

Factors that affect the repeatability of personality in yellow-bellied marmots, *Marmota flaviventris*

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Abstract

Animal personality is becoming increasingly relevant behavioral ecology because of its potential impact on reproductive success. Measuring personality however can be difficult because many factors, such as microhabitat variation and habituation, affect how an animal responds to a given test. Using novel object tests to measure exploration and a flight initiation distance test to measure boldness, we quantified which variables significantly affect individual responses in a population of yellow-bellied marmots near Rocky Mountain Biological Laboratory. We found that alert distance and distance to burrow affect boldness tests. Furthermore, although we could not demonstrate habituation over time to the tests, other significant factors, such as age class and location in the valley suggests that the marmots may already be habituated to humans.

Introduction

Animal personality is typically defined as a behavioral manifestation that is consistent across context and time (Wilson *et al.* 1994, Stamps and Groothuis 2010, Réale *et al.* 2007). For example, if an individual is considered bold in one situation, we would expect that individual to be bold in other contexts. Personality may have important implications for population dynamics and may influence how an individual disperses and reacts to conspecifics and heterospecifics (Réale *et al.* 2007, Sih *et al.* 2004).

Ultimately, personality may have an effect on fitness; Reale *et al.* (2000) demonstrated this relation in bighorn ewes (*Ovis canadensis*) by correlating boldness with age of first birth and weaning success. Additionally, North American red squirrels (*Tamiasciurus hudsonicus*) that are more aggressive produce young that have higher over winter survival rates (Boon 2007). Finally, a meta-analysis of 31 studies found that bolder and more aggressive individuals tend to have higher reproductive success, while exploration has no effect on reproductive success (Smith and Blumstein 2008). The link between fitness and personality traits has also been demonstrated in a wide variety of species that include mammals, fish, birds and even insects (Réale *et al.* 2007). Therefore, it is becoming increasingly important to understand personality types and variation within a population.

Personality, by definition, is repeatable (Wilson *et al.* 1994, Stamps and Groothuis 2010, Réale *et al.* 2007). While testing personality, it is essential to prove that an individual's response is repeatable and not simply context dependent (Martin and Réale 2007). However, this is not easily done, as many things may affect tests for personality. For example, changes in habitat or predator composition in which the tests are preformed may alter behavioral responses of the individual (Réale *et al.* 2007). For example, Li *et al.* (2011) demonstrated that, in yellow-bellied marmots, flight initiation distance varied on the amount and type of human disturbance. These changes may be accounted for by repeating tests multiple times for each individual. However, after repeated trials, the individual may habituate to tests.

I examined how microhabitat including human disturbance, habituation over time, and individual difference in habituation affect repeatability in two personality traits, boldness and exploration. I tested these traits in yellow-bellied marmots (*Marmota flaviventris*) at the Rocky Mountain Biological Laboratory (RMBL). The marmot

population at RMBL is an optimal study system because they have been previously shown to have personalities that are variable among individuals (Armitage 1986, Armitage and Van Vuren 2003). In addition, individuals are clearly marked, allowing easy repetition of trials on each individual. This is essential, as the study of habituation relies on individual differences in the marmots (Runyan and Blustein, 2004). Finally, there are two separate populations (up valley and down valley) with varying ecology and predation risk.

Methods

All tests were performed near the Rocky Mountain Biological Laboratory in Gothic, CO, USA (38°57' N, 106°59' W). Flight initiation distance is used as a measure of boldness (Li *et. al.* 2011). After arriving at a colony, a 15 minute “acclimation period” was observed to allow marmots to get used to the presence of an observer. When a marmot was observed, the fur mark, initial substrate, and behavior was recorded. Then, moving at a steady pace of 0.5m/s, the marmot was directly approached. Dropped pegs marked each of the following distances: start; first alert (i.e. when the marmot first looks in the direction of the observer); first escape (i.e. if the marmot runs away, but not to the burrow); and flight initiation (i.e. when the marmot runs to the burrow). Using either a laser range finder or pacing, each of these distances was measured along with the distance to that the marmot was from the burrow. A clinometer was used to measure the slope of the terrain on which the marmot started, on which it escaped, and the angle from the observer to the marmot. All observers are trained to walk at a 0.5m/s pace consistently.

Novel object tests were used as a measure of exploration. The novel object was a plastic decoy goose in 2010 and a zebra shaped child’s pool toy in 2011. The novel object was placed 1-1.5 meters from a burrow entrance, and a pile of horse food (Omolene 100, Purina, St. Louis, USA) was placed directly in front of the zebra. The object was observed from 50-100 meters away. The time an individual approached within 10 meters and when it started foraging or touched the object was recorded. The time difference between these two events gave us latency to approach and can be used as a proxy for exploration. We also conducted a foraging focal when the individual started foraging next to the novel object. The focal consisted of a two-minute tape recording that monitors the behavior of the marmot. Actions recorded were: stand forage (quadrupedal foraging), rear forage (bipedal foraging), stand look, rear look, walk, run, other (including social behavior, grooming, etc.), and out of sight. Additionally, all marmots within 10 meters were recorded. To avoid the affects of group foraging, the focal was truncated if another individual foraged at the food pile. Tapes were scored using JWatcher 1.0 (Blumstein & Daniel 2007), and the proportion of time spent performing each activity will be determined.

Archived data was analyzed by fitting a mixed-effects model using R (R Development Core Team 2011) to determine what factors may affect the repeatability of flight initiation distance tests and novel object tests on yellow-bellied marmots.

The mixed effects model for flight initiation distance included the following factors; trial number, Julian date, age class, sex, valley, time (AM or PM), initial

behavior, number within 10 meters, start distance, alert distance, initial substrate, escape slope, and distance to burrow (see table 1). The model for exploration included trial number, Julian date, age class, sex, valley, time (AM or PM), number within 10 meters, and substrate. P-values were then obtained by a Monte Carlo Markov Chain with 30,000 simulations.

Results

Boldness

Trial number, Julian date, sex, time, initial behavior, initial substrate, number of marmots within 10 meters and escape slope had no effect on flight initiation distance in yellow-bellied marmots (Table 1). The repeatability of boldness was measured using the intraclass correlation coefficient and was $r_{ic}=0.215$. Alert distance was also significant. Pups were significantly less bold than adults, fleeing an average of 4 meters sooner, but showed no difference from yearlings. Additionally, marmots were bolder when closer to burrow entrances (For every meter farther from the burrow they are, they will escape 0.4 meters sooner) and with decreased alert distance (For every meter closer one gets before they alert, they will flee 0.7 meters sooner). Finally, animals down valley fled significantly later (an average of 7 meters) than those up valley.

Exploration

We can not use the novel-object test at this point to look at exploration because unique individual didn't explain a significant amount of the variance. We tested this by using a log-likelihood ratio test between models with and without unique I.D (Table 2).

Discussion

The purpose of this experiment was to examine how personality tests are affected by microhabitat and habituation. Environmental variables (i.e. time of day, date etc.) had no significant effect on boldness. As in a similar study performed by Martin *et al.* on the Eastern chipmunk (*Tamias striatus*), most microhabitat variables had no effect (2008). The only exception was that of location in the valley. Additionally, trial number did not have a significant effect on flight initiation distance, indicating that there was no habituation over time to the test by individuals. This is in contrast to other studies, which have demonstrated individual variances in habituation (Glowa 1994, LaRowe 2006). However, other significant factors, such as age and location in the valley suggest that habituation may already have occurred.

Animals were bolder when closer to burrow entrances. Similar studies in other species have also found that flight initiation distance increased as distance to burrow increased (Bonenfant & Kramer 1996). Presumably, this is because escape is easier, and marmots that are closer to their burrows optimize their foraging time by fleeing later.

Marmots also tended to be less bold as alert distance increased. A study on five grassland birds found that as alert distance increased, flight initiation distance increased (Fernandez-Juricic *et al.* 2005). This may be because a marmot cannot escape before it sees the predator. Alternatively, it may be that marmots "flush early and avoid the rush."

This suggests that because approaching predators require attention, animals cannot properly forage or perform other activities once one has been spotted. Therefore, it is actually optimal to escape soon after a predator has been detected (Blumstein 2010).

Older animals tended to be bolder. Boon *et al.* (2007) found no effect of the age of juveniles on personality of red squirrels (*Tamiasciurus hudsonicus*). Reale *et al.* (2000) also found no effect of age on boldness in bighorn ewes (*Ovis canadensis*). Despite this, laboratory work has demonstrated that consistency in personality declines around the time of sexual maturation. This may be due to either physiological or social changes that occur in many animals at this time (Stamps *et al.* 2010). Alternatively, it may be that a “cumulative experience of the environment leads to increasing consistency with age,” suggesting habituation to humans over time (Bell 2009). Furthermore, pups may simply be more wary than adults. Koivunen *et al.* 1996, Marti & Hogue 1979). Past studies have shown that predators preferentially prey on smaller animals. This may be because smaller animals are presumably weaker and less experienced. Additionally, predators have to expend more energy to capture and kill large animals, which may explain this disparity (Marti & Hogue 1979).

The significant difference between animals that are up valley versus those that are down valley suggests habituation to humans as well. Marmots down valley experience a much higher level of human disturbance, and may already be habituated to humans. Because of this habituation, marmots located down valley tend to be much bolder in response to a human threat than those up valley.

Habituation to humans can have profound impacts on wild populations. Studies have shown that birds with high levels of habituation have lower nesting success (Vennesland 2010, Beale & Monaghan 2004). Olympic marmots at sites with high levels of human activity have altered foraging habits, with a higher amount of time spent being vigilant (Griffen 2007). Work has also shown that frequent human disturbances can have a direct impact on survival rate (Beale & Monaghan 2004). This suggests that habituation can affect the repeatability of personality and therefore have lasting effects on fitness. Our work indicates that the marmots of RMBL have at least some habituation to humans which may have profound impacts on the future population.

Literature Cited

- Armitage, K. B. 1986. Individuality, social behavior, and reproductive success in yellow-bellied marmots. *Ecology*, 67, 1186-1193.
- Armitage, K. B. & Van Vuren, D. H. 2003. Individual differences and reproductive success in yellow-bellied marmots. *Ethology Ecology & Evolution*, 15, 207-233.
- Blumstein, D.T., Daniel, J.C., 2007. Quantifying Behavior The JWatcher Way. Sinauer, Sunderland, MA.
- Beale, C. M., & Monaghan, P. 2004. Human disturbance: people as predation-free predators? *Journal of Applied Ecology*, 41, 335-343

- Bell, A. M., Hankison, S. J., & Laskowski, K. L. 2009. The repeatability of behaviour: a meta-analysis. *Animal Behaviour*, 77, 771-783.
- Blumstein, D.T. 2010. Flush early and avoid the rush: A general rule of anti-predator behavior? *Behavioral Ecology* 21: 440-442
- Boon, A. K., Réale, D., & Boutin, S. 2007. The interaction between personality, offspring fitness and food abundance in North American red squirrels. *Ecology Letters*, 10, 1094–1104.
- Bonenfant, M., & Kramer, D. L. 1996. The influence of distance to burrow on flight initiation distance in the woodchuck, *Marmota monax*. *Behavioral Ecology*, 7, 299-303.
- Fernández-Jurici, E., Venier, M. P., Renison, D., & Blumstein, D. T. 2005. Sensitivity of wildlife to spatial patterns of recreationist behavior: A critical assessment of minimum approaching distances and buffer areas for grassland birds. *Biological Conservation*, 125, 225-235.
- Glowa, J. R. & Hansen, C. T. 1994. Differences in response to an acoustic startle stimulus among forty-six rat strains. *Behavior Genetics*, 24, 79-84.
- Griffin, S. C., Valois, T., Taper, M. L., & Mills, L. S. 2007. Effects of tourists on behavior and demography of Olympic Marmots. *Conservation Biology*, 21, 1070-1081.
- Koivunen, V., Korpimäki, E., & Hakkarainen, H. 1996. Differential avian predation on sex and size classes of small mammals: doomed surplus or dominant individuals? *Annales Zoologici Fennici*, 33, 293-301.
- Li, C., Monclús, R., Maul, T. L., Jiang, Z., & Blumstein, D. T. 2011. Quantifying human disturbance on antipredator behavior and flush initiation distance in yellow-bellied marmots. *Applied Animal Behavior Science*, 129, 146-152.
- LaRowe, S.D., Patrick, C. J., Curtin, J. J. & Kline, J. P. 2006. Personality correlates of startle habituation. *Biological Psychology*, 72, 257-264.
- Marti, C. D., & Hogue, J. G. 1979. Selection of prey by size in screech owls. *The Auk*, 96, 319-327.
- Martin, J. G. A. & Réale, D. 2007. Temperament, risk assessment and habituation to novelty in eastern chipmunks, *Tamias striatus*. *Animal Behaviour*. 75, 309-318.

- R Development Core Team. 2011. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, URL <http://www.R-project.org/>.
- Réale, D., Gallant, B. Y., Leblanc, M. & Festa-bianchet, M. 2000. Consistency of temperament in bighorn ewes and correlates with behaviour and life history. *Animal Behaviour*, 60, 589-597.
- Réale, D., Reader, S. M., Sol, D., McDougall, P. & Dingemanse, N. 2007. Integrating animal temperament within ecology and evolution. *Biological Reviews*, 82, 291-318.
- Runyan, A. M. & Blumstein, D. T. 2004. Do individual differences influence flight initiation distance? *The Journal of Wildlife Management*, 68, 1124-1129
- Sih, A., Bell, A. M., Johnson, J. C. & Ziemba, R. E. 2004. Behavioral syndromes: an integrative overview. *Quarterly Review of Biology*, 79, 241-277.
- Smith, B. R. & Blumstein, D. T. 2008. Fitness consequences of personality: a meta-analysis. *Behavioral Ecology*. 19, 448-455.
- Stamps, J. & Groothuis, T. G. G. 2010. The development of animal personality: relevance, concepts and perspectives. *Biological Reviews*, 85, 301-305.
- Vennesland, R. G. 2010. Risk perception of nesting Great Blue Herons: experimental evidence of habituation. *Canadian Journal of Zoology*, 88, 81-89.
- Wilson, D. S., Clark, A. B., Coleman, K. & Dearstyne, T. 1994. Shyness and boldness in humans and in other animals. *Trends in Ecology and Evolution*, 9, 442-446.

Tables and Figures

	Estimate	MCMCmean	HPD95lower	HPD95upper	pMCMC	Pr(> t)
Intercept	-5.1130	-4.2785	-25.8174	16.0833	0.6910	0.6312
Trial	-0.4469	-0.3398	-1.2744	0.5563	0.4709	0.3220
Julian date	-0.0084	-0.0179	-0.1035	0.0675	0.6800	0.8477
Age class (yearling) §	-1.7547	-2.9393	-7.4610	1.6990	0.2085	0.4653
Age class (adult) §	-4.5097	-6.0053	-10.5575	-1.3866	0.0096*	0.0708
Sex (M)°	0.1909	-0.2598	-2.8367	2.2154	0.8371	0.9002
Valley (up valley) †	7.1222	5.2795	2.0476	8.7259	0.0021*	0.0005
Time (PM) ∞	1.6936	1.6314	-1.5047	4.9778	0.3203	0.2999
Initial behavior (look) Ø	0.5328	0.7191	-5.0330	6.1906	0.7987	0.8503
Initial behavior (social interaction) Ø	10.0633	10.3434	-3.0479	22.6784	0.1145	0.1313

Initial behavior (walk) Ø	5.0210	4.7061	-13.2155	22.2713	0.6055	0.5862
N within 10m	0.1377	0.0057	-1.1332	1.1077	0.9879	0.8048
Start distance	0.0774	0.0962	-0.0054	0.1952	0.0592◇	0.1272
Alert distance	0.7115	0.7273	0.6144	0.8357	<0.0001*	0.0000
Initial substrate (high vegetation) μ	10.4570	11.7976	-6.0880	29.8417	0.1963	0.2625
Initial substrate (low vegetation) μ	7.0497	7.2685	-1.1020	15.9658	0.0938◇	0.1018
Initial substrate (stone) μ	5.6767	6.5363	-1.5280	14.2416	0.1041	0.1483
Initial substrate (experimental) μ	2.8362	4.0649	-4.7868	12.9078	0.3717	0.5233
Slope of escape	0.0229	0.0284	-0.0289	0.0883	0.3403	0.4483
Distance to burrow	0.3898	0.3331	0.1129	0.5654	0.0045*	0.0004

Table 1. Results from the Monte Carlo Markov Chain with 30,000 simulations. (*) indicates significance, (◇) indicates trending towards significance, § juvenile as reference, ° female as reference, † down valley as reference, ∞ AM as reference, Ø forage as reference, μ dirt as reference.

Test	p-Value
Flight Initiation Distance	0.001464407*
Novel Object	0.9455544

Table 2. Results of the log-likelihood ratio test between models with and without Unique ID.

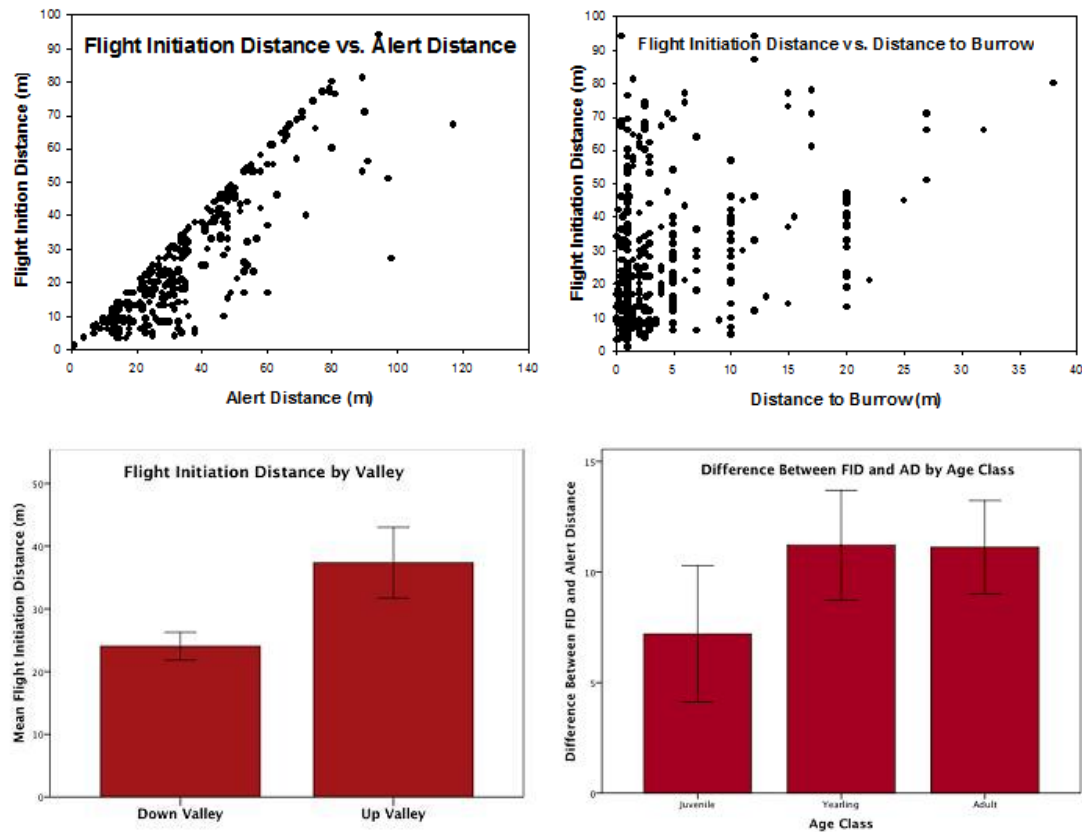


Figure 1. Flight initiation distances based on factors that significantly affect boldness in yellow-bellied marmots of RMBL. (a) Flight initiation distance vs. alert distance. (b) Flight initiation distance vs. distance to burrow. (c) Mean flight initiation distance based on valley (d) Difference between mean flight initiation distance and mean alert distance based on age class.