Beyond WEIRD humans and STRANGE dogs: Using big team science to improve generalizability and reproducibility in comparative psychology

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Abstract

Canine science aims to understand dogs as a species uniquely adapted to live alongside humans. Research in the field has increased rapidly in the 21st century, but has struggled with representativeness and generalizability. Here we discuss key issues and identify solutions through big team science innovation and collaboration with researchers in the Global South. Sampled populations are usually from the Global North, where researchers and guardians can be characterized by WEIRD attributes and dogs may be shaped by STRANGE factors, severely limiting generalizability across locations and the overall replicability of the science. These constraints limit the inclusiveness of canine science research both in the representativeness of the populations being sampled as well as the researchers who are conducting these studies. Big team science provides an ideal avenue to overcome some of these biases and include diverse perspectives, fostering global collaboration.

Shaped by millennia of natural and artificial selection pressures, dogs (*Canis familiaris*) are house pets, working companions, and free-roaming individuals adapted to share the human ecological niche. In research, dogs have transitioned from models of mammalian evolution (Darwin, 1872) and human learning and behavior (Seligman et al., 1968) to being regarded as thinking and feeling subjects of comparative psychology, valued for providing unique insights about the ontogeny and evolution of cognitive processes (Arden et al., 2020; Aria et al., 2021). Emerging in the 1990s, the field of canine science rapidly expanded to include a range of basic science and applied disciplines. Further, dog welfare, environmental conservation, and human health are closely linked, highlighting the importance of exploring how different dog populations impact local ecosystems as well as deepening our knowledge about dog behavior and socioecology across the globe. Despite a broadly relevant need to understand the factors shaping dog behavior, cognition, and welfare, canine research is largely based on Western perspectives and scientific traditions, focusing on a narrow slice of the dog-human experience through a particular cultural lens.

Thus far, canine science has focused on pet dogs from the Global North, paralleling the WEIRD (**W**estern, **E**ducated, **I**ndustrialized, **R**ich, and **D**emocratic) contexts that undermine human psychological study (Henrich et al., 2010). Drawing on a small subpopulation of dogs impacts the reproducibility and broader generalizability of canine research in a similar way that WEIRD populations skew human research. The analogous STRANGE framework (**S**ocial background; **T**rapability and self-selection; **R**earing history; **A**cclimation and habituation; **N**atural changes in responsiveness; **G**enetic make-up; and **E**xperience; Webster & Rutz, 2020) is especially relevant for contextualizing companion dogs as a non-representative population with multiple factors limiting inferences in comparative psychology. Therefore, while we've gained insights to the cognitive and affective experiences of our nonhuman "best friends", this information only applies to a

subgroup of the world's domestic dogs (Gompper, 2014). To move the field forward to where we can address pressing global challenges in human-animal interaction, we need to critically evaluate the populations of dogs and their guardians being sampled, address the challenges of conducting inclusive, equitable research across the Global North *and* South, and co-create innovative approaches for achieving ethical, internationally relevant research.

Here we discuss core issues limiting the replicability of canine science, the generalizability and representativeness of dogs and guardians. A possible solution could be a big team science approach, such as the ManyDogs Project (ManyDogs Project, 2023a), which can advance our understanding of dog behavior and promote inclusive international collaborations, leading to a more nuanced understanding of human-animal interactions.

Generalizability Across Locations

Dogs inhabit every continent and almost every island on Earth (Wandeler et al. 1993), making them an accessible species to study worldwide. However, is a dog in New York City the same as one in Vienna or Kyoto or Mumbai or Buenos Aires? Across the world, dogs vary substantially, which can make findings in one location less generalizable to others (Figure 1).

Figure 1: Dogs are found across the world with marked differences between the Global North and South in dog-human relationships, breeds and morphology, and research traditions.

One of the most obvious and potentially strongest sources of variation in dogs is the hundreds of distinctly recognized breeds. Breeds differ dramatically not only in morphology (a 75-fold difference between smallest and largest breeds) but also in behavior. While some breeds excel at detecting scents, others show higher levels of trainability, impulsivity, or problem behaviors (Pongracz & Dobos, 2025). Variation in breeds alone probably makes dogs the most behaviorally diverse species on the planet. And breeds are not evenly distributed across the globe, leading to variation in breed composition in different locations. Additionally, many dogs are a mix of different breeds, adding more variation. Interestingly, countries may vary in the frequency of mixed breeds with potentially more in the Global South and the United States than Europe.

Alongside pronounced dog breed differences, human guardians exhibit clear cultural differences within and between countries. The dog-human bond is a critical component of companion dogs' behavior, with guardians shaping their lives from nutrition to socialization to training. There are massive differences between and even within cultures in how dogs are

perceived, valued, and treated (Serpell, 2004). Some herding and guarding dogs live outside with the livestock that they tend, while some "fur babies" in cities may live in luxury with their every need satisfied. The intricate layering of dog and guardian diversity results in a level of variation not observed in other species.

This extreme variation observed between rural/urban dogs and across countries and cultures is rarely accounted for in dog behavior and cognition studies. Dozens of canine science research sites exist in North America, South America, Europe, Asia, and Oceania. Would we expect behavior in one site to generalize to another? Research teams in different regions likely recruit different subpopulations of guardians. For instance, the ManyDogs 1 project recruited guardians from 20 different research sites in North America, South America, and Europe (ManyDogs Project et al. 2023b). Yet, the guardian populations differed across sites in terms of their age distribution (Figure 2). Though New England sites had fairly uniform age distributions, New York City, Budapest, and Messina skewed toward younger guardians, while Arizona skewed toward older guardians. Guardian age likely affects their dog's behavior (e.g., older, retired guardians may spend more time with their dogs) and even which breeds they selected (e.g., older guardians may choose smaller, less energetic breeds). Thus, different subpopulations of guardians can result in different subpopulations of dogs being tested across research sites.

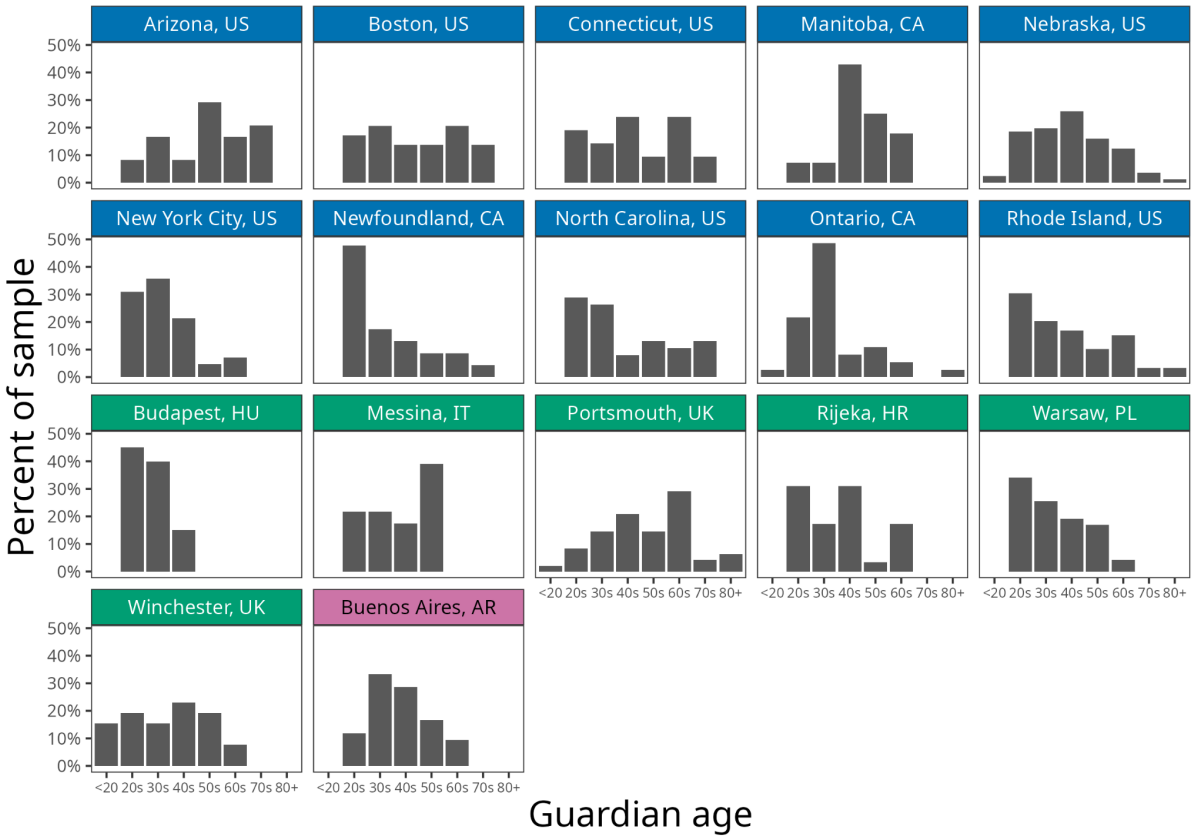

Figure 2. Guardian age distribution across research sites. For the ManyDogs 1 project, 17 research sites tested pet dogs. Bars represent the relative frequency of different age groups tested at each site. Sites labeled in blue are North American, green are European, and pink are South American.

These research site differences are important to account for because some dog behavior studies have failed to replicate (Stevens et al. 2022). Though it is possible that unreplicated effects result from idiosyncratic designs or analysis, truly absent effects, or random error, another possibility is that effects found in one sample of dogs do not generalize to all dogs. That is, research sites may be testing different subpopulations and getting different results.

Representativeness of Guardians and WEIRD Contexts

Building on the generalizability limits between research sites, there are critical differences within sites contributing to replicability issues. Most prominently, canine research

is often conducted at urban university campuses in the Global North, which comes with systemic accessibility issues. Guardian recruitment typically occurs through social media and by word of mouth, either from previous participants, the research team, or dog-centered communities (e.g., training schools). This constrains which dogs and guardians end up contributing to research.

There are inherent sampling biases through which guardians may contribute to research, similar to other fields (e.g., Elston, 2021; Kaźmierczak et al., 2023). They could be people who are more interested in dog behavior, value novel enrichment opportunities, or share a closer bond, all factors which could influence behavior and reduce representativeness in a given sample. Additionally, some breeds may be overrepresented in certain samples, as socio-demographic characteristics can impact dog selection based on physical characteristics, behavioral traits and breed expectations (e.g., Özcan et al., 2017). Further, just as dogs with highly invested guardians may be overrepresented, guardians with dogs that struggle in social situations, or find transportation stressful, will self-screen themselves.

In addition, socioeconomic status may influence guardians' ability to participate in research. Guardians may need to live close enough to the laboratory to make travel feasible and have access to reliable transportation options such as a personal vehicle, as public transit systems often restrict animals by weight or fitting in carrier. Moreover, participants need to have enough flexibility in their schedule to take time off to bring their dog to campus.

Because of these factors, only a narrow range of companion dogs and guardians are included in research. These constraints are similar to biases observed in human psychological research, where findings are often based on readily available student samples rather than representative cross-sections of the population (Hanel & Vione, 2016). Therefore, the current state of knowledge does not explain dogs as a species and limits our understanding of human-animal interactions.

Representativeness of Dogs and STRANGE Samples

Another threat to reproducibility in canine science is the limited representativeness of dog populations being studied. Compounding the *weird* biases that influence which guardians opt into research, their companion dogs fit several of the categories described in the STRANGE framework (Webster & Rutz, 2020). Parallelling themes found in human-focused sampling biases, particularly relevant categories in the context of human-animal interaction research include subjects' *social background, rearing history, genetic make-up,* and *experience.*

Most dogs included in canine research could be described as *strange* in these categories. Frequently from recognizable single breeds or intentional hybrids originating in Europe or North America (e.g., Border Collie, Labrador Retriever, or Goldendoodle) these dogs have experienced selective breeding and genetic bottlenecks (Marsden et al., 2015; Dutrow et al., 2022). Further, Companion animals' interactions with their environment are a reflection of their human guardian's preferences, socioeconomic status, and lifestyle. By contrast, the majority of domestic dogs in the world are free-roaming, freely-breeding individuals whose patterns of behavior reflect their need to access food, shelter and mating opportunities (e.g., Sen Majumder et al., 2014). While unowned dogs make up ~75% of the world's domestic dog population (Hughs & Macdonald, 2013), they are rarely studied and as a result we know little about normative dog behavior and cognition in the general population. Another *weird* factor is that the majority of researchers are in the Global North, embedding research themes and questions in a particular cultural perspective which does not represent the breadth of epistemologies on animal behavior and human-animal interactions.

Big Team Science and Other Solutions

Big team science has the potential to overcome the challenges of generalizability and representativeness within canine science. Big team science, as the name implies, is large-scale collaborative research conducted across multiple independent research sites. In comparative psychology, big team science initiatives such as ManyDogs, ManyBirds, and ManyPrimates actively work to reduce sampling biases, increase transparency, and integrate diverse research perspectives to advance their fields (ManyPrimates, 2019; Lambert et al., 2022). In the canine science context, leveraging the power of larger samples and increasing the diversity of sampled populations and researcher identities has the potential to address many of the issues identified above, in addition to addressing systemic issues with justice, equity, diversity, and inclusion in research.

Big team science provides a solution to low generalizability across research sites. Instead of sites conducting studies independently and consistently reinforcing their own results, big team science allows us to combine data and collectively investigate widely applicable effects. In addition to testing for generalizability, large-scale collaboration allows us to observe and test what features across sites might account for differences we observe. Thus, facilitating both the broader assessment of general phenomenon and the smaller-scale investigation into what factors may moderate observed effects.

Big team science can also address fundamental limitations in dog representativeness in canine science. Collaborations that span the Global South and North can lead to the co-creation of globally relevant research questions and the innovation of culturally sensitive methods. To avoid across-region generalizability pitfalls and to capture differences in eco-ethology of free-roaming dogs in the Global South, it is especially critical to include multiple different populations from diverse cultures and habitats. Including dogs from different regions will advance canine science by directly addressing some of the *strange* problems with

companion dog populations and further, simultaneously work towards researcher equity and inclusion by building partnerships with researchers in the Global South.

Though big team science offers exciting possibilities, it comes with a number of challenges (Forscher et al., 2022). Research funding is scarce for large, distributed initiatives, and research groups are frequently expected to use their existing resources (i.e., space, supplies, personnel) to participate in multi-lab collaborations. Between the Global South and North there are marked resource inequities, which imposes additional barriers to inclusion. Additionally, big team science projects are necessarily slower moving and do not align with traditional incentive structures in academia, making it particularly risky for early career researchers or those facing high publication demands and low job security to invest time without quicker outcomes to advance in their careers.

Big team science cannot solve all of the problems of generalizability or representativeness in canine science. Guardian self-selection biases may persist despite sampling more populations, as participation may still be highly motivated individuals with well-socialized dogs and the time and resources to participate. It also cannot address the representativeness of guardians included in canine science. For this, researchers could visit guardians and dogs in their homes or develop remote, online participation methods. These approaches reduce transportation costs and remove some accessibility barriers. Moreover, dogs may feel more at ease in their own home, helping those who might experience stress or fear in new environments to participate. Online methods may be particularly effective at increasing the representation of dogs and guardians, allowing fearful and aggressive dogs to be studied when they would otherwise be excluded for safety concerns. However, online approaches limit the type of tasks that can be done, and there are still socioeconomic status limitations in accessibility, as not all guardians have access to reliable internet connections and electronics. By combining big team science with thoughtful selection of sample

populations, inclusive research development, and proactively identifying biases in our research (e.g., Winder et al., 2025), we can increase the reproducibility of research in canine science.

Final Considerations

Canine science, and the broader field of human-animal interaction, have severe limitations and biases, both in the researchers carrying out the work and in the populations being studied. In particular, generalizability is hampered by limited access to diverse samples and representativeness of the research participants is influenced by socioecological factors and biological traits. Current findings are difficult to generalize even within the studied populations (primarily dogs the Global North), due to breed differences and cultural variation in guardianship and training norms. Further, the limited inclusion of guardians from diverse backgrounds and socioeconomic classes and narrow focus on companion animals prevents a deep understanding of domestic dogs as a species.

Big team science initiatives offer the potential for expanding collaborations and overcoming systematic issues with researcher and population diversity and inclusion. While there is still much that can be improved, big team science is starting to change the norms around research collaborations and open the door for underrepresented research populations and researchers to have a voice.

Recommended Reading

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Author Contributions

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Writing: Review & editing – JE, CC, MB, AB, JRS

Figure Captions

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