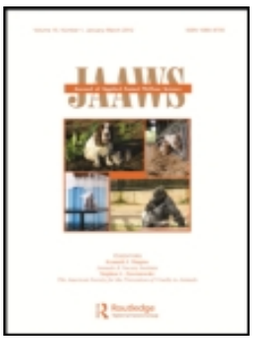

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ARTICLES

Puppy Temperament Assessments Predict Breed and American Kennel Club Group but Not Adult Temperament

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ABSTRACT

Puppy assessments for companion dogs have shown mixed long-term reliability. Temperament is cited among the reasons for surrendering dogs to shelters. A puppy temperament test that reliably predicts adult behavior is one potential way to lower the number of dogs given to shelters. This study used a longitudinal design to assess temperament in puppies from 8 different breeds at 7 weeks old ($n = 52$) and 6 years old ($n = 34$) using modified temperament tests, physiological measures, and a follow-up questionnaire. For 7-week-old puppies, results revealed (a) puppy breed was predictable using 3 variables, (b) 4 American Kennel Club breed groups had some validity based on temperament, (c) temperament was variable within litters of puppies, and (d) certain measures of temperament were related to physiological measures (heart rate). Finally, puppy temperament assessments were reliable in predicting the scores of 2 of the 8 adult dog temperament measures. However, overall, the puppy temperament scores were unreliable in predicting adult temperament.

KEYWORDS

Companion nonhuman animal; dog; temperament; American Kennel Club; puppy

"He's happy when you walk in the door, and he never talks back to you. Everyone should have a dog." This comment from one of our participants reflects the importance that temperament plays in our affections toward dogs. Temperament is typically defined as the genetic predispositions that predict a nonhuman animal's behavior or patterns of behavior beginning in infancy and continuing over the course of the animal's life; temperament endures across environments (Goldsmith et al., 1987; McDougall, Réale, Sol, & Reader, 2006; Réale, Reader, Sol, McDougall, & Dingemanse, 2007). Factors associated with temperament include genetics, environment, and hormone levels (Curley et al., 2008; D'Eath et al., 2009; Hausberger, Bruderer, Le Scolan, & Pierre, 2004). Temperament is made up of multiple traits that predict behavior such as reactivity, aggressiveness, and dominance (Buss & Plomin, 1975; Goldsmith et al., 1987; Thomas & Chess, 1977).

While it was first studied in humans, temperament has since been studied in a variety of animals including dogs (*Canis familiaris*; Mehrkam & Wynne, 2014; Thomas & Chess, 1977; reviewed in Gosling, 2001). Pfaffenberger (1963) started developing puppy temperament assessments in 1963 to assess the suitability of puppies as later guide dogs. Following this work, Campbell (1972) developed a test to assess the suitability of puppies for selection as companion animals. Most of the studies on puppy temperament assess their usefulness in predicting puppy suitability for service- and guide-dog training with mixed results (Slabbert & Odendaal, 1999; Wilsson & Sundgren, 1998). Jones and Gosling (2005)

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noted there are few studies on temperament in companion and shelter dogs and that the majority of studies focus on Labrador retrievers and German shepherds. They also stated that the majority of temperament studies focus on dogs younger than 4 years old, and therefore, we do not know the long-term validity of these studies.

In Diederich and Giffroy's (2006) review of temperament, they found that during the past 50 years, only six temperament studies had data on dogs older than 4 years of age. A temperament study that focuses on multiple breeds of pet dogs and goes beyond the age of 4 would be an important addition to the dog temperament literature.

Individual temperament is affected by multiple factors, both environmental and genetic. The domestic dog genome has been mapped and studied since the 1990s in an effort to better understand genetic diversity and plasticity, which in turn can be used for research on both canine and human disease (Kim, Lee, Jeong, & Ha, 1998; Lindblad-Toh et al., 2005; Parker et al., 2004). Researchers believe at least some aspect of dog temperament is genetic due to the artificial selection for neotenous, or infantile, traits that may have allowed for domestication (Trut, 2001; Trut, Oskina, & Kharlamova, 2009). Domestic dogs retain many juvenile traits into adulthood because humans specifically select neotenous traits in dogs such as large heads and eyes and playful behavior (Coppinger et al., 1987; Ruvinsky & Sampson, 2001; Trut, Plyusnina, & Oskina, 2004). Saetre et al. (2006) studied genetics and personality in two breeds and found that genetics influenced almost all of the behaviors studied.

Genetics clearly play a role in predicting adult temperament in animals, but so does environment. The effects of environment can be seen in research such as the study by Fox and Stelzner (1966) that showed a marked behavioral difference between puppies who had been handled early and puppies who had been isolated. Further studies have shown that socialization classes and training classes improved the likelihood that a dog would be kept by their caregiver (Diesel, Pfeiffer, & Brodbelt, 2008; Duxbury, Jackson, Line, & Anderson, 2003). Even behaviors related to working in dogs such as shepherding skills can be so greatly influenced by environment that genetics plays a very small role (Courreau & Langlois, 2005).

Research into puppy temperament continues because of the potential benefit of being able to accurately predict adult temperament at an early age. A practical benefit to studying temperament in dogs is to reduce the number relinquished to shelters and euthanized. In the United States, reasons given for surrendering dogs to shelters include problems with the animal such as aggression and inability to get along with other companion animals, as well as problems related to the caregiver such as incorrect expectations about guardianship and the inability to provide veterinary care (Patronek, Glickman, Beck, McCabe, & Ecker, 1996; Salman et al., 1998, 2000). According to Salman et al. (2000), there is an increase in relinquishment, due at least in part to behavioral reasons, in dogs aged 9 months to 6 years old. Because there are very few studies on temperament in dogs older than 4 years old, it is difficult to know what temperamental changes and associated behavioral problems occur over the animal's life span to influence relinquishment.

Being able to predict later behavioral problems would allow for early behavioral intervention and even prevention (Hsu & Serpell, 2003; Ledger & Baxter, 1997). In theory, if puppy temperament assessments were found to be stable across development and into adulthood, caregivers could then select compatible puppies as companions, which would reduce the number of dogs in shelters. We therefore decided to assess the long-term usefulness of an established puppy temperament assessment using the behavioral measures that Campbell developed in 1972.

Using Campbell's (1972) five categories of behavioral measures, our current study aimed to assess temperament using physiological and behavioral measures. We also included three other measures based on Lindsay's (2001) handbook on dog training. Our study determined puppy scores on multiple behavioral dimensions and then followed up 6 years later with caregiver-reported scoring of the same (adult) dogs. Campbell's five categories—social attraction, following, restraint, social dominance, and elevation dominance—were used as the basis for the behavioral temperament measures. In addition, we used Lindsay's rag play (renamed rope play), ball play, and startle reflex. Campbell's work was used with the intent of incorporating multiple concepts of temperament assessment into a single broad test of functionality within and across breed or group. Lindsay's measures were added to gather further

information on the behaviors that may be specific to different breeds. As these scales have not been used in assessing long-term predictive value, we also wanted to test their usefulness in predicting later traits.

In Part A of the current study, we sought to test and validate Campbell's (1972) and Lindsay's (2001) temperament measures in 6- to 8-week-old puppies. It was hypothesized that if these measures were valid in assessing temperament, then we should find breed differences and thus be able to statistically predict breed based only on the temperament scores. Likewise, we also wanted to assess whether all or any of the measures were capable of predicting American Kennel Club (AKC) breed group assignment. In this analysis, it was our aim to test whether certain breeds within a group were similar enough to warrant being classified together—that is, whether breeds cluster together based on temperament.

Studies in dogs, humans, and nonhuman primates have demonstrated that heart rate may be associated with temperament (Byrne, DiGregorio, & Thompson, 1988, as cited in Suomi, Chaffin, & Higley, 2011; Kagan, Reznick, & Snidman, 1988; Scott & Fuller, 1965). Therefore, to test our hypotheses, we used Campbell's (1972) measures and also gathered data on heart rate to gauge physiological reactivity. Given the similarities in some of the behavioral measures, it was predicted that distinct clusters of related variables as well as predictive independent variables could be identified through statistical analysis.

Finally, we assessed temperament differences between littermates. We hypothesized temperament among littermates would be more similar than temperament between different litters of the same breed due to the heritability of temperament and personality (Jang, Livesley, & Vernon, 1996; Mackenzie, Oltenacu, & Leighton, 1985; Wilsson & Sundgren, 1998).

Part B of the study sought to determine whether any of Campbell's (1972) puppy measures had long-term predictive value. It was hypothesized that if temperament is stable over time, then the adult measures would significantly correlate with the original puppy scores. If environment was the only variable affecting temperament, then we predicted that there would be few or no correlations between the puppy and adult scores.

Materials and methods

Experimental subjects

Local Western Washington state dog breeders were selected based on recommendations from local dog trainers. Additional breeders were selected through the AKC website or by word of mouth from breeders already participating in the study. There were 11 breeders and a total of 66 dogs from 12 litters; litter size at birth was recorded for each litter. Average litter size at birth was 7.85 ($SE = 0.30$). Eight different breeds from five of the AKC groups were represented: Belgian Tervuren (1 litter; herding group), Pembroke Welsh corgi (1 litter; herding group), Cavalier King Charles spaniel (1 litter; toy group), Bernese mountain dog (1 litter; working group), Labrador retriever (4 litters; 4 breeders; sporting group), golden retriever (2 litters; 1 breeder; sporting group), Australian cattle dog (1 litter; herding group), and Lhasa Apso (1 litter; nonsporting group; Table 1).

Table 1. Parts A and B research subjects.

Breed	Number of breed Part A	Number of breed Part B
Australian cattle dog	8	0
Belgian Tervuren	4	3
Bernese mountain dog	8	7
Cavalier King Charles spaniel	3	1
Golden retriever	14	8
Labrador retriever	12	10
Lhasa Apso	0	2
Pembroke Welsh corgi	4	3

All dogs were initially tested at 6 to 8 weeks old, with a mean age of 49.10 days ($SE = 0.30$). After this, the dogs were sold to new caregivers with the exception of one Cavalier King Charles spaniel who was kept by the breeder. The follow-up was conducted in 2010 when the dogs ranged in age from 5 years, 27 weeks to 7 years, 33 weeks; the mean age at the time of the follow-up test was 6.41 years ($SE = 0.07$). All work was performed under the approval of the University of Washington Institutional Animal Care and Use Committee.

Experimental procedure: Part A

Heart rate

Heart rate was measured using a stethoscope. The puppy was allowed limited movements, so as to avoid the undue stress of constraining the animal while also allowing the tester to accurately hear and record the heart rate. Baseline heart rate was measured before the start of the behavior assessment. Heart rate was also measured after the restraint test, the elevation test, and the startle test for a total of four times. Heart rate was measured in 10-s intervals for a total duration of 90 s (giving nine heart-rate scores for each heart-rate measurement). Using the nine 10-s heart-rate data points, the mean 10-s interval heart rate was calculated and used for statistical analysis. Intervals where an accurate heart rate could not be measured were skipped. The follow-up was performed remotely; therefore, heart rate was not measured in the follow-up tests.

Behavioral measures

Behavioral measures of the temperament test were adapted from Campbell (1972) and Lindsay (2001). There were eight behavioral measures given in the same order for each puppy. For each measure, there were five or six predefined responses, as shown in Table 2. Each response was given a numeric value that was used to calculate total temperament score; a single observer performed all ratings. After each measure, the predefined response that was closest to the puppy's actual response was marked and the next measure was performed. The latency of the puppy to respond and make contact with the tester was recorded for Measures 1, 3, and 5.

Table 2. List of measures and scored responses.

Measure	Response	Measure	Response
1 Social attraction	Came readily, tail up; jumped/bit at hands	5 Elevation	Struggles fiercely, bites, growls
	Came readily, tail up; pawed at hands		Struggles Fiercely
	Came readily, tail up		Struggles, settles, licks
	Came readily, tail down		Does not struggle, licks at hands
	Came hesitantly, tail down		Does not struggle, freezes
	Did not come at all (no response)		
2 Following	Follows readily, tail up; gets underfoot; bites at feet	6 Ball play	Fetches ball, but runs away or teases assistant with it
	Follows readily, tail up; gets underfoot		Fetches ball, but does not bring it back
	Follows readily, tail up		Fetches ball and brings it straight back
	Follows readily, tail down		Runs after the ball but does not pick it up
	Follows hesitantly, tail down		Ignores the ball
	Does not follow or goes away (no response)		
3 Restraint	Struggles fiercely, flails, bites	7 Rope play	Takes rope with aggressive growling and does not let go
	Struggles fiercely, flails		Takes rope immediately with sustained growling and tugging
	Struggles, then settles		
	Does not struggle, licks at hands		Takes rope and tugs, releases on verbal request
	Does not struggle, strains to avoid eye contact		Follows the rope but does not take it
			Ignores the rope
4 Social dominance	Jumps, paws, bites, growls	8 Startle reflex	No response
	Jumps, paws		Barks at the can/assistant
	Squirms, licks at hands		Holds grounds and stares at can/assistant
	Stands, licks at hands		Crouches down but quickly recovers and approaches
	Rolls over, licks at hands		Cowers, recovers slowly and retreats
	Goes and stays away (no response)		Frightened and runs away

Measure 1: Social attraction. The puppy was placed in the center of the test area. The tester moved approximately 2 m away from the puppy, knelt down, gently patted the floor, and called, "Here, puppy, puppy" to get the puppy's attention.

Measure 2: Following. The tester placed the puppy next to her leg and then walked away in a normal manner, while ensuring the puppy saw her. The puppy was encouraged to follow by the tester patting his or her leg and saying, "Here, puppy, puppy."

Measure 3: Restraint. The tester crouched down and gently rolled the puppy onto his/her back, holding him/her with one hand on his/her chest for 30 s. The duration of the struggle was recorded. At the end of the 30-s period, the puppy was positioned on his/her feet and his/her heart rate was measured.

Measure 4: Social dominance. The tester crouched over the puppy and gently pet the puppy from the top of his/her head downward along the neck and back to the tail for 30 s.

Measure 5: Elevation. The tester kneeled on the floor and cradled the puppy under his/her belly with his/her fingers interlaced and palms up; the puppy was elevated just off the ground. The tester made eye contact and held the puppy this way for 30 s before placing the puppy on the ground. Duration of struggle while the puppy was elevated was recorded. Immediately after the puppy was placed on the ground, his/her heart rate was measured.

Measure 6: Ball play. The puppy was shown a rubber ball and the ball was then rolled a short distance away (approximately 3 m). Each puppy was given three opportunities to retrieve the ball and was graded on the best outcome.

Measure 7: Rope play. A small rope was wiggled by the puppy's nose and dragged away from the puppy. If the puppy took the rope, he/she was engaged in a brief tug game and the tester would say, "Drop."

Measure 8: Startle reflex. The tester faced the puppy and ensured the puppy was looking at him/her. Behind the puppy, a metal can filled with pebbles was shook, approximately 1 m away.

Experimental procedure: Part B

When the puppies were adopted, each caregiver was given a permission form allowing the research team to contact them. An online survey was created in which each of the eight original measures was converted to an online question. The questions were altered to apply to the caregivers and their dogs rather than the researcher's performance. Each question contained a description of how each measure was performed and answers that matched the original scored response. Each answer was given a number value of 1 through 6.

The dog caregivers of the original animals were contacted 6 years later and were asked to either go through the measures with their adult dog or, if this was not an option, to pick the answer to which their dog would most likely correspond. The caregivers were given the following instructions:

> In the next section, we would appreciate it if you could answer these questions in regard to how your dog reacts, or how you think she/he would have reacted if you no longer have the dog. If need be, feel free to try the exercise with your dog and pick the answer that matches best with his/her reaction. If you believe that the answers available do not represent how your dog reacts, there will be a section at the end where you can make comments. Please pick the answer that fits closest and make note of the question number and your comment. At the end, feel free to fill in the space with your comments.

Following data collection, we dropped two scores related to dogs who were no longer with their caregivers, leaving only scores of dogs currently with caregivers.

The questions were presented as follows with the answer options being the same as in Table 2:

Measure 1: *Social attraction*. If I pat the ground and call my dog, he or she:
Measure 2: *Following*. If I ask my dog to follow me, he or she:
Measure 3: *Restraint*. If I roll my dog onto his or her back, he or she:
Measure 4: *Social dominance*. When I pet my dog from head to tail for a small amount of time, he or she:
Measure 5: *Elevation*. When I pick up my dog, he or she:
Measure 6: *Ball play*. When I throw a ball for my dog, he or she:
Measure 7: *Rope play*. If I try to get my dog's attention with a rope, he or she:
Measure 8: *Startle reflex*. My dog responds to loud noises in one of the following ways:

Data analysis

Due to missing scores from some puppies, some of them were dropped from Part A: Data from seven Labrador retrievers were dropped due to missing latency and struggle duration scores (reducing the number of litters to two); data from all six Lhasa Apsos were dropped due to missing latency, struggle duration, and heart-rate scores; and data from one golden retriever were dropped due to a missing baseline heart-rate score. In total, Part A contained 52 subjects (24 males and 28 females), representing seven breeds in four AKC groups. Some of the puppies dropped from Part A due to lack of physiological data were included in Part B (two Lhasa Apsos), which did not include these data and thus boosted our sample size for the long-term data set.

The majority of caregivers who were successfully contacted participated in the questionnaire; we were unable to contact all the caregivers. As mentioned previously, two participants reported no longer having the dogs and were dropped from analysis. As a result, Part B contained 34 subjects (18 males, 16 females), representing six breeds. AKC group was not considered in Part B due to limited sample size; we were unable to contact the Australian cattle dog caregivers and some of the other breed caregivers.

Based on our observations, we felt that "independence" was a meaningful variable for puppies, and in an attempt to quantify this trait, an independence score was calculated by adding the number of times a puppy scored as "no response" in the social attraction test, the following test, or the social dominance test. This score could range from 0 (puppy was never scored as having no response) to 3 (puppy was scored as having no response in all three tests). A total temperament score (*Total*) was calculated by summing each individual's score in each of the subtests; the possible range for this score was 7 to 43. A Spearman rank correlation was used on these variables to determine the degree to which these measures correlated among themselves.

A stepwise discriminant function analysis was performed to determine the degree to which a combination of these measures could distinguish AKC groups or breeds themselves. Part B met the criteria for parametric testing; therefore, a Pearson correlation was used to look at how the follow-up measures correlated with themselves; a canonical correlation was used to test for linear combinations of the measure scores from the puppy assessments. These were used to test if they could predict a significant amount of variance in the later adult measures (referred to as *follow-up measures*).

Results

Part A

Group differences

Total temperament scores ranged from 19 to 36, with an average of 28.08 ($SE = 0.54$). When examining variance in total temperament score for AKC group, temperament did not vary across AKC group, $F(3, 48) = 1.77$, $p = .17$. There was no effect of sex on any of the variables analyzed with the independent t tests after the Bonferroni correction. There was no difference in variation within breeds

compared with between breeds for temperament scores, $F(6, 45) = 1.25$, $p = .30$. There were two breeds with data from multiple litters: golden retrievers and Labradors. There was no difference in variation within litters of golden retrievers in total temperament scores compared with variation between litters, $F(1, 12) = 0.16$, $p = .69$. There was also no difference in variation within litters of Labradors in total temperament scores compared with variation between litters, $F(1, 9) = 0.07$, $p = .79$.

American Kennel Club group predictability

After controlling for litter size and age during the test, the stepwise discriminant function analysis grouped by AKC group revealed two significant variables: ball-play score (*F-to-remove* = 7.02) and postrestraint heart rate (*F-to-remove* = 6.96). These two variables were successful at predicting the correct AKC group 71% of the time (Table 3). The stepwise discriminant function analysis grouped by breed produced the same two latent variables as the analysis grouped by AKC group, with the addition of a third latent variable, independence score: independence score (*F-to-remove* = 6.80), ball-play score (*F-to-remove* = 5.73), and postrestraint heart rate (*F-to-remove* = 4.91). When the data were grouped by breed, the three variables identified by the discriminant function analysis were able to correctly predict breed 88% of the time (Table 4).

Part B

Correlation of original measures with follow-up measures

Total adult temperament score ranged from 18 to 32, with an average of 24.68 ($SE = 0.58$). None of the original puppy measures correlated with their adult counterparts. However, two of the follow-up measures were found to significantly correlate with different measures of the original puppy assessment scores. The social attraction follow-up score was found to be associated with the puppy elevation dominance score, $\beta = .535$, $SE = 0.17$, $t(64) = 3.20$, $p = .004$, and puppy ball-play score, $\beta = 0.514$,

Table 3. Jackknifed classification matrix from stepwise discriminant function analysis by AKC group.

Breed	Herding	Sporting	Working	% correct
Herding	8	3	0	50
Sporting	4	19	2	76
Toy	0	0	0	100
Working	0	1	7	88
Total	12	23	9	71

Note. Rows represent number of dogs of that breed, and columns represent number of dogs classified as that breed by the discriminant function analysis.

Table 4. Jackknifed classification matrix from stepwise discriminant function analysis by breed.

Breed	Australian cattle dog	Belgian Tervuren	Cavalier King Charles spaniel	Bernese mountain dog	Pembroke Welsh corgi	Golden retriever	Labrador retriever	% correct
Australian cattle dog	8	0	0	0	0	0	0	100
Belgian Tervuren	0	4	0	0	0	0	0	100
Cavalier King Charles spaniel	0	0	3	0	0	0	0	100
Bernese mountain dog	0	0	0	8	0	0	0	100
Pembroke Welsh corgi	0	0	1	0	3	0	0	75
Golden retriever	1	0	0	3	0	10	0	71
Labrador retriever	1	0	0	0	0	0	10	91
Total	10	4	4	11	3	10	10	88

Note. Rows represent number of dogs of that breed, and columns represent number of dogs classified as that AKC group by the discriminant function analysis.

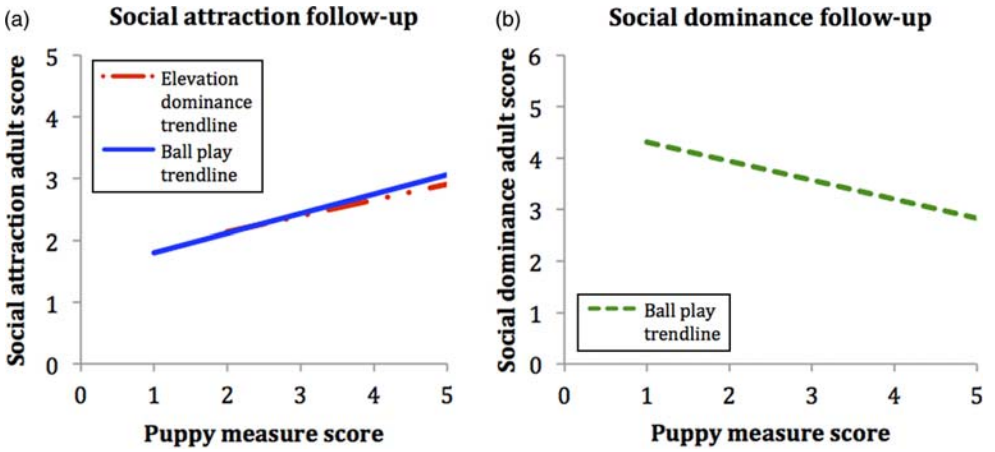

Figure 1. Trend lines of puppy score by dog score. (A) Puppy elevation dominance and ball-play scores and adult social attraction scores. (B) Puppy ball-play score and adult social dominance score.

$t(64) = 2.89$, $SE = 0.18$, $p = .008$ (Figure 1A). The social dominance follow-up score was found to be correlated with the puppy ball-play play score, $\beta = .484$, $SE = 0.18$, $t(64) = -2.68$, $p = .013$ (Figure 1B).

Correlation of measures

After finding that the measures and heart rates were predictive of AKC group and breed, we wanted to test whether the measures were related to one another. Using a Spearman rank correlation, we found that many of the measures were strongly correlated ($p < .0001$) with other measures and heart-rate scores (Table 5). As a follow-up, we performed a Pearson correlation to test whether any of the same variables were correlated in adult dogs; we found none of the same correlations, with the exception of the measures correlated with Total—an expected result because the Total score is a sum of individual scores (Table 5).

Discussion

Our results demonstrate that breeds differ in behaviors even as young puppies and that, although weak, some measures of puppy temperament predict later temperament. Our study aimed to assess the validity of Campbell's (1972) and Lindsay's (2001) puppy assessments by testing whether they could predict breed, AKC group, and adult temperament. We found that a combination of measures from Campbell's and Lindsay's temperament tests were valid, as they were capable of identifying puppy breed and AKC group. However, they did not predict adult dog temperament. The strong statistical significance of the results and longitudinal design add to the current dog temperament literature in spite of a small sample size and lack of breed diversity.

In addition to the aforementioned goals, we assessed litter and breed temperament variation. It was hypothesized that variability within litters of the same breed would be lower than variability between litters, due to the effects of genetics on temperament. This hypothesis was not supported; a wide range of temperaments was found within each of the litters tested (two Labrador litters and two golden retriever litters). Fox (1972) found similar results when testing wolf puppies for behavioral reactivity and dominance status at 8 weeks old; behavioral reactivity was correlated with dominance status. Fox hypothesized that this variation helped maintain stability within the litter and made it easier to maintain a pack structure even for adults. In domestic dogs, the concept of pack hierarchy has been questioned and has been found to be lacking by some (Bradshaw, Blackwell, & Casey, 2009; van

Table 5. Correlation matrix of temperament measures and heart rate.

Measure	Social attraction	Following	Restraint	Social dominance	Elevation dominance	Ball play	Rope play	Startle Reflex	HR base	HR restraint	HR elevation	HR startle	Independence	Total
Social attraction	—	.17	−.12	−.12	−.05	.04	.14	.01					−.08	.27
Following	.53***	—	.07	−.11	.11	−.09	.37*	.18					.29	.4*
Restraint	−.01	−.09	—	.16	.19	−.06	.05	.19					.07	.35*
Social dominance	.06	.21	.07	—	.05	.34*	−.04	−.00					−.04	.34*
Elevation dominance	.05	.02	.31*	.05	—	.04	.05	.03					.18	.34
Ball play	−.02	−.22	.24	.25	.2	—	.43*	.25					−.45**	.61**
Rope play	.1	.12	.18	−.13	.11	.09	—	.13					.12	.57**
Startle reflex	.07	.14	−.08*	.02	.23***	−.09	.28	—					−.56**	.64**
HR base	−.26	−.16	−.17	0	−.41**	−.35*	−.1	.05	—					
HR restraint	−.14	−.17	−.17	.02	−.49***	−.22	−.11	.1	.79***	—				
HR elevation	−.09	−.16	−.25	.12	−.39**	−.17	−.16	.07	.72***	.9***	—			
HR startle	−.18	−.16	−.13	.06	−.39**	−.23	−.2	.08	.73***	.89***	.87***	—		
Independence	.57***	.59***	−.13	.25	−.16	−.19	−.05	.02	−.02	.14	.2	.11	—	−.34
Total	.49***	.52***	.49***	.5***	.4**	.33*	.33*	.34	−.28*	−.23	−.17	−.19	.37**	—

Note. HR = heart rate.
*$p < .05$. **$p < .01$. ***$p < .001$.

Kerkhove, 2004). Nonetheless, it has been suggested that this variation is part of the normal development of social dominance (Pawloski, Albert, & Scott, 1956).

We suggest that this behavioral diversity is just another example of natural selection favoring animals who are behaviorally diverse and genetically plastic as a way of ensuring that animals can adapt to their environments and pass on their genes. Prenatal stress results in animals who are more reactive, have lower attention spans, and show greater anxiety (Glover, 2011). Moreover, before animals are born, they may be able to adjust to the environment into which they will enter. Having a group of postpartum offspring who are temperamentally diverse may further increase the odds that at least one of these temperaments will be well suited for the environment in which the puppies enter.

According to the Humane Society of the United States (2014), 83% of dogs with caregivers are spayed or neutered, meaning the temperament diversity may not lead to proliferation of the genetics regardless of their value. However, it is likely that natural selection for temperamental diversity is so ingrained in the genetics of dogs that it cannot be changed. Along these lines, Archard and Braithwaite (2010) suggested that by studying wild animals, we may be better able to account for temperament diversity. We agree with this suggestion and would be interested in studies on temperament in feral dogs to see if the same temperament diversity is present in their populations as in our puppy litters. We would also like to see a greater number of litters included for different breeds, as our sample size was relatively small.

We found breed to be predictable using three variables: heart rate after restraint, independence score, and ball-play score. This result suggests there is significant variability across breeds and they may have "typical" puppy temperaments. The ability to accurately predict breed supports Jones and Gosling's (2005) suggestion that more research should be done on different breeds of dogs. If more breeds were assessed for temperament using a standardized method, then it would allow for comparisons between breeds. The results on AKC group are more difficult to interpret due to the limited number of AKC groups represented; our analysis had one working breed, one toy breed, two sporting breeds, and three herding breeds. We found ball-play score and heart rate after the restraint test to accurately predict AKC group; however, without more breed diversity in each AKC group, it is difficult to know for certain if AKC group accuracy was due to similarity of individuals in the same breed or characteristics of the group.

In Part B, we aimed to evaluate the usefulness of Campbell's (1972) and Lindsay's (2001) measures as long-term predictors of behavior. Our results came up mixed: Two of our eight follow-up measures correlated with different measures on the original puppy assessment scores. Although we did manage to get a substantial number of caregivers to participate, we only gathered one rating per dog and were unable to validate the scores. None of the measures matched up with their follow-up questions, suggesting that the measures are not good predictors of themselves. The results suggest that it may be possible to predict specific adult temperament traits using some combination of puppy temperament assessments.

In nonhuman primates, temperament has been correlated with behaviors such as social interaction and has been shown to change with age (Heath-Lange, Ha, & Sackett, 1999; Weinstein & Capitanio, 2008). It is possible that temperament, while genetically mediated, changes with age, which may explain our mixed results. As our research puppies aged, certain temperament traits (specifically those unrelated to neotenous behaviors) changed to best fit their current environment. Other traits were based in the animal's genetics, making them less plastic and more likely to be useful as predictors of adult dog temperament.

One puppy measure stood out—ball play. This measure from Lindsay (2001) was the only measure that was involved in predicting both of the significant follow-up measures as well as the original puppy breed and AKC group. As previously discussed, breeders artificially select neotenous physical and behavioral traits such as play behavior in dogs. When humans breed for playful, friendly behavior in puppies, they are likely selecting for a genetically based behavior. This makes it less variable than other traits and thus a better long-term predictor of temperament. We suggest this is the reason that ball play is such a strong factor in predicting adult scores. Although the dog does not maintain the same level of

play, as is common in adult animals (Fagen, 1981; Pellis & Iwaniuk, 2000), the neotenous trait is genetically based and these genes go on to influence other behaviors in adults.

In Part B, adult social attraction, adult social dominance, puppy elevation dominance, and puppy ball-play scores were found to be associated in the follow-up; none of the other measures were related. This finding suggests that not all of our measures are useful for predicting adult temperament when performed on puppies at 7 weeks old. Temperament has been correlated with success in working dogs such as search and drug-detection dogs (Maejima et al., 2007; Rooney, Gaines, Bradshaw, & Penman, 2007; Wilsson & Sundgren, 1997). Guide dogs in particular have been well studied, and factors such as reaction to strangers, fear response, excitability, and attachment have all been shown to reliably predict guide-dog suitability (Batt, Batt, Baguley, & McGreevy, 2008; Goddard & Beilharz, 1983; Serpell & Hsu, 2001; E. Weiss & Greenberg, 1997).

Why, then, are tests performed on working dogs so reliable, whereas our results with companion dogs are mixed? The largest differences between companion animals and dogs trained to be service animals are the training and environment. Dogs being trained for service work must meet specific requirements in their ability to perform tasks, and this requires substantial training. It follows that service-dog temperament tests only have to be reliable in predicting one thing: success within a working-dog occupation. As such, they do not have to assess the reliability of broader traits that are stable over time but not associated with training success. According to Assistance Dogs International (www.assistancedogsinternational.org), a service dog should undergo at least 120 hr of training over 6 months, and trainers should undergo a 2- to 3-year apprenticeship to become a service trainer. In contrast, there is no requirement that a caregiver train his or her companion dog, and even if they do, there is a plethora of techniques for doing so. Rooney and Cowan (2011) found that a caregiver's history of training choice affected the dog's behavior and success in different tasks. This finding suggests that the caregivers, whether consciously or not, are actually altering their dogs' behavior, which likely influences the caregivers' interpretation of their dogs' temperament.

Another factor that increases the accuracy of service-dog testing is that temperament tests are performed at a later age. Current theories regarding human psychological disorders suggest that they occur when the environment acts on genetic predisposition to activate genes (Moffitt, 2005). Dog temperament may be under similar influence. At 7 weeks old, when our puppies were tested, puppies are not accurate representations of their future selves. Puppies at this age are full of genetic and behavioral potential. Each puppy has a genetic predisposition for certain temperament traits that can be activated by the environments they enter. Six years later and a world of experiences gained, the dogs we tested were no longer the same ones we met at 7 weeks old.

At a later age, temperament is more concrete and the dog is likely to represent his/her adult temperament, making guide-dog testing more reliable. The genetic potential has been greatly reduced and is less likely to be influenced by the environment, as suggested by Waddington's (1957) epigenetic landscape. Unfortunately, testing companion dogs at 6 months is impractical, as many dogs, specifically pedigree dogs, are sold at 7 to 10 weeks old.

There are problems with our current study that should be avoided in future research. One is that we did not test the puppies' temperament more than once. As none of the puppy measures correlated with their adult measure counterparts, it is possible that we require measures that are better suited to reflect how adult animals behave, such as typical reductions in play behavior. Sample size clearly needs to be increased for future studies, as it was also relatively low for the number of breeds. Other than sample size, there are factors we would improve in future research. The reliability of the caregivers who followed up with us could not be assessed. It would be beneficial to be able to perform these follow-up tests ourselves in a way in which observer interrater reliability is testable. Some of the measures also need to be changed to apply to adult dogs; several of the participants (particularly those with Bernese mountain dogs) commented that picking up their dogs was not possible or for that matter, good for either dog or caregiver. One participant did not agree with the request of forcing the dog onto his/her back.

We suggest that future studies have a larger sample size involving multiple breeders. It would also be interesting to have a larger diversity of breeds that represent all the AKC groups. Bringing more factors into the follow-up would also be beneficial. Furthermore, a scale designed specifically for adult dogs, which accounts for their differences in neotenous behavior and demonstrates convergent validity, would be valuable in future studies. If such an assessment is developed, it could then be tested on puppies for further longitudinal research. Although we are pleased with our results, we were unable to account for variables such as experience of the caregivers, number of children in the household, and obedience training. As previously mentioned, caregiver reliability cannot be ruled out as a factor in our study.

Conclusion

We would be interested to see more research on dog caregiver-report interrater reliability in assessing temperament and behavior. Previous studies with nonhuman primates have shown that individual differences in personality are related to health, suggesting that it is an important future direction (Byrne & Suomi, 2002; A. Weiss, Adams, Widdig, & Gerald, 2011; A. Weiss, Gartner, Gold, & Stoinski, 2013). We intend to further investigate this line of research with nonhuman primates, companion dogs, and cats and would like to see other researchers take a similar direction.

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