The relationship between personality traits and their effect on learning in dogs

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Summary

Dogs fulfil numerous important rolls in our society, such as police dogs, military working dogs and guide dogs for the blind. To perform well on duty it is crucial for these service dogs to learn certain behaviours and to be able to carry them out under any and all circumstances. For different reasons some dogs are more able to function as a service dog than others. To assess which individual dogs are most suitable to fulfil a certain role researchers have been working on the development of different methods to evaluate dog personality and temperament. Over the years this has led to numerous behavioural tests and questionnaires being developed. Assessing the quality of these tests has proven to be challenging, for the degree to which their reliability and validity have been assessed varies greatly. The aim of this study was to assess whether personality plays a role in learning ability in dogs. Additionally we wanted to investigate whether we could identify other factors influencing learning ability and whether different personality traits correlated with each other.

For this study we used 22 pet dogs with various backgrounds and training experience. To assess the dogs' learning ability we measured how many trials it took them to learn a size discrimination task. For the assessment of their personality we used three previously validated questionnaires (Dog Impulsivity Assessment Scale, Positive And Negative Activation Scale and Monash Canine Personality Questionnaire – Revised) filled out by the owners of the dogs.

We found that younger dogs learned the discrimination task significantly more quickly compared to older dogs. In contrast we found no effect of gender, training experience or personality on the number of trials the dogs needed to learn the task. Looking at the relationship between the different personality traits as assessed by the questionnaires we found significant positive correlations between impulsivity, positive activation and extraversion, between impulsivity and motivation and between neuroticism and aggression & response to novelty. We explain these effects in light of the Reward Sensitivity Theory in human personality research.

Introduction

Dogs fulfil numerous important roles in our society varying from assistance dogs for the blind, working dogs for the military and the police, to our loving companions. A dog's value in a service role depends on its ability to learn quickly and reliably, and its ability to perform under any and all circumstances. For pet dogs these factors also play a role in determining how well they fit into human society. Research in the field of personality and temperament has expanded rapidly over the years given the need to accurately assess and match an individual's suitability for a specific role, particularly with working dogs. A wide range of personality and temperament tests, and questionnaires for dogs have been developed by different research groups and for different reasons. Some aimed to search for a tool to determine which dogs will be suitable for a function as assistance dogs for either people with disabilities[1-4] or for the police and military[5-7]. Others were interested in finding a way to match shelter dogs' personalities with owner expectations and finding a way to predict future behaviour in a different environment.[8-10] This growing interest in dog personality has led to over 95 published studies on this topic since the 1930s.[11]

Personality in dogs

Personality can be defined as a set of behaviours that is relatively consistent over context and time. Within personality different traits or dimensions can be identified. In 2005 Jones and Gosling reviewed 51 articles on personality in dogs.[12] They found little agreement within the field with great variation in research goals and the terminology used to describe personality traits. Additionally, the populations used in most of these studies were limited in their variance: Labrador Retrievers and German Shepherds made up 32% of the populations studied in contrast to mixed breeds, which were hardly represented. In addition, a large proportion of the dogs involved had been specifically bred and reared to fulfil a service role later in life. All these factors made it difficult to compare the results of the studies and to extrapolate their findings to the general dog population. In conjunction with other professionals from the field, the authors did however extract seven broad personality dimensions based on the studies they reviewed. The dimensions were labelled reactivity, fearfulness, activity, sociability, aggression, submissiveness and responsiveness to training. Of these dimensions fearfulness and sociability were studied most extensively.

In 2015 Gartner conducted a similar review and identified an additional 44 articles on personality in dogs.[11] Of these, 26 focussed on pet dogs, compared to only 17 out of 51 articles published before 2005. This has led to a greater variety in breeds used and an increase in the inclusion of mixed breeds. Therefore the results of all these studies combined are more likely to be representative of the general dog population and their given roles within society. However, there is still a large variety in terminology used in different studies which means comparison of results remains challenging.

Assessing personality

To assess different traits within the concept of personality different methods are available. Jones and Gosling (2005) grouped the studies they reviewed by the assessment type for the individual animal. Assessment types included test batteries, observational tests, ratings of individual dogs, and a combination of these.[12] In both the test batteries and the observational tests the dog's behaviour was recorded during the presentation of different stimuli. In the test batteries dogs were presented with very specific and usually novel stimuli in a controlled situation. In the observational studies dogs were presented with naturally occurring and relatively common stimuli. An example of a subtest would be a dog's willingness to walk with a stranger, which would be a measure for its sociability. Of these methods the test battery is usually considered to be most objective even though this varied between studies.[12] By using experienced observers to evaluate the dog's response in controlled and replicable situations, and using well-defined behaviour units in terms of duration, frequency and latency to describe

these responses, the highest level of objectivity can be reached, whereas allowing the observer to use nominative scales or scoring systems leads to more subjectivity.[13] The use of test batteries also has a number of downsides including the limitation to the number of test situations one can use which could mean the results are context specific. Another issue is test items that might elicit a fearful or aggressive response are excluded because of ethical and welfare concerns or this response is not displayed by dogs in controlled test situations, which makes it harder to identify traits associated with these behaviours.[13]

For the rating of individual dogs Jones and Gosling (2005) identified studies in which researchers relied on the owners or handlers to rate the occurrence and frequency of certain behaviours by means of a questionnaire.[12] Using this method to gather data about an individual dog is generally considered to be a subjective measure. As owners may differ in how they interpret the scale used for quantification or qualification, or their interpretation of their dog's behaviour. Questionnaires do however leave more room to describe a larger set of contexts and might therefore provide a more generalised overview of a dog's behaviour in everyday life. Additionally it is less time consuming to use owners' ratings compared to using behavioural tests to assess personality. This generally means a larger dataset can be generated in a shorter period of time.[13]

In humans, questionnaire based rating systems either filled out by the individual or a close acquaintance have been used for over fifty years to assess personality.[14, 15] Researchers have shown that humans are equally capable of reliable assessment of their dog's personality as they are when assessing the personality of their close acquaintances.[16] There are now numerous personality questionnaires which have been developed for dogs.

When it comes to evaluating the quality of a questionnaire, it is essential to look at its reliability and validity. Reliability refers to the degree to which the results of the questionnaire are free from measurement errors. It is assessed by looking at the consistency of the questionnaire outcome when the individual who fills out the questionnaire does so at multiple points in time (intra-observer reliability), between two individuals who fill out the questionnaire about the same dog at the same time (inter-observer reliability), over time within the same individual (test-retest reliability) and between items grouped in the same factor (internal consistency). The test-retest reliability is a distinct part of the development of personality tests since it relies on the consistency of personality traits over time, as opposed to behavioural tests whose results might change over time due to behavioural modification for example.

Validity refers to the degree to which the questionnaire measures what it is said to measure. It is assessed by looking at the extent to which items within a factor cover all aspects of the personality trait (content validity), the extent to which factors correlate positively with similar factors and negatively with dissimilar factors (construct validity), and the extent to which the questionnaire outcome correlates with the outcome of another, more established test that measures the same personality trait (concurrent validity).[17, 18] The degree to which reliability and validity have been assessed in currently available questionnaires varies considerably. Additionally, in a lot of studies that mention reliability and validity no numerical indices have been reported.[12, 18]

The three most thoroughly assessed questionnaires when it comes to reliability and validity, are the Dog Impulsivity Assessment Scale (DIAS), the Positive And Negative Activation Scale (PANAS) and the Monash Canine Personality Questionnaire - Revised (MCPQ-R) which are designed solely for the purpose of assessing personality traits that are considered stable over time, unlike some other questionnaires, for example the Canine Behavioral Assessment and Research Questionnaire (C-BARQ)[19], which is used for screening dogs for behavioural problems and assessing the effect of treatment.

In the development of the DIAS, PANAS and MCPQ-R items of interest were subjected to principal component analysis, a data reduction technique used to place individual items into

factors based on their consistent correlation. Its outcome indicate the number of factors that can be identified within the questionnaire.

The DIAS was designed to assess the impulsivity level of individual dogs.[20] This trait can be defined as the inability to react in a well-considered manner to either internal or external stimuli and without taking possible consequences into account.[21, 22] In the development of the questionnaire a three-factor solution proved to have the highest internal consistency and was easiest to interpret in a biological sense. The test-retest reliability (>6 weeks apart) was assessed and items that did not correlate or whose median test-retest scores differed significantly were removed from further analysis. There is evidence that the questionnaire measured what it intended to measure, therefore showing face (or content) validity. Construct validity was assessed by looking at the correlation between two subjective statements regarding a dog's impulsivity level and the questionnaire outcomes (convergent validity).[20] In a follow-up study they demonstrated concurrent validity by comparing the DIAS outcomes with physiological and behavioural parameters. They found high impulsivity scores were significantly correlated with a reduced tolerance to delay in a delayed reward test and with lower levels of urinary serotonin and serotonin/dopamine ratio.[23] The combined results of these studies demonstrate high reliability and validity, which means the quality of the questionnaire can be considered high.

The PANAS was designed to measure a dog's sensitivity to punishing and rewarding stimuli in the environment. A two-factor solution proved to be most suitable for this questionnaire. Further data reduction resulted in the identification of three facets of positive activation, which corresponded well with the hypothesised construct. The test-retest reliability was assessed in the same way as in the DIAS. The construct of the PANAS is similar to the one used to describe positive and negative activation in humans, therefore providing evidence for content validity. However, the authors warn against assuming homology between the canine and human scales in the absence of concurrent validity measured by the correlation between the questionnaire outcome and physiological parameters.[24] Although the PANAS shows evidence of reliability and validity, it would benefit from further validation, particularly in the area of concurrent validity which would increase the value of the questionnaire.

The MCPQ-R was developed to assess multiple distinct traits in dog personality, for which five-factor solution was deemed most appropriate.[25] In a follow-up study structural equation modelling indicated instability of the initial questionnaire, which resulted in a revision of the questionnaire by the removal of a number of items from the item pool. The five factors identified in the initial MCPQ were highly similar in the new revised model and showed good internal consistency. Several goodness-of-fit indices indicated the new model was appropriate to the data set at hand.[26] The inter-observer reliability and test-retest reliability were investigated in yet another study. Both methods indicated a high reliability of the revised questionnaire.[27] This questionnaire has been assessed for validity and reliability to the approximate same degree as the PANAS. This means the MCPQ-R should also be further validated against physiological and/or behavioural parameters that are more established in measuring the personality dimensions identified in this questionnaire.

The relationship between personality traits and learning ability

A number of personality traits are expected to influence a dog's ability to learn, the most obvious being 'trainability'. This trait, under different names, has been extensively studied and was also one of the dimensions identified by Jones and Gosling (2005). It was rated by looking at parameters such as how willing dogs were to work with people, how quickly they would learn in new situations, how playful they were and to what extent they reacted to the environment.[12] In the more recent review by Gartner (2015) numerous new articles were identified studying trainability in dogs.[11] Some of these studied trainability among other things by questionnaires scores only[25, 28, 29], while others compared questionnaire scores with the outcome of a temperament test.[30-34] To the author's knowledge only one study looked at comparing a

questionnaire score with a dog's performance on a learning task. In this study by Jakovcevic (2012) researchers compared questionnaire scores with the outcomes of a sociability test and a learning task involving gazing behaviour. They found clear associations between the questionnaire scores for trainability, the outcome of the sociability test and the learning task. More sociable dogs did better on the learning task and were perceived as being more easily trainable. However, they did not look at how long it took dogs to learn or set a criterion for achieving the task which makes it difficult for them to have truly assessed the dogs' learning ability.[35]

Besides trainability, some other personality traits are expected to influence a dog's performance on a learning task to some degree. One example would be impulsivity, for it seems likely that the inability to control one's actions would result in numerous errors in a decision making task and would therefore increase the number of trials an individual needs to master the task. Another factor that might influence the training outcome is an individual's sensitivity to positive and negative stimuli in the environment. Research suggests that training performance in dogs could benefit from tailoring one's training methods to the dog's individual sensitivity to reward and punishment.[24] In humans the trait neuroticism also seems to play a role in learning differences. Research suggests that more neurotic individuals perform better on a discrimination task which requires combining stimuli.[36] However, neurotic individuals appear to lose accuracy when slowing down following negative feedback in contrast to individuals scoring low on the neuroticism trait.[37] This suggests a relationship between neuroticism and the sensitivity to negative stimuli in the environment. Impulsivity on the other hand seems to be related to sensitivity to positive stimuli in the environment in humans.[38] Although it hasn't yet been studied in dogs, it seems likely that correlations between traits do not exclusively occur in humans.

Assessing learning ability

One way to measure a dog's ability to learn is by assessing its performance in a discrimination task, for example by measuring the number of trials a dog needs to master the task or the number of errors it makes during training. In animal research a number of different types of discrimination tasks are used including visual (i.e. size, object, colour), auditory and scent discrimination. Visual discrimination tasks have been extensively used in laboratory beagles in research on age related cognitive decline in relation to human and canine Alzheimer's disease.[39-45]

Aims

The aim of this study was to evaluate the possible effects of personality and several demographic variables on learning ability, measured by the number of trials it took a dog to learn a discrimination task. We hypothesised that certain personality traits (e.g. impulsivity, positive and negative activation, training focus and neuroticism) would influence learning ability in dogs.

Additionally, the correlation between the different personality traits described in different questionnaires was evaluated. We hypothesised that certain personality traits would occur concurrently in dogs, as they do in humans.

Materials and methods

Animals

A total of twenty-two dogs were recruited for this study from Lincoln University's PetsCanDo database. The group comprised pet dogs from the UK with various backgrounds. Dogs with visual or auditory impairments, a history of aggression or extreme fearfulness were excluded from the study.

Of the twenty-two dogs that were recruited, ten (n=10) dogs completed the study. The characteristics of these dogs can be found in table 1. The mean age of the dogs who completed the study was 4 years and 5 months ± 2y1m.

	Breed	***Age***	***Gender****	***General training experience†***	***Problem solving experience‡***
1	Working Cocker Spaniel	1y2m	♂ n	Small	None
2	Siberian Husky	5y0m	♀ n	Large	Large
3	Siberian Husky	3y6m	♀ n	Large	Large
4	Labrador Retriever	2y0m	♂ n	Large	Large
5	Border Collie	6y6m	♀ n	Large	Large
6	Labrador Retriever	7y5m	♀ n	Large	Moderate
7	Labrador Retriever	2y5m	♀ n	Large	Moderate
8	Cocker Spaniel	5y6m	♀ n	Large	Moderate
9	Labrador Retriever	5y5m	♂ n	Moderate	Moderate
10	Crossbreed	5y6m	♀ n	Large	Large

Table 1. Characteristics of the successful dogs
* n = Neutered
† Owner response to statement: *Concerning my dog's general level of training, I would say that (s)he has a _____ experience.*
‡ Owner response to statement: *Concerning my dog's level of training which involves problem solving (e.g. clicker training, shaping and having to work things out for themselves) I would say that (s)he has a _____ experience.*

When looking at learning ability only the data of dogs that reached criterion (n=10) were used for analysis.

An additional six (n=6) dogs were withdrawn from the study before reaching criterion. Their characteristics can be found in table 2. The mean age was 3y5m ± 2y.

	Breed	***Age***	***Gender****	***General training experience†***	***Problem solving experience‡***
1	Miniature Schnauzer	1y6m	♂	Moderate	Small
2	Labradoodle	6y2m	♂ n	Moderate	Small
3	Working Cocker Spaniel	2y0m	♀	Large	Moderate
4	Cockerpoo	2y6m	♂	Large	Large
5	Miniature Schnauzer	5y7m	♂	Large	Moderate
6	German Spitz Mittel	2y6m	♀ n	Moderate	Moderate

Table 2. Characteristics of the pulled dogs
* n = Neutered
† Owner response to statement: *Concerning my dog's general level of training, I would say that (s)he has a _____ experience.*
‡ Owner response to statement: *Concerning my dog's level of training which involves problem solving (e.g. clicker training, shaping and having to work things out for themselves) I would say that (s)he has a _____ experience.*

When assessing correlations between different personality traits as assessed by the questionnaire scores the data of all sixteen dogs (n=16) shown in table 1 and 2 were used for analysis.

Questionnaires

Owners whose dogs participated in this study completed a consent form, a demographics form and three questionnaires assessing different personality traits.

The Dog Impulsivity Assessment Scale (DIAS) comprises a 3-factor owner questionnaire. A total of 18 different statements are divided over the following factors: Factor 1 "Behavioural regulation", Factor 2 "Aggression & response to novelty" and Factor 3 "Responsiveness". All statements are scored on a 5 point Likert scale ranging from "strongly agree" to "strongly disagree". An overall score is calculated for each factor individually and for the overall questionnaire.

The Positive And Negative Activation Scale (PANAS) consists of 21 statements being either associated with positive (n=10) or with negative activation (n=11). Statements were scored in the same fashion as the DIAS. In addition to an overall score for positive and negative activation, "energy and interest", "persistence" and "excitement" were calculated separately as different facets of positive activation.

The Monash Canine Personality Questionnaire – Revised (MCPQ-R) comprises a total of 26 single words considered 'trait words' that fall in either of the following five personality dimensions: "extraversion", "motivation", "training focus", "amicability" and "neuroticism". All trait words are scored on a 6 point Likert scale ranging from "really describes my dog" to "really doesn't describe my dog".

Training

The initial setup and training protocol were largely based on a previous study by Bordin in 2013.[46] For this study the dogs were taught a size discrimination. For this purpose two differently sized cream coloured Curver boxes were acquired from Morrisons supermarket. The larger box was 35 x 29 x 22cm and the smaller box was 25 x 19 x 10cm. The dogs were semi-randomly assigned to one of the boxes.

A pilot study was conducted with 5 staff dogs to determine the optimal distance the dogs had to travel to the boxes (i.e. not too close for the task to be too easy, yet not too far to cause dogs to become unwilling to travel the distance) and the positioning of the dog and researcher. Based on the pilot and the studies by Hewison et al. (unpublished) and Brady et al. (unpublished) on the maximum distance dogs were willing to travel to receive a higher value reward, a maximum distance of 3m was decided on. After testing 4 privately owned pet dogs recruited from the Pets Can Do database the protocol was amended to include a pre-training phase which made it easier for dogs to learn the task.

Before the training started each dog was allowed as much time as it needed to habituate to the new environment and the presence of the researcher and assistant. Owners were encouraged to be present during this time. Dogs were considered as having habituated once they voluntarily approached the researcher after which time, the pre-training phase started. During this phase dogs that had not been previously trained using a clicker were classically conditioned to associate the sound of a clicker with a food reward. Additionally, using the clicker to shape the behaviours, we taught all dogs to sit or lay on a mat and to touch a target on a target stick with their nose. Once the dog was engaged and working successfully with the researcher the owners were asked to leave the room so they did not influence their dog's behaviour. At all time, owners were able to observe activities through a one way mirror. All exercises practiced during the pre-training stage were repeated without the owners present to check whether the dog was still willing to work for the researcher and cope with their absence,

after which the training phase started. If the dog didn't cope, the owners were asked to return and be present during the entire training phase. They were then asked to sit behind the start point for the dog facing away from the setup to prevent them from influencing their dog's behaviour.

The researcher wore sunglasses and was positioned behind the dog during each trial to avoid influencing the dog's choice with her gaze direction or position. The dogs were taken outside for a break after each 20 minutes of training. Additional indoor breaks between sessions were provided when needed. Water was available at all times.

Setup

The study was set up in one of three available large training rooms. The boxes were each placed in a 70 x 75cm rectangular mark on the floor. The distance between these marks was 1,5m (figure 1).

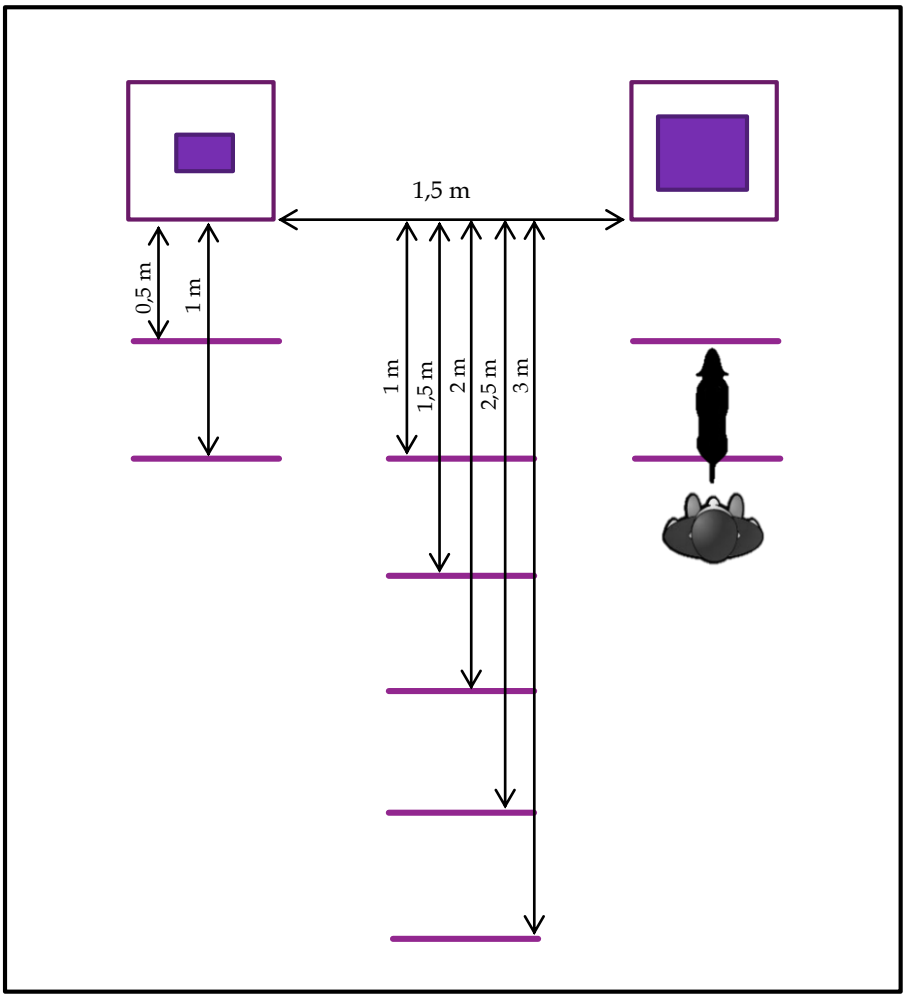

Figure 1. Schematic overview of the setup

During a trial the boxes were placed at their designated marks. The dog was positioned behind the appropriate mark on the floor and was restrained by the researcher. The dog was released after a verbal release cue and allowed to roam freely in the room. When the dog crossed the mark on the floor surrounding the correct box with one or more front paw the researcher used a clicker to indicate a correct behaviour and the dog received a reward from the hand of the researcher. If the dog had not reached the correct box after 20 seconds, the trial ended and the dog was repositioned for a next trial.

All trials were scored based on the scoring system presented in table 3. Score 5 required the dog to have directed itself towards the correct box before they cross the 1m mark in the middle (figure 1).

Scoring System used during Training

Score	**Description**
0	No response within twenty seconds of the release cue
1	A **non-specific response** to the release cue (e.g. the dog sits or engages in any other behaviour without crossing the line that marks the start of the trial within twenty seconds of the release cue)
2	An **incomplete response** to the release cue (e.g. the dog crosses the line that marks the start of the trial but goes in a direction not related to the presence of the boxes, or directs itself towards the incorrect box without correcting itself within twenty seconds of the release cue)
3	A **complete but corrected response** to the release cue (e.g. the dog crosses the line that indicates the start of the trial and initially crosses the mark around the incorrect box but corrects itself by going to the correct box within twenty seconds of the release cue)
4	A **complete but delayed response** to the release cue (e.g. the dog crosses the line that indicates the start of the trial and crosses the mark around the correct box within six to twenty seconds)
5	A **complete and instant response** to the release cue (e.g. the dog crosses the line that indicates the start of the trial and crosses the mark around the correct box within five seconds of the release cue)

Table 3. Scoring system adapted from Fukuzawa et al. (2005)[47] and Bordin (2013)[46]

Training protocol

Initially the dog was positioned at 0,5m from the mark surrounding the assigned box to facilitate shaping of correct behaviour. For further facilitation the correct box was baited with a treat in the first two trials. At first the dog was repositioned behind the 0,5m mark on the floor after each trial until 5 rewarded trials were reached from this distance. Then the boxes were switched and 5 rewarded trials were done at the same distance on the other side.
From this point on the boxes were semi-randomly switched each trial. The assigned box was not placed in the same position more than twice consecutively to prevent the development of a side bias. During the switch the dog was placed behind a visual barrier to ensure the switch could not be witnessed. For the next 8 rewarded trials the dog was positioned behind the 1m tape on the side of the correct box.

Next the dog was positioned behind the 1m mark in the middle of the two boxes. After each 10 rewarded trials the distance was increased with 0,5m until the dog was positioned behind the 3m mark on the floor. From this point onwards each 10 trials formed a session. Once the dog got a score 5 in 8 out of 10 trials for two consecutive sessions the training was complete.

If a dog at some point during training received no reward (score 0, 1 or 2) for 5 consecutive trials the previous step in the protocol was repeated.

Statistical analysis

All statistical analyses were performed with SPSS Statistics version 20. Initially all data were assessed for normality using a Shapiro-Wilk test. Since all data deviated significantly from normality only non-parametric tests were used for further analysis.

Spearman's Rho correlations were used to assess the relationship between age, the total number of trials needed to complete training and the different personality traits as assessed by the questionnaires. A Kruskal-Wallis test was used to determine whether a different training experience, as indicated in table 1, influenced the number of trials a dog needed to complete training. A Mann Whitney U test was used to determine whether gender or being assigned to

either the small or the large box influence the number of trials a dog needed to complete training. All statistical tests were two-tailed.

When assessing whether different personality traits correlated with each other the Bonferroni method was used to correct for multiplicity. Correlations between traits of different questionnaires and not correlations within questionnaires were looked for. This meant all DIAS factors were compared with 10 other traits and all PANAS and MCRQ-R factors were compared with 9 other factors. When correcting applying the Bonferroni method this led to a level of significance set at $p=0.0050$ ($p=0.05/10$) and $p=0.0056$ ($p=0.05/9$) respectively for these correlations. For all other tests the level of significance was set at $p=0.05$.

Results

Learning ability

A significant correlation was found between age and the number of trials a dog needed to complete training (*Spearman's Rho:* r_s*=-0.685, p=0.029*), with younger dogs needing fewer trials to reach criterion. Data is shown in figure 2.

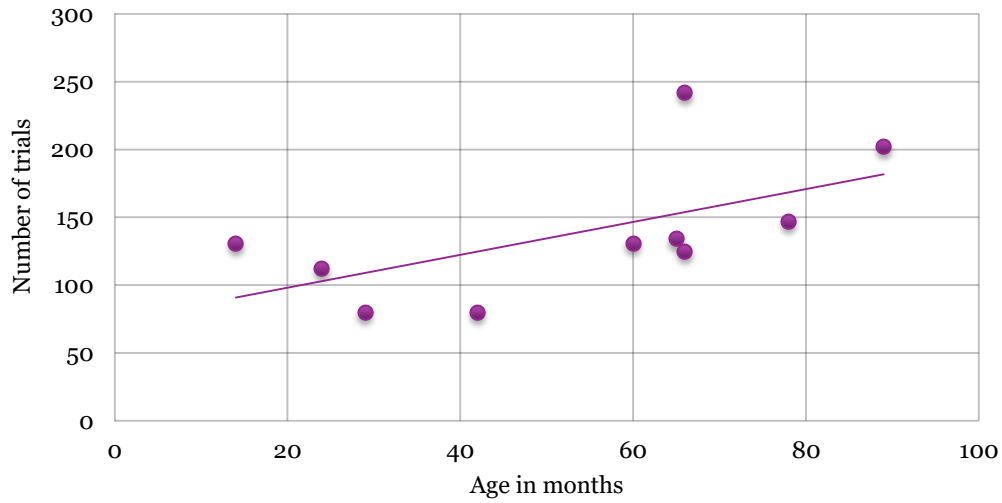

Figure 2. Scatterplot showing the correlation between age and number of trials.

No significant difference in number of trials needed to complete training was found between dogs assigned to the large box and dogs assigned to the small box (*Mann Whitney U: U=11.0, z=-0.325, ns*). We also did not find gender differences in number of trials needed to complete training (*Mann Whitney U: U=9.5, z=-0.229, ns*).

We found that previous training experience, both general and problem solving as described in table 1, did not significantly influence the number of trials a dog needed to complete training (*Kruskal-Wallis: H(2) = 0.280, ns* and *Kruskal-Wallis: H(2) = 1.503, ns* for general training level and problem solving respectively). Data is shown in figure 3.

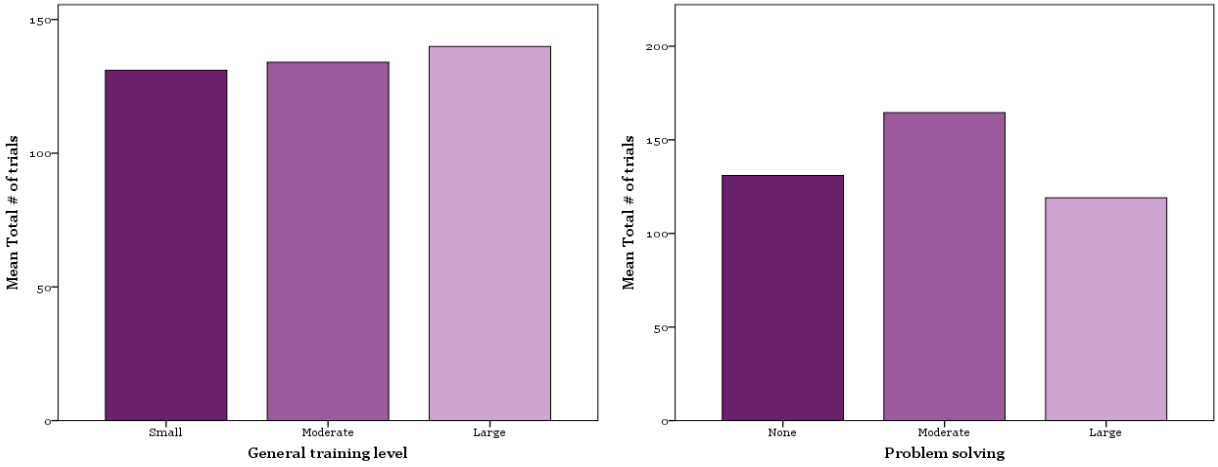

Figure 3. Graphic representation of the effect of general training experience and experience in problem solving on the number of trials a dog needed to complete training (n=10)

No significant correlations were found between the number of trials dogs needed to complete training and the different questionnaire scores (table 4).

		Overall Questionnaire Score	Behavioural Regulation	Aggression & Response to Novelty	Responsiveness	Negative activation	Positive activation	Energy and interest	Persistence	Excitement	Extraversion	Motivation	Training focus	Amicability	Neuroticism
Number of trials	r_s	.208	.506	-.053	-.009	.349	.370	-.151	.363	.469	.367	.055	.411	-.511	.238
	p	.564	.136	.885	.980	.324	.293	.678	.302	.171	.297	.880	.239	.131	.507

Table 4. Spearman's Rho correlation (r_s) between the number of trials a dog needed to complete training and the different personality traits as assessed by the questionnaire scores. N=10 for all correlations.

Personality traits

Significant correlations were found between the overall questionnaire score from the DIAS and positive activation and excitement from the PANAS, and motivation from the MCPQ-R. The trait behavioural regulation from the DIAS correlated significantly with positive activation, excitement and persistence from the PANAS, and extraversion from the MCPQ-R. The trait extraversion from the MCPQ-R also correlated significantly with positive activation, excitement and persistence from the PANAS. Finally the trait neuroticism from the MCPQ-R correlated significantly with aggression & response to novelty from the DIAS. The results of these correlations can be found in table 5, 6 and 7.

		Negative activation	Positive activation	Energy and interest	Persistence	Excitement
Overall Questionnaire Score	r_s	-.037	.670	.266	.600	.745
	p	.892	**.005**	.320	.014	**.001**
Behavioural Regulation	r_s	.100	.771	.215	.707	.880
	p	.711	**.000**	.423	**.002**	**.000**
Aggression & Response to Novelty	r_s	.531	-.022	-.119	-.033	-.051
	p	.034	.936	.662	.905	.851
Responsiveness	r_s	-.457	.380	.288	.300	.365
	p	.075	.147	.280	.259	.164

Table 5. Spearman's Rho correlations (r_s) between the personality traits identified by the DIAS (rows) and the PANAS (columns). N=16 for all correlations. Level of significance set at p=0.005.

		Extraversion	Motivation	Training focus	Amicability	Neuroticism
Overall Questionnaire Score	r_s	.620	.739	-.293	-.556	.056
	p	.010	**.001**	.270	.025	.838
Behavioural Regulation	r_s	.754	.646	-.352	-.625	.195
	p	**.001**	.007	.181	.010	.468
Aggression & Response to Novelty	r_s	.002	-.234	-.342	-.607	.718
	p	.996	.383	.194	.013	**.002**
Responsiveness	r_s	.407	.561	-.048	-.020	-.340
	p	.117	.024	.860	.940	.197

Table 6. Spearman's Rho correlations (r_s) between the personality traits identified by the DIAS (rows) and the MCPQ-R (columns). N=16 for all correlations. Level of significance set at p=0.005.

		Extraversion	Motivation	Training focus	Amicability	Neuroticism
Negative activation	r_s	-.349	-.468	-.151	-.430	.313
	p	.185	.068	.578	.096	.237
Positive activation	r_s	.966	.587	-.137	-.279	.163
	p	**.000**	.017	.613	.295	.547
Energy and interest	r_s	.651	.282	-.040	-.015	.051
	p	.006	.291	.884	.956	.850
Persistence	r_s	.820	.438	-.190	-.171	.046
	p	**.000**	.090	.480	.527	.867
Excitement	r_s	.881	.640	-.229	-.281	.050
	p	**.000**	.008	.395	.293	.853

Table 7. Spearman's Rho correlations (r_s) between the personality traits identified by the PANAS (rows) and the MCPQ-R (columns). N=16 for all correlations. Level of significance set at p=0.0056.

Discussion

In this study a significant correlation was found between age and the number of trials dogs needed to complete training. No significant effect of gender, previous training experience or personality was found on learning ability.

The effect of age on learning ability has been investigated before. A recent study by Thompson et al. (2015) found a significant negative correlation between age and the number of trials needed to reach criterion in a population of pet and shelter dogs using a colour discrimination task. However, when dogs were subsequently presented with a size discrimination and a reversal discrimination task no significant correlation between age and performance was detected.[48] Several studies looking at performance in laboratory beagles also found that age influenced the number of errors made and the number of trials needed to reach criterion in a size discrimination task.[39, 42, 43] For example, Head et al. (1998) divided a group of 24 beagles in the following three groups: young (<5 years), middle aged (6-9 years) and old (>10 years). They found that all groups significantly differed from each other when looking at the number of errors they made before reaching criterion, with young dogs making the least errors.[39] Two studies by Tapp et al. (2003 and 2004) also studied the link between age and learning ability. In 2003 they divided their population of 55 beagles in four groups: young (2.91–3.73 years), middle-aged (4.05–5.50 years), old (8.61–10.94 years) and senior (11.10–13.81 years). They found a significant effect of age on both number of errors and trials to reach criterion.[42] In 2004 they used slightly different groups: young (0.5-3.9 years), middle-aged (4-7.9 years), old (8–11.4 years) and senior (>11.5 years). In this study they only found significant correlations between some groups and for some subtests. When only looking at the first discrimination task they exposed the dogs to, young dogs made significantly fewer errors compared to middle-aged, old and senior dogs. The same difference was found between middle-aged and old dogs, but not between old and senior dogs.[43] Although these studies looked at differences between age groups and not a correlation of age with learning ability, all results agree there is an effect of age on learning ability.

In a previous study using a discrimination task, Tapp et al. (2004) found no relationship between a dog's gender and its performance on the learning task.[43] Researchers studying humans[49] and Rhesus monkeys[50] also found no significant effect of gender on learning ability when subjected to a similar task. A study in birds found that the degree to which animals displayed exploratory behaviour influenced learning performance differently in males and females, but only when it came to very difficult tasks. Unfortunately they did not report the effect of gender irrespective of this personality trait.[51] The overall consistency of these findings among different species makes sense from an evolutionary point of view, for both sexes rely on their ability to discriminate between stimuli for their survival, for example to discriminate between food and non-food items and supports why no differences in gender were observed in this study.

We hypothesized that previous training experience would influence a dog's performance during a discrimination task with more experienced dogs needing fewer trials to complete training. The reason we did not find this relationship might be related to the subjective nature of the statements used in our demographic form. For this reason different owners may have interpreted a certain amount of time spend on training as either a small, moderate or large experience. The small sample size (n=10) and the fact that the variation in reported training experience was very limited may have influenced the results as well. The majority of the dogs were perceived as having a large general training experience whereas none of the dogs had no previous training experience, only 1 dog had a small experience and 1 dog had a moderate experience. A similarly small variation was found regarding problem solving experience. In addition to the above, which makes it difficult to draw conclusions from the dataset at hand, there is another factor that might explain why we didn't find the differences we anticipated. This is related to the fact that we only asked about the quantity of training dogs experienced.

Of the total number of dogs tested a few made it through the pre-training phase but didn't manage to get past the first step of training. Upon discussing this with the owners most indicated that this way of 'low-feedback' training was new to their dogs. When training their dogs they used gestures and facial expressions to help them work out the task at hand whereas in this study the researcher stood completely still and gave no signals. The lack of input they received from the researcher upon looking back to her caused a considerable number of dogs to disengage from the task. This corresponds with the results from a study by Bentosela et al. (2008). In this study researchers initially reinforced dogs for gazing at the researcher. After this acquisition phase they divided the dogs in an omission group, which was rewarded for gazing in any direction but the body of the researcher, and an extinction group, which was not rewarded at al. They found that the behaviour of the dogs changed significantly during the extinction trials. Dogs moved away, turned their back on the researcher and decided to lay down more frequently.[52] This may explain why dogs in our study, who have most likely been rewarded for gazing to the owner for years, decided to move away from the researcher and engaged in other behaviours during trials. We therefore speculated that training *method* may be a better predictor of success than the *amount* of training a dog has experienced. This is partially supported by a previous study by Marshall-Pescini et al. (2009) in which researchers found that the frequency and the duration of looking back at the owner during a novel problem solving tasked differed between dogs with search and rescue experience, dogs with agility experience and untrained pet dogs. The latter two gazed back more frequently and for a longer time compared to the former. They found no significant difference in the time it took different groups to solve the task. However, since 87% of dogs completed the task within 1 minute and the mean latency was 20 seconds, the task could be considered very easy. It is possible that they would have found a difference in solving speed when using a more difficult task. When they made the problem solving test 'unsolvable' the difference between gazing time disappeared.[53] In horses Dorey et al. (2014) found similar results. When the horses were presented with a novel task which required human cues to solve, horses trained using a natural horsemanship method performed significantly better compared to horses trained using a traditional method.[54] This suggests that previous training method at least influences animals' reliance on and use of human cues.

To the author's knowledge the relationship between personality and performance on a learning task has not previously been studied in dogs. In other species however, researchers have found that some personality traits influenced learning performance. For example, Guenther et al. (2014) found that the personality traits activity, boldness and aggression all correlated positively with learning speed in a discrimination task in wild cavies.[55] Trompf et al. (2014) also found that boldness was associated with quicker learning in a discrimination task in feral guppies. Sociality however, was not associated with learning performance in this task.[56] Contrary to our prediction, we did not find any correlation between any personality trait and the number of trials a dog needed to complete training in our study. This might be related to the fact that the dogs needing more than three session days for training were pulled from the study by their owners. This left us with a dataset comprising only dogs that mastered the task fairly quickly. A previous study by Head et al. (1998) found that size discrimination tasks are more difficult for dogs to learn and require more trials to criterion compared to object discrimination.[39] For the latter task objects usually differ in more than one feature (e.g. colour, shape, size, texture, material), for example a yellow plastic coffee jar lid and a blue plastic Lego block which were used in the study by Head et al..[39] For some dogs in our study the difficulty of the task would therefore have led to a need for more training sessions. It is not unthinkable that if all dogs had been provided with the opportunity to complete training we would have found a larger variation in the number of trials they needed to reach criterion, which might have correlated with some personality traits.

The relationship between different personality traits has not yet been studied in dogs. In humans the Reinforcement Sensitivity Theory (RST) is considered one of the most prominent biologically oriented theories with regard to personality. It was originally proposed in 1970 with the psychophysiological basis of introversion-extraversion by Gray.[57] With this he posed

a different approach to Eysenck's extraversion and neuroticism dimensions.[58] Over the years Gray's theory has been further unfolded and revised. In the revised RST three motivational systems are thought to be responsible for the behavioural response towards different stimuli. The behavioural activation system (BAS) is considered responsible for reacting to all rewarding and appetitive stimuli. The fight, flight, freezing system (FFFS) on the other hand is responsible for reacting to all punishing and threatening stimuli. When presented with conflicting stimuli that might send signals of both reward and punishment the behavioural inhibition system (BIS) is activated.[59] BAS, which can be seen as high reward sensitivity or positive activation, is strongly associated with extraversion. Besides interpersonal engagement, impulsivity is considered one of the characteristics of extraversion.[60] Since the beginning of the development of the RST impulsivity has also been considered part of the BAS and therefore strongly associated with sensitivity to reward.[38, 61, 62] Looking at this general structure of personality in humans and extrapolating this framework to dogs we can easily explain some of the correlations we found in this study. When comparing the different traits assessed by the different questionnaires we found significant positive correlations between behavioural regulation, extraversion and positive activation, as well as its facets persistence and excitement. Since behavioural regulation can be considered the most narrow form of impulsivity it would make sense for this to correlate most strongly. We also found significant positive correlations between the overall level of impulsivity (OQS) and positive activation and its facet excitement. Due to application of the Bonferroni correction the P value set for the level of significance was so low that correlations between the overall level of impulsivity (OQS) with extraversion and persistence were strong ($p=0.010$ and $p=0.015$ respectively), but no longer significant.

In the RST the higher order trait neuroticism is considered to be an amplifier of emotion and therefore increases reactivity to both rewarding and punishing stimuli.[60] This can lead to hypervigilance and an increased response to novel stimuli. It is therefore not surprising we found a significant positive correlation between neuroticism and aggression & response to novelty. Aggression in the context of this DIAS factor can manifest itself in cases of extreme fear in response to threatening stimuli and in cases of frustration when stimuli perceived as rewarding cannot be reached. Both can be considered an excessive response when elicited by everyday situations.

In human personality research all responses to rewarding and punishing stimuli are thought to be regulated by motivational systems.[63] The term motivation is therefore not used to describe a personality trait one can possess to some degree. In the MCPQ-R however, motivation is used to describe a trait within dog personality. This discrepancy makes it impossible to draw any parallels between the results generated by the MCPQ-R questionnaire and RST in humans with regard to motivation. When we look at the term motivation as a dog's perceived persistence, like the developers of the MCPQ-R suggest, one could argue this trait would be a facet of positive activation and would therefore be correlated with impulsivity. However, since the MCPQ-R's motivation does not correlate with persistence (PANAS) nor with positive activation in general this proposal cannot be defended. Our findings can therefore not be explained in the light of other literature regarding personality and would need further investigation.

When assessing the correlations between different personality traits there were some traits we expected to correlate but didn't. One example is the relation between motivation (MCPQ-R) and persistence (PANAS). Since the developers of the MCPQ-R described motivation as a dog's perceived persistence it seems likely this would correlate with the same trait measured by a different questionnaire.[24] Similarly we expected that extraversion (MCPQ-R), described as a dog's perceived energy level, would correlate with energy and interest (PANAS). However, after applying the Bonferroni correction this correlation was no longer significant. The most obvious explanation for this would be a discrepancy in the definition used to describe different personality traits by different authors.[17] Persistence for example can be perceived in a negative

sense, continuously nagging, or in a positive sense, persevering in the face of setbacks. This problem has been previously emphasised by Jones and Gosling (2005) and Gartner (2015), with both studies indicating a need for standardisation of terminology used to describe dog personality.[11, 12] Especially if we want to compare different questionnaires it is crucial for different terms to have the same definition.

In contrast to our predictions our results do not demonstrate a relationship between personality and learning ability nor between training experience and learning ability. In light of some shortcomings in the present study, further research is necessary to more fully investigate these factors and their effect on learning ability before we can conclude that no relationship exists. The author recommends the following modifications. 1) Using a larger sample size to increase the statistical power of the study. 2) Making sure all dogs get the chance to reach criterion by allowing more time spent on training. 3) Looking at the effect of the method used to train the dog in conjunction with its training experience on learning ability. Utilisation of these recommendations might generate results that are in agreement with our current hypothesis, which would therefore have a larger practical application for the selection of service dogs.

Conclusion

Multiple factors influence learning performance in dogs, of which age is most consistently found in research. A possible effect of training experience, training method and personality on performance was not demonstrated in our study. However to more fully assess whether or not these factors play a role in a dog's ability to learn a range of different tasks, further research is required. For this purpose it is essential to clearly quantify training experience, clearly describe training methods and use validated methods for the assessment of dog personality. Our findings suggest different personality traits correlate with each other in dogs in a similar way they do in humans. However, to facilitate comparison of different literature and assessment methods it is crucial that the terminology surrounding dog personality is be standardised.

References

1. Goddard, M. E. & Beilharz, R. G. Genetics of traits which determine the suitability of dogs as guide-dogs for the blind. *Applied Animal Ethology* **9**, 299-315 (1983).

2. Murphy, J. A. Describing categories of temperament in potential guide dogs for the blind. *Appl. Anim. Behav. Sci.* **58**, 163-178 (1998).

3. Serpell, J. A. & Hsu, Y. Development and validation of a novel method for evaluating behavior and temperament in guide dogs. *Appl. Anim. Behav. Sci.* **72**, 347-364 (2001).

4. Arata, S., Momozawa, Y., Takeuchi, Y. & Mori, Y. Important behavioral traits for predicting guide dog qualification. *J. Vet. Med. Sci.* **72**, 539-545 (2010).

5. Svartberg, K. Shyness-boldness predicts performance in working dogs. *Appl. Anim. Behav. Sci.* **79**, 157-174 (2002).

6. Maejima, M. *et al.* Traits and genotypes may predict the successful training of drug detection dogs. *Appl. Anim. Behav. Sci.* **107**, 287-298 (2007).

7. Sinn, D. L., Gosling, S. D. & Hilliard, S. Personality and performance in military working dogs: Reliability and predictive validity of behavioral tests. *Appl. Anim. Behav. Sci.* **127**, 51-65 (2010).

8. De Palma, C. *et al.* Evaluating the temperament in shelter dogs. *Behaviour* **142**, 1307-1328 (2005).

9. Dowling-Guyer, S., Marder, A. & D'Arpino, S. Behavioral traits detected in shelter dogs by a behavior evaluation. *Appl. Anim. Behav. Sci.* **130**, 107-114 (2011).

10. Valsecchi, P., Barnard, S., Stefanini, C. & Normando, S. Temperament test for re-homed dogs validated through direct behavioral observation in shelter and home environment. *J. Vet. Behav. : Clin. Appl. Res.* **6**, 161-177 (2011).

11. Gartner, M. C. Pet personality: A review. *Pers. Individ. Differ.* **75**, 102-113 (2015).

12. Jones, A. C. & Gosling, S. D. Temperament and personality in dogs (Canis familiaris): A review and evaluation of past research. *Appl. Anim. Behav. Sci.* **95**, 1-53 (2005).

13. Miklósi, A., Turcsán, B. & Kubinyi, E. The Personality of Dogs. *The Soc. Dog: Behav. and Cogn.*, 191-222 (2014).

14. Block, J. The Q-sort method in personality assessment and psychiatric research. *Springfield, Ill, Charles C Thomas* (1961).

15. McCrae, R. R. Consensual validation of personality traits: Evidence from self-reports and ratings. *J. Pers. Soc. Psychol.* **43**, 293-303 (1982).

16. Gosling, S. D. & Vazire, S. Are we barking up the right tree? Evaluating a comparative approach to personality. *Journal of Research in Personality* **36**, 607-614 (2002).

17. Diederich, C. & Giffroy, J. Behavioural testing in dogs: A review of methodology in search for standardisation. *Appl. Anim. Behav. Sci.* **97**, 51-72 (2006).

18. Taylor, K. D. & Mills, D. S. The development and assessment of temperament tests for adult companion dogs. *J. Vet. Behav. : Clin. Appl. Res.* **1**, 94-108 (2006).

19. Hsu, Y. & Serpell, J. A. Development and validation of a questionnaire for measuring behavior and temperament traits in pet dogs. *J. Am. Vet. Med. Assoc.* **223**, 1293-1300 (2003).

20. Wright, H. F., Mills, D. S. & Pollux, P. M. Development and validation of a psychometric tool for assessing impulsivity in the domestic dog (Canis familiaris). *International Journal of Comparative Psychology* **24** (2011).

21. Moeller, F. G., Barratt, E. S., Dougherty, D. M., Schmitz, J. M. & Swann, A. C. Psychiatric aspects of impulsivity. *Am. J. Psychiatry* **158**, 1783-1793 (2001).

22. Arce, E. & Santisteban, C. Impulsivity: A review. *Psicothema* **18**, 213-220 (2006).

23. Wright, H. F., Mills, D. S. & Pollux, P. M. J. Behavioural and physiological correlates of impulsivity in the domestic dog (Canis familiaris). *Physiol. Behav.* **105**, 676-682 (2012).

24. Sheppard, G. & Mills, D. S. The development of a psychometric scale for the evaluation of the emotional predispositions of pet dogs. *International journal of comparative psychology* **15** (2002).

25. Ley, J., Bennett, P. & Coleman, G. Personality dimensions that emerge in companion canines. *Appl. Anim. Behav. Sci.* **110**, 305-317 (2008).

26. Ley, J. M., Bennett, P. C. & Coleman, G. J. A refinement and validation of the Monash Canine Personality Questionnaire (MCPQ). *Appl. Anim. Behav. Sci.* **116**, 220-227 (2009).

27. Ley, J. M., McGreevy, P. & Bennett, P. C. Inter-rater and test-retest reliability of the Monash Canine Personality Questionnaire-Revised (MCPQ-R). *Appl. Anim. Behav. Sci.* **119**, 85-90 (2009).

28. Kubinyi, E., Turcsán, B. & Miklósi, A. Dog and owner demographic characteristics and dog personality trait associations. *Behav. Processes* **81**, 392-401 (2009).

29. Turcsán, B., Kubinyi, E. & Miklósi, Á. Trainability and boldness traits differ between dog breed clusters based on conventional breed categories and genetic relatedness. *Appl. Anim. Behav. Sci.* **132**, 61-70 (2011).

30. Svartberg, K. A comparison of behaviour in test and in everyday life: Evidence of three consistent boldness-related personality traits in dogs. *Appl. Anim. Behav. Sci.* **91**, 103-128 (2005).

31. Duffy, D. L. & Serpell, J. A. Behavioral assessment of guide and service dogs. *J.Vet.Behav* **3**, 186-188 (2008).

32. Duffy, D. L. & Serpell, J. A. Predictive validity of a method for evaluating temperament in young guide and service dogs. *Appl. Anim. Behav. Sci.* (2012).

33. Mirkó, E., Dóka, A. & Miklósi, A. Association between subjective rating and behaviour coding and the role of experience in making video assessments on the personality of the domestic dog (Canis familiaris). *Appl. Anim. Behav. Sci.* **149**, 45-54 (2013).

34. Foyer, P., Bjällerhag, N., Wilsson, E. & Jensen, P. Behaviour and experiences of dogs during the first year of life predict the outcome in a later temperament test. *Appl. Anim. Behav. Sci.* **155**, 93-100 (2014).

35. Jakovcevic, A., Mustaca, A. & Bentosela, M. Do more sociable dogs gaze longer to the human face than less sociable ones? *Behav. Processes* **90**, 217-222 (2012).

36. Byrom, N. C. & Murphy, R. A. It's not just what we encode, but how we encode it: Associations between neuroticism and learning. *J. Pers.* **81**, 345-354 (2013).

37. Robinson, M. D., Moeller, S. K. & Fetterman, A. K. Neuroticism and Responsiveness to Error Feedback: Adaptive Self-Regulation Versus Affective Reactivity. *J. Pers.* **78**, 1469-1496 (2010).

38. Ávila, C. & Parcet, M. A. Individual differences in reward sensitivity and attentional focus. *Pers. Individ. Differ.* **33**, 979-996 (2002).

39. Head, E., Callahan, H., Muggenburg, B. A., Cotman, C. W. & Milgram, N. W. Visual-discrimination learning ability and β-amyloid accumulation in the dog. *Neurobiol. Aging* **19**, 415-425 (1998).

40. Milgram, N. W. *et al.* Landmark discrimination learning in the dog: Effects of age, an antioxidant fortified food, and cognitive strategy. *Neurosci. Biobehav. Rev.* **26**, 679-695 (2002).

41. Milgram, N. W. Cognitive experience and its effect on age-dependent cognitive decline in beagle dogs. *Neurochem. Res.* **28**, 1677-1682 (2003).

42. Tapp, P. D. *et al.* Size and reversal learning in the beagle dog as a measure of executive function and inhibitory control in aging. *Learn. Mem.* **10**, 64-73 (2003).

43. Tapp, P. D. *et al.* Concept abstraction in the aging dog: development of a protocol using successive discrimination and size concept tasks. *Behav. Brain Res.* **153**, 199-210 (2004).

44. Milgram, N. W. *et al.* Learning ability in aged beagle dogs is preserved by behavioral enrichment and dietary fortification: a two-year longitudinal study. *Neurobiol. Aging* **26**, 77-90 (2005).

45. Snigdha, S. *et al.* Age and distraction are determinants of performance on a novel visual search task in aged Beagle dogs. *Age* **34**, 67-73 (2012).

46. Bordin, A. D. How can sound stimuli impact the dogs' performance on a visual discrimination task? A study about factors underlying sustained attention in domestic dogs. *Submitted for publication* (2013).

47. Fukuzawa, M., Mills, D. S. & Cooper, J. J. More than just a word: Non-semantic command variables affect obedience in the domestic dog (Canis familiaris). *Appl. Anim. Behav. Sci.* **91**, 129-141 (2005).

48. Thompson, H. & Zulch, H. Investigating the effects of a problem solving toy on learning ability of a novel task in the domestic dog. *Submitted for publication* (2015).

49. Nehrke, M. F. Age and sex differences in discrimination learning and transfer of training. *J. Gerontol.* **28**, 320-327 (1973).

50. Drea, C. M. Status, Age, and Sex Effects on Performance of Discrimination Tasks in Group-Tested Rhesus Monkeys (Macaca mulatta). *J. Comp. Psychol.* **112**, 170-182 (1998).

51. Titulaer, M., van Oers, K. & Naguib, M. Personality affects learning performance in difficult tasks in a sex-dependent way. *Anim. Behav.* **83**, 723-730 (2012).

52. Bentosela, M., Barrera, G., Jakovcevic, A., Elgier, A. M. & Mustaca, A. E. Effect of reinforcement, reinforcer omission and extinction on a communicative response in domestic dogs (Canis familiaris). *Behav. Processes* **78**, 464-469 (2008).

53. Marshall-Pescini, S., Passalacqua, C., Barnard, S., Valsecchi, P. & Prato-Previde, E. Agility and search and rescue training differently affects pet dogs' behaviour in socio-cognitive tasks. *Behav. Processes* **81**, 416-422 (2009).

54. Dorey, N. R., Conover, A. M. & Udell, M. A. R. Interspecific communication from people to horses (Equus ferus caballus) is influenced by different horsemanship training styles. *J. Comp. Psychol.* **128**, 337-342 (2014).

55. Guenther, A., Brust, V., Dersen, M. & Trillmich, F. Learning and personality types are related in cavies (cavia aperea). *J. Comp. Psychol.* **128**, 74-81 (2014).

56. Trompf, L. & Brown, C. Personality affects learning and trade-offs between private and social information in guppies, poecilia reticulata. *Anim. Behav.* **88**, 99-106 (2014).

57. Gray, J. A. The psychophysiological basis of introversion-extraversion. *Behav. Res. Ther.* **8**, 249-266 (1970).

58. Eysenck, H. J. Types of personality: A factorial study of 700 neurotics. *Journal of Mental Science* **90**, 851-861 (1944).

59. Gray, J. A. & McNaughton, N. The Neuropsychology of Anxiety: An enquiry into the function of the septo-hippocampal system. *The Neuropsychol. of Anxiety: An enq. into the funct. of the septo-hippocampal syst.*, 1-442 (2008).

60. Depue, R. A. & Collins, P. F. Neurobiology of the structure of personality: Dopamine, facilitation of incentive motivation, and extraversion. *Behav. Brain Sci.* **22**, 491-517 (1999).

61. Gray, J. A. A critique of Eysenck's theory of personality. *A Model for Personality*, 246-276 (1981).

62. Pickering, A. D., Corr, P. J. & Gray, J. A. Interactions and reinforcement sensitivity theory: A theoretical analysis of Rusting and Larsen (1997). *Pers. Individ. Differ.* **26**, 357-365 (1998).

63. Corr, P. J., Deyoung, C. G. & Mcnaughton, N. Motivation and Personality: A Neuropsychological Perspective. *Soc. Pers. Psychol. Compass* **7**, 158-175 (2013).