

# Science AMA Series: I'm David Mellor from the Center for Open Science talking about the biases that affect scientific research and what we're doing to make science more transparent and reproducible.

CenterForOpenScience<sup>1</sup> and r/Science AMAs<sup>1</sup>

<sup>1</sup>Affiliation not available

April 17, 2023

## Abstract

Scientists value transparency and reproducibility, but are rewarded for highlighting the novelty of unexpected findings. This is one reason why published research findings are hard to reproduce. See, for example, the recent work done by us and the scientists involved in the Open Science Collaboration on Estimating the Reproducibility of Psychological Science (<https://osf.io/ezcuj/wiki/home/>). When scientists preregister their research, they are making key decisions without being biased by the data they collect, which makes standard statistical tests more effective. Though preregistration is required by law for clinical research involving human medical studies, it is not widely practiced by most scientists. We at the Center for Open Science have \$1,000,000 to hand out as prizes for researchers who publish the results of their preregistered research. See <https://cos.io/prereg> We'll be back at 12 pm ET (9 am PT, 5 pm UTC) to answer your questions, Ask us anything! Answering questions today: Courtney Soderberg is our Statistical and Methodological Consultant who advises researchers on best practices in experimental design and statistical analysis to make their work more reproducible. Jolene Esposito works with researchers in Africa to improve the rigor of their work using the tools we've made, such as the Open Science Framework ([osf.io](https://osf.io)) April Clyburne-Sherin is our Reproducible Research Evangelist who conducts workshops to train researchers on reproducible research methods and open science tools. David Mellor works on encouraging researchers to preregister their work on the Open Science Framework. Hello Reddit! <http://imgur.com/DpMrjKV> (edits for formatting, picture, our names) Edit 2 PM EST: Thanks for all of your questions everyone! We've enjoyed talking to you. We will come back later today to see if any more questions are up. Follow us on Twitter! @OSFramework

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# Science AMA Series: I'm David Mellor from the Center for Open Science talking about the biases that affect scientific research and what we're doing to make science more transparent and reproducible. AM

CENTERFOROPENSOURCE [R/SCIENCE](#)

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When scientists preregister their research, they are making key decisions without being biased by the data they collect, which makes standard statistical tests more effective. Though preregistration is required by law for clinical research involving human medical studies, it is not widely practiced by most scientists. We at the Center for Open Science have \$1,000,000 to hand out as prizes for researchers who publish the results of their preregistered research. See <https://cos.io/prereg>. We'll be back at 12 pm ET (9 am PT, 5 pm UTC) to answer your questions, Ask us anything!

Answering questions today:

Courtney Soderberg is our Statistical and Methodological Consultant who advises researchers on best practices in experimental design and statistical analysis to make their work more reproducible.

Jolene Esposito works with researchers in Africa to improve the rigor of their work using the tools we've made, such as the Open Science Framework ([osf.io](https://osf.io))

April Clyburne-Sherin is our Reproducible Research Evangelist who conducts workshops to train researchers on reproducible research methods and open science tools.

David Mellor works on encouraging researchers to preregister their work on the Open Science Framework.

Hello Reddit! <http://imgur.com/DpMrjKV>

(edits for formatting, picture, our names)

Edit 2 PM EST: Thanks for all of your questions everyone! We've enjoyed talking to you. We will come back later today to see if any more questions are up. Follow us on Twitter! [@OSFramework](#)

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CORRESPONDENCE:

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How much will the move to reproduce psychological studies impact the field as a whole? Is there anything that indicates how much currently accepted research in psychology could be shown to be unreplicable?

[Rytle](#)

The Reproducibility Project: Psychology (<https://osf.io/ezcuj/wiki/home/>), was the first attempt at a wide scale effort to get an estimate of the extent of the problem. Approximately 40% of the studies chosen for that three year long project reproduced, depending on how exactly you define a "successful" reproduction. We hope that the impact will be to encourage more rigorous practices, and preregistration of specific analysis plans is a great tool to do that. The Transparency and Openness

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Promotion ([TOP](#)) Guidelines have other recommendations for improving the field, including sharing data and adding transparency to other research design processes.

For those of us who don't do these kinds of studies, can you take us through what pre-registration means in this context?

Most grants require a proposal that goes into depth about these key decisions regarding methods, don't they? Does pre-registration simply hold them accountable to those decisions in a different way?

[firedrops](#)

The level of detail required for a typical grant application requires the researcher to specify the research questions, the reasons they are important for a field, and a general plan for collecting and analyzing the necessary data. After that, there is a lot of flexibility permitted, and that is for good reason. From when a project is proposed to when the real work of collecting the data begins, a lot can change.

Preregistration, on the other hand, is designed for when a very specific hypothesis is ready to be confirmed in a very specific way. So for example, are you, the researcher, confirming that there is a difference between how two species of fish will react to a particular stimulus? Which statistical test will you use to confirm that prediction, which variables will be included in that test? What is your definition of a "confirmed" result? Specifying all of those decisions ahead of time makes it more clear what you are testing. Then, after data collection, you may see new, interesting patterns in the data that weren't exactly expected, or only happen if you remove a few fish from the data that acted in very strange ways. That is the best time to create a new hypothesis to test with the next round of data collection. Preregistration simply makes clear what was decided ahead of time.

Your push for preregistration seems to be inspired by clinical research. Can you comment on how reproducible clinical trials have been historically? How much improvement in the reproducibility of non-clinical research would you envision if preregistration became a common practice? What else is hurting reproducibility?

[SirT6](#)

Before preregistration of clinical trials, over half of published studies funded by the National Heart Lung, and Blood Institute concluded that the intervention was significantly beneficial to the primary outcome. Since preregistration, that proportion has dropped significantly (about 8% according to [Kaplan and Irvine 2015](#)). Prespecified primary outcomes and the reporting of all results likely contributed to this trend towards more null results. Therefore, preregistration has helped contain some biases in clinical research such as publication bias and outcome reporting bias. However, reanalyses of clinical trial data show that trial registration alone does not guarantee the reproducibility of reported trial results ([Ebrahim et al. 2014](#)). Examples of additional steps towards reproducibility includes the sharing of research data, transparent and complete reporting, and shifts in career incentives away from novelty and towards rigor.

I was wondering if you could comment on the link between The Reproducibility Project (Psychology) and The Pre-Registration Challenge.

The potential reasons why a replication attempt might not produce a similar result to the original study seem numerous - to what extent can we draw strong conclusions from the Reproducibility Project about the *cause* of low replication rates? And thus, to what extent can we argue that pre-registration

will help to address the problem of low replication rates?

[bobCouldBeYourUncle](#)

The basic link is that the Reproducibility Project: Psychology showed the extent of the problem, and preregistration of specific analysis plans is one of the most rigorous solutions to the problem.

You are absolutely correct that there are many reasons why a replication might not reproduce. One of the really interesting questions is "What was different between the original and the reproduction, which may be a previously unknown factor that affects the results?" Another possibility is that the reproduction was a false negative. Finally, perhaps the original finding was a false positive. The answer to those questions is not yet known.

To answer your last question, we are right now planning the project to measure the effectiveness of preregistration. Currently, [Kaplan and Irvin 2015](#) is some great evidence of the effect of preregistration. In that study, researchers found that large scale clinical trials were much more likely to show a "clean" positive result before those trials were required to be registered, compared to afterwards.

There is enormous pressure to make high-impact novel findings for academic career progression, which can affect data reproducibility. How do you think you can solve this problem?

[DignamsSwearBox](#)

That pressure is huge for every scientist. A lot of work that we do is to meet scientists where they are and provide tools that make their lives easier. Then, if they choose to do so, they can share their data or preregister their work. After seeing the benefits of these Open Science practices to their work, we think they'll come back and do it again!

Preregistration, for example, puts a lot of the details about analyzing the results of a study earlier in the process, when it is easier to make improvements to the design.

Our largest project here at the Center for Open Science is the [Open Science Framework](#), which is a free, open source scholarly commons that can be used to effectively manage the work in a research lab. It also has tools baked in to make sharing or preregistering as easy as possible, if the researcher chooses to do so.

While I personally appreciate the effort to make studies more reproducible, what will you do as a next step in order to motivate researchers to reproduce more studies in general?

Also, does the rigor of your preregistration require researchers to make available the full experimental results where possible? What about source code?

[novanexus](#)

We are working now on a project to reproduce a large number of high profile cancer biology studies, the [Reproducibility Project. Cancer Biology](#).

The preregistration requires a lot of detail about the data collection and analysis. We encourage researchers to share code, especially the analysis scripts that they plan to use for this study, but do not require it. An analysis script is the code that will be used in a program such as R to run the exact tests required to analyze the data.

Hi David (I know you....)

A couple of questions for you:

1. Is there any particular research science discipline that would most benefit from preregistration?
2. Do you think preregistration may solve some of the perceived (or actual) bias with industry sponsored studies?
3. We are political climate marked by skepticism in science. Do you think preregistration would be effective in combating push back on things like climate change?

Thanks!!

[fenixrock](#)

Hi Fenixrock! 1) Preregistration is pretty widely applicable. Any time you are trying to make an inference based on sample from a larger population (of people, of cells, of fish, of stars, etc) there is a lot of undisclosed flexibility in how to do that. If you specify ahead of time exactly how you're going to make that inference (typically using a traditional, frequentist statistical test that has a p value, such as a T-test, ANOVA, or linear regression), it makes the process more transparent and rigorous.

2) I think it already has! Large scale clinical trials are less likely to show a significant result today than they were before those trials were required to be registered. See [Kaplan and Irvin 2015](#).

3) I think that anything we do to improve the rigor and reliability of the scientific literature is good. Some of our work has been to show the extent of the problem, which is important in order to have a baseline for comparison in the future. Will our efforts affect the tone of the general discourse around controversial issues such as climate change? I sure hope so!

I never understood why there was not a journal, or several journals for that matter, who published rejected papers with clear explanations, as well a journals specialised in failed experiments, as I view them as valuable as successful experiments, as they provide some guidance on "what no to not waste time and resources on". not really a question, but I wold appreciate your input on that situation.

[DrogoDeserto](#)

Hi, This is David Mellor responding. The ultimate solution to this problem is [Registered Reports](#), in which the decision to publish or not is made before the results are known. Peer review of the research questions and the methods to answer those questions takes place in stage 1 of a Registered Report. If the reviewers and editors agree that the question is worth answering and the methods to do so are sound, then the authors are given "in principle acceptance" and guaranteed publication after conducting the study. Stage 2 peer review checks to make sure the study was conducted as specified ahead of time before final publication. Several journals are adopting this format.

How did you raise the funds for this? \$1,000,000 for a vague topic like "better research" is important, but it's hard to write a grant around.

[nallen](#)

SirT6 is right, the funding for this project comes from the Laura and John Arnold Foundation. They fund a lot of the work that we do. LJAF funds organizations that conduct high quality research, promote research transparency and data sharing, and support reproducibility of research. Since Preregistration is a process that is unfamiliar to most researchers (except clinical trials where preregistration is required by law) we and the Arnold Foundation thought that the \$1,000 prizes would be a nice incentive to encourage researchers to try it out. We're convinced that after being enticed to do it once,

individuals will see its benefit preregister future studies.

Could you elaborate on what preregister means? What this preregistration would look like outside of clinical trials is not clear.

Thank you for taking the time to answer our questions!

[ClaireAtMeta](#)

Preregistration means documenting some of your important methods before collecting or looking at your data. For scientific research generally, this information helps others distinguish what parts of your research were confirmatory (hypothesis testing) and what parts were exploratory (hypothesis generating). Information in a preregistration includes: how will a researcher collect their data, what are their rules for excluding data or dealing with missing data, or how will they analyze their data. Different scientific disciplines would require different details on these methods in their preregistration, but the need to distinguish confirmatory from exploratory analyses is the same. Basically, a preregistration should contain sufficient information to retain the validity of their confirmatory analyses.

I have a question as a non-scientist. Would preregistration allow for, or increase the possibility of media outlets to run with sensationalist headlines and hyperbolic titles for pending studies causing more confusion for the layperson? Such as "X Street Drug Found To Cure Y Disease!", as a loose example of what we already see.

[ehandlr](#)

We don't expect this to happen, because a preregistration does not contain any data or results. Also, researchers can embargo their preregistration for up to 4 years, which means that it is private and inaccessible until then (or when the results are published).

Would this preregistration process have any (positive) impact on the file-drawer problem in meta-analysis? If researchers preregistered a study that did not find significant results and did not end up published, could this data still be used for metas?

[StudentII](#)

Yes it can! Preregistrations do eventually have to become public, although preregistrations on the [OSF](#) can be kept private for up to 4 years. It is not required that the data collected from a preregistered study ever be made available. For example, maybe the study was not feasible. But at least there will be a record that this study was attempted.

This paragraph is copied from an answer above: The ultimate solution to this problem is [Registered Reports](#), in which the decision to publish or not is made before the results are known. Peer review of the research questions and the methods to answer those questions takes place in stage 1 peer review of a Registered Report. If the reviewers and editors agree that the question is worth answering and the methods to do so are sound, then the authors are given "in principle acceptance" and guaranteed publication after conducting the study. Stage 2 peer review checks to make sure the study was conducted as specified ahead of time before final publication. Publication occurs regardless of results. Several journals are adopting this format.

1. Is there a way to see what currently gets researched or what is yet to research from current

knowledge?

2. can a normal person help in any way? (except throwing money at them, dunno maybe inform others about new advances, help them understand complicated new topics, etc...)
3. will research ever get into the private area? as in, will normal ppl ever be able to contribute in some way? alot equipment becomes cheaper and more available, also the internet delivers needed information and offers contact to peers to compare results with. Or will research always stay in the hands of governemnts and big companys?

#### [WarrantyVoider](#)

I think the general answer to your first question is simply education. Whether it's online classes, reading popular science books, or having a degree in science, there are many ways to really figure out what is known, what is unknown, and what is currently being worked on.

I think the best way to get involved in scientific research without being a professional researcher is to get involved with citizen science, in which members of the public can contribute to authentic scientific discoveries. A great resource for getting involved with citizen science is [SciStarter.com](#)

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Funders of scientific research have a big role to play, and are on board with many new practices to increase rigor. For example, many US government funded research now requires papers to be published open access within a year of publication. There is also a push to encourage access to raw research data, when that data does not pose privacy issues.

In general, the whole research community wants to do the best research possible, from individual scientists, journal editors, government funders, and private funders. The challenge is in agreeing on exactly what those best practices are and how to best encourage them.

I am curious as to your opinion on the quality of modern scientific writing.

While I realize that some taxonomy is necessary, it seems like papers are written in a manner such as to purposely make understanding the content (particularly if you are outside the field) very difficult. Do you feel that is a correct assessment?

#### [CaptainFairchild](#)

From David: There is a lot of scientific writing today, so there is a wide range in the quality of that writing. In general, some of it is very technical because the author feels it is necessary in order to be sufficiently precise as to describe exactly what happened in a study. However, there is a pretty strong push to make our writing as clear as possible in order to reach as wide an audience as possible. Even if that means making it clearer to members of the scientific community in slightly different fields. The author of a favorite blog of mine, Stephen Heard, [writes about](#) the need to improve the quality of our writing.

April here. As David mentioned, scientific writing may be hard to understand due to technical content. However, sometimes scientific writing is hard to understand because it is ambiguous or incompletely reported. There is guidance on scientific reporting that helps improve reporting such as through [The EQUATOR Network](#).

How much will the move to reproduce more studies in general?

[1riley13](#)

[Edit: I answered the wrong question here, sorry! Below is my response.]

I think that the effect of trying to reproduce more studies will give us a better understanding of how rigorous our methods are where there are still gaps in our knowledge.

[deleted]

[\[deleted\]](#)

There's a lot of similarity, but our main goal is to make the process as easy as possible. That way, scientists are more likely to see the benefits of preregistration, which include improving experimental design because more decisions are made ahead of time. Also, making the process easy allows scientists to focus more on their science and less on the extraneous work that goes along with running a lab.

Could you elaborate on the statistical issues behind the exploratory vs confirmatory distinction and the value of pre-registration?

A specific question on this theme - if you are conducting proper corrections for multiple comparisons during data analysis (e.g., with Bonferroni), what is the additional value of having a pre-registered hypothesis?

[bobCouldBeYourUncle](#)

Yes of course! An exploratory test happens when you look through a data set and see that there is an unexpected difference between some groups, or a correlation between X and Y. The result of that is a hypothesis that you can confirm with a new data set.

A confirmatory test happens when you specify ahead of time the methods to test a very specific hypothesis.

The problem is that sometimes the line can blur between the two, because there is a lot more flexibility in statistical tests than most people realize. So a Bonferroni correction is good if I know that I conducted exactly N tests, but once I go looking through a dataset, the number of possible tests that I am unintentionally trying out could be much higher than I realize.