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Letter

# Suggestions for optimizing a global behavioral trait database

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In our forum article entitled 'Extensive behavioral data contained within existing ecological datasets', we provide methods for extracting data on intraspecific behavioral variation from ecological datasets spanning local to macro-ecological scales [1]. In the same issue, Keith *et al.* [2] published an opinion article advocating for the establishment of the new field of 'macrobehavior', which seeks to integrate behavioral ecology and macroecology. Both papers share a goal of fostering large-scale behavioral studies, hoping to catalyze future research. We are excited that our work has already sparked discussion and ideas on the topic.

In their letter, Wooster and Nimmo [3] note the complementarity of these articles [1,2]; they further propose that platforms where global researchers could deposit individual- and species-level behavioral data would permit the emerging field of macrobehavior to provide insight into the evolution of both intraspecific and interspecific behavioral variation. The creation of behavioral trait databases, akin to functional trait databases [3], is an outstanding idea with great promise for advancing our understanding of the evolutionary underpinnings of intra- and interspecific behavioral variation and the ecological interactions driven by this variation at multiple scales. Herein we provide recommendations to maximize the utility of such a database and guide its use for research on intra- and interspecific behavioral variation. Functionality allowing users to create custom queries for locating and downloading data – such as the PIT Tag Information Systems (PTAGIS) 'Advanced Reporting' interface – or capabilities for downloading, unzipping, and stacking/reformatting numerous diverse datasets (possible with NEON's 'neonUtilities' packages for R and Python) are desirable features for a behavioral trait database [1]. To advance research on the evolutionary underpinnings of behavioral variation at multiple scales, a database should be designed to facilitate the organization and storage of data attributes (Box 1).

Wooster and Nimmo stress that behavioral trait databases could organize and catalyze macrobehavioral research, and we wholeheartedly support this suggestion. As we describe in our forum [1], existing big behavioral datasets contain information on among- and within-individual variation, as well as data that empower analyses of interspecific interactions (including competition, predation, parasitism, and disease). We emphasize that the methods we detail allow researchers across different disciplines to extract behavioral data for contributing, advocated by Wooster and Nimmo [3]. Moreover, such data are available from long-established sampling and monitoring programs (such as small mammal trapping and bird mist-netting projects), facilitating comparisons with historical behavioral trait data and providing an opportunity to explore the intersection of intra- and interspecific variation in behavior and other individual-, population-, and community-level traits. Long-term population studies yield crucial insights into viability and, when paired with behavioral data from the same animals, enable the integration of behaviors that predict population increase or decline into population projection models [4]. Global behavioral trait databases may permit the connection between environmental variation, cue reliability, and adaptive decision making [5], elucidate the role of temporal variation in susceptibility to evolutionary traps [6], and establish links between animal behavior and plant traits [7,8].

We are encouraged by the ongoing conversation surrounding big behavioral data and enthusiastically endorse the creation of global behavioral trait databases. We hope these suggestions will help optimize an outstanding idea.

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## Declaration of interests

The authors declare no competing interests.

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Box 1. Key considerations for developing and contributing to behavioral trait databases: facilitating research on behavioral variation at multiple scales

(i) Whenever possible, contributed data should involve repeated measures from individually identifiable animals. Single measures prohibit estimation of within-individual behavioral variation and are rarely representative of an individual's mean behavior [9]. Additionally, providing repeated measures instead of an individual's mean measurements over repeated observations enables error variance to be carried forward into future statistical analyses. Repeated measures of behavioral data are fundamental for formal investigations into animal personality [10].

(ii) Ideally, data should include timestamps and information about environmental context (e.g., providing geographic coordinates of observation locations for behaviors recorded from wild or non-laboratory animals). It is advisable to design studies that enable statistical control of potentially biasing spatiotemporal factors [10,11], such as choosing an inter-test interval that is biologically relevant for the study species.

(iii) Details regarding the assay type used to measure each behavior are essential to report, as behaviors collected in distinct assays are necessary for studying behavioral syndromes or the among-individual correlation in repeated measures across multiple behaviors [10].

(iv) If available, individual state/trait information should be given (e.g., sex, reproductive status, body condition) along with sampling details (e.g., observer presence/absence).

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