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Personality studies in dogs

Thesis of Doctoral Dissertation

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Background

In the recent decades, several studies provided evidence that personality exists in a wide range of animal species, from primates to cephalopods (Gosling, 2001), and individuals differ in a wide range of personality traits from aggressiveness to fearfulness. Studying individual behavioural variations in animals could be useful from both a theoretical point of view (e.g. understanding of the evolution and development of behaviour, Wolf et al., 2008) and for possible applied consequences (e.g. understanding the relationship between personality and disease susceptibility/resilience, Cavigelli, 2005). Moreover, since several elements of personality are universal in animals and show generality across species (Gosling and John, 1999), studying animal personality could also contribute to our knowledge about personality in humans.

As dogs became one of the most frequently owned pets throughout the world, many groups of people (owners, trainers, shelter organizations) became interested in assessing individual differences in behaviour of dogs. The general aims of the studies described in this thesis were to develop reliable ethological methods for measuring personality traits in dogs and to identify both environmental and genetic factors in association with these traits.

Personality can be defined as an individual's distinctive behavioural pattern that is consistent across time and situations. In dogs, personality assessment methods are based on the observed behavioural pattern of the animals in different situations – in the case of a test battery, the researcher observes the dog's behaviour in several standardized situations and in the case of a questionnaire, the owner reports what he/she observed during the dog's everyday life. In both cases, the consistency of the behaviour across situations and the consistency across time should be proved in order to call the derived traits personality.

Personality is the outcome of the interplay between genetic and environmental effects. Environmental factors like the dog–keeping practices of the owner (e.g. how much time the owner spends with the dog) or the characteristics of the household (e.g. the dog lives alone or with other dogs), as well as the dog's biological characteristics (e.g. sex, age, neutering) influence what kind of experiences the dog could gather during its life, which, in turn, could contribute to the development of the dog's personality. Dogs' great morphological and behavioural diversity and their unique genetic make–up make them an ideal model species in behavioural genetic research (Spady and Ostrander, 2008). As dog breeds are genetically isolated units (Shearin and Ostrander, 2010) and some personality traits could have a considerable genetic background (e.g. Liinamo et al., 2007), analysing the behaviour differences among breeds could indirectly reflect the genetic background of the investigated traits. However, in studies aiming to assess direct genotype–phenotype

associations, individual–based methods are preferable to breed comparisons since the effect of a single allele on behaviour is relatively small and could be easily overshadowed by breed effects.

Aims

In *Study I*, analysing a large number of dogs (N > 10,000 individuals) we aimed to explore the most relevant demographic and environmental factors and their complex interactions in association with four dog personality traits.

As an exploratory study, we did not have any direct hypotheses regarding the results.

In *Study II*, we focused on the personality of the owner as a special environmental factor affecting the dogs' personality and also investigated the possible sources of this personality correspondence.

- Based on the evidence of personality similarity described in various human relationships (e.g. Barelds and Barelds–Dijkstra, 2007), we expected positive correlations (similarity) between the owners and their dogs (*Hypothesis 1*).
- We tested if peer raters also assess the owner and dog as similar to each other – we predicted weaker but significant similarity between the owners and dogs (*Hypothesis 2*).
- We tested if time spent together affects the similarity; however, we made no specific predictions, since the human literature is inconsistent on this matter.
- We took into account how multiple owner–dog relationships influence personality matching – we hypothesized different similarity patterns to the owner in the case of two dogs living in the same household (*Hypothesis 3*).
- We repeated the observation in two countries (Austria and Hungary) – expecting different similarity patterns in them (*Hypothesis 4*).

In *Study III*, we investigated the behaviour of dog breeds. Our aims were threefold:

- We investigated the across–breed and intra–breed variability of four personality traits among 98 dog breeds.
- We characterized the breeds based on their typical behaviour and investigated their behavioural similarity.
- We analysed whether the earlier function of the breeds or the genetic relatedness between breeds affects their behaviour.

Again, as an exploratory study, we did not make direct predictions regarding the results.

In *Study IV* we investigated direct gene × behaviour associations. We used the candidate gene approach to explore the associations between the gene polymorphisms in the dopamine and oxytocin systems and certain personality traits in dogs. In human studies, genetic polymorphisms in

the dopamine system were related to a number of psychiatric diseases, including ADHD (e.g. Ebstein et al., 1996). In dogs, polymorphism in the dopamine D4 receptor gene (DRD4) was found to be associated with an activity–impulsivity phenotype (Héjjas et al., 2007). We investigated whether the polymorphisms in the tyrosine hydroxylase (TH) gene (a rate–limiting enzyme in the dopamine system) are also associated with the activity–impulsivity phenotype of dogs.

- Based on the role the TH gene plays in the dopamine system, we expected that TH polymorphisms will be associated with activity–impulsivity in dogs (*Hypothesis 1*).

Oxytocin is considered to have a key function among the regulators of social behaviour - for example, relating to mother–infant attachment (Campbell, 2008) or prosocial behaviour (Tost et al., 2010). We investigated the associations between polymorphisms in the oxytocin receptor gene (OXTR) gene and the social behaviour of dogs.

- Based on human findings, the polymorphisms in the OXTR gene were expected to associate with social behaviours of dogs towards humans (*Hypothesis 2*).

Methods

Subjects, data collection

In *Study I*, we used an online questionnaire to collect information about dogs' behaviour (24 items) and the demographic and environmental characteristics of dogs and owners (14 variables). Altogether, data on N = 10,330 dogs were analysed.

In *Study II*, we used two already established questionnaires, the 44–item Big Five Inventory (John and Srivastava, 1999) and the 43–item Canine Big Five Inventory (Gosling et al., 2003) to assess the owners' and dogs' personality. Altogether N = 518 dogs (N = 389 owners) participated in this study, and N = 104 peer ratings were collected.

In *Study III*, we used a subset of the data gathered in *Study I*. Our subjects were adult purebred dogs from breeds with at least 10 individuals. These breeds were grouped based on their hypothesised earlier function (using the AKC breed groups) and based on their genetic relatedness (using the clusters created by Parker et al., 2007). Altogether N = 5733 dogs (98 breeds) were analysed.

In *Study IV*, we developed a test battery consisting of 7 situations to measure the dogs' activity–impulsivity and social behaviour. The activity–impulsivity phenotype was also assessed with a questionnaire (Dog–ADHD RS, Vas et al., 2007). We tested N = 104 German Shepherd Dogs with this battery. The DNA of the dogs was collected with a non–invasive method; the TH and OXTR genotypes were analysed by our collaborative partners at Semmelweis University.

Trait extracting

In *Study I* and *IV* we used principal component analyses (PCA) to investigate the relationship between the questionnaire items (*Study I*) and behaviour variables (*Study IV*). In *Study II* and *III* we used already established measures in assessing the personality of the dogs (and owners, in the case of *Study II*). In all our studies, internal consistency (consistency across situations – assessed by Cronbach's alpha), test–retest reliability (consistency over time – assessed by intraclass correlation), and inter–rater reliability (assessed by intraclass correlation) were analysed for all traits.

Statistical analyses

Study I – To examine the associations between the demographic and dog keeping variables and the personality of the dogs, we carried out four regression tree analyses, one for each trait.

Study II – The personality similarity between owners and dogs and the similarity assessed by peer raters were analysed by Pearson correlations. The effect of the length of ownership, number of dogs in the household and country of residence were investigated using five GLM models (one for each dog trait).

Study III – To compare the trait scores and intra–breed variability between the breeds we used two MANCOVA models. The breeds' behavioural similarity was assessed by hierarchical cluster analysis. To analyse the effect of the earlier function of the breeds and the genetic relatedness between breeds on their behaviour, we again used two MANCOVA models.

Study IV – To investigate the associations between the TH and OXTR genotypes of the dog and its activity–impulsivity and social behaviour, we used one–way ANOVA.

Results

STUDY I. Demographic and environmental factors in association with dog personality traits

The aim of this exploratory study was to analyze the effects of multiple environmental factors and their interaction on dog personality.

- We obtained four personality traits from the dog behaviour questionnaire, labelled as calmness, trainability, dog sociability and boldness. The internal consistency, test–retest reliability and inter–rater reliability of these traits were acceptable.
- The dog's age, the age at acquisition, neutering status and training experience had the most significant effect on the calmness trait. Older dogs were calmer than their younger counterparts, neutering was related to lower calmness scores, and earlier acquisition of the dog and more training experience were reported to enhance the dogs' calmness.

- The dog's training experience, the age of the dog, and purpose of keeping the dog had the most significant effect on the trainability score. More training experience resulted in higher trainability score, younger dogs were reported to be more trainable than older dogs, and dogs kept only as a member of the family (without any specific function) had lower scores on trainability than dogs that had a specific function (e.g. workmate).
- The dog's age, the time spent together with the owner, and the sex of the dog had the most significant effect on the dog sociability trait. Older dogs and males were less sociable towards other dogs, and time spent together with the dog enhanced its sociability.
- The sex of the dog, the age at acquisition, and age of the dog had the most significant effect on the boldness trait. Males were reported to be bolder than females, and younger dogs were bolder in both sexes. Males were bolder if acquired at a younger age; females were less bold if they were either bred by the owner or acquired after one year of age.

STUDY II. Personality matching in owner–dog dyads

In the present study, we tested for the association between owners' and their dogs' perceived personality.

- Four of the five personality traits derived from the questionnaires (extraversion, agreeableness, conscientiousness, and neuroticism) were reliable both in the case of dogs and humans, but the Openness trait seems to be not reliable in the case of dogs.
- We found significant positive correlations between owners and dogs in all five traits; the correlations between real dog–owner pairs were significantly higher than those between random created dog–owner pairs, confirming *Hypothesis 1*.
- We found significant positive correlations between dog and owner personality in all but the openness trait, when a peer person assessed the dogs' personality and when a peer person assessed both the owner and dog, confirming (partly) *Hypothesis 2*.
- We found no significant effect of the length of ownership on the owner–dog personality similarity.
- The correlations, particularly in extraversion and neuroticism traits, were affected by the number of dogs in the household, confirming *Hypothesis 3*. We found the highest mean correlation in the case of single dog households in both countries. In multi–dog households, the similarity patterns of dogs acquired first and second complemented each other and formed the same similarity pattern as that of single dogs.
- The country of residence also affected the similarity pattern. We found more and higher correlations between the owners and dogs in the Hungarian sample; particularly, no similarity

was found in conscientiousness and openness traits in the Austrian sample, confirming *Hypothesis 4*.

STUDY III. Breed and breed–group differences in personality traits

The main focus of this study was directed to the typical behaviour and behavioural differences among dog breeds.

- Dog breeds differed in all four traits (calmness, trainability, dog sociability and boldness); the strongest breed difference was found in the trainability trait, the weakest in calmness. The highest intra–breed variability was found in the calmness trait, the lowest in trainability.
- We provided descriptive analyses of 98 breeds in terms of their typical behaviour, within–breed variability, and behavioural similarity / divergence. The latter analysis resulted in 6 behavioural breed clusters.
- Significant differences in the trainability and boldness traits were found between the AKC breed groups: Herding dogs were reported by their owner to be more trainable than Hounds, Working dogs, Toy dogs, and Non–sporting dogs. Sporting dogs were also more trainable than Non–sporting dogs. Terriers scored higher on boldness than Hounds and Herding dogs; Working dogs were also bolder than Hounds.
- The genetic clusters differed also in trainability and boldness: the cluster of Ancient breeds was less trainable than the Mastiff/Terrier cluster, the Herding/Sighthound cluster, and the Hunting cluster. The Mastiff/Terrier cluster was bolder than the Herding/Sighthound cluster, the Ancient breeds cluster, and the Hunting cluster.

STUDY IV. Gene polymorphisms in association with dog personality traits

Our aim in the current study was to investigate the associations between certain candidate gene polymorphisms and personality traits in dogs.

- We obtained four traits from the dog behaviour test battery: Activity–impulsivity, Proximity seeking, Reaction to separation from the owner, and Looking at humans. The internal consistency, test–retest reliability and inter–rater reliability of the first three traits were acceptable; the Looking at humans trait was not consistent across situations nor over time.
- The TH polymorphism was associated with both the Activity–impulsivity behaviour scale, and the Dog–ADHD activity–impulsivity questionnaire scale, confirming *Hypothesis 1*. Dogs possessing at least one short allele were reported to be more active–impulsive by the owners and reached higher scores on the behavioural scale than homozygotes possessing the longer alleles exclusively.

- Both the rs8679684 and the 19131AG polymorphisms of the OXTR gene were associated with the traits of Proximity seeking and Reaction to separation from the owner, confirming *Hypothesis 2*. Dogs carrying the T allele in the case of the rs8679684 SNP / the G allele in the case of the 19131AG SNP showed lower proximity seeking towards the experimenter and higher reaction to separation from the owner.

Summary of the most important findings

I. Our studies provided further evidence that personality axes related to reactivity–fearfulness–neuroticism, sociability–aggressiveness–agreeableness, and activity–extraversion exist in dogs. Another, more dog–specific personality axis might be composed from trainability, conscientiousness and some aspects of openness.

II. We demonstrated that the most important demographic and dog keeping factors affecting the dog personality traits were the age of the dog, the sex and neutering status, the training level and the dog's age at acquisition. These factors did not act independently from each other; instead we found complex interactions between them in association with each trait.

III. We provided the first evidence that owners and dogs are similar to each other in their personality profile. The similarity in extraversion, agreeableness, conscientiousness and neuroticism is not only the owners' perception and is not related to the length of relationship, but is affected by the number of dogs in the household and the country of residence. However, the similarity in openness trait seems to be only a perception of the owner. Our results indicate that owners treat their dogs similarly to their human social partners, suggesting that the dog–human relationship could be used as a model for the development and maintenance of social relationships among humans.

IV. We found large differences among dog breeds in four personality traits. Our results showed that trainability could be considered as a characteristic feature for a large number of breeds, while calmness is more likely to differ between individuals rather than between breeds. The earlier function of the breeds, as well as their genetic relatedness, are both associated with trainability and boldness traits.

V. The TH gene polymorphism was related to activity–impulsivity, and two SNPs of the OXTR were related to the traits of Proximity seeking and Reaction to separation from the owner. These results support previous findings (e.g. Héjjas et al., 2007; Wan et al., 2013) and provided the first evidence that OXTR polymorphisms are related to human–directed social behaviour in dogs. Both of these gene × behaviour associations support the results of human

studies and offer the dog as a model for studying underlying genetic factors of certain human behaviours.

Publications that form the basis of the thesis

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Kubinyi, E., Vas, J., Héjjas, K., Ronai, Zs., Brúder, I., **Turcsán, B.,** Sasvári–Székely, M., Miklósi, Á., 2012. Polymorphism in the tyrosine hydroxylase (TH) gene is associated with activity–impulsivity in German Shepherd dogs. *PLoS ONE,* 7: e30271.

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