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Tamarins are one of more than 40 primate species that researchers can study through the ManyPrimates collaboration.

Build up big-team science

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Researchers are creating grass-roots collaborative networks to tackle difficult questions in primate studies and more, but they need funding and other support.

Are some of science's biggest questions simply unanswerable without redefining how research is done? This is the question that motivated the researchers who would later establish the ManyBabies Consortium: a grass-roots network of some 450 collaborators from more than 200 institutions who pool resources to complete massive studies on infant development (see, for example, ref. 1). Human infants are perhaps the most powerful learning machines on the planet — and understanding how that learning occurs could inform artificial intelligence, public policy, education and more. Yet a full understanding of infant learning seemed difficult (if not impossible) under the current research model.

Consider the question of what captures infants' attention. Surely the probability that an infant will pay attention to, say, a rabbit, depends on presentation (for example, by a mother or a stranger), the child's previous experiences with mammals, what else is present alongside the rabbit, and much more. Unpacking this effectively would require dozens of experimental conditions and hundreds of infant participants. But most research projects are run by individual principal investigators and a shifting population of PhD students, meaning that data-collection efforts typically recruit fewer than 25 infants for each condition being tested[2].

But what if researchers worked interdependently and distributed work across many laboratories? Such consortia might be

able to answer questions that no individual lab could tackle alone. In a proof-of-concept study, the ManyBabies Consortium used word of mouth, social media and e-mail lists to amass a team of 69 labs to test whether infants across several world regions prefer 'baby talk': the high-pitched, sing-song speech that adults in many cultures use with babies. Data from 2,329 infants in 16 countries provided a resounding yes, demonstrating that infants even prefer baby talk that is not in their native language[3]. This study, the largest of its kind, was cited more than 100 times within a year of its publication, according to Google Scholar.

The ManyBabies Consortium is not a one-off. It is part of a broader movement towards grass-roots big-team science: endeavours in which an unusually large number of researchers – often dispersed across institutions and world regions – self-organize to pool intellectual and material resources in pursuit of a common goal[4]. In addition to the ManyBabies Consortium, the authors have collectively been involved in creating the Psychological Science Accelerator (involving some 1,200 researchers)[5], the Disturbance and Resources Across Global Grasslands network (DRAGNet; around 100 researchers; https://dragnetglobal.weebly.com) and the ManyPrimates project (comprising about 150 researchers[6]; see 'Examples of big-team science'). These self-organized consortia pool resources to conduct massive studies in psychology, ecology and primatology, respectively. They perform collaborative endeavours similar to those of the Human Genome Project and groups within CERN, Europe's particle-physics lab near Geneva, Switzerland, but have been founded without formal funding mechanisms or well-developed infrastructure.

We have found that grass-roots big-team science is capable of generating knowledge that is difficult to obtain – but faces several barriers to sustainability.

Barrier 1: rewarding team players

Michele Grigsby Coffey, a historian at the University of Memphis in Tennessee, has described academia as "a selfish sport" in which researchers "are rewarded for self-absorbed fixations", and in which "prioritizing yourself at the expense of others is encouraged"[7]. Big-team science, however, is a team sport that often requires researchers to prioritize discovery over their own self-interests. For example, the first ManyPrimates study (of which D.A. is a co-author) examined the working-memory capacity of more than 40 species of primate by testing whether the animals could remember the locations of hidden food after short time delays[8]. D.A. estimates that he committed some 200 hours to the project. Yet on the resulting paper, the consortium is listed as the first author, the corresponding author e-mail is a shared mailbox and D.A. occupies one of 79 slots in the alphabetically sorted author list. Such authorship arrangements highlight the accomplishments of the team over any individual.

Pursuing relatively selfless ideals of big-team science can mean being penalized by the referees of the selfish sport of academia. For example, when one of us (N.A.C.) was nominated to direct the Psychological Science Accelerator during a postdoctoral fellowship, a well-meaning adviser told him that it was an important role and that he was a great fit, but that pursuing it would "kill chances of getting a tenure-track position". The more senior co-authors of this manuscript (J.K.H., L.L.S. and T.H.P.) have offered junior colleagues similar warnings. For instance, they have seen members of hiring committees baulk when a job candidate's CV contains several papers in which their name is in the middle of a long list of authors. A selfish sport rewards stars – not those who have crucial supporting roles. Indeed, when one of us in a big-team effort expressed excitement about a recent milestone to a department head, the response was: "Great. Just make sure you have work coming out of your own research group."

"Leading the big-team-science movement can feel like climbing mountains without so much as a rope."

Academia could change the game by rewarding researchers who make large contributions to team efforts. Otherwise, teams will be forced to find other ways to increase benefits or decrease the costs of participation. For example, project leaders could fund collaborators, as is being done for a collaboration designing tools to predict the replicability of research findings in the social and behavioural sciences, supported by the US Defense Advanced Research Projects Agency (www.cos.io/score). Such solutions, however, prohibit researchers with fewer resources from leading big-team science efforts. As an alternative, some collaborations offer non-financial perks. For example, both DRAGNet and the Nutrient Network offer participating researchers exclusive access to the full project database. However, these policies conflict with goals to make science more open and inclusive. A reduction in costs could be accomplished by recruiting even more researchers to split the bill, but this makes coordination much more difficult.

Barrier 2: diversity

One large potential benefit of this way of doing science is the opportunity to increase the diversity of participants, researchers and research questions. But we have noticed a worrisome trend: pre-existing inequality in science infrastructure seems to be perpetuated in big-team science.

A 2021 analysis noted that researchers in previously colonized countries often lack the access to lab space and funding that are necessary to participate in big-team science[9]. Not surprisingly, perhaps, these inequalities also seem to affect who leads these endeavours. Not a single behavioural-science big-team project included in this analysis was led by a researcher in a developing nation. Furthermore, the combined governing and steering boards of ManyBabies, the Psychological Science Accelerator, the Nutrient Network and DRAGNet include only 4 (of 32) members from outside North America or Western Europe (17 are from the United States, 5 from Canada, 6 from Western Europe, 1 from Kenya, 1 from Argentina, 1 from Australia and 1 from India).

Big-team science should find ways to enable change. For example, the Psychological Science Accelerator uses donations to award participation grants to researchers in under-represented regions. The ManyBabies Consortium launched an extension of its first study that provides funding, training and support for data collection in Africa – an operation that would have been impossible without support from the Jacobs Foundation in Zurich, Switzerland. DRAGNet minimizes costs at institutions that have few resources by getting them to ship seed samples for processing at better-resourced institutions. Many Primates fosters connections in the global south by participating in local meetings and reaching the community through publications in languages such as Spanish and French.

Researchers can also help to close the infrastructure gap by training and supporting researchers in under-represented areas. For example, a big-team project testing how people in various African regions evaluate moral transgressions is led by a PhD student from Nigeria, and is supported by several members of the Psychological Science Accelerator[10].

Barrier 3: funding and sustainability

Despite well-recognized outputs, we all scramble constantly to keep our big-team initiatives going. These grass-roots projects can be established with little funding, but they are difficult to maintain without financial support. Big-team science needs funds to retain researchers who know how to coordinate the next wave of science, to support tools for managing increasingly complex workflows, and to support participation from researchers who are not well resourced.

For example, the first Psychological Science Accelerator study examined how people around the world judge others on the basis

EXAMPLES OF BIG-TEAM SCIENCE

Large teams of researchers have come together in various ways to tackle difficult questions in science, from soil samples to cancer biology.

Consortium or project name	How and when organized	Example of project finding or question	Data collection
Psychological Science Accelerator	Grass-roots consortium launched by a 2017 blogpost. Now involves some 1,200 researchers.	'Cognitive reappraisal' improves emotional reactions to the COVID-19 pandemic.	Data from more than 20,000 people in 87 countries collected by more than 450 researchers[12].
ManyBabies Consortium	Grass-roots consortium launched by a 2015 blogpost. Now involves around 450 researchers.	Infants prefer 'baby talk' even when it's not in their native language.	Data from 2,329 infants collected by 150 researchers in 16 countries across the world[3].
ManyPrimates project	Grass-roots consortium launched through 2018 symposium, word of mouth, e-mail and social media; now involves about 150 researchers.	Among 41 closely related primate species, phylogeny matters more for short-term memory than do ecology or social factors.	81 researchers studied 421 primates[8].
Nutrient Network (NutNet)	Launched in 2006 through e-mail and Twitter requests to join the network. Data collection began in 2007.	Does herbivory and light availability resolve the loss of plant species caused by nutrient addition?	Using data from the broader Nutrient Network experiment (>130 collaborating sites), researchers documented effects of controlled combinations of nutrient addition and herbivore exclusion on plant diversity at 40 sites across the globe[13].
Many Smiles Collaboration	Grass-roots effort launched in 2018. Collaborators formed adversarial teams recruited through social media and e-mail.	Does changing facial expression affect emotions?	Nearly 50 researchers collected data from 3,878 participants across 19 countries[14].
Reproducibility Project: Cancer Biology	Launched in 2013 through funding provided by Arnold Ventures to the Center of Open Science and Science Exchange.	Can the results of experiments from high-impact cancer-biology papers be reproduced?	200 collaborators attempted to replicate 158 effects from 50 preclinical experiments[15].
Disturbance and Resources Across Global Grasslands network (DRAGNet)	Grass-roots consortium conceived in 2018. Data collection began in 2019; network built through e-mail and Twitter.	When grasslands are disturbed by tilling and nutrient additions, how do they respond?	Some 90 researchers monitor 70 sites in 18 countries (https://dragnetglobal.weebly.com).

of facial appearance[11]. The project involved 241 collaborators and 11,570 participants spanning 41 countries. In principle, this study should have cost hundreds of thousands of dollars. If participants and research assistants were each paid just US$5 for every 30-minute data-collection session, the cost would be more than $115,000. The price tag gets much bigger when factoring in labour for project management, which included acquiring more than 150 ethics-approval documents, translating study materials into 23 languages and developing research tools to track progress and validate data from labs all over the world (see go.nature.com/3jcsutx). Yet the project officially operated on less than $2,000; hundreds of collaborators donated their time and resources to make up the difference (see go.nature.com/3qstumf).

Operations that run on shoestring donations are neither sustainable nor scalable. This hard truth became apparent at the beginning of 2020, when the Psychological Science Accelerator received 66 urgent proposals for global research projects on the psychology of the COVID-19 pandemic. Financial considerations meant that the network had to reject all but three. One rejected proposal aimed to test whether reminding people to consider accuracy before sharing news could help to curb COVID-19 misinformation in different world regions and demographics. Every time we see a post promoting false claims that the antiparasitic drug ivermectin prevents COVID-19, that pregnant women should not get vaccinated or that COVID-19 vaccines contain microchips, we are painfully reminded of the work we did not have the funds to support.

Why is it so hard to get funding for grass-roots big-team science initiatives? Government and philanthropic funders have provided various reasons. For instance, they worry that big-team science will ultimately prove to be unsustainable because of academia's selfish rulebook. They say that big-team science is still not diverse enough in terms of researchers and research questions. They say that their systems are not set up to process proposals with hundreds of collaborators, or to handle funding requests that go out to dozens of research sites. Most frustratingly, they say that big-team science has managed so far without their support.

Leading the big-team-science movement can sometimes feel like climbing the world's tallest mountains without so much as a rope. We have caught glimpses of the peaks and can imagine the views they might offer, but we lack the resources to climb higher. Every step forward will become increasingly treacherous until academic institutions and funders provide long-overdue support.

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The authors declare competing interests; see go.nature.com/3tnjtrr for details.