The use of real-time heart rate monitors to assess arousal levels during canine behavioural test batteries

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An accurate, objective and reliable test to identify behavioural traits in pet dogs is thought to be an important and useful tool in companion dog management and welfare. However, disagreement between interest groups as to how such tests should be constructed, administered and interpreted, has lead to confusion, distrust of results and worse, in some situations inaccurate interpretations resulting in an animal's death. This is partly due to a variation in focus between purebred and sporting enthusiasts, animal management and animal welfare professionals (Taylor & Mills, 2006), and partly due to a general lack of trust for test results due to the haphazard way tests have been developed to date (Bräm, Doherr, Lehmann, Mills, & Steiger, 2008; Diederich & Giffroy, 2006; Mornement, Coleman, Toukhsati, & Bennett, 2010).

Despite several decades of research into canine behaviour, and much discussion about how tests should be developed and assessed, we are still a long way from having a practical, objective test that is capable of providing reliable information about dogs. Taylor and Mills (2006) stress the need for behavioural tests to be objective, reliable and valid in order for tests to be of useful, regardless of whether the test is being used for identifying sporting or working dogs, or selecting a suitable pet from a shelter or pound. They also highlighted the difference between behavioural and temperament tests, the results of the former being highly influenced by learning and situational variables, while the latter (confirmed by assessing test-retest reliability over time) being more reflective of a dog's inherent 'personality'. Finally, the authors suggested that similarities in the tests currently used by different canine interest groups, may indicate that a suitable series of subtests could yield information useful in the selection of dogs for pet, sporting and working roles.

Studies following that of Taylor and Mills (2006) have yielded reliability and validity results for test protocols, but even the most comprehensive tests and evaluations have encountered issues with reliability - inter-rater reliability and concurrent validity in particular. For example, the test protocol presented by Valsecchi et al. (2011) showed significant agreement between testers for many behavioural traits, but not in two important areas, sociability with both people and dogs and the interpretation of passive responses, despite the testers having worked and trained together for several years. This exemplifies the issues plaguing a behaviour-only approach to developing test protocols. The accurate interpretation of subtle canine behaviours is difficult, especially if the dog is apparently doing little. Understanding of canine behaviour and communication requires attention to subtle body language as well as gross body movements, but the sheer volume of information from these subtle signals makes any test incorporating these completely impractical for general use (Figure 1). Furthermore, even with extensive training and experience, a tester's previous experiences with dogs or breeds, and their own understanding of canine nature, will inevitably influence results where any subjective interpretation of behaviour is required or allowed. Tests must be based on easily observable, objective measures if the results of tests carried out by one person, are going to aid interpretation of tests carried out by others. It seems unlikely that either of these two issues will be addressed fully while the focus of test developers remains solely on behaviour.

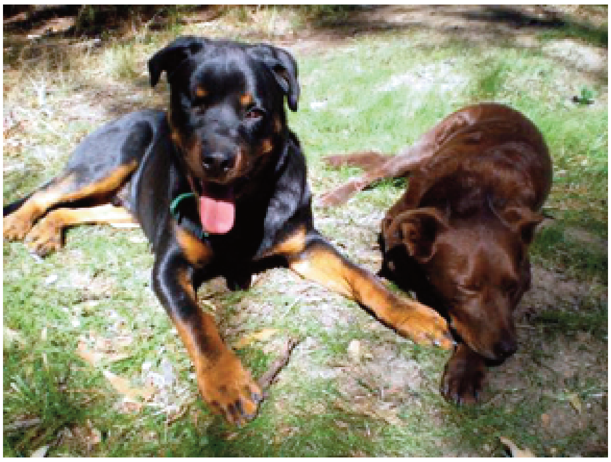

Figure 1 In many current behavioural tests, the behaviour of the dogs in this photo would score similarly due to the fact that they are both lying down with similar body positions, despite their facial expressions and postures indicating quite different responses to the situation. In order to accurately describe each dog's response, detailed information about the size and shape of their eyes, the direction and focus of their gaze, the position of their mouth and tongue and their ear-set would all need to be included in the scoring system.

Taylor and Mills (2006) proposed that the use of relevant physiological measures might help reduce issues with inter-rater reliability in behavioural tests. Physiological measures such as heart rate are both objective and can be easily measured. However, these measures will only be reflective of behavioural traits that are strongly affected by arousal. Almost a decade prior to the suggestion by Taylor and Mills (2006), Vincent and Leahy (1997) noticed that there was a relationship between heart rate variability of guide dogs while on a training walk and how the dogs normally responded to novelty and stress. Dogs described by trainers as 'calm and non-stress prone' showed low mean baseline heart rates and smaller variation in overall heart rate during training walks, than those described by trainers as 'excitable and stress-prone'. Similarly, Wright, Mills and Pollux (2012) showed that owner reports of poor impulse control and a reduced tolerance of delayed rewards in pet dogs during a learning task, correlated with low urinary levels of serotonin and dopamine. Low circulating levels of serotonin have been linked with anxiety disorders, characterised by intense or prolonged stress during typically non-stressful situations, in people and other animals. Both of these results indicate that a simple measure of arousal, such as heart rate, could be applied within a behavioural test protocol to aid understanding of the underlying stress response of dogs.

Within the field of canine behavioural research, study into the biological basis of temperament and behavioural traits stems primarily from two areas. Firstly, behavioural biochemistry has been studied frequently as the basis for diagnostic and treatment options for maladaptive stress-related and aggressive behaviours in dogs, treatment of which now often includes psychotropic drugs like Valium and Prozac. Studies in this area have tended to focus on the function (or lack of function) of key neurotransmitters, such as serotonin and dopamine, occurring alongside specific behavioural syndromes (Riva, Bondiolotti, Michelazzi, Verga, & Carenzi, 2008; Rosado, García-Belenguer, León, Chacón, Villegas, & Palacio, 2010). Secondly, selection of working dogs has lead to a steadily increasing focus on the heritability of measurable temperament traits (Kubinyi, Sasvari-Szekely, & Miklosi, 2011; Meyer, Schawalder, Gaillard, & Dolf, 2012; Takeuchi, Hashizume, Arata, Inoue-Murayama, Maki, Hart, & Mori, 2009; Wilsson & Sundgren, 1997). Due to the different focuses of each area of research into the biochemical and genetic basis of temperament, no clear picture of the mechanism through which biochemistry and physiology controls temperament has emerged. However, the broad traits of fearfulness/fearlessness, reactivity/impulsivity and sociability have consistently appeared to correlate with each other, which could be indicative of a 'higher-order' trait observed in a number of mammalian species termed the ‘shy-bold axis’, suggested to have some physiological basis (Kubinyi et al., 2011).

Based on the results of the Swedish Dog Mentality Assessment (DMA), Svartberg (2002; 2005) proposed a shy-bold 'super trait' in dogs, showing that 'bold' dogs performed better across a range of working dog trials including tracking, search and protection work, and that boldness scores correlated with scores for playfulness, curiosity-fearfulness and sociability. Several other authors have studied the shy-bold continuum in dogs, showing somewhat comparable results and indicating that these traits are generally stable over short periods of time. Traits that vary independently of the shy-bold super trait include chase-proneness, intelligence and overall aggression. While no studies correlating the shy-bold axis with physiological variables have yet been published, Svartberg (2002) draws parallels between shy-bold axis and the emotionality-coping style model proposed by Koolhaas et al. (1999), which linked activity of the sympathetic and parasympathetic nervous systems to stress reactivity (termed 'emotionality') and characteristic behavioural patterns for dealing with stressors (termed 'coping style') (Figure 2). While Starling, Branson, Thomson, and McGreevy (2013) also suggest that aspects of the shy-bold continuum could be analogous to the emotionality-coping styles model, the relationship between these two models remains unclear, limiting the application of findings from studies of the shy-bold continuum to those based on the emotionality-coping styles model.

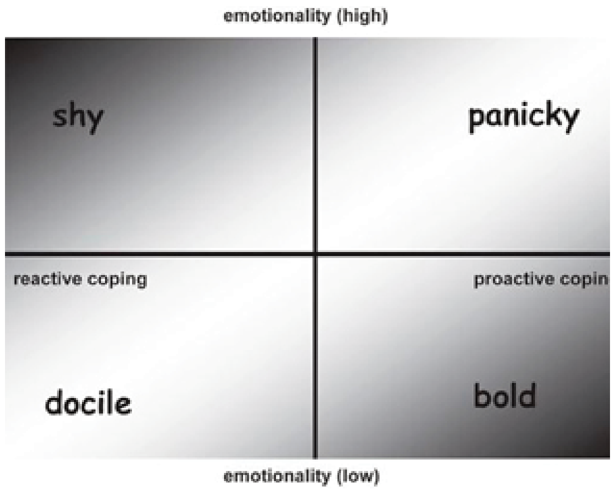

FIGURE 2 The dual axes model of 'emotionality-coping style' proposed by Koolhaas, De Boer, Buwalda, and Van Reenen (2007). In this model, the typical behavioural response of a stressed animal falls along a horizontal 'coping style' axis, while the vertical 'emotionality' axis indicates how easily aroused or stressed the animal is.

One limitation of the current literature on the ‘shy-bold’ axis in dogs is that test methodologies have focused upon 'proactive' coping styles, i.e. those characterised by active avoidance or approach of the stressor (Koolhaas et al., 2007) which fall on the far right of the graph in Figure 2. Behavioural tests commonly presented in the shy-bold literature are scored based on intensity of gross behaviour repertoires, placing animals that actively avoid a stressor at one end of the continuum with those actively approaching a stressor at the other. However, these tests fail to include subtle communications of passively responding dogs during tests and instead group all passively responding dogs together regardless of arousal level (Horváth, Igyártó, Magyar, & Miklósi, 2007; Svartberg, 2002). This presents a significant limitation in the broader application of these findings, as differentiation between dogs experiencing a negligible level of stress (i.e. those in the 'docile' quadrant of Figure 2), and those that are stressed but respond in a passive manner (i.e. those in the 'shy' quadrant of Figure 2), is not taking place. Koolhaas et al. (2007) also points out that despite animals having a characteristic behavioural style for dealing with stressors, or 'default strategy', which is indicative of their temperament, the behaviour of an individual is highly situation-dependent. This is because animals will choose the strategy perceived to work most effectively in reducing stress, a choice that is influenced by both previous learning and the level of threat perceived by the animal during the encounter. Few studies in the shy-bold continuum literature acknowledge these limitations, failing to address the requirements for multiple subtests to determine the 'default' strategy of the animal, while ensuring that all animals tested experience equal levels of stress during each subtest. Careful test design and an objective assessment of arousal levels to indicate perceived stress, such as heart rate, could potentially address both of these issues in behavioural test situations.

To further complicate test development, behavioural tests of dogs are often compared against owner reports of their dogs' typical behaviour in order to assess how accurately the test reflects the dogs' true nature. This information is often gathered via a questionnaire, asking the owners to indicate how often their dog behaves a certain way, or how they think their dog 'feels' about a particular situation. In an effort to overcome issues of owner bias and poor quality descriptions of pet dog behaviour as reported by Mariti et al. (2012) and Tami & Gallagher (2009), design of owner report questionnaires has trended away from subjective descriptions of behaviour, like 'my dog appears happy when visitors arrive', in favour of physical descriptions of behaviour such as 'my dog freely approaches visitors with his tail wagging and mouth open', with the frequency or intensity of the behaviour scored against numerical scales (Hsu & Serpell, 2003). While this approach limits subjectivity of owner reports to a degree, the focus on frequency of gross dog behaviours such as barking, growling, baring of teeth and lunging (Hsu & Serpell, 2003) and relative lack of subtle behavioural indicators of stress, such as lip licking or averting of gaze, means this method also suffers from an inability to properly identify stressed, but passively responding dogs. Some research focus has been directed towards the development of questionnaires based on personality descriptions by people well known to the dog (Ley, Bennett, & Coleman, 2009; Ley, McGreevy, & Bennett, 2009), as these have proved to be quite reliable when used for human studies. However, variation in definitions of traits like 'friendly and sociable' between studies limits the use of these questionnaires for behavioural test development, as we cannot compare directly between personality traits described owners and behaviours observed in tests. These limitations highlight the importance of objective test measures in obtaining accurate information about dogs, although it appears that, at this point in time, using multiple questionnaires to allow comparisons to be made between multiple results is the best way forward.

Our research project seeks to evaluate a number of behavioural test battery subtests currently used in behavioural tests or proposed in the literature, using measures of both behaviour and real-time heart rate recordings. A total of 16 interactive and 25 sound-based subtests that have shown some promise for eliciting a variety of behaviours in a test situation, were selected from the literature. One hundred and eighty dogs of various breeds and cross-breeds were brought into the testing facility by their owners and were subjected to the same 60-minute protocol by the same tester. All dogs wore a Polar RS800CX telemetric heart rate monitor throughout the tests, and were also video recorded to allow accurate scoring of behaviours at a later date. Blood samples were collected on arrival at the facility and directly following the tests, to allow heart rate results to be compared to changes in plasma cortisol and prolactin levels over the test, as additional indicators of stress intensity. While the tests were conducted, owners were asked to fill out a questionnaire about themselves and their dogs, which included demographic questions, the Canine Behavioural and Research Questionnaire (CBARQ), the Dog Impulsivity Assessment Survey (DIAS) and the Monash Dog-Owner Relationship Survey (M-DORS). Results obtained during the tests will be compared to results obtained from the owner-questionnaires, in order to ascertain whether the behaviour seen during the test was typical of owner perceptions of the dogs' behaviour in day-to-day situations.

While no formal evaluations of test results have been carried out as yet, a wide variety of behaviours and patterns were observed and several interesting preliminary results were noted during testing. Dogs with a reported history of separation-related anxiety maintained high baseline heart rates throughout the test, with a noticeable drop in heart rate at the onset of each subtest that produced a response. This pattern was opposite to that shown by all other dogs, who maintained a lower baseline heart rate with an increase at the start of each subtest that produced a stress response. However, these dogs showed less variation overall than dogs who appeared to experience a similar level of overall stress throughout the test, that was not related to being separated from their owners (i.e. dogs with pronounced fear responses to sounds or novel objects). Dogs that were described by their owners as typically adapting well to new situations and being relatively 'non-stress prone' exhibited a steady decrease in baseline heart rate throughout the test, as well as a relatively low level of variation in heart rate, particularly during the auditory section of the test in which the dogs were freely roaming the room (some even fell asleep!). Interestingly, dogs who appeared easily stressed during the test, but were described by their owners as playful or somewhat chase-prone (i.e. they typically show a pronounced predatory response to small animals or toys), did not consistently display those behaviours during the test, and showed a reduced behavioural repertoire overall. Dogs that were somewhat relaxed throughout the protocol were more likely to show a fuller behavioural repertoire and were more likely to exhibit play or predatory behaviours during a number of subtests, even if they were not described as highly playful or chase-prone by their owners. This indicates that playfulness is perhaps not directly related to a dog's typical 'coping style' as suggested by previous literature, but rather that in dogs falling on the higher end of the 'emotionality' axis, play and predatory behaviours are suppressed by their stress response in non-familiar situations or with new people.

If the results of this project show promise in the use of the telemetric monitors during a test battery, we would like to proceed by refining the protocol and producing a 'gold standard' test. Ideally, the aim is to produce a test that can be used to aid good dog-owner matching in re-homing programs, and that could also be used to aid animal management professionals to identify problems with owned dogs and suggest appropriate, problem-specific management and treatment options. Failing that, we hope the results stimulate a broader focus during test development in the future, accounting for both behavioural and physiological responses in order to achieve a better understanding of dogs overall.

References

Bräm, M., Doherr, M.G., Lehmann, D., Mills, D., & Steiger, A. (2008). Evaluating aggressive behavior in dogs: a comparison of 3 tests. *Journal of Veterinary Behavior: Clinical Applications and Research, 3*(4), 152-160. doi: 10.1016/j.jveb.2008.04.001

Diederich, C., & Giffroy, J.M. (2006). Behavioural testing in dogs: A review of methodology in search for standardisation. *Applied Animal Behaviour Science, 97*(1), 51-72. doi: 10.1016/j.applanim.2005.11.018

Horváth, Z., Igyártó, B.Z., Magyar, A., & Miklósi, Á. (2007). Three different coping styles in police dogs exposed to a short-term challenge. *Hormones and Behavior, 52*(5), 621-630. doi: 10.1016/j.yhbeh.2007.08.001

Hsu, Y., & Serpell, J.A. (2003). Development and validation of a questionnaire for measuring behaviour and temperament traits in pet dogs. *Journal of American Veterinary Medical Association, 223*(9), 1293-1300.

Koolhaas, J., De Boer, S., Buwalda, B., & Van Reenen, K. (2007). Individual Variation in Coping with Stress: A Multidimensional Approach of Ultimate and Proximate Mechanisms. *Brain, Behavior and Evolution, 70*(4), 218.

Koolhaas, J.M., Korte, S.M., De Boer, S.F., Van Der Vegt, B.J., Van Reenen, C.G., Hopster, H., Blokhuis, H.J. (1999). Coping styles in animals: current status in behavior and stress-physiology. *Neuroscience & Biobehavioral Reviews, 23*(7), 925-935. doi: 10.1016/s0149-7634(99)00026-3

Kubinyi, E., Sasvari-Szekely, M., & Miklosi, A. (2011). Genetics and the social behaviour of the dog revisited: searching for genes relating to personality in dogs. In M. Inoue-Murayama (Ed.), *From genes to animal behaviour* (pp. 255-274). Budapest, Hungary: Primatology Monographs.

Ley, J.M., Bennett, P.C., & Coleman, G.J. (2009). A refinement and validation of the Monash Canine Personality Questionnaire (MCPQ). *Applied Animal Behaviour Science, 116*(2–4), 220-227. doi: 10.1016/j.applanim.2008.09.009

Ley, J.M., McGreevy, P., & Bennett, P.C. (2009). Inter-rater and test–retest reliability of the Monash Canine Personality Questionnaire-Revised (MCPQ-R). *Applied Animal Behaviour Science, 119*(1–2), 85-90. doi: 10.1016/j.applanim.2009.02.027

Mariti, C., Gazzano, A., Moore, J.L., Baragli, P., Chelli, L., & Sighieri, C. (2012). Perception of dogs' stress by their owners. *Journal of Veterinary Behavior: Clinical Applications and Research, 7*(4), 213-219. doi: 10.1016/j.jveb.2011.09.004

Meyer, F., Schawalder, P., Gaillard, C., & Dolf, G. (2012). Estimation of genetic parameters for behavior based on results of German Shepherd Dogs in Switzerland. *Applied Animal Behaviour Science, 140*(1–2), 53-61. doi: 10.1016/j.applanim.2012.05.007

Mornement, K.M., Coleman, G.J., Toukhsati, S., & Bennett, P.C. (2010). A Review of Behavioral Assessment Protocols Used by Australian Animal Shelters to Determine the Adoption Suitability of Dogs. *Journal of Applied Animal Welfare Science, 13*(4), 314-329. doi: 10.1080/10888705.2010.483856

Riva, J., Bondiolotti, G., Michelazzi, M., Verga, M., & Carenzi, C. (2008). Anxiety related behavioural disorders and neurotransmitters in dogs. *Applied Animal Behaviour Science, 114*(1–2), 168-181. doi: 10.1016/j.applanim.2008.01.020

Rosado, B., García-Belenguer, S., León, M., Chacón, G., Villegas, A., & Palacio, J. (2010). Blood concentrations of serotonin, cortisol and dehydroepiandrosterone in aggressive dogs. *Applied Animal Behaviour Science, 123*(3–4), 124-130. doi: 10.1016/j.applanim.2010.01.009

Starling, M.J., Branson, N., Thomson, P.C., & McGreevy, P.D. (2013). "Boldness" in the domestic dog differs among breeds and breed groups. Behavioural Processes, 97(0), 53-62. doi: http://dx.doi.org/10.1016/j.beproc.2013.04.008

Svartberg, K. (2002). Shyness–boldness predicts performance in working dogs. *Applied Animal Behaviour Science, 79*(2), 157-174. doi: 10.1016/s0168-1591(02)00120-x

Svartberg, K. (2005). A comparison of behaviour in test and in everyday life: evidence of three consistent boldness-related personality traits in dogs. *Applied Animal Behaviour Science, 91*(1–2), 103-128. doi: 10.1016/j.applanim.2004.08.030

Takeuchi, Y., Hashizume, C., Arata, S., Inoue-Murayama, M., Maki, T., Hart, B.L., & Mori, Y. (2009). An approach to canine behavioural genetics employing guide dogs for the blind. *Animal Genetics, 40*(2), 217-224. doi: 10.1111/j.1365-2052.2008.01823.x

Tami, G., & Gallagher, A. (2009). Description of the behaviour of domestic dog (Canis familiaris) by experienced and inexperienced people. *Applied Animal Behaviour Science, 120*(3–4), 159-169. doi: 10.1016/j.applanim.2009.06.009

Taylor, K.D., & Mills, D.S. (2006). The development and assessment of temperament tests for adult companion dogs. *Journal of Veterinary Behavior: Clinical Applications and Research, 1*(3), 94-108. doi: 10.1016/j.jveb.2006.09.002

Valsecchi, P., Barnard, S., Stefanini, C., & Normando, S. (2011). Temperament test for re-homed dogs validated through direct behavioral observation in shelter and home environment. *Journal of Veterinary Behavior: Clinical Applications and Research, 6*(3), 161-177. doi: 10.1016/j.jveb.2011.01.002

Vincent, I.C., & Leahy, R.A. (1997). Real-time non-invasive measurement of heart rate in working dogs: a technique with potential applications in the objective assessment of welfare problems. *The Veterinary Journal, 153*(2), 179-183. doi: 10.1016/s1090-0233(97)80038-x

Wilsson, E., & Sundgren, P.E. (1997). The use of a behaviour test for selection of dogs for service and breeding. II. Heritability for tested parameters and effect of selection based on service dog characteristics. *Applied Animal Behaviour Science, 54*(2–3), 235-241. doi: 10.1016/s0168-1591(96)01175-6

Wright, H.F., Mills, D.S., & Pollux, P.M.J. (2012). Behavioural and physiological correlates of impulsivity in the domestic dog (Canis familiaris). *Physiology & Behavior, 105*(3), 676-682. doi: 10.1016/j.physbeh.2011.09.019

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