Overview. The **Community of Open Scholarship Grassroots Networks** (COSGN), includes 107 grassroots networks, representing virtually every region of the world and every research discipline. These networks communicate and coordinate on topics of common interest. We propose, using an NSF 21-511 Implementation grant, to formalize governance and coordination of the networks to maximize impact and establish standard practices for sustainability. In the project period, we will increase the capacity of COSGN to advance the research and community goals of the participating networks individually and collectively, and establish governance, succession planning, shared resources, and communication pathways to ensure an active, community-sustained network of networks. By the end of the project period, we will have established a self-sustaining network of networks that leverages disciplinary and regional diversity, actively collaborates across networks for grassroots organizing, and shares resources for maximum impact on culture change for open scholarship.

Intellectual Merit. The open scholarship community is fueled by recognition that the social structure and culture of research does not promote practices and reward behaviors in line with scholarly values. Networks promoting open scholarship represent a variety of aims, including: increasing the transparency and accessibility of research processes, content, and outputs; improving the rigor and reproducibility of research practices; and advancing inclusivity of who can contribute to scholarship and how to diversify reward systems to encourage their contributions. The challenges and opportunities to improve research practices exist in every scholarly discipline, every region of the world, and every stakeholder group (e.g., researchers, institutions, publishers, funders, consumers of science).

An essential component of the open scholarship movement is that much of the culture change is occurring via grassroots networks with strong representation of early-career researchers. These networks identify problems relevant to the communities they serve, and organize disciplinary, topical, or regional communities to solve them. The networks provide training, change norms, help internalize new practices within their research communities, and accelerate the pace of discovery. Bottom-up culture change via grassroots networks is an essential complement to top-down policy changes toward open science to build the capacity, skills, and internalization of the new norms and behaviors. *The problem is that grassroots networks face the fundamental challenges of under-resourcing, lack of coordination, and lack of content and knowledge sharing across networks. These reduce the effectiveness of grassroots movements. COSGN will solve these challenges.* A successful network will leverage resources to tackle the global challenge of reforming the research culture, prepare early-career researchers with skills to succeed in the reformed culture, and, ultimately, accelerate the process of scientific discovery.

Broader Impacts. Reducing dysfunctional incentives and accelerating research progress requires bottom-up work that improves inclusion, training, norms, research, and solutions. It also requires coordination across disciplines, geographies, and stakeholder communities. COSGN will have substantial impact beyond the network itself. Advancing open scholarship will facilitate ***Harnessing the Data Revolution*** by improving research rigor, and by opening training pathways for advancing reproducibility. Advancing open scholarship supports ***NSF INCLUDES*** by embodying inclusivity and identifying new paths and rewards for diversity in who and how contributions are made to research. And, particularly, COSGN will facilitate early-career researchers' rigorous and transparent research practices and leadership in shaping the research culture. Finally, advancing open scholarship helps catalyze ***Growing Convergence Research*** by addressing the foundational questions about the social, cultural, and methodological issues for how scholarly work gets done that are common across research disciplines. Open scholarship is fundamentally interdisciplinary and the network will open opportunities for collaboration across domains.

AccelNet-Implementation: Community of Open Science Grassroots Networks (COSGN)
Project Description

Intellectual Merit

Theme, Rationale, and Goals

The scholarly community recognizes that some core values of research--rigor, transparency, sharing, inclusivity--collectively called *open science* or *open scholarship*, are not operating ideally in practice. Across disciplines, topics, and geographies, there are dysfunctional norms, incentives, and policies that create friction in the pace of discovery and accumulation of knowledge.

Much research is never reported, particularly research producing negative or null outcomes, resulting in publication bias (Fanelli, 2012; Rosenthal, 1979; Sterling, 1959). Incentives promoting novel, positive, and clean results combined with substantial flexibility in reporting leads to questionable research practices including *p*-hacking, selective reporting, and overfitting that undermine the credibility of reported findings (Simmons et al., 2011; John et al., 2012; Nosek et al., 2012). Lack of incentives for transparency and rewards for sharing leads to significant barriers to reproducibility because of unavailability of data (Wicherts, et al., 2006), code/software (Stodden et al., 2018), and incomplete reporting of protocols and materials (Kidwell et al., 2016; Iqbal et al., 2016). Insufficient training for open research practices leaves researchers, particularly early-career researchers, with little opportunity to improve the rigor and transparency of their research (Allen & Mehler, 2019). The dominance of a vertically integrated research model in which resources are centralized to few people, labs, and institutions inhibits more inclusive research systems that enable and reward contributions of many based on the skills, resources, and interests that are available to them (Uhlmann et al., 2019). And, finally, the skewed allocation of research resources across researchers inhibits opportunity for those receiving fewer resources to gain access, develop skills, and make contributions commensurate with their abilities and interests. These realities create inefficiencies in science by interfering with learning from failures, aggregating evidence, managing motivated reasoning, reusing research artifacts, making scholarship accessible, and leveraging the broad, diverse talents of the available workforce.

The pessimism that this summary might invoke is countered by the emergence of grassroots networks to promote open scholarship and transform the research culture. For example, here are five of the 107 grassroots networks in this proposal promoting culture change in their communities:

- *UK Reproducibility Network*: Peer-led consortium of 47 local networks at UK universities and institutions supporting rigor, reproducibility, and transparency.
- *Humanities Commons*: An open-source, open-access, academy-governed network for scholars and practitioners in the humanities making the work of the humanities available to the world.
- *ANZORN*: An Australia/New Zealand network of networks directed at supporting local grassroots community activities on open scholarship.
- *Brazilian Reproducibility Initiative*: A systematic replication initiative of published experiments in Brazilian biomedical science with online meetings, webinars, and social networking.
- *Young Academy of Europe*: A pan-European bottom-up initiative of outstanding young scientists for networking, scientific exchange, and science policy.

Researchers, particularly early-career researchers (ECRs), recognize the opportunity to change the research culture toward scholarly values of rigor, transparency, sharing, and inclusivity. Grassroots researcher networks are directly addressing the dysfunctional norms, incentives, and policies that create friction in the research process, and promoting new behaviors that accelerate discovery. The researcher networks are highly diverse by discipline, topics, and geography. The networks are also highly diverse on strategy, priorities, resources, scope, and progress. Amid this productive diversity, the researcher networks are highly aligned on core values and purpose. The 107 networks in this proposal share the goal to make scholarly research more rigorous, transparent, open, and inclusive.

Grassroots networks provide an essential part of the movement to transform the research culture to embrace open scholarship. Stakeholder groups such as publishers, funders, and institutions can implement top-down policies that alter incentives and require changes to researcher behaviors. And, networks such as FORCE11 and Research Data Alliance can coordinate the updating of information

technology and infrastructure to support open scholarship. Grassroots networks are complementary to these efforts by conducting "in the trenches" work fostering the development and internalization of new norms via peer influence and training to do the new behaviors, meet the new policy demands, and use new infrastructures. Also, despite shared values and goals, there is disciplinary diversity in how open science principles could be most productively translated into practice. Facilitated, regular coordination and exchange among grassroots communities will help to identify when common solutions across disciplines or regions are viable and when there are boundary conditions or customized needs for effective disciplinary and regional implementation.

        Statement of purpose and shared vision. The AccelNet-Implementation: Community of Open Science Grassroots Networks *(COSGN)* fosters communication, coordination, and collaboration across a global community of diverse researcher networks for a concerted effort to promote culture change toward shared aims of improving research rigor, transparency, openness, and inclusivity with the ultimate goal of reducing friction and accelerating discovery.

Community of Open Scholarship Grassroots Networks
An open exchange of researcher networks across topic, discipline, and geography
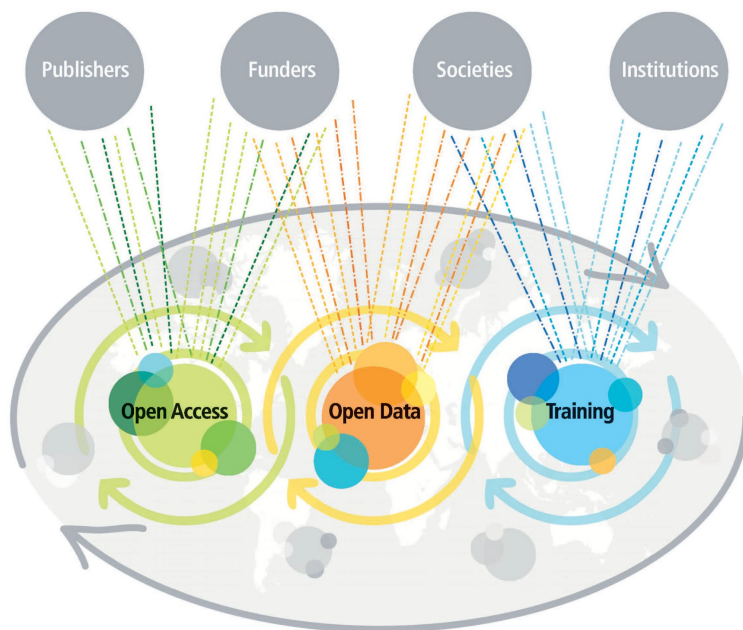
Figure caption: The top-down stakeholder influencers appear on top, and the research community appears on the bottom. COSGN is represented by three examples of topical interest working groups (Open Access, Open Data, Training) illustrating how COSGN connects grassroots networks on topics of shared interest. Those working groups are comprised of multiple networks, distributed by geography and discipline, with a shared topical interest. Each working group fosters communication and collaboration across networks and with the whole research community as denoted by the expanding circular arrows. COSGN also fosters communication and collaboration across working groups and networks, and with the broader research community, as represented by the large gray circling arrows. COSGN networks and working group activities may interact with publisher, funder, society, and institution stakeholders via informal and proactive social and professional engagement as represented by the dotted lines connecting grassroots networks of networks with stakeholder groups.

        Mapping COSGN's relationship with other networks. All stakeholders in the scientific enterprise have an interest in open scholarship. Journals and publishers are engaged in these issues via their role in scholarly communication, particularly peer review and dissemination of research findings. Funders are engaged via their interest in maximizing the return on investment of the research that they support. Research societies are engaged for setting the norms and standards for their disciplinary domain to accelerate discovery. Universities are engaged to advance their missions for promoting knowledge accumulation and dissemination in the public interest. COSGN is the bottom-up grassroots researchers' complement to all of these stakeholder communities that have top-down opportunities to shape open scholarship. Whereas stakeholder communities and networks play a significant role in policy making and setting incentives and requirements for research, COSGN networks operationalize the incentives and policies into daily research practice via training, conducting open research, and studying the implications

of policies. They also identify when policies and interventions are not effective in the lived realities of researchers, particularly for solutions that are applied widely, but may not work effectively for all circumstances across disciplines, methodologies, or regions. Further, COSGN networks shape norms among researchers and collaborate or pressure the stakeholder communities or networks via grassroots organizing to change policies and practices that are creating friction in the pace of scientific discovery. The mapping of this relationship is illustrated in the Figure above.

Broader Impacts

Connection to NSF Big Ideas. The COSGN is aligned with NSF Big Ideas. Advancing open scholarship will facilitate ***Harnessing the Data Revolution*** by improving research rigor, and by opening education and training pathways for advancing reproducibility. Advancing open scholarship supports ***NSF INCLUDES*** by embodying inclusivity and by implementing new paths and regards for diversity in who and how contributions are made to research. COSGN will facilitate early-career researchers' leadership in shaping the research culture. Finally, advancing open scholarship helps catalyze ***Growing Convergence Research*** by addressing the foundational questions about the social, cultural, and methodological issues for how scholarly work gets done and what is common and idiosyncratic across research disciplines. The network-of-networks will open opportunities for collaboration across fields.

Potential impact on participants and U.S. and international research communities. Participating networks within COSGN--in the U.S. and internationally--are already making substantial contributions in their scholarly communities; some already becoming national networks (e.g., ANZORN, UKRN, and Open Science Communities in the Netherlands). An implementation of COSGN will connect and elevate those contributions by improving visibility and sharing of effective strategies across networks by enabling collective action for interventions that will benefit from coordination and shared resources across stakeholders, and by harmonizing efforts for more efficient and effective use of resources and improved likelihood of success. The U.S. will benefit from COSGN by improving the transfer of rapid advancement in open scholarship policies and practices from elsewhere to the U.S.

Benefit to U.S. scientific enterprise and societal value of the activities. True culture change in scholarly research is contingent on the success of bottom-up networks that provide the training, opportunities, norms, and collective action to encourage stakeholders to embrace change. COSGN exists to foster that grassroots movement. Shifting norms, incentives, and policies toward open scholarship will reduce friction in knowledge accumulation and accelerate discovery. And, with true culture change, the return on investment will continue to accumulate long past the project period and impact the entire research community, not just the members of the COSGN networks.

Unique opportunities provided by a network-of-networks for open scholarship. There is an enormous amount of knowledge, energy, and goodwill within open scholarship grassroots networks. COSGN will mature and accelerate the existing communication, coordination, collaboration, and resource sharing to leverage that capacity for collective benefit. Improving the infrastructure of communication will foster efficient collaboration and will lead to a self-sustaining network. NSF resources will mature an organizational framework that can be maintained with minimal ongoing resource investment. The established framework, with clear charters, succession plans, and areas of practice will "institutionalize" COSGN as a network from which small in-kind investment of participation comes with outsized benefits for each network via its membership.

Participating Networks, Resources, and Synergies

There are a total of 107 participating networks in COSGN representing interests in nearly every region, discipline, and open scholarship topic. Moreover, membership in COSGN will not be restricted to these networks. We will be particularly attentive to improving diversity of the included networks as a primary purpose of COSGN is to raise capacity of all research communities and to identify how open scholarship solutions are aligned or misaligned with the realities facing research communities based on their membership, reward systems, methodologies, or situated positions in scholarly systems. Because open scholarship topics are abstracted themes that are potentially relevant for all areas of research, there is substantial opportunity for synergies across networks.

Many of the existing networks have made substantial progress in articulating principles of open scholarship, testing solutions that work within their community, developing new incentives or policies, building community support, developing training and education materials, and conducting research to evaluate effectiveness of the solutions. Simultaneously, because of their respective missions, the networks have advanced such content with a focus on meeting their communities' disciplinary, regional, language, and methodological needs. Breaking silos between these networks will open avenues for translation of content across networks and rapid identification of barriers or boundary conditions that must be acknowledged, accommodated, or respected for maximizing the benefit of open scholarship for all. There is an incredible amount of knowledge, experience, and opportunity contained within networks. COSGN's primary synergistic activity is to unlock that potential energy and translate it into kinetic activity.

Here we summarize key characteristics across the networks to highlight their diversity, characteristics, resources, and priorities.

Snapshot of COSGN Member Networks *100% (N=107) of participating networks responded to requests for information, providing data cited in this and subsequent tables.*

Staffing	46 staffed by volunteers; 11 staffed by leaders indirectly compensated as part of other professional roles; 15 staffed by leaders directly compensated for network activity; 34 staffed by mix of volunteers, indirectly, and directly compensated
Budgets	43 have no operating budget; 19 have budgets under $10K; 14, $10K-$99,999; 15, $100K-$999,999K; 8, $1M+.
Longevity	31 have existed for 1-2 years; 56 for 2-10 years; 19 >10 years.
Languages	Huge variety of languages represented and supported across the global network
Size of Community Served	Networks estimated the size of the community receiving their services in the last year. The median community served was 750 and mean was 140,639.

International Collaborations and Contributions. In the table below, we provide a general mapping of the broad coverage of grassroots networks across scholarly disciplines, topics of focus, and geographies. If a network had substantial participants or activities in more than one region, discipline, or topic area, they could select multiple values for the category. "Primary" indicates networks citing a single value for a category. "Total" includes all networks citing a value whether as a single response or as one of multiple values cited. "Applied Sciences" is inclusive of education, business, public policy, and other "non-basic" research domains.

Primary Region(s) Served	Primary (Total)	Primary Discipline(s) Served	Primary (Total)	Primary Topics Served	Primary (Total)
Global	43 (50)	Multiple/All (3+ values cited)	58 (58)	No Single Highest Priority	14

Africa	4 (7)	**Applied Sciences**	1 (4)	**Alternative Metrics**	0 (20)
Asia	5 (8)	**Arts, Humanities**	3 (4)	**Citizen Science**	1 (17)
Australia & Pacific Islands	4 (10)	**Engineering**	1 (3)	**Diversity & Inclusion**	1 (34)
Europe	31 (41)	**Exercise Sciences or Sports Sciences**	1 (1)	**Metaresearch**	2 (27)
North America	6 (12)	**Human-Computer Interaction**	1 (1)	**Education of Open and Reproducible Science**	1 (1)
South America	2 (6)	**Life Sciences**	6 (12)	**Norms, Incentives, & Policies**	8 (46)
		Medicine	1 (2)	**Open Access**	23 (57)
		Natural Sciences	4 (7)	**Open Collaboration**	7 (50)
		Research Libraries	1 (1)	**Open Content**	9 (70)
		Social and Behavioral Sciences	12 (19)	**Open Governance**	2 (23)
				Open Process	7 (54)
				Open Source	3 (47)
				Rigor & Reproducibility	16 (53)
				Training	8 (58)

Participating Networks

Academic Data Science Alliance

Açık Bilim Topluluğu Türkiye (Open Science Community Turkey)

AfricaOSH (Africa Open Science and Hardware Network)

APSOHA (Association for the Promotion of Open Science in Haïti and Africa).

ArabiXiv

arXiv.org

Association for Interdisciplinary Meta-Research and Open Science (AIMOS)

AUS-RN (i.e., like UKRN but in Australia)

Australasian Open Access Strategy Group (AOASG)

Australia and New Zealand Open Research Network (ANZORN)

Berkeley Initiative for Transparency in the Social Sciences (BITSS)

BodoArXiv

Brazilian Reproducibility Initiative

Bullied Into Bad Science

Center for Reproducible Science (CRS) of the University of Zurich

Centre for Journalology (at the Ottawa Hospital Research Institute)

Chinese Open Science Network

Consortium for the Advancement of Special Education Research (CASPER)

CORE

CREATOR (CREAting Transparent and Open Research) -- Open Science Working Group at Essex University

Digital Library Services

EarthArXiv
EcoEvoRxiv
EdArXiv
Edinburgh Open Science Initiative
EFOSI (Erfurter Open Science Initiative)
eLife Community
EURODOC - European Council of Doctoral Candidates and Junior Researchers
FAIRDOM Association e.V.
FORTT
FOSTER
Free Our Knowledge
Freie Universität Berlin Open Science Working Group
FrenXiv - French arXiv
Global Young Academy
Göttingen Open Science Meet-up, University of Göttingen
Harvard Open Access Project (HOAP)
Helmholtz Open Science Office
Humanities Commons
ICSI (Information and Communication Society of India)
IndiaRxiv and AgriXIv (Open Access India)
Innovations for Poverty Action
Institute for Globally Distributed Open Research and Education (IGDORE)
Izmir Institute of Technology
Japanese Community for Open and Reproducible Science (JCORS)
Lancaster University
Läpinäkyvää tiedettä
Leibniz Research Alliance Open Science
LIBER
LIS Scholarship Archive
LMU Open Science Center
ManyBabies
Mass pre-reg replications of classic findings in JDM
MediArXiv
No-Budget Science
Open Access Directory - OAD
Open Access India
Open Engineering
Open Knowledge Foundation
Open Scholar CIC
Open Science Community Amsterdam
Open Science Community Eindhoven
Open Science Community Groningen

Open Science Community Leiden (OSCL)
Open Science Community Nijmegen
Open Science Community Rotterdam
Open Science Community Utrecht (OSCU)
Open Science Federation
Open Science in Archaeology Interest Group
Open Science Initiative Leipzig
Open Science Initiative, Ruhr University Bochum
Open Science Sweden
Open Science UMontreal
OpenAIRE Community of Practice
OpenScienceMOOC
ORION Open Science EU-project
PaleorXiv
PhysioNet
PREreview
PsyArXiv
Psychological Science Accelerator
ReplicationWiki
ReproducibiliTea
Reproducible Science @ Stanford
Research Data Alliance
Research Software Alliance (ReSA)
rOpenSci
Saint Louis University
SciPost
Society for the Improvement of Psychological Science (SIPS)
Software Sustainability Institute
SOPSI
SORTEE (Society for Open, Reliable, and Transparent Ecology and Evolutionary biology)
Strengthening the Evidence in Exercise Sciences Initiative (SEES Initiative)
Structural Genomics Consortium (SGC)
Swinburne Open Science Task Force
Swiss Reproducibility Network (SwissRN)
Taiwan Collaboration for Psychological Scientific Research (TCPSR)
The Replication Network
Transparent Statistics in HCI
Tübingen Open Science Initiative
Ubiquity Partner Network
UCT Libraries
UK Reproducibility Network
Volcanica
WSSSPE
Young Academy of Europe (YEA)

Potential for advances beyond existing efforts. COSGN is a unique opportunity to break regional, disciplinary, and topical silos to dramatically enhance the impact of grassroots networks. The key enabling agent for this to become truly interdisciplinary work is that all of the participating organizations share a common core value of improving research rigor and transparency. This shared starting point provides a basis of having productive conversation, coordination, and collaboration across diverse regional and disciplinary circumstances.

A network for information exchange and collaboration across these networks will stimulate a variety of important activities that are not easily accomplished otherwise. Here are a few case examples that we expect to occur and recur across the open scholarship topics of interest across networks.

- Preregistration is gaining popularity in the social and behavioral sciences, particularly psychology, as a methodology to reduce publication bias by ensuring that all studies are discoverable even if they produce negative results and as a methodology to increase rigor and transparency by making clear what plans and hypotheses existed a priori and which were discoveries after observing the data. One observation in that research community is that implementation of preregistration has many shortcomings for meeting its promise. There is, simultaneously, a metascience research literature that has been accumulating about registration for 20 years in clinical trials. Much of the challenges observed in implementation of registration for clinical trials a decade ago are playing out in another discipline. Breaking silos of communication and knowledge could be an enormous benefit for new fields adopting a behavior to learn from and avoid some of the implementation challenges of fields that have been through it already.
- While preregistration is rapidly gaining popularity in social-behavioral sciences, there are many open questions about the extent to which preregistration would provide benefit, or could be usefully adapted, to be applied in other fields. COSGN working groups are an ideal mechanism for articulating these translation challenges and investigating whether preregistration has hit a boundary condition of applicability into a subfield, or whether adaptation to meet the subfield's needs could improve its applicability or even provide feedback to improve preregistration in its originating discipline.
- The research community is evolving quickly toward Open Access. While there is widespread support for Open Access even beyond the COSGN networks, there is also substantial variation in how business models can be implemented that will reduce rather than exacerbate equity gaps, especially between wealthy and less wealthy regions. Communication across COSGN networks via working groups offers a substantial opportunity to improve understanding of the cultural and financial challenges facing researchers across regions, and particularly to conceive and advocate for ecumenical models for achieving Open Access that raise the capacity of researchers in all regions, not just those with sufficient wealth to participate.
- Some issues for open scholarship are common challenges across all disciplines and regions. For example, for preprints, data, software, and other materials, researchers are now prompted to consider open licensing and must select which license is best for their circumstance. COSGN working groups and symposia are perfect occasions to transmit that knowledge rapidly across regions and disciplines to help researchers make informed decisions.
- Data sharing is gaining substantial traction among stakeholders across disciplines and regions. Implementation of new data sharing policies is challenging without informed consideration of implementation opportunities and challenges across regions and disciplines. Seemingly basic questions like "What are the relevant data to meet a data sharing policy?" are actually quite complex when applied across all of scholarship. Grassroots communities working independently by region or discipline may arrive at infrastructures or definitions that work locally but conflict globally. Lack of recognition of those conflicts will make it more difficult for the funder and publisher stakeholders to implement effective policies. There may be some opportunity to harmonize, and there also may be opportunity to articulate where harmonization is not possible, and customization is essential for effective policy making and implementation. Work among COSGN members to identify those gaps and potential solutions can improve efforts within grassroots networks for advocacy and can provide extremely helpful guidance to funder and publisher stakeholders.

Network of Network Activities

The proposal aims to mature the existing open scholarship network activities as a full-scale implementation into the COSGN to help transform the research culture to embrace open scholarship. This work will build on and strengthen existing network activities including: a curated database of 200+ grassroots networks sharing priorities for informal collaboration, a Google Group to foster communication and collaboration across the networks, a diverse offering of ad hoc collaborative activities among subsets of the network of networks, and four active working groups represented by a diverse membership of network members. Dedicated support for COSGN will dramatically improve its breadth, inclusivity, connectivity, and impact, and enable more effective sharing and curation of open resources for reuse across networks.

The primary purpose of COSGN is to enable networks to be more effective in their own grassroots efforts to advance open scholarship and to leverage the power of collaboration and share resources for maximizing impact. Fundamentally, COSGN is a collaborative framework of processes and standards to facilitate communication, coordination, and collaboration. The goal for the project period is to strengthen COSGN so that it becomes self-sustaining by ensuring that its value exceeds the resources contributed by the individual networks. The COSGN infrastructure is a shared conceptual understanding of the norms, standards, and goals of the framework, a specified set of standing activities, and a collection of shared and open resources.

There are three activities of COSGN during the project: (1) Working group collaborations to advance open scholarship (WGs), (2) Open Scholarship Symposium (OSS), and (3) Regional Open Scholarship Events (ROSEs).

Working Group Collaborations To Advance Open Scholarship COSGN will consist of a Steering Committee and 15 WGs that will serve to foster communication and collaboration across disciplinary and regional stakeholders for their substantive topic. WGs have different areas of emphasis and will not be restricted to treat their emphasis area narrowly as many of these topics are interrelated. Cross-WG communication facilitated by the Steering Committee and Open Scholarship Symposium will foster coordination on interrelated topics and activities. The Network Coordination and Management Plan details the formation, governance, and operation of the WGs. The activities of each WG include:

- Articulation and promotion of the shared values motivating change in the research culture on the topic
- Identification of shared goals and idiosyncratic needs across regional and disciplinary categories
- Assessment of the applicability of policy and behavior changes for the topic across regional and disciplinary categories
- Assessment of the risks for effective implementation of policy and behavior changes across regional and disciplinary categories, particularly to identify gaps or challenges in which universal standards may not apply for inclusivity of particular regions, methods, or disciplines
- Identification of solutions to address idiosyncratic needs or define boundary conditions of solutions
- Testing proposed solutions with interviews and pilots across communities
- Promoting solutions to stakeholders that are inclusive of the needs and realities of researchers across disciplines and communities

- Evaluating the implementation of the solutions in practice with quantitative and qualitative research activity
- Coordinating communications and advocacy of solutions across regional and disciplinary communities
- Sharing information and accumulated experience about implementation of solutions across communities
- Fostering availability of education and training resources and translating resources for use across disciplines and regions
- Planning evaluation of effectiveness of solutions in practice and implementing feasible methods for tracking effectiveness or pursuing resources to do effective evaluation
- Advancing diversity and inclusion of all stakeholders interested in research to be involved in improving research practices for rigor, transparency, and contributions by all that have motivation and interest to do so

Each organizational member of COSGN is doing a subset of these activities on their own already for the community that they serve. COSGN provides interconnective tissue across organizations to improve efficiency and effectiveness by sharing knowledge, strategy, and experience, and to increase the impact of these individual efforts by enabling them to be scaled across groups as appropriate and to address barriers to scaling as needed. Below are illustrations of four of the 15 WGs.

Working Group	Description
Open Access (new)	Will address existing barriers to equitable inclusion and global dissemination of scientific and scholarly work.
Preprints (existing)	Coordinates on common interests relating to preprints including best practices for moderation, operational standards, licensing, fostering innovation in peer review, and sustainability.
Open Content (new)	Will coordinate localized activities aimed at promoting: (i) best practices on how to structure research data and code following accepted guidelines (e.g., FAIR principles); (ii) familiarization (by means of hands-on tutorials and workshops) with tools that facilitate the organization and dissemination of Open Content; (iii) reusability and impact of Open Content by increasing their visibility.
Open Source (existing - Research Software Alliance)	Coordinates across research software (RS) organizations to leverage investments and activities to achieve the long-term goal of RS being valued as a fundamental and vital component of research worldwide.

The Open Scholarship Symposium (OSS) As a global network-of-networks, COSGN will have its strongest impact by leveraging its shared resources, intellectual capacity, and access to communities to foster global engagement on open scholarship in a way that no one network could do on its own. The impact of COSGN will be enhanced by having regular activities that strengthen network relationships and intellectual exchange. The OSS will be a year-round, cost-effective virtual conference/seminar series. Approximately every other week (up to 20 events per year), the OSS will feature a presentation by an individual, team, or panel about their work relevant to open scholarship. The goals of the OSS are to: (1) establish a shared environment for persistent communication, (2) foster social and intellectual connections between COSGN participants with a regular, ongoing series, (3) elevate and disseminate the work of COSGN networks to the broader research community, and (4) advance collective community outreach at a scale not achievable by individual networks.

The COS webinar series provides proof-of-concept for the OSS. Managed via Zoom, representatives from COSGN networks have presented on a variety of open scholarship related topics with themes that are cross cutting or are more likely to appeal to specific stakeholder communities. Branding the topics as part of a singular series helps to identify the interdependence of stakeholder communities and interests on open scholarship topics. An example of cross-network collaboration was a seminar led by the Tim Sains Terbuka/Sains Terbuka Airlangga network with presentations by representatives from three COSGN networks. More than 1,500 researchers from 29 universities across Indonesia participated in the event.

A Symposium WG will help institutionalize the OSS as a collaborative activity of COSGN, conducting the seminar series, soliciting and selecting presenters (open to people inside or outside COSGN), moderating the sessions, and marketing the series. Seminar scheduling will be sensitive to a global audience, rotating the timing of events to allow participants to attend sessions during normal working hours. Also, all events will be recorded and be made openly available. As a coordinated, branded effort with dedicated leadership, we expect that the OSS will become an innovative alternative for the standard conception of a disciplinary conference with the attractive features of increasing accessibility, minimizing environmental impact, and spreading events year-round.

Supporting Regional Open Scholarship Events (ROSEs), The strengths of the OSS do not eliminate the fact that in-person interaction can be highly productive for social bonding, intellectual

exchange, and advancing collaboration. During the project period, COSGN will strengthen and mature the collaborative bonds across networks by allocating funds annually to administer small awards ($500 - $2,500 range) for 45 regional events that advance open scholarship. With these grassroots communities, modest funds for food or space can make a dramatic difference in the ability to host events and attract participants. With a regional focus, financial support can enable many events to complement the virtual collaboration activities and provide avenues for many to participate. Also, leveraging regional connections among the network will be a cost efficient and environmentally sensitive way to solidify network activity and connectivity.

The awards will support training, research collaborations, or other mini-meetings that connect regionally proximal networks or link to existing conferences (e.g., supporting a preconference). A COSGN Events WG will administer the awards through an open call for event proposals from network members. Events will be selected based on the relevance of the event for COSGN objectives, the extent to which the event strengthens network connections, the potential impact on advancing open scholarship in the broader research community, the responsible use of funds for maximizing that impact, and, particularly, the extent to which the events support opportunities for early career researchers and researchers from groups under-represented in scholarship.

Timeline of activities, expected outcomes, and milestones

Activity area	Year 1	Year 2	Year 3	Year 4	Year 5
Steering Committee	Form interim committee; Establish by-laws; Committee elections	Form Committee	Review and update by-laws		Review and update by-laws
COSGN Collaborative Framework	Define committee structure and operating principles	Define succession process	Revise committee structure and operating principles	Revise succession process	Revise committee structure and operating principles
Working Group (WG) Formation	Transition existing WGs to new structure	Form three new WGs	Form three new WGs	Form three new WGs; Sunset 2 WGs	Form three new WGs; Sunset 2 WGs
Open Scholarship Symposium	Form WG; Launch call/selection process; six symposia	16 symposia	20 symposia	20 symposia	20 symposia
Events	45 events	45 events	45 events	45 events	45 events
Internal Evaluation	Baseline survey of networks and network members; Annual report from interim SC	Pre/post surveys of OSS participants and regional event attendees; Annual report from all committees	Pre/post surveys of OSS participants and regional event attendees; Annual report from all committees	Pre/post surveys of OSS participants and regional event attendees; Annual report from all committees	Concluding survey of networks and network members; Annual report from all committees
External Evaluation with Open Scholarship Survey	Yearly assessment of researchers in communities engaged by COSGN networks	Yearly assessment of researchers in communities engaged by COSGN networks	Yearly assessment of researchers in communities engaged by COSGN networks	Yearly assessment of researchers in communities engaged by COSGN networks	Yearly assessment of researchers in communities engaged by COSGN networks

Student and Early-Career Professional Development

Student and Early-Career Development Plan. Early-career scholars are essential contributors and leaders in COSGN networks. A key priority of COSGN will be to facilitate those contributions, and support training and professional development of early-career scholars more broadly. First, we will prioritize full integration of early-career scholars in the activities and governance of COSGN, including the Steering Committee. Second, the OSS and ROSEs will be organized with an eye towards maximizing professional development opportunities for early-career scholars. Third, COSGN networks place a high priority on including and serving students and early-career researchers. The Table below illustrates the networks' distribution of career stages in the communities they serve. For example, most networks serve graduate students: four serve grad students almost exclusively (76-100% of their community), nine mostly serve grad students (51-75%), 35 substantially serve grad students (26-50%), and 46 partially serve grad students (1-25%). Just two do not serve graduate students. Most networks serve a highly diverse community by career stage, and very few are exclusive or near exclusive to any specific stage.

	Number of Networks Serving Each Career-Stage (Split by Percent of Community Served)				
	0%	**1-25%**	**26-50%**	**51-75%**	**76-100%**
Primary/secondary school students	63	12	0	0	0
Undergraduates	17	50	9	3	4
Graduate students	2	46	35	9	4
Postdocs	2	52	28	13	3
Junior faculty	2	49	33	8	6
Senior faculty	4	58	20	5	8
Non-academic researchers	20	46	21	3	7
Non-academic/non-researcher professionals	24	42	15	1	3

Early Career Training and Professional Development in the Open Scholarship Symposium (OSS) and Regional Open Scholarship Events (ROSEs). The OSS and the ROSEs are opportunities to enhance early-career training and professional development. In each symposium, sessions will be organized on topics such as open sharing of data and materials, managing the research workflow for reproducible results, establishing and managing international collaborative and open research, the latest metaresearch findings, and more. Dissemination and marketing of the OSS will target existing member networks with heavy early-career participation (for instance, ReproducibiliTea). Calls for presenters will also target early-career audiences, and the symposium can therefore highlight and amplify valuable early-career scholar-led initiatives. For the ROSEs, early-career scholars will be encouraged both to participate in the meetings and to take a leadership role in organizing them. Events with opportunities for early-career participants and/or presenters will be priorities by the Events WG for receiving resources. In terms of training and professional development, events will be organized keeping professional development goals (for both early and later-career scholars) at the forefront.

Leadership Development. The key personnel on this proposal have substantial experience creating and leading community networks. They will use this experience to advance COSGN. They will also use the project period to transfer this knowledge and experience to participating members, particularly ECRs, to increase capacity of the network and its members for future activity.

The PI, Brian Nosek, earned his PhD in 2002 and co-founded and directed the non-profit organization Project Implicit while operating a research lab at the University of Virginia. In 2013, he co-founded the Center for Open Science at which he still serves as Executive Director. At UVA, Project

Implicit, and COS, he led or supported large-scale research and community-action collaborations. For example, he led the creation of the Transparency and Openness Promotion (TOP) Guidelines with stakeholders across scholarly research (Nosek et al., 2015), the Reproducibility Project: Psychology (Open Science Collaboration, 2015), and he co-founded the Society for the Improvement of Psychological Science (SIPS). Nosek has mentored ECRs in leadership of team science and coalition building. For example, he was senior author of the Many Labs projects led by ECRs (e.g., Klein et al., 2014, 2018; Ebersole et al. 2016, 2020).

The co-PI, Katie Corker, earned her PhD in 2012. She has led team science research projects and served as President and Executive Officer of the *Society for Improvement of Psychological Science (SIPS)*. She has substantial leadership experience in the mission-advancing and research aims of large-scale collaborative work, having grown SIPS' membership from a few dozen to over 500 active members in three years, as well as in the operational implementation of those aims in organizational practice, growing the organization from an operating budget of less than $5,000 to over $80,000. She has substantial experience in building the capacity of ECRs in team science and community collaboration. For example, the SIPS governance model includes ECRs in every committee, including organizational leadership.

David Mellor, COS Director of Policy Initiatives, has a PhD in Behavioral Ecology and leads COS's policy activities. This work involves continuous community development in aligning stakeholder interests, coordinating communication and collaboration, and enabling stakeholders at all levels to promote culture change. His portfolio at COS includes leadership of committees for TOP, badges for open practices, and Registered Reports. Also, he leads the grassroots NSF-funded work in Education research and the NSF-funded work to advance rigor and transparency initiatives across scholarly communities. All of these projects include heavy involvement of ECRs at every stage of planning and implementation.

The three project leads and other senior members from the dozens of networks will foster an empowered environment for ECRs to increase their skills, experience, and capacity for leadership and operations. There are many highly credentialed senior scholars involved in the participating networks who have substantial experience and commitment to mentoring ECRs in substantive research and open scholarship advocacy. Some examples of such senior scholars involved in a COSGN network include:

- *Shinichi Nakagawa*: Professor of Evolutionary Biology and Synthesis. UNSW, Sydney. He supervised and mentored 16 PhD students and 17 postdoc and served on the editorial board of 11 international journals such as *Biological Reviews* and *Ecology Letters.*
- *Peter Suber*: Director of the Harvard Office for Scholarly Communication and Harvard Open Access Project (in the Berkman Klein Center for Internet & Society). He stepped down from his position as a full professor of philosophy in 2003 to work full-time on open access. He was the principal drafter of the Budapest Open Access Initiative (2002) and serves on the boards of many groups devoted to open access and scholarly communication.
- *Fiona Fidler*: Professor with joint appointment in the School of Biosciences (Ecology and Evolution) and the School of Historical and Philosophical Studies (History and Philosophy of Science), University of Melbourne. She is an Australian Research Council 'Future Fellow', lead PI of the DARPA-funded repliCATS project, and co-chair of the Australian Reproducibility Network.
- *Marcus Munafò*: Professor of Biological Psychology at the University of Bristol and programme lead in the MRC Integrative Epidemiology Unit. His group has a strong ethos of supporting and developing early career researchers and featured as a case study in the recent Royal Society report on research integrity and culture.
- *Michael C. Frank*: David and Lucile Packard Professor of Human Biology at Stanford University and Director of the Symbolic Systems Program. He is the founder and governing board member of the ManyBabies Consortium with heavy ECR participation, as well as a former Chair of the Cognitive Science Society. He has served as editor for journals including *Cognition, Child Development*, and *Proceedings of the National Academy of Sciences*.
- *Stefan C. Schmukle*: Professor of Personality Psychology at Leipzig University. Open Science Initiative Leipzig. He investigates determinants and consequences of personality using representative large-scale panel data, has supervised numerous doctoral students, and is a founding member of the local Open Science initiative.
- *Bob Reed*: Professor of Economics at the University of Canterbury. He has supervised 18 PhD students and led the replication section of two economics journals: *Public Finance Review* and

Economics: The Open-Access, Open Assessment E-Journal. He is also on the editorial board of the only journal in economics solely dedicated to replications: *The International Journal for the Re-Views of Empirical Economics*. In addition, he serves as Chutian Professor at Zhongnan University of Economics and Law where he is tasked with helping ECRs publish in Western journals.

- *Mine Misirlisoy*: Professor of Cognitive Psychology, Middle East Technical University, Turkey, Founding member of AcikBilim.Türkiye. She has offered the first undergrad and graduate courses dedicated to Open Science in Turkey and gives invited seminars to interested departments and universities in Turkey on Open Science Practices.
- *Kathleen Fitzpatrick*: Director of Digital Humanities and Professor of English at Michigan State University, where she directs MESH Research and is project director of Humanities Commons. She is the author of *Generous Thinking* (JHUP, 2019); her work focuses on the future of open, academy-owned platforms for scholarly communication and their potential for creating public reinvestment in U.S. universities.
- *Michelle Barke*r earned her PhD in 1999. From 2015-19 she was a director of the Australian Research Data Commons, where she led the strategic planning for the Australian government's $180 million investment in the organisation, the national research software infrastructure investment program, and developed a national strategy to enhance digital workforce capacity in the research sector. In 2018 she co-founded the Research Software Alliance and became its inaugural director in 2020.
- *Edward Miguel* is the Oxfam Professor of Environmental and Resource Economics at the University of California, Berkeley and Faculty Director of the Berkeley Initiative for Transparency in the Social Sciences (BITSS) and the Center for Effective Global Action (CEGA). He has conducted research and written extensively on the adoption of open science practices and their impact on the credibility of social science research. He also leads several research transparency projects focused on training early career researchers, supporting a network of transparency trainers and advocates, and advancing pre-registration and computational reproducibility.

Support for ECRs in local environments. One of the key challenges for ECRs in the culture change movement is the potential for conflict and career risk in local environments when more senior colleagues are antagonistic to change and open practices. COSGN will address this in four ways:

1. The networks have substantial accumulated experience with navigating these challenges for ECRs and will serve as a knowledge-sharing support system for ECRs across networks.
2. The networks themselves provide a mechanism for reducing risk for ECRs. Specifically, some of the risks associated with advancing new practices is that ECRs are acting on their own to challenge existing norms and practices. The individual networks and COSGN serve as norm-setting communities that make it easier for ECRs to promote changes that are coming from a broad community of scholars, not just from their own individual interests.
3. The project leaders have substantial experience with promoting change in risky or heated contexts. They have established a model much like what is used in other organizations in which "front line" actors know that they have support from more senior members for difficult situations. For example, in COS's SCORE program, the master's level Project Coordinators and postdoctoral level Research Scientists engage researchers on replication projects that occasionally have conflict. Those team members can bring in the Program Manager or Director of Research for strategy or to contribute directly to the engagement. If that is insufficient, the team can bring in the Executive Director to manage the conflict. This support system keeps the ECRs out front in leadership and experience building but manages risk by having the more senior members available whenever needed.
4. The networks provide training and leadership opportunities to build skills and one's CV, even recalcitrant PIs want such opportunities for their trainees.

ECR-led Networks. Many COSGN networks are largely or entirely ECR led. COSGN will provide these networks with access to more senior scholars who are leading networks with similar goals and have experience with navigating similar issues. As such, COSGN will serve both the substantive goals of advancing open scholarship and as a capacity-building network for ECRs to get mentorship and support. Such mentorship is already routine within networks participating in COSGN. The unique addition is the cross-network mentorship that will occur via the WG meetings on substantive topics, via the Open Scholarship Symposium for general training and education about cross-network efforts, and via the sponsored events that will foster relationship building across networks with and without senior scholars.

Evaluation

 Evaluating COSGN Activities. Each Working Group (WG) will define specific objectives for advancing open scholarship and then report a yearly assessment of progress on those objectives to the steering committee. Those objectives will be idiosyncratic to each WG and will evolve over the grant period in relation to the grassroots movement to advance open scholarship. We will also assess objective outputs: [1] committee/network activity: number of meetings, attendance, and specific resulting actions and/or communications (papers, reports, datasets, support guides), [2] diversity: gender, career stage (i.e., number and proportion of early-career researchers (ECRs)), and of committee members and meeting attendees, and [3] adherence by committees to COSGN operating principles. These are indicators of the health of COSGN.

 We will collect survey data from symposia and events attendees, with a particular emphasis on accounting for the participation and advancement of ECRs. We will evaluate impacts on participant knowledge and attitudes directly following their participation in these programs. Where possible, we will include pre-assessments to evaluate change, or even randomly assign participation such as having a delayed treatment group to gain causal evidence for impact of training events. We will also assess the number of events, attendees at events, ratings of the quality of events by attendees, outputs of committees (papers, reports, datasets, support guides), and number of networks participating in COSGN.

 Evaluating COSGN Impact. COSGN exists to promote open scholarship across regions, disciplines, and methodologies. Its true impact will be realized by affecting culture change. We will leverage existing resources and grants to conduct broad evaluation of culture change success. It will be difficult to isolate the extent to which COSGN itself is responsible for any change, but it is nevertheless useful to track the extent to which of COSGN's goals are realized during the grant period.

 With other grant support, COS developed a standard, modular survey to assess attitudes, reported behavior, and perceived incentives for open scholarship activities. This Open Scholarship Survey is in use already for two other NSF-funded projects tracking longitudinal change in education research (NSF #1937698) and in ten disciplinary communities associated with funders promoting open research (NSF #2023403). The survey is openly licensed and will be made available to all networks for conducting cross-sectional and longitudinal research in their communities. As a standardized instrument, it will provide comparative data for networks to assess progress and areas that are relatively ahead or behind others. As a modular instrument, networks can customize its application to cover areas of open scholarship most relevant to them. We reserved some resources to cover administration costs of delivering the Open Scholarship Survey for some networks to ensure useful data for broad evaluation of impact. As a naturalistic investigation, it will not be possible to identify the causal impact of COSGN on increased adoption of open scholarship globally. However, coupled with the direct indicators of COSGN activities above, these data will provide a broader understanding of the evolving cultural landscape of open behaviors. Outcomes will be tracked to monitor the maturation of COSGN through annual reporting by the steering committee and standing committees. Reports will be disseminated to the full COSGN membership to increase awareness and use of the products the standing committees have created. Finally, we will make all data openly available to facilitate metaresearch of COSGN and culture change in open scholarship by anyone.

 Expected outcomes. By the end of the project period, the networks and WGs will have produced and shared a large amount of training, knowledge, best practices, and social coordination resources for advancing open scholarship. These resources will be shared via public OSF projects operated by WGs, integrated into a curated knowledge hub, and disseminated via a symposium series and regional events for all researchers, not just members of COSGN. Moreover, there will be a mature framework for a self-sustaining COSGN. That framework will leverage freely available infrastructure for organizing, managing, and sharing resources; it will have a steering committee that maintains the committee framework, by-laws, and operational standards; it will have clear criteria for membership and succession planning; it will have clear criteria for starting and sunsetting committees for advancing issues of shared interest in open scholarship; it will have clear criteria for joining COSGN; it will have matured social and intellectual bonds between networks with its events program; and, it will have a prominent, externally facing, maintainable symposium series that strengthens the network and amplifies the networks' impact on the broader research community.

Center for Open Science
NSF 21-511
AccelNet-Implementation: Community of Open Science Grassroots Networks (COSGN)
References Cited

Allen C, Mehler DMA (2019) Open science challenges, benefits and tips in early career and beyond. PLoS Biol 17(5): e3000246. https://doi.org/10.1371/journal.pbio.3000246

Ebersole, C. R., Mather, M. B., Baranski, B., Bart-Plange, D., Buttrick, N. R., Chartier, C. R., Corker, K. S., … Nosek, B. A. (2020). Many Labs 5: Testing pre-data collection peer review as an intervention to increase replicability. Advances in Methods and Practices in Psychological Science, 3(3)

Ebersole, C. R., Atherton, O. E., Belanger, A. L., Skulborstad, H. M., Allen, J. M., Banks, J. B., ... & Brown, E. R. (2016). Many Labs 3: Evaluating participant pool quality across the academic semester via replication. Journal of Experimental Social Psychology, 67, 68-82.

Fanelli, D. (2010). "Positive" results increase down the hierarchy of the sciences. PLoS ONE, 5(4), e10068. doi:10.1371/journal.pone.0010068

Fanelli, D. (2012). Negative results are disappearing from most disciplines and countries. Scientometrics, 90, 891-904.

Iqbal SA, Wallach JD, Khoury MJ, Schully SD, Ioannidis JPA (2016) Reproducible Research Practices and Transparency across the Biomedical Literature. PLoS Biol 14(1): e1002333. https://doi.org/10.1371/journal.pbio.1002333

John, L., Prelec, D., & Lowenstein, G. (2012). Measuring the prevalence of questionable research practices with incentives for truth-telling. Psychological Science.

Kidwell MC, Lazarević LB, Baranski E, Hardwicke TE, Piechowski S, Falkenberg L-S, et al. (2016) Badges to Acknowledge Open Practices: A Simple, Low-Cost, Effective Method for Increasing Transparency. PLoS Biol 14(5): e1002456. https://doi.org/10.1371/journal.pbio.1002456

Klein, R. A., Vianello, M., Hasselman, F., Adams, B. G., Adams Jr, R. B., Alper, S., ... & Batra, R. (2018). Many Labs 2: Investigating variation in replicability across samples and settings. Advances in Methods and Practices in Psychological Science, 1(4), 443-490.

Klein, R. A., Ratliff, K. A., Vianello, M., Adams Jr, R. B., Bahník, Š., Bernstein, M. J., ... & Cemalcilar, Z. (2014). Investigating variation in replicability. Social Psychology, 45, 142-152.

Nosek, B. A., Spies, J. R., & Motyl, M. (2012). Scientific utopia: II. Restructuring incentives and practices to promote truth over publishability. Perspectives on Psychological Science, 7, 615-631. doi:10.1177/1745691612459058.

Nosek, B. A., Alter, G., Banks, G. C., Borsboom, D., Bowman, S. D., Breckler, S. J., ... & Contestabile, M. (2015). Promoting an open research culture. *Science*, *348*(6242), 1422-1425.

Open Science Collaboration. (2015). Estimating the reproducibility of psychological science. *Science*, *349*(6251).

Rosenthal, R. (1979). The file drawer problem and the tolerance for null results. *Psychological Bulletin, 86*, 638-641.

Simmons, J. P., Nelson, L. D., & Simonsohn, U. (2011). False-positive psychology: Undisclosed flexibility in data collection and analysis allows presenting anything as significant. Psychological Science, 22, 1359–1366. http://dx.doi.org/10.1177/0956797611417632

Sterling, T. D. (1959). Publication decisions and their possible effects on inferences drawn from tests of significance—or vice versa. Journal of the American Statistical Association, 54, 30-34.

Sterling, T. D., Rosenbaum, W. L., & Weinkam, J. J. (1995). Publication decisions revisited: The effect of the outcome of statistical tests on the decision to publish and vice versa. The American Statistician, 49, 108-112.

Stodden, V., Seiler, J., and Ma, Z. (2018). PNAS March 13, 2018 115 (11) 2584-2589; first published March 12, 2018 https://doi.org/10.1073/pnas.1708290115

Uhlmann, E. L., Ebersole, C., Chartier, C., Errington, T., Kidwell, M., Lai, C. K., McCarthy, R., Riegelman, A., Silberzahn, R., & Nosek, B. A. (in press). Scientific utopia III: Crowdsourcing science. Perspectives on Psychological Science.

Wicherts, J. M., Borsboom, D., Kats, J., & Molenaar, D. (2006). The poor availability of psychological research data for reanalysis. American Psychologist, 61, 726–728. http://dx.doi.org/10.1037/0003-066X.61.7.726

"Integrity in Practice Toolkit." royalsociety.org. The Royal Society, The UK Research Integrity Office (UKRIO). Accessed December 16, 2020. https://royalsociety.org/-/media/policy/projects/research-culture-images/integrity-in-practice-september-2018.pdf.