded during the NOTs decreased from NOT 1 to NOT 2, including orientation, sniffing, direct approach, and exaggerated retreat. The dogs spent much less time oriented towards and sniffing the novel object from NOT 1 to 2, suggesting that the dogs spent less time paying attention to and exploring the object. The number of dogs that

directly approached the object and performed exaggerated retreats both decreased, which makes sense as these behaviours were correlated in both NOT 1 and NOT 2. This also suggests that as exploratory behaviour decreases, so will the need to get away quickly, hence the decrease in exaggerated retreats. The drop in these behaviours suggests that after NOT 1, the dogs lost interest and habituated to the novel object and had a supressed emotional response towards the novel object during subsequent testing. In a study by Zimmerman et al. (2001) exploring the effect of rearing conditions on behavioural responses to novelty in rats, it was found that rats reared in a stimulating, complex, and bright environment were more efficient at exploring. The researchers suggested that due to increased skills in the performance of spatial tasks, the animals will not need to spend as much time exploring the object, therefore causing the object to lose its novelty very quickly (Zimmerman et al., 2001). The dogs that participated in this experiment were volunteered by owners that tend to put extra effort into providing a stimulating social environment for their pets, taking the time to even participate in scientific studies such as this one. As a result, we may being seeing an effect in which these dogs may be more efficient at exploring novel objects and habituating faster, producing these results. It is also possible that age and experience play a role. Older dogs may have had more opportunities to come into contact with similar items and will therefore not react as strongly as a younger dogs.

The behaviours of the NOTs were compared with the personality measures of Extraversion, Amicability, Motivation, Training Focus, and Neuroticism of the MCPQ-R in order to explore whether the behaviours of the dogs toward novelty could be used as predictors of personality. I hypothesized that an increased quantity of stress behaviours such as retreat and bark would indicate a high score for the measure of Neuroticism, but this correlation did not exist in the data. It is possible that we saw these results due to the types of participants tested in

this study. As mentioned before, volunteers willing to participate in studies like this may be more likely to have raised their dogs in a matter where the dog is well socialized and stimulated, therefore not developing traits associated with Neuroticism. I also hypothesized that an increased quantity of bold behaviours of the dog such as direct approach and increased time spent oriented toward the novel object would indicate a high score of Extraversion and Motivation. The only behaviour that had a relationship with these scores was the number of direct approaches, which had a significant positive correlation with both. As previously mentioned, direct approach is a bold and energetic behaviour in which the dog will move straight toward the object, in most cases, to explore it. Dogs that scored high in Extraversion were high in traits including restlessness, excitability, and hyperactivity and dogs that scored high in Motivation were high in traits for independence, tenacity, and determination. It makes sense that dogs that are energetic and determined to explore a novel object would be bolder and are more likely to directly approach the object (Ley et al., 2008). There has also been plenty of evidence found that Extraversion and Motivation are correlated, with more active dogs being more highly motivated to perform tasks that require energy (Ley et al., 2009a). Therefore, during a dog's first exposure to a novel object, the number of times it directly approaches the object is predictive of personality traits involved in Extraversion and Motivation.

When comparing the relationships between these behaviours and the measures of the MCPQ-R during NOT 2, any relationship between direct approach and Extraversion and Motivation was lost. Between the two tests, there was a significant decrease in the number of dogs that directly approached the novel object, which may have been due to habituation as mentioned above. During this test, there was a relationship that formed between the number of exaggerated retreats of the dog and the personality measure of Training Focus. Dogs with a

higher number of exaggerated retreats had lower scores for Training Focus, suggesting that dogs that continued retreating from the novel object in an exaggerated way after NOT 1 were less trainable than dogs who showed fewer instances of this behaviour.

We explored some of the traits of the dogs at the time of testing in order to determine whether there were any confounding variables to explain the relationships between the behaviours of the NOTs and the relationships between these behaviours and the MCPQ-R personality measures. The age of the dogs at the time the test occurred had an inverse relationship with orientation, direct approaches, indirect approaches, and the exaggerated retreats performed by the dogs during NOT 1. As the age of the dogs increased, the number of times the dogs carried out these behaviours related to exploration on the novel object decreased. This result does not surprise me as older dogs do not have as much energy and may have more life experience and not react to a stimulating novel object the same way a younger dog would by paying more attention to the item, approaching it, and then jumping away from it. Younger dogs also scored higher on the Extraversion personality measure. This finding suggests that the relationship previously discussed between the number of direct approaches and Extraversion may instead be the result of age on either the dog's personality or behaviour, rather than the personality of the dog affecting behaviour. Ley et al. (2009a) also found this result between age and Extraversion and suggested that as dogs age and gain experience, they become less extraverted in a similar fashion to these measures in humans (Ley et al., 2009a; McCrae et al., 2000). In NOT 2, the age of the dog remained inversely related to number of direct approaches and exaggerated retreats but there was no longer this same relationship between orientation, which may be the result of habituation as previously stated, and indirect approach. The loss of the relationship with indirect approach may suggest that younger dogs that do not display bold

behaviours related to Extraversion (direct rather than indirect approach) may result in the dogs performing less exploratory behaviour the longer they are in the presence of the novel object.

We attempted to determine whether the proportion of TPT wins, which has been previously found to increase with personality measures of Extraversion and Motivation, had any relationship with the behaviours coded during the NOTs (Castro, 2017). During NOT 1, it was found that bite was the only behaviour to be related to the proportion of TPT wins. As winning the TPT requires the dog to take possession of the toy, normally by picking the object up and holding it in their mouth, this would suggest that dogs with more TPT wins would also exhibit more behaviour associated with mouth exploration or manipulation of objects. This correlation was lost in NOT 2. It is possible that after the initial exploration of the object during NOT 1, the dog ceased attempts to explore or manipulate the toy after habituating in the first test. However, the number of bites during both tests was very low with only two dogs biting during each test as mentioned above. It was also found that the proportion of TPT wins was positively correlated with the MCPQ-R dimension, Extraversion, as was age and number of direct approaches during both NOTs. Within Extraversion, the adjectives that most relate to this dimension include "active", "energetic", and "restless", traits that suggest dogs higher in Extraversion would have the energy to participate and take possession of the toy during the TPT. These tests are an attempt to measure resource competition between animals and by having more energy and being active the individual would have an advantage in acquiring resources from conspecifics. Castro (2017) found that using the MCPQ-R, the proportion of TPT wins scored higher on measures of Extraversion and Motivation. However, she also found that high levels of testosterone with low levels of cortisol were also related to these results. The dogs winning the TPTs were also found to be younger, suggesting that this finding could be the result of age, rather than personality. In a

study by Cafazzo et al. (2010), they found that in free-ranging domesticated dogs, rank-order shared a significant correlation with age, and both of these measures were correlated with food stealing. This relationship was not seen in our study, suggesting that the TPT may not be a test of dominance between housemates, and instead it may be a test for comparing levels of activity and motivation. Our results showed that the proportion of TPT wins are a valid predictive measure for scores of Extraversion but not a predictive measure for the outcomes of NOTs, with the exception of times with dog bit the novel object.

For a portion of the results seen in this study, it is possible that some of the correlations could be spurious and may not actually be significant despite the statistics saying they are. As more tests are conducted, it is more likely that the correlations produced are not actually significant. To counteract this effect, a Bonferroni correction factor can be used to address this issue by adjusting the p values (Eichstaedt et al., 2013). As a result, this will decrease the probability of Type I errors. However, there are some issues with using Bonferroni. It has been suggested that this factor is much too conservative and puts too much constraint on the data (Eichstaedt et al., 2013).

In order to expand on the results of this study, the behaviours displayed by each dog toward their other household member, as well as the behaviours of the dogs toward their owners, could be coded in to find more evidence that could potentially support or refute the results of this study. The behaviours involved in dog-dog interactions could shed more light on the results of the TPTs as this test is meant to be a measure of competitive performance between two or more animals. The behaviours displayed by the dogs toward each other could also be used to discuss the possibility of dominance hierarchies that may or may not exist between dyads. The interactions between the dog and the owner may offer some insights on how dogs with differing

personality traits interact with their owners while faced with the potential threat of a novel object. Due to time constraints, I was unable to code the behaviours presented in Tables 3 and 4. Future research on this subject should also take into account the results of the salivary hormones collected before and after the NOTs in order to determine whether the level of hormones being released indicate any other relationships or aid in explaining the results of this study. By conducting this study, we found several relationships linking behaviours displayed during NOTs with the personality measures of the MCPQ-R and a lack of a relationship between these behaviours and the TPT. To go forward, I would like to continue studying the relationships between measures of personality and outcomes of NOTs but incorporate a way of measuring previous socialization and stimulation in the rearing environments of dogs. This may offer some insight on how rearing environment can be used to predict a dog's future reaction to novelty and how personality development may be affected. There may also be applications for this research in programs such as the ones studied by Bray et al. (2017), which found predictive behaviours displayed during NOTs for program failure in guide dogs. If we are aware of the rearing conditions needed to raise dogs that are less reactive to novelty, then it may be possible to apply the findings to induce more traits associated with Extraversion and Motivation and less with Neuroticism.

**References:**

Boogert, N. J., Reader, S. M., & Laland, K. N. (2006). The relation between social rank, neophobia and individual learning in starlings. *Animal Behaviour, 72*, 1229-1239.

Bradshaw, J. W. S., Blackwell, E., & Casey, R. A. (2016). Dominance in domestic dogs—A response to Schilder et al. (2014). *Journal of Veterinary Behavior: Clinical Applications and Research, 11*(C), 102-108.

Bray, E. E., Sammel, M. D., Cheney, D. L., Serpell, J. A., and Seyfarth, R. A. (2017). Effects of maternal investment, temperament, and cognition on guide dog success. *Proceedings of the National Academy of Sciences of the United States of America, 114*(34), 9128-9133.

Cafazzo, S., Valsecchi, P., Bonanni, R., & Natoli, E. (2010) Dominance in relation to age, sex, and competitive contexts in a group of free-ranging domestic dogs. *Behavioral Ecology, 21*(3), 443–455.

Cafazzo, S., Lazzaroni, M., and Marshall-Pescini, S. (2016). Dominance relationships in a family pack of captive arctic wolves (*Canis lupus arctos*): the influence of competition for food, age and sex. *PeerJ, 4*:e2707.

Castro, M. (2017). *Assessing the social organization of multi-dog households: Dog behaviour, hormones, personality, and demographics*. (Unpublished Master of Science Thesis) Memorial University of Newfoundland, St. John's, Newfoundland.

Chamove, A. S. (1983). Role of dominance in macaque response to novel objects. *Motivation and Emotion, 7*, 213-228.

Eichstaedt, K., Kovatch, K., & Maroof, D. (2013). A less conservative method to adjust for familywise error rate in neuropsychological research: The Holm's sequential Bonferroni

procedure. *NeuroRehabilitation, 32*(3), 693-696.

Fox, R. A., Ladage, L. D., Roth II, T. C., & Pravosudov, V. V. (2009). Behavioral profile predicts dominance status in mountain chickadees. *Animal Behaviour, 77(6)*: 1441–1448.

Fox, M. W. (1972). Socio-ecological implications of individual differences in wolf litters: a developmental and evolutionary perspective. *Behaviour , 41*, 298–313.

Ley, J. M., Bennett, P. C., & Coleman G. J. (2008). Personality dimensions that emerge in companion canines. *Applied Animal Behaviour Science, 110*, 305-317.

Ley, J. M., Bennett, P. C., & Coleman G. J. (2009a). A refinement and validation of the Monash Canine Personality Questionnaire (MCPQ). *Applied Animal Behaviour Science, 116*, 220-227.

Ley, J. M., Mcgreevy, P., & Bennett, P. C.(2009b). Inter-rater and test–retest reliability of the Monash Canine Personality Questionnaire-Revised (MCPQ-R). *Applied Animal Behaviour Science, 119*, 85-90.

Lisberg, A. E. & Snowdon, C. T. (2009). The effects of sex, gonadectomy and status on investigation patterns of unfamiliar conspecific urine in domestic dogs, *Canis familiaris*. *Animal Behaviour, 77*, 1147-1154.

MacDonald, K. B. (1987). Development and stability of personality characteristics in pre-pubertal wolves: implications for pack organization and behavior. In *Man and Wolf*, ed. H Frank. Dordrecht, The Netherlands: Dr. W. Junk Publishers, 293–312.

McCrae, R.R., Costa, P.T., Ostendorf, F., Angleitner, A., Hrebickova, M., Avia, M.D., Sanchez-Bernardos, M.L., Kusdil, M.E., Woodfield, R., Saunders, P.R., Smith, P.B. (2000). Nature over nurture: temperament, personality, and life span development. *J. Pers. Soc. Psychol., 78*, 173–186.

Montiglio, P., Garant, D., Pelletier, F., & Réale, D. (2012). Personality differences are related to long-term stress reactivity in a population of wild eastern chipmunks, *Tamias striatus*. *Animal Behaviour, 84*(4), 1071-1079.

Ottenheimer Carrier, L., Cyr, A., Anderson, R. E., & Walsh, C. J. (2013). Exploring the dog park: Relationships between social behaviours, personality and cortisol in companion dogs. *Applied Animal Behaviour Science, 146*(1), 96-106.

Posluns, J., Anderson, R., & Walsh, C. (2017). Comparing two canine personality assessments: Convergence of the MCPQ-R and DPQ and consensus between dog owners and dog walkers. *Applied Animal Behaviour Science, 188*, 68.

Rayment, D. J., Peters, R. A., Marston, L. C., & De Groef, B. (2016). Investigating canine personality structure using owner questionnaires measuring pet dog behaviour and personality. *Applied Animal Behaviour Science, 180*, 100-106.

Serpell, J., Duffy, D., & Jagoe, J. (2016). Becoming a dog: Early experience and the development of behavior. In J. Serpell (Ed.), *The Domestic Dog: Its Evolution, Behavior and Interactions with People* (pp. 93-117). Cambridge: Cambridge University Press.

Visser, E. K., van Reenen, C. G., van der Werf, J. T. N., Schilder, M. B. H., Knaap, J. H., Barneveld, A., & Blokhuis, H. J. (2002). Heart rate and heart rate variability during a novel object test and a handling test in young horses. *Physiology & Behavior, 76*, 289–296.

Wolf, M. & Krause, J. (2014). Why personality differences matter for social functioning and social structure. *Trends in Ecology & Evolution, 29*(6), 306-308.

Zimmermann, A., Stauffacher, M., Langhans, W., & Würbel, H. (2001). Enrichment-dependent differences in novelty exploration in rats can be explained by habituation. *Behavioural Brain Research, 121*(1), 11-20.