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Individuality matters but its cause has consequences

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Individuality matters but its cause has consequences

Commentary on **Owens et al.** on *Wildlife Personality*

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Abstract: I discuss the relationship between individuality and heritability and note that the mechanism driving individual differences matters for conservation and management outcomes.

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Since clonal fish diverge and develop individually-specific traits when raised in uniform environments (Bierbach et al. 2017) we should generally expect individual differences in many species traits, particularly those raised in more heterogenous environments and those that are more variable genetically than clonal fish! Indeed, individual differences are essentially ubiquitous and a burgeoning literature—partially reviewed by Owens et al. (2024)—has shown that in many cases they have consequences for fitness as well as for how wildlife interact with humans and respond to our conservation and management interventions. I agree with Briffa (2024) that these individually-specific differences are not evidence of sentient traits, but as Owings et al. note, they have important applied and ethical importance.

Individuality is studied various ways. However, it's essentially a statistical phenomenon seen when within-individual variance in some measurable trait is less than between-individual variance. Thus, repeatability (Bell et al. 2009) provides an upper-limit estimate of heritability. Recall that heritability is the proportion of total phenotypic variance that is attributable to genetic variation. Thus, $h^2 = V_g/V_p$, with $V_p = V_g + V_e$, where V_g is genetic variation, V_p is total phenotypic variation, and V_e is the total environmental variation). Also note that repeatability is V_i/ V_p where $V_i = V_g + V_{pe}$, where V_i is individual variation and V_{pe} is the variation attributable to the permanent environment. Where permanent environment effects are negligible, our estimates of repeatability are pretty good estimates of heritability. More research is thus needed to identify the magnitude and diversity of permanent environment effects.

It's important to study heritability because it gives us insights into the propensity for evolutionary change as well as into the history of selection. Genetically variable populations may fare better in a dynamic environment. Yet, strong directional selection should eliminate heritable variation. Thus, it's a bit of a paradox as to why individual differences are maintained. A likely solution to the paradox is that context is everything and a trait that is favorable under certain conditions may not be so in other conditions. Owens et al. provide some examples.

From an instrumental perspective, we care about individuality and heritability. The ability of a population to respond to perturbations, which are more common than ever in the Anthropocene, may require both phenotypic plasticity and heritable variation. Knowing more about both of these will enable us to identify vulnerable populations and species. At an individual level, knowledge of individual differences, as Owen et al. highlight, can affect management outcomes. But this fact raises some ethical concerns.

From an ethical perspective, if certain animals are more predisposed to interact with humans, what does it mean when we 'control' those animals or prevent these traits from being expressed? To answer this, it matters how animals become more predisposed to interact with humans.

Individuals could vary in their 'average' response. This can be estimated as the intercept using a random intercept mixed model where there are repeated measures on individuals (Dingemanse Dochtermann 2013). For example, when giant clams are successively touched until they close their mantels, the time it takes to re-open generally declines over days but individuals differ in 'average' re-opening times (Johnson et al. 2017).

Individuals could also vary in their response time or over repeated exposures. This would indicate a phenotypic reaction norm and is studied using a random intercept, random slope model (Dingemanse & Dochtermann 2013). In the context of a repeated perturbation, individuals could undergo an habituation-like process (seen as a decline in responsiveness over time) or they could sensitize (with increased responsiveness over time; Blumstein 2016). Yellow-bellied marmots vary quite a bit both in their 'average' response but also in the way their flight initiation distance responds to repeated experimental approaches (Uchita and Blumstein 2021).

If individuals do not vary in how they become tolerant to humans over time or with more experience (habituation-like processes are but one mechanism—see Čapkun-Huot et al. 2024), it suggests heritable variation and that the population is comprised of uniquely different types. Any control attempts to remove 'problem' animals will likely change the genetic variation in the population, which could have detrimental impacts on how the population will respond to Anthropogenic assaults.

If individuals vary in their reaction norms to humans, then further research is required to understand whether this reaction norm has a genetic basis or whether managing human-wildlife interactions could be a way to manage a potential 'conflict' with no impact on the population's genetic variation.

My main point is that individual differences are ubiquitous and often attributable to genetic differences. Quantifying repeatability gives us valuable insights into genetic variation. Genetic variation is an important way populations can respond to change, which, in the Anthropocene, is an increasingly common threat to biodiversity. Anything we do to manage individual differences is likely to have impacts on genetic variation. We must know more about the genetic basis of individual differences so that we are not inadvertently reducing population-sustaining genetic variation.

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