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Development and Validation of a Psychometric Tool for Assessing Impulsivity in the Domestic Dog (*Canis familiaris*)

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Impulsivity is a trait that has received much attention in humans, but in dogs impulsivity is ill-defined, and previous studies have tended to focus on aggression, rather than its more pervasive effect on behavior. The objective of this study was to develop a valid psychometric assessment tool of impulsivity in dogs. An owner report questionnaire was constructed using items generated by a survey of experts. Five hundred and seventy one dog owners returned the questionnaire and data were subjected to principal components analysis, revealing a three-factor structure: Factor 1: Behavioral Regulation, Factor 2: Aggression & Response to Novelty, and Factor 3: Responsiveness. The resulting Dog Impulsivity Assessment Scale comprised of 18 items demonstrated evidence of reliability and validity.

Studies on impulsivity in human psychology and psychiatry often rely on self-rating scales specifically developed for assessing the impulsivity trait, for example, Eysenck's Impulsivity Scale (Eysenck & Eysenck, 1977), the Barratt Impulsiveness Scale (Patton, Stanford, & Barratt, 1995), and the Impulsivity Rating Scale (Lecrubier, Braconnier, Said, & Payan, 1995). Impulsivity is also assessed on subscales of wider personality assessments, such as the Multidimensional Personality Questionnaire (Tellegen, 1982) and the Temperament and Character Inventory (Cloninger, Svrakic, & Pryzbeck, 1993). Self-rating scales of impulsivity in adults rely on the individual's ability to consider how they might feel or act in a list of given situations and this provides an impression of their tendency towards impulsiveness. Assessment of impulsivity in children and adolescents (frequently assessed in relation to Attention Deficit Hyperactivity Disorder, ADHD) may additionally involve teacher rating scales and / or parent rating scales, both of which are suggested to be reliable and demonstrate criterion validity (DuPaul, 1991). This indicates that assessment of such traits can be successfully completed by an individual other than the subject of interest. The use of questionnaire by proxy has also been applied to studying personality dimensions in non-human primates (Capitanio, 1999; Gosling, 2001), providing further support to the method of assessing personality of animal subjects by other individuals.

In dogs, little consideration has previously been given to impulsivity as a personality trait, but 'impulsivity' or 'impulse control' is often mentioned in the context of aggressive behavior (Fatjó et al., 2005; Overall, 2001; Peremans et al.,

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2003; Reisner, Mann, Stanley, Huang, & Houpt, 1996). These studies describe ‘impulsive aggression,’ which has been defined as “aggressive behaviors occurring with reduced or absent warning signals” (Fatjó et al., 2005), for example, a dog that bites without a preceding growl or bared teeth. These studies on impulse control problems in dogs often draw similarities with the human literature on impulse control (e.g., Overall, 2001; Peremans et al., 2003), without prior consideration of whether the trait exists, or is expressed in the same way in dogs. They also fail to consider impulsivity in other, non-aggressive contexts, and so do not provide an overall assessment of the underlying behavioral tendency. Such studies are limited by the restricted view of how the trait manifests in specific behaviors, such as aggression.

It has been suggested that the study of companion animal behavior is developing through the use of methods and concepts developed in the human field to explore the mind of other animals (Sheppard & Mills, 2002), including psychometric approaches to the assessment of personality or temperament. There has been a number of studies on ‘personality’ in dogs (e.g., Ley & Bennett, 2007; Svartberg & Forkman, 2002; Svartberg, Tapper, Temrin, Radesäter, & Thorman, 2005), which may otherwise be referred to as ‘temperament’ (Serpell & Hsu, 2001; Taylor & Mills, 2006), ‘character’ (Ruefenacht, Gebhardt-Heinrich, Miyake & Gaillard, 2002) and ‘emotional predispositions’ (Sheppard & Mills, 2002). Regardless of the terminology used, these studies are all attempting to assess behavioral styles (or traits) that are consistent over time.

Attempts have been made to define the overall structure of personality in dogs using psychometric techniques derived from the study of human personality (e.g., Ley & Bennett, 2007). Other studies have been based on direct behavioral observations (e.g., Svartberg & Forkman 2002). It is suggested that some of the factors identified in dog personality show similarities with other animal species (Ley & Bennett, 2007); in particular, it is suggested that those relating to the shyness-boldness axis are comparable to extraversion and neuroticism in humans (Ley & Bennett, 2007; Svartberg & Forkman, 2002). It has also been suggested that studies of dog personality may be suitable as models for exploring personality in other species (e.g., Gosling, Kwan, & John, 2003; Vas, Topál, Péch, & Miklósi, 2007). Vas et al., (2007) used a questionnaire derived from the study of human personality to evaluate impulsivity-activity in dogs and drew similarities with impulsivity-activity in human ADHD. Whether such specific inferences about dog personality can be made from an assessment tool constructed for personality assessment in humans is, however, questionable and may raise concerns about validity.

Despite general concerns over anthropomorphism in the study of dog personality, it has been suggested that there is strong evidence that personality differences do exist and can be measured accurately in domestic dogs (Gosling et al., 2003). Given that there is biological continuity in the animal kingdom, the presence of variations in behavioral styles in animals other than humans is not surprising. A major criticism of previous studies on dog temperament (or personality), including owner report ratings of dogs, is that they rarely report assessments of reliability and validity; those that do often do so without reference to numerical indices (Jones & Gosling, 2005; Taylor & Mills, 2006). The aim of

the current study is to develop a reliable and valid psychometric tool based on opinions of international dog behavior experts and on owner reports which could be used to investigate the impulsivity trait in domestic dogs.

Method

Assessment Tool – Item Generation

A convenience sample of thirty-two international experts was selected and invited to present their views on the following question: “How might you recognize a dog with a low level of impulse control (i.e., very impulsive), as opposed to one with less impulsivity?” Information was returned from twenty experts and collated anonymously into a single list of 28 items.

Assessment Tool - Public Response Questionnaire

The 28 items generated from the expert survey were used to generate twenty-eight items in a public response questionnaire for distribution to pet dog owners, titled ‘Dog Personality Questionnaire’ (DPQ). Instructions for completion were included on the title page. A section for the dog’s details was included at the beginning of the questionnaire to collect demographic data with an optional section for owner details at the end, to establish if the participants were willing to be contacted again regarding the study. The items were phrased as statements that were considered comprehensible for the typical dog owner.

An additional item specifically asking about impulsive behavior was included (“*I would consider my dog to be very impulsive, i.e., has sudden, strong urges to act; acts without forethought; acts without considering effects of actions*”), resulting in twenty-nine items in total. Five randomly chosen distracter questions were added to the list of items to break up any obvious patterns or theme in the questions, resulting in thirty-four items being included in the personality component of the questionnaire. A random number generator was used to provide the order of items for the questionnaire (Table 1).

The DPQ was administered to a small pilot sample of ten dog owners, to identify areas of confusion for revision. Changes made included further clarification of statements and simplification of technical terms relating to behavior, e.g., stereotypes was further defined as “fixed repetitive behavior (i.e., an action that is repeated in the same way over and over again), such as tail chasing or spinning around in circles” (Table 1).

Responses to the items were scored on a 5-point Likert scale, having “strongly agree” (scores 5) and “strongly disagree” (scores 1) at the extremes and “partly agree, partly disagree” in the middle. A “*don’t know / not applicable*” option was also provided. Nine of the items were reversed (Table 1), so that the extremes of impulsive behavior (as suggested by the survey results) received high scores for some questions and low for others, this format was chosen to reduce the chance of response set (DeVellis, 1991).

The DPQ was distributed by a variety of methods. These included distribution in the street, dog training classes, local and national dog shows, local kennels, university staff and students, veterinary surgeries throughout the United Kingdom and clients of the university’s Animal Behavior Clinic. The DPQ was administered as convenient in each of these areas, no inclusion or exclusion criteria were applied. The DPQ was also available internationally, by download from a link on the university website, which was advertised on a range of mailing lists relating to animal behavior and other animal discussion lists. DPQs were handed back in person, posted or emailed. This diverse sample was selected to optimize the range of individuals, breeds, training, background and other possible variables.

Table 1

Items included in the DPO.

1	My dog often over reacts (e.g., a relatively small event produces an unnecessarily large reaction)
2	My dog shows extreme physical signs when excited (e.g., drooling, panting, raising hackles, urination, licking lips, widening of eyes)
3	When my dog gets very excited it can lead to fixed repetitive behavior (i.e., an action that is repeated in the same way over and over again), such as tail chasing or spinning around in circles
4	I would consider my dog to be very impulsive (i.e., has sudden, strong urges to act; acts without forethought; acts without considering effects of actions)
5	My dog doesn't like to be approached or hugged
6	My dog becomes aggressive (e.g., growl, snarl, snap, bite) when excited
7	My dog appears to be 'sorry' after it has done something wrong
8	My dog does not think before it acts (e.g., would steal food without first looking to see if someone is watching)
9	My dog can be very persistent (e.g., will continue to do something even if it knows it will get punished or told off)
10	My dog is very good at controlling the strength of its bite, either during play or intentional biting*
11	My dog may become aggressive (e.g., growl, snarl, snap, bite) if frustrated with something
12	My dog is easy to train*
13	My dog is very cautious when meeting unknown dogs (DISTRACTER)
14	If my dog is ever aggressive (to either people or dogs), the behavior occurs without warning (e.g., Bites occur without warning growl, lip lifting, snarling)
15	My dog is very friendly towards strangers (DISTRACTER)
16	I would consider my dog to be overactive
17	My dog is not keen to go into new situations*
18	My dog stops certain behaviors suddenly for no apparent reason
19	My dog is constantly demanding attention or social interaction from people when in the home (DISTRACTER)
20	My dog takes a long time to lose interest in new things*
21	My dog calms down very quickly after being excited*
22	My dog appears to have a lot of control over how it responds*
23	My dog is very interested in new things and new places*
24	My dog does not like being disturbed while resting
25	My dog interrupts or intrudes on others (e.g., butts into games)
26	My dog reacts very quickly
27	My dog is not very patient (e.g., gets agitated waiting for its food, or waiting to go out for a walk)
28	My dog responds to the same thing in the same way each time*
29	My dog pays attention and responds when being punished or told off
30	My dog often steals objects from the house (e.g., shoes, socks, remote controls) (DISTRACTER)
31	My dog likes to play with toys (DISTRACTER)
32	My dog seems to get excited for no reason
33	My dog is very good at reading social signals from other dogs & people (i.e., has good social manners)*
34	My dog shows extreme behavior when excited (e.g., whining, barking, jumping up, running around)

* Items reverse scored

Assessment Tool – Test-Retest Reliability

One third of those that indicated willingness to be contacted again were selected by removing every third DPQ (Shepherd & Mills, 2002). The retest sample included only those participants that had completed the DPQ a minimum of six weeks before the retest request. One hundred and twenty seven participants were requested to respond to the repeat DPQ; of these, 72 responded. The second DPQ included the same items as the first; items had been re-ordered using the random number generator. Participants were asked to ensure that the original answers on the first DPQ were not considered and that the same individual completed the DPQ. This provided two sets of data for these 72 respondents. Pearson's correlation was calculated for test-retest items to provide a reliability coefficient for impulsivity items. Items that did not have a significant correlation between test and re-test scores ($p < 0.05$) were considered unreliable and removed from further analysis. Additionally, a Wilcoxon signed rank test was used to compare the median test-retest scores for each item. Items that were found to have significant differences between the test and re-test scores resulted in item removal (Shepherd & Mills, 2002).

Assessment Tool – Statistical Analysis

Error checks on the data were completed (by manually cross checking entries in the database with the original questionnaire) for fifty of the DPQ. A further fifty questionnaires were examined every time a mistake was found. This procedure was followed to reduce the risk of errors resulting from data entry. A single error was identified, resulting in 100 DPQs being checked.

Items that had a high non-response rate, (> 10% of respondents did not answer the item or responded “*don't know / not applicable*”) were removed from future analysis. Data from individual respondents that had four or more missing items (i.e., “*don't know / not applicable*” responses) were removed from the data set. The five distracter questions were also removed.

Principal Components Analysis (PCA) was conducted on the remaining response scores. The number of factors to be extracted was identified by consideration of the Kaiser criterion, (Kaiser, 1960) and the Scree test (Cattell, 1966). The Kaiser criterion, (Kaiser, 1960) suggests that only factors with an Eigen value over 1 are retained. The Scree test (Cattell, 1966), suggests that the elbow of the graphical plot (at the point of inflection) be used to determine the number of factors to retain. The internal consistency of the factors in each solution was estimated using Cronbach's α (DeVellis, 1991). The biological interpretation of the factors was also taken into consideration. A PCA with varimax rotation was used for this purpose; this orthogonal rotation imposes the restriction that the factors are independent (Kline, 1994). The resulting three-factor tool was termed the Dog Impulsivity Assessment Scale (DIAS).

The Overall Questionnaire Scores for the 560 cases were calculated as follows: scores for all of the questions that had been answered were summed, and the total was divided by five times the number of questions which received scores (since five is the maximum possible score for each item). So for example, if all 18 items were scored, the sum of the scores was divided by 95 (18x5). This gave a final score within the range 0-1 that described the rating of the dog's level of ‘impulsivity’ (where impulsivity is defined according to the reliable items extracted from the expert survey); high scores relate to high impulsivity, or reduced self-control. This was termed the “Overall Questionnaire Score” (OQS).

Scores for the three factors were calculated according to the distribution of the final 20 items, Table 2. Scores for all of the items were summed and then divided by 5 times the number of items which received scores in each factor to obtain standardized scores. So, for example, if all items in Factor 1 were scored the sum of the scores was divided by 50 (10x5), as there as 10 items in factor 1 and 5 is the maximum possible score for each item.

The distribution of the OQS and three factor scores were explored in the population, and the correlations between these measures investigated. Additionally, more specific relationships between the questionnaire scores and age, breed, sex, and data source were examined.

Theoretically related concepts within the DIAS were used to assess convergent validity using two items, 4 and 8. An ‘owner's view’ of impulsivity was taken from the response to item 4 (“*I would consider my dog to be very impulsive*”), to determine if the owners assessment of impulsivity correlated with the questionnaire scores. The relationship between the DIAS scores and item 8 (“*My dog does not think before it acts*”) was also investigated. Item 8 was chosen as a lack of

premeditation (thinking before acting) is a key personality facet in human impulsivity (Whiteside & Lynam, 2001), but can only be subjectively perceived in non-human animals.

Table 2

Item factor loading for the DIAS. Repeated three-factor solution with final eighteen items.

Factor 1	Factor 2	Factor 3
(2) Extreme physical signs when excited.	(5) Dog doesn't like to be approached or hugged	(7) Dog appears to be 'sorry' after it has done something wrong
(3) Excitement can lead to fixed repetitive behavior	(6) Dog becomes aggressive when excited	(12) Dog is easy to train
(4) Dog is considered to be very impulsive	(11) Dog may become aggressive if frustrated with something	(20) Dog takes a long time to lose interest in new things
(8) Dog does not think before it acts	(17) Dog is not keen to go into new situations	(23) Dog is very interested in new things and new places
(9) Dog can be very persistent	-(23) Dog is very interested in new things and new places	(26) Dog reacts very quickly
-(12) Dog is easy to train		
-(21) Dog calms down very quickly after being excited		
-(22) Dog appears to have a lot of control over how it responds		
(27) Dog is not very patient		
(32) Dog seems to get excited for no reason.		
Items cross loading = (23) and (12) – positive and negative loadings		
Factors not loading = none		
Biological interpretation:		
Behavioral regulation	Aggression / Response to Novelty	Responsiveness

Results

Public Response Questionnaire - Demographic Data

Five-hundred and seventy one completed DPQs were returned in the initial survey, with the majority (62%) being downloaded from an online link and returned via email. The remainders were from dog shows (12%), university campus (9.7%), local boarding kennels (5.3%), dog training classes (3.7%), veterinary clinics (3%), the university's Animal Behavior Clinic (1.2%) and handed in the street (1.1%). Data were provided for five-hundred and seventy one dogs from 20 countries; (51.8%) from the United Kingdom, (16.3%) USA,

(16.2%) Australia, (4.8%) Canada, (3.2%) New Zealand and the remaining (7.7%) were from 15 other countries.

The sample included dogs that varied in age from three months to 16.5 years-old. All sexes were represented: male neutered ($n = 199$, 34.9%), female neutered ($n = 187$, 32.7%), male entire ($n = 103$, 18.0%), female entire ($n = 82$, 14.4%). There was representation from each size category: toy, < 5kg ($n = 11$, 1.9%); small, 5-10kg ($n = 103$, 18.0%); medium, 10-25kg ($n = 284$, 49.8%); large, 25-45kg ($n = 157$, 27.5%); giant, >45kg ($n = 16$, 2.8%). A large proportion of the dogs were pedigrees ($n = 435$, 76.2%), from 107 different breeds; the remainder ($n = 136$, 23.8%) were crossbreeds. The dogs were acquired from breeders (52%), rescue shelters (24.3%), friends (8.1%), bred by the owners (7.7%) and other sources (7.9%).

Test-Retest Reliability

Pearson's correlation showed that all twenty-nine items had a significant correlation between test and re-test scores ($p < 0.05$). However, Wilcoxon signed rank test revealed significant differences in the median test-retest scores for seven items, 1, 16, 24, 25, 29, 33, 34 (as numbered in Table 1). These items were removed from future analyses as they were considered unreliable in terms of temporal stability, leaving 22 items.

Questionnaire Development

A further two items were discarded because they had greater than 10% missing responses or responses marked as “*don't know / not applicable*.” The two items were, question 14, which had 18.2% missing responses, and question 18, which had 21.7% missing responses (Table 1). Eleven respondents had sixteen or less completed questions (i.e., four or more unanswered questions) and were also removed from the data set. This resulted in 560 cases (98%), and 20 being taken forward for PCA.

Principal Components Analysis

The remaining twenty items were subject to PCA using a varimax rotation. The Eigen analysis of the correlation matrix of the remaining items following principal component analysis indicated that the first, second and third components accounted for 22.8%, 9.2%, and 7.2% respectively, of the total variability in the correlation matrix. Each of the remaining principal components accounted for less than 7% with the seventh principal component and beyond each accounting for less than 5%.

Considering the Kaiser criterion, (Kaiser, 1960) and Scree test (Cattell, 1966) a 3, 4, 5 or 6 factor solution could be appropriate for these data (Fig. 1). These solutions were considered with regard to the extent to which each solution could be interpreted biologically. Items that loaded on a factor with a value less than 0.4 were suppressed in the assessment of the solutions. Factors 3, 4, 5 and 6 had α values < 0.4, indicating low internal consistency; hence, the inclusion of

additional factors did not result in increased reliability of the overall questionnaire (Table 3).

Scree Plot

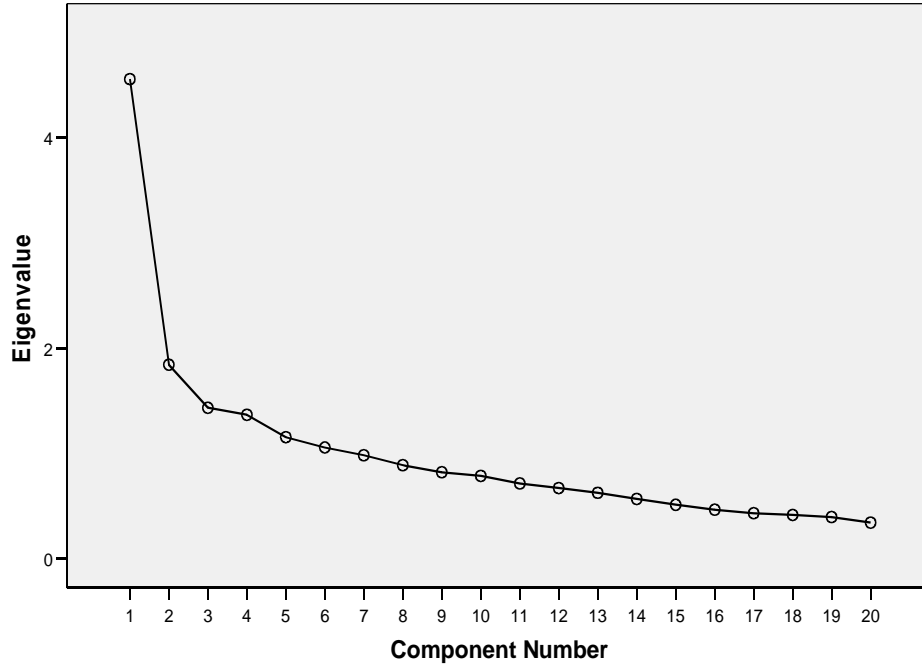


Figure 1. Scree plot of the components identified in the PCA of the twenty reliable items from the DPQ.

Table 3
Cronbach's alpha (α) reliability coefficient for 3-, 4-, 5- and 6-factor solutions following PCA.

	F1	F2	F3	F4	F5	F6
3-Factor solution	0.82	0.67	0.35			
4-Factor solution	0.74	0.76	0.67	0.36		
5-Factor solution	0.71	0.68	0.67	0.42	0.39	
6-Factor solution	0.78	0.64	0.67	0.47	0.32	0.16

The 4-, 5-, and 6-factor solutions had cross loading items, and less clarity in the biological interpretation. Considering the possible factor solutions, the three factor structure had greatest face validity using a 0.4 loading threshold and unique item loading criteria (important for clarity in interpreting what behavioral concepts the factors represent).

The three-factor solution following varimax rotation resulted in 18 of the 20 items loading strongly (> 0.4) on unique factors, with no items cross loading. Two items did not load on any of the three factors. These were items 10 and 28 (Table 1). The three factors in this solution were clearly interpretable in a biological sense with three distinct factors; Factor 1: containing items considered

to relate to ‘Behavioral Regulation,’ Factor 2: containing items considered to relate to ‘Aggression’ and ‘Response to Novelty,’ and Factor 3: containing items considered to relate to a more general level of ‘Responsiveness’ (as opposed to the responses specific to novel stimuli described in Factor 2).

The factor analysis was repeated with the final 18 items (following removal of the two non-loading items in the original three-factor solution) to confirm that the three-factor solution remained the same following the removal of these two items. The structure remained the same with the addition of an item on both Factors 1 and 3 (see Table 2). These additional items were cross loadings of original items (12 and 23), with opposite valence, therefore, remaining unique.

Repeating the PCA also increased the internal consistency of Factor 3 (Table 4). The OQS and Factor 1 (Behavioral Regulation) were found to have high internal consistency as the alpha values exceeded 0.7. This can be considered as the threshold for statistical significance (Muszbek et al., 2006). The alpha value for the other two factors was lower. However these two factors did contain fewer items than both Factor 1 and the OQS, which contributes to the decreased reliability.

Table 4
Cronbach’s alpha (α) reliability coefficient for repeated 3-factor solution (PCA) with 18 items.

	OQS	F1	F2	F3
Original 3-Factor solution ($n = 20$)	0.77	0.82	0.67	0.35
Repeated 3-Factor solution ($n = 18$)	0.74	0.82	0.67	0.44

Questionnaire Scores

The resulting tool was termed the DIAS. The data ($n = 560$) for OQS, Factor 1 (Behavioral Regulation), Factor 2 (Aggression with Response to novelty), and Factor 3 (Responsiveness) had non-normal distributions (OQS: Kolmogorov-Smirnov $Z = 1.681, p < 0.05$. Factor 1: Kolmogorov-Smirnov $Z = 2.134, p < 0.05$. Factor 2: Kolmogorov-Smirnov $Z = 3.732, p < 0.05$. Factor 3: Kolmogorov-Smirnov $Z = 1.681, p < 0.05$).

Factor 1 and Factor 2 had a significant positive correlation ($r = 0.399, p < 0.01$). There was no significant correlation between Factors 1 and 3. However, a significant negative correlation between Factors 2 and 3 was identified ($r = -0.272, p < 0.01$).

Relationship Between the OQS and Demographic Data

A significant negative correlation between the age of dog (at time of filling out questionnaire) and the OQS was found (Spearman’s $r = -0.84, p = 0.048$). Younger dogs tended to score more highly for ‘impulsivity’ (as described by the OQS. There was a significant difference in the OQS between size categories (Kruskal-Wallis $H = 22.746, p = 0.001$), with small dogs having the highest mean score, followed by medium, large and toy dogs; giant breeds had the lowest OQS) There was no significant difference in the OQS between pedigree and crossbreeds (Mann-Whitney $U = 25121.5, p = 0.064$). The OQS from breeds with > 10

individuals were compared. A significant difference was found between breeds (Kruskal-Wallis $H = 24.119$, $p = 0.004$); Table 5 shows the mean ranked position for each breed, dogs with a higher mean rank have higher OQS, indicating more impulsivity, and breeds with a lower mean rank have lower OQS, indicating less impulsivity.

No significant difference was found between the OQS and the sex of dog when all four sex categories were compared (Kruskal-Wallis $H = 5.616$, $p = 0.132$). Also, no significant difference was found between the following: Entire males and entire females (Mann-Whitney $U = 3786.0$, $p = 0.319$); neutered males and neutered females (Mann-Whitney $U = 15676.0$, $p = 0.051$); neutered males and entire males (Mann-Whitney $U = 9078.0$, $p = 0.334$); neutered females and entire females (Mann-Whitney $U = 9131.0$, $p = 0.338$).

The two largest categories from ‘source dog acquired from’ accounting for 76.3% of subjects (Breeder and Rescue) were compared; no significant difference in the OQS was found (Mann-Whitney $U = 17837.5$, $p = 0.158$).

A significant difference was found between the data source (Kruskal-Wallis $H = 35.623$, $p < 0.001$). The data with the highest mean OQS was collected from the university’s Animal Behavior Clinic and the lowest mean OQS from the data collected at dog shows.

A significant difference was found between the OQS of dogs with the absence and presence of a behavior problem (Mann-Whitney $U = 15050.0$, $p < 0.001$). Dogs that had a behavior problem had higher OQS scores.

Table 5
OQS listed by mean rank (Kruskal-Wallis $H = 24.119$, $p = 0.004$) for dog breeds with over 10 subjects.

Breed	<i>n</i>	Mean rank (out of 144 dogs)
Jack Russell Terrier	12	118.29
Staffordshire Bull Terrier	10	113.90
Labrador Retriever	26	112.29
Border collie	49	99.44
German Shepherd Dog	24	98.63
Cocker Spaniel	13	98.00
Dalmatian	10	87.25
Shetland Sheepdog	10	81.50
Golden Retriever	19	65.37
Poodle (standard)	14	46.93

Relationship to Theoretically Related Concepts

A significant positive correlation was identified between the owner view of impulsivity (item 4, Table 1) and the OQS (Spearman’s correlation, $r = 0.726$, $p < 0.001$). A significant correlation was also found between the owner view of impulsivity and Factor 1 (behavioral regulation), ($r = 0.742$, $p < 0.001$). The owners’ response to question 8 (“*My dog does not think before it acts*”) also had a

significant positive correlation with the OQS ($r = 0.606, p < 0.001$) and Factor 1 ($r = 0.638, p < 0.001$).

Discussion

The main aim of this study was to develop a reliable psychometric tool that could be used to assess trait impulsivity in the domestic dog. In addressing this aim, the study has explored how the impulsivity trait is broadly expressed in the behavioral repertoire of the domestic dog.

Previously, little consideration has been given to impulsivity as a personality trait in dogs and so no defining behaviors currently exist in the published literature. The initial survey of experts revealed high variability in suggested items so an attempt to reach a consensus between the experts was not made. The list of proposed items was used to develop a public response questionnaire (DPQ) and examine the potential to extract the structure of the impulsivity trait mathematically.

Studies on dog temperament and personality have been criticized for infrequent consideration of the reliability and validity of such tools (see Jones & Gosling, 2005; Taylor & Mills, 2006). In order to address these concerns, the items in the DIAS were tested for reliability using test-retest scores; items that were identified as unreliable were discarded. The remaining items were considered reliable in terms of the temporal stability in owners' perceptions of their dogs. The authors plan to investigate the accuracy of these perceptions in future cross validation with other, objective measures of impulsivity.

The face validity of the 3-, 4-, 5-, and 6-factor solutions were evaluated when determining the number of factors to retain. The three-factor solution showed greatest face validity as each factor was easy to interpret uniquely in a biological sense. Three independent factors were identified, with items grouped relating to 'Behavioral Regulation' 'Aggression and Response to Novelty' and a more general level of 'Responsiveness.'

The correlation found between the owner view of impulsivity and the OQS, supports the convergent validity of the tool. In addition, this result indicates that dog owners may have a good idea of how impulsive their dog is.

The OQS was used to investigate relationships between 'impulsivity' (as described by the expert derived items) and the demographic data. These results were then compared to findings from previous studies on impulsivity in a range of species. Younger dogs were found to be significantly more impulsive, supporting findings in rats, wild Grivet monkeys (*Cercopithecus aethiops aethiops*), and humans (Dellu-Hagedorn, Trunet, & Simon, 2004; Fairbanks et al., 1999; Semple, Zians, Grant, & Patterson, 2005). The significant difference found between size categories can be explained in terms of the types of dogs in each category. The small dogs in this sample included many terriers (e.g., Jack Russell's), which have, in evolutionary terms, been bred for more impulsive behavior when compared to the larger breeds (e.g., standard poodles). This is supported by the mean rankings from the ten most frequent breeds were compared. These findings are consistent with the difference between the 'impulsivity-activity' factor and size, previously identified in dogs (Vas et al., 2007). The exception was that the 'toy' size category

dogs were found to be less impulsive than the small, medium and large sized dogs. It could be speculated that because the toy breeds are primarily bred as companions and lap dogs, that impulsivity is a highly undesirable trait. However the toy group in this sample included only 11 subjects, so such predictions based on this sample should be treated with caution. An additional explanation for smaller dogs (e.g., terriers) scoring more highly for impulsivity is that the owners may not be as inclined to train their small dog's self-control. It is physically easier to control smaller dogs, but also the potential consequences of a small dogs being out of control are much less than for a larger dog. For example, an aggressive dog is perceived to be much less threatening to a person if it is small, and can cause less physical damage if it were to bite. Therefore it is possible that impulsivity may be partly down to nurture, with owners of larger breeds working harder to teach their dog to be self-controlled.

A significant difference was also identified between the OQS and data source; the data collected from dogs being treated at the university's Animal Behavior Clinic had a greater mean OQS than the other categories, supporting the idea that 'impulsivity' plays a role in problem behavior. The data source with the lowest mean OQS was 'dog shows.' This result is not surprising since show dogs need to be able to suppress responding to distraction (e.g., reacting to other dogs and people) in the busy and rich environment generally associated with dog shows. An additional point to consider is that the population of show dogs included dogs in the small size category (e.g., the terriers). This further supports the suggestion that it is possible for smaller dogs to be more self-controlled with appropriate training and socialization, as many small breeds, including the terriers also participate successfully in dog shows.

Dogs with behavior problems (as reported by owners on the DPQ) had a significantly higher OQS than dogs whose owners did not report behavior problems. Also, questionnaires returned from clients of the university's Animal Behavior Clinic had higher OQSs than those returned from other sources. These findings provide further evidence for the idea that impulsivity is an important factor in a range of behavior problems in dogs, such as impulsive aggression ("aggressive behaviors occurring with reduced or absent warning signals," Fatjó et al, 2005). This relationship between impulsivity and problem behavior has previously been suggested (Overall, 2001; Peremans et al., 2003; Reisner et al., 1996). In addition, this finding draws parallels with the human literature, as impulsivity is also reported to be an underlying factor in certain psychiatric disorders, including the manias (e.g., pyromania, kleptomania) and many personality disorders, including borderline personality disorder and bipolar disorder (Moeller et al., 2001).

No evidence was found for the idea that impulsivity is related to sex of the dog. This is consistent with the lack of gender difference found in studies of 'impulsivity-activity' in dogs (Vas et al., 2007), but inconsistent with findings in humans, where males have been suggested to be equal to, or more impulsive than females (Claes, Vertommen, & Braspenning, 2000).

It might be assumed that dogs obtained from breeders that remain with their first owners have more appropriate training input early in life, than those that end up in rescue shelters. Hence rescued dogs may be considered to be less self-

controlled, and display higher levels of impulsivity. However no significant difference was found in the level of impulsivity in dogs acquired from breeders versus rescue shelters, so it could be suggested that impulsivity is not an important factor in the surrender of dogs from the home. However, it is plausible that rescue dogs displaying extreme impulsive traits are euthanized before leaving the shelter as they are deemed unsuitable for re-homing. Therefore these data may not be representative of all animals given up to rescue, but rather those that are re-homed from it.

The three factors identified in the DIAS were considered independently, in terms of how they relate to the expression of impulsivity. Factor 1 (Behavioral Regulation) seems to be a more narrow assessment of impulsivity than the OQS when considered in relation to the psychobiological literature. Factor 1 includes four items that are related to control (items 4, 8, 22, 27, Table 2), which are all defining items of impulsivity in human personality (Evenden, 1999; Eysenck & Eysenck, 1977; Moeller et al., 2001; Patton et al., 1995). Dogs scoring higher on these four items, are rated more 'impulsive' (item 4) and reported not to think before they act (item 8), by the owner. They are also described as having less control over their responses to stimuli (item 22), and being more impatient. This first factor (Behavioral Regulation) also includes four items related to arousal levels (items 2, 3, 21, 32, Table 2), suggesting that arousal may be an important factor in the expression of impulsivity in dogs. Dogs scoring highly on the arousal items are more likely to show extreme physiological signs when excited (item 2), more likely to show repetitive behavior when excited (item 3), to take longer to calm down after being aroused (item 21), and to show spontaneous arousal in the absence of obvious stimuli (item 32).

Factor 2 contains items that relate to aggression, indicating that dogs with a higher level of impulsivity are more likely to express aggression, comparable to the close relationship identified between aggression and impulsivity in humans, rats, and non-human primates (e.g., Apter, van Pragg, Plutchik, Sevy, Korn, & Brown, 1991; Evenden & Ryan, 1996; Harmon-Jones, Barratt, & Wigg, 1997; Higley et al., 1996). Dogs scoring highly on Factor 2 items are less likely to tolerate close contact (item 5: dog doesn't like to be approached or hugged), and more likely to have lower thresholds for aggression (item 6: dog becomes aggressive when excited, item 17: dog may become aggressive if frustrated). Factor 2 also contains items indicating a tendency towards negative response to novelty. Dogs scoring highly on Factor 2 are less likely to be keen on new situations and less likely to be interested in new items and places (item 23). It is perhaps not surprising that this set of items have loaded on the same factor as the items associated with aggression, since novel stimuli can be considered as fear eliciting, and so a trigger of aggression (Archer, 1976). So for example, dogs that 'become aggressive when excited or frustrated' may also 'not be keen to enter new situations' and this may indicate that these individuals have lower tolerance thresholds in general to diverse stimuli.

Factor 3 includes items that appear to be related to general responsiveness and environmental awareness. Dogs that score highly on this factor are described as easy to train (item 12), remain interested in new stimuli for longer (item 20) and react quicker (item 26), which are desirable traits in a dog from a training

perspective. This factor is not significantly related to Factor 1 (Behavioral Regulation). Factor 3 is of relatively low importance in the overall assessment, as the third factor generated by the PCA, accounting for only a small amount of the variance. However, it should be investigated further, as it may provide information on the wider expression of impulsivity. In particular, it would be valuable to investigate this factor in relation to success of training and behavior modification programs.

The DIAS has a number of potential applications in non-scientific settings. It could be used by dog trainers and behaviorists to indicate the degree to which impulsivity underlies problem behaviors or difficulties in training. This would enable them to develop more appropriate training plans, for example targeting a more general level of self-control as opposed to specific behaviors where impulsivity is deemed to be high. The tool could also be applied to the assessment of assistance dogs (e.g., guide dogs, mobility support dogs), considering impulsivity as a potential factor in the success or failure during selection, training and placement in assistance dog programs. The DIAS may also be of value to rescue shelter staff conducting temperament assessments on dogs. This would provide further information for staff when placing dogs in new homes, and matching dogs with potential new owners. It may also give early indications of their tendency towards developing behavior problems after leaving the shelter.

In conclusion, this study has described the use of expert opinion to develop an assessment tool (the DIAS) that is a reliable method of gathering owners' perceptions about their dogs' personality in relation to the expression of impulsivity. The scale has a number of potential applications, both for further research, and also in non-scientific settings. The DIAS appears to be valid in terms of face (or content) validity (i.e., it appears to measure what it is intended to measure) and construct validity (i.e., theoretically related factors and items within the tool are positively correlated). The face validity of the 3-factor structure suggests that Factor 1 measures a narrow form of impulsivity closely related to the regulation of behavior, while the OQS assesses impulsivity in a broader sense, also covering the effect on responses to novelty, aggression thresholds and a more general level of responsiveness. The authors suggest that the DIAS need to be investigated further, particularly its convergent validity with objective measures of impulsivity at both a behavioral and physiological level.

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