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Citizen science: A new direction in canine behavior research

Julie Hecht[a,*], Eleanor Spicer Rice[b]

[a] Julie Hecht, Department of Psychology, The Graduate Center, City University of New York, 365 Fifth Avenue, New York, NY 10016, USA
[b] Eleanor Spicer Rice, Verdant Word, 304 Brooks Avenue, Raleigh, NC 27607, USA

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ABSTRACT

Researchers increasingly rely on members of the public to contribute to scientific projects—from collecting or identifying, to analyzing and disseminating data. The "citizen science" model proves useful to many thematically distinctive fields, like ornithology, astronomy, and phenology. The recent formalization of citizen science projects addresses technical issues related to volunteer participation—like data quality—so that citizen scientists can make longstanding, meaningful contributions to scientific projects. Since the late 1990s, canine science research has relied with greater frequency on the participation of the general public, particularly dog owners. These researchers do not typically consider the methods and technical issues that those conducting citizen science projects embrace and continue to investigate. As more canine science studies rely on public input, an in-depth knowledge of the benefits and challenges of citizen science can help produce relevant, high-quality data while increasing the general public's understanding of canine behavior and cognition as well as the scientific process. We examine the benefits and challenges of current citizen science models in an effort to enhance canine citizen science project preparation, execution, and dissemination.

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1. Introduction

People have observed the natural world since before recorded time. For centuries, professional scientists and the general public alike have asked scientific questions, collected data, and analyzed and explained findings (Miller-Rushing et al., 2012). The term 'citizen science' increased in usage toward the end of the 20th century to describe formalized public participation in scientific inquiry and research (Bonney, 1996; Bonney et al., 2009a). Citizen science encompasses the range of activities that generate new scientific knowledge or understanding as a result of participation by members of the public, "often in collaboration with or under the direction of professional scientists and scientific institutions" (OED, 2014). The term can be conceptualized broadly, to describe *any* type of public participation in scientific inquiry, or it can be used *narrowly* to suggest something more involved than simple participation, such as explicit data collection or analysis by volunteers (Bonney et al., 2014). Citizen science has flourished in recent years, in part due to the need for large-scale datasets, the public's increased access to technology and associated increases in communication capabilities, and funding agencies' emphasis on outreach and experience-based science education (Silvertown, 2009).

Citizen science can provide researchers with myriad benefits, including the ability to sample large spatial scales; use large quantities of citizen resources to collect labor-intensive data; gather data on private land; and examine data over long periods of time (Cohn, 2008; Dickinson et al., 2010). With increasing Internet access and technological advances, projects can readily engage volunteers on a global level (Bonney et al., 2014).

Additionally, partnerships between scientists and the general public can enhance the public's understanding and appreciation of the scientific process, the natural world, and advocacy for research (Cohn, 2008). Some citizen science projects focus heavily or entirely on public learning outcomes like knowledge acquisition and attitude or behavioral change. Leaders in the field of participatory science hope that citizen science practitioners not only consider public learning engagement, but also explicitly measure and test for learning outcomes (Bonney et al., 2009a).

Citizen science projects are increasing in number and appear across disciplines, from population genetics (e.g., https://genographic.nationalgeographic.com/) to ornithology (e.g., http://nestwatch.org/), quantum physics (e.g., http://scienceathome.org/), astronomy (e.g., http://stardustathome.ssl.berkeley.edu/), and entomology (e.g., http://schoolofants.org/), among others. Fields like zoology, ecology, phenology, entomology, and

* Corresponding author. Tel.: +1 608 509 2223.
E-mail address: dogspies@gmail.com (J. Hecht).

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meteorology also rely more and more on public participation (Bonney et al., 2014). For particular areas of research, citizen science can be instrumental. For example, public participants provide ecologists with important geospatial data on species presence, absence, distribution, and abundance (Dickinson et al., 2010; Hochachka et al., 2012) and offer "many eyes" to locate rare organisms or track species (Dickinson et al., 2012). Given the desired scope and scale of ecological pursuits, ecologists could not perform comprehensive surveys or scans without public assistance.

Nonetheless, volunteer participation in scientific research poses challenges. For example, public participation projects are often subject to questions of quality assurance, a topic that garners considerable attention from leading citizen science practitioners (Bonney et al., 2014).

Canine science is a growing field with contributors from many disciplines incorporating a variety of methodological approaches. Contributors come from fields like psychology, ethology, veterinary behavior and medicine, animal sheltering, anthrozoology, genetics, ecology, archeology, and evolutionary biology, among others. While some researchers examine the thoughts, perceptions, or actions of companion dog owners (McMillan et al., 2011; Voith et al., 1992), others investigate behavioral underpinnings of the dog–human relationship (Cooper et al., 2003; Topál et al., 1998). Further, other researchers may collect biological samples to assess dog stress-related behavior and physiology (Denham et al., 2014; Dreschel and Granger, 2005), while others explore intraspecific social behaviors (Bekoff, 2001; Horowitz, 2009). The common denominator throughout is the use of domestic dogs—often companion dogs—and researchers can work as *de facto* citizen science facilitators.

Although existing public participation platforms provide useful roadmaps, little is currently known about the unique challenges facing canine-based citizen science projects. Additionally, canine researchers are not necessarily familiar with models of citizen science projects and the potential strengths and limitations of each. Here, we examine several benefits and challenges in current canine citizen science projects and provide recommendations for developing and implementing future projects. The potential of public participation projects depends on understanding their challenges. In particular, we review ways to enhance data quality and project success while supporting participant learning and science education. To inform our analysis of canine-focused projects, we elucidate strengths and weaknesses currently evident in citizen science projects generally. This analysis can fortify and expand the scope, validity, and rigor of canine citizen science projects while encouraging meaningful connections between professional researchers and the general public.

2. Citizen science design and implementation

Citizen science projects are generally placed in one of three categories: *contributory*, *collaborative*, or *co-created* (Bonney et al., 2009a). In contributory projects, professional researchers act as experiment architects, setting up the full project design, while citizens provide data by direct contribution or through passive use of citizen resources, such as online access to idle computer memory (the Skynet). Collaborative projects, on the other hand, offer the public a more hands-on experience of experiment design and analysis; scientists design the project, and citizens not only contribute data but also help sharpen experimental design, analyze data, and circulate experimental results. The category representing the greatest level of partnership and involvement between professional researchers and the general public, co-created, allows the public to not only work with scientists to design the project, but also to participate actively in all stages of the scientific process. The majority of citizen science projects are contributory, although projects can become increasingly collaborative if researchers build in flexibility. Projects vary in their objectives—such as data collection and hypothesis-testing, conservation and public interest, or improving science literacy—and objectives often shape project design. With the growth in scope, complexity, and sheer number of citizen science projects, field-wide self-audits have led to an increased emphasis on reviewing and fine-tuning citizen science approaches (Bonney et al., 2014).

2.1. Project preparation and participant motivation

Citizen science projects can benefit from interdisciplinary scientific teams (Bonney et al., 2009b). Team-approach proponents argue that, depending on the nature of the project, one discipline might not have all the necessary skills required. Accordingly, veteran citizen science practitioners stress the need for interdisciplinary relationships to cover project planning and development as well as data management and cyber-infrastructure (Newman et al., 2011). Protocols should be designed with institutional and federal regulations in mind and possess well-defined data acquisition methods with easily-understood, process-driven protocols that produce clear and useful data (Bonney et al., 2009b).

Obtaining a relevant sample of participants can be difficult, as the very nature of citizen science can attract one subset of the population while excluding another (Ess and Sudweeks, 2001; Newman et al., 2012). For example, collecting data using a smartphone application reduces the population to those who can afford smartphones or those who embrace smartphone technology, potentially excluding members of the public who cannot afford or have not adopted the technology. This does not mean, of course, that citizen science projects cannot rely on smartphones. However, if relevant conclusions depend on thorough representation of, for example, age or education level, these groups must be considered and drawn into project design.

A further consideration in successful project design is participant tracking. Tracking participant performance, or choosing not to, can impact data quality. For example, studies may decide whether each participant can contribute once or provide multiple contributions over time. In the latter, participant training or tracking can enable researchers to assess and identify over-representative data from a subject whose assessments are inaccurate or could introduce bias that skews results (Bird et al., 2014).

Projects should also consider participant motivation—how much can researchers ask of volunteers? If researchers ask too much, it is possible citizens will provide unfinished or non-comprehensive data. For example, Delaney et al. (2008) found that participants were particularly unlikely to provide all the information requested when data collection was overly challenging. This phenomenon affects project design and data collection (e.g., online surveys that save input after every question so that even incomplete surveys can provide data), as well as order of information sought (e.g., lead with more important queries so that if participants do resign, relevant data can be acquired prior to resignation).

Citizen science projects utilize a variety of participant motivation and reward strategies. Feedback and engagement prove more successful than 'altruistic' rewards like emphasizing that participant data is instrumental for scientific research and that volunteers can play a large role in advancing science (Hochachka et al., 2012). For example, eBird (http://ebird.org/content/ebird/) a citizen science project that engages global participants to collect data points on birds, reported that participation increased substantially when participants were able to track their bird records, sort their data, share their list with others, and visualize their data (Hochachka et al., 2012; Sullivan et al., 2009). Competitive elements can also increase participation, as eBird provides information

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