Lecture 5: Open Science

The replication crisis, preregistration, and the Lab report

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UNIVERSITY OF SUSSEX

It is university policy to recommend mask wearing

Masks are available if you need one

Today's lecture

The aim of today's lecture is to provide you with information about the lab report, including information on the technical details (length, format, content) and the motivation behind the lab report.

The lecture will be split into two parts

Part I

- The replication crisis, pre-registration, and open science

Part II

- The lab report itself

In the lab report you'll be asked to write a pre-registration plan for an experiment...

But what is a pre-registration plan and why are we writing one?

Some terminology

Replication and Reproducibility? What's the difference?[†]

Reproducibility [same methods, same dataset]
A study is reproducible if you can take the original data (and *possibly* the computer code) and reproduce the numbers/statistics reported in the original journal article.

This might sound like it's trivial but it turns out that it isn't! One of the reasons you're learning R and R Markdown in this course is so that you can learn how to do reproducible science.

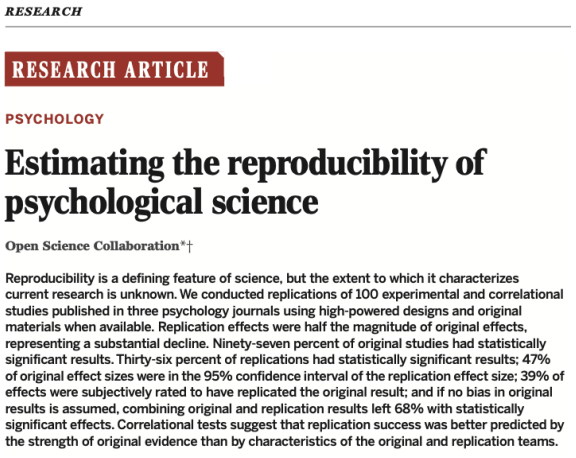
Replicability [same methods, new dataset]
A study is replicable if you can repeat the study using the same methods (e.g., experimental design, analysis) to produce a new dataset that produces the same results as the original study

This lecture will mainly focus on replicability rather than reproducibility

[†]There isn't universal agreement on these definitions, but these are the definitions favoured by the American Statistical Association...

A Spectre if haunting psychology...

The spectre of failed replications



RESEARCH

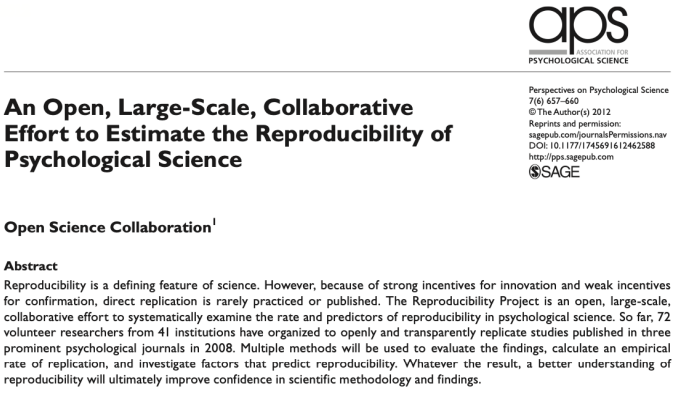
RESEARCH ARTICLE

PSYCHOLOGY

Estimating the reproducibility of psychological science

Open Science Collaboration*†

Reproducibility is a defining feature of science, but the extent to which it characterizes current research is unknown. We conducted replications of 100 experimental and correlational studies published in three psychology journals using high-powered designs and original materials when available. Replication effects were half the magnitude of original effects, representing a substantial decline. Ninety-seven percent of original studies had statistically significant results. Thirty-six percent of replications had statistically significant results; 47% of original effect sizes were in the 95% confidence interval of the replication effect size; 39% of effects were subjectively rated to have replicated the original result; and if no bias in original results is assumed, combining original and replication results left 68% with statistically significant effects. Correlational tests suggest that replication success was better predicted by the strength of original evidence than by characteristics of the original and replication teams.



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An Open, Large-Scale, Collaborative Effort to Estimate the Reproducibility of Psychological Science

Perspectives on Psychological Science
7(6) 657–660

DOI: 10.1177/1745691612462588
http://pps.sagepub.com
SAGE

Open Science Collaboration[1]

Abstract

Reproducibility is a defining feature of science. However, because of strong incentives for innovation and weak incentives for confirmation, direct replication is rarely practiced or published. The Reproducibility Project is an open, large-scale, collaborative effort to systematically examine the rate and predictors of reproducibility in psychological science. So far, 72 volunteer researchers from 41 institutions have organized to openly and transparently replicate studies published in three prominent psychological journals in 2008. Multiple methods will be used to evaluate the findings, calculate an empirical rate of replication, and investigate factors that predict reproducibility. Whatever the result, a better understanding of reproducibility will ultimately improve confidence in scientific methodology and findings.

- Several large scale replication attempts have shown that many classic findings in the psychological literature can not be replicated.
- Some estimates suggest > 50% of finding aren't replicable
- This has prompted some to claim that psychology is in a state of *crisis!*

What is the cause of this crisis?

There's likely to be several causes of this crisis. These might include:

- How statistics and statistical procedures are used and abused in psychology
- Incentives in the publishing and university system
- Lack of *statistical power*[1]
- Lack of clearly defined theories in psychological science

These causes probably aren't independent but are likely to be interconnected and related to each other.

When we designed the psychology methods courses at Sussex, many of these issues were in the forefront of our minds.

In this lecture, I'll focus on the causes that are most relevant in motivating the design of the lab report.

[1] You won't learn about statistical power in this course, but you will in upcoming courses.

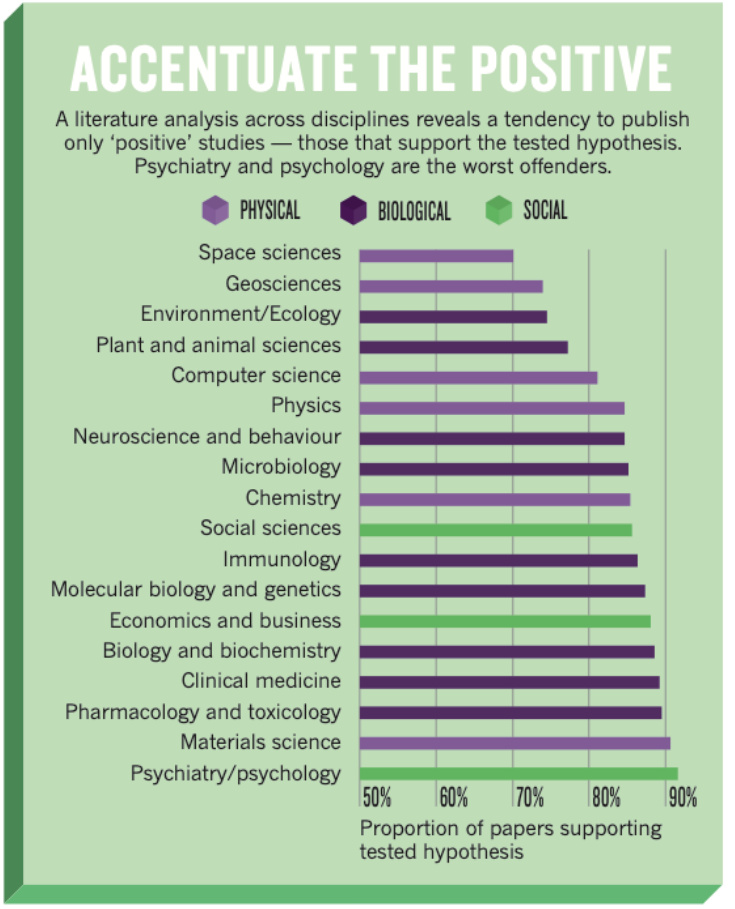
Bias in publishing

If we look specifically at the published literature in psychology we'll notice something odd

The vast majority of published papers in psychology journals report findings that support the *tested hypothesis*

But how is this possible?

- Maybe psychology researchers as psychic and they always test hypotheses than turn out to be true...
- Maybe the hypotheses they're testing a *trivial*...
- Maybe there is some sort of bias in publishing...
- Or maybe they only report the results at support their hypothesis



Bias in publishing

One source of bias in publishing of psychology studies is that journal editors and peer reviewers might not want to publish studies when they don't like the results!

- This might especially be the case when it comes to famous or influential theories.
- If a new study doesn't find support for a *famous or influential theory* then editors/reviewers might be *more likely* to suspect there's *some kind of problem with the new study*

But if this is a problem, then what is the solution?

One solution that has been proposed is pre-registration

The idea of pre-registration can be covered in popular media. For example, it's been written about in The Guardian on several occasions: article 1; article 2; article 3; article 4.

Pre-registration and combating bias

Pre-registration can get around publication bias by making editors and reviewers accept studies for publication before the results are known

But it also has other benefits...

- Pre-registration can also get around certain kinds of experimenter and statistical biases

It is very easy for researchers to engage in certain practises that invalidate certain statistical procedures...

- Running a statistical test, looking at the result, collecting more data, re-running the statistical test... rinse, repeat.. until you find the desired result
- Collecting data under many many conditions and only reporting the conditions that produce the desired result

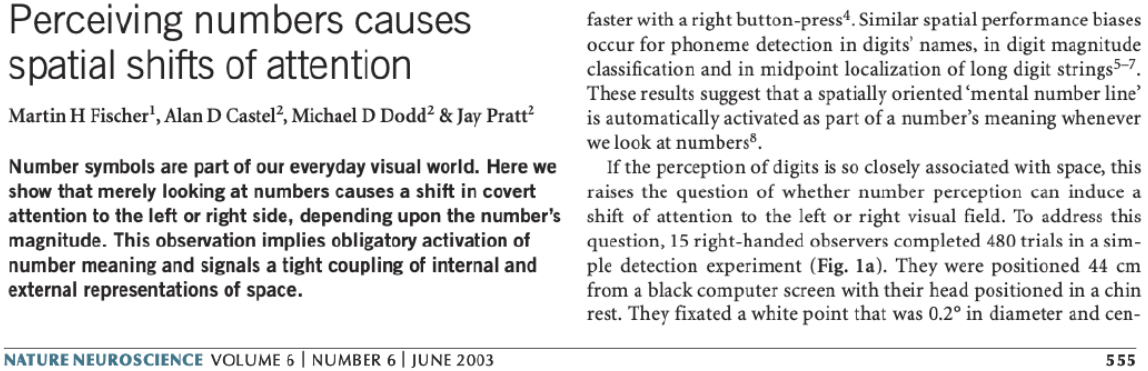
Pre-registration and combating bias

Preregistration means that before conducting a study, researchers plan their study in detail

1. Specifying the theory they plan to test and all of their hypotheses
    - This means they can't change their hypothesis to make it fit whatever their data happened to show (think about *falsification* and infinitely flexible theories!)
    - They can't cherry-pick their data or engage in subtle procedures to make the data fit their hypotheses
2. By outlining their plans in detail, reviewers are able to judge
    - Whether the methods are scientifically rigorous
    - Are likely to produce clear (rather than ambiguous results)

And they have to do this all before seeing the results, which might otherwise bias their decision

Pre-registration in action...



Perceiving numbers causes spatial shifts of attention

Martin H Fischer[1], Alan D Castel[2], Michael D Dodd[2] & Jay Pratt[2]

Number symbols are part of our everyday visual world. Here we show that merely looking at numbers causes a shift in covert attention to the left or right side, depending upon the number's magnitude. This observation implies obligatory activation of number meaning and signals a tight coupling of internal and external representations of space.

faster with a right button-press[4]. Similar spatial performance biases occur for phoneme detection in digits' names, in digit magnitude classification and in midpoint localization of long digit strings[5–7]. These results suggest that a spatially oriented 'mental number line' is automatically activated as part of a number's meaning whenever we look at numbers[8].

If the perception of digits is so closely associated with space, this raises the question of whether number perception can induce a shift of attention to the left or right visual field. To address this question, 15 right-handed observers completed 480 trials in a simple detection experiment (**Fig. 1a**). They were positioned 44 cm from a black computer screen with their head positioned in a chin rest. They fixated a white point that was 0.2° in diameter and cen-

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In 2003 a paper was published claiming to show that *merely looking at numbers* would cause a *shift in attention* to either the left or right side of space depending on whether the number was big (6–10) or small (1–4).

- This finding was very influential with more that 700 subsequent studies citing this finding or building on it
- There were some published studies that tried to replicate it. Most of the published studies showed successful replications (i.e., they supported the original claim) and very few published studies failed to replicate it

But is it true?

- If you spoke to people at scientific conferences then many researchers would tell you that they couldn't successfully replicate the effect...
- But this wasn't reflected in the scientific literature where most published papers on the effect showed that it could be replicated and where scientists continued to cite the original finding *believing it to be true*

But why?

- The original finding was published in an extremely prestigious journal (Nature Neuroscience) and it quickly became influential...
- This means it probably got accepted as something like an established fact

Overturning established findings...

Once a finding is accepted as like an established fact then journal editors and reviewers might be reluctant to publish studies that don't support the original finding...

If something is established fact and a new study comes along overturning that fact then what is more likely?

1. The established fact is wrong?

2. There's something wrong with the new study?

If there's a bias in publishing (which definitely seems to be the case in psychology) then it can be hard to tell, because things can become established facts too easily because findings running counter to these *established* don't get published

Getting around publishing bias

If there is a bias for publishing certain findings (i.e., findings that support established findings) then what is the solution?

Agreeing to publish studies before the results are known!

That is, pre-registration!

In one form of pre-registration known as a registered report you actually submit the plan to a journal before you run the study

- The journal reviews the plan and agrees to publish the study when it's done provided that you do the study exactly how you said you would
- This means you can't *deviate* from your plan and editors and reviewers can't reject your study if they don't like the findings

An example registered report

- In 2017 I put together a pre-registration that involving a replication attempt of the original 2003 attentional cuing finding and some additional experiments to attempt to understand the mechanism that produced the effect (that is, if I could replicate it!)[1]
- I then approached a journal with this plan to see if they were willing to publish the study if I did it according to the plan
- The plan was sent our for review to be checked and then the journal agreed that they would
- I then gathered together 30+ psychological scientists from 17 universities around the world and we ran the experiment on over 1300 participants (nearly 100 times the original sample size!)

What did we find?

[1]That is, we wanted to do more than just a replication. We wanted to try replicate the effect but we also wanted to try improve the methods as much as possible.

An example registered report

Registered Replication Report

Registered Replication Report on Fischer, Castel, Dodd, and Pratt (2003)

Lincoln J. Colling*, Dénes Szűcs*, Damiano De Marco, Krzysztof Cipora, Rolf Ulrich, Hans-Christoph Nuerk, Mojtaba Soltanlou, Donna Bryce, Sau-Chin Chen, Philipp Alexander Schroeder, Dion T. Henare, Christine K. Chrystall, Paul M. Corballis, Daniel Ansari,

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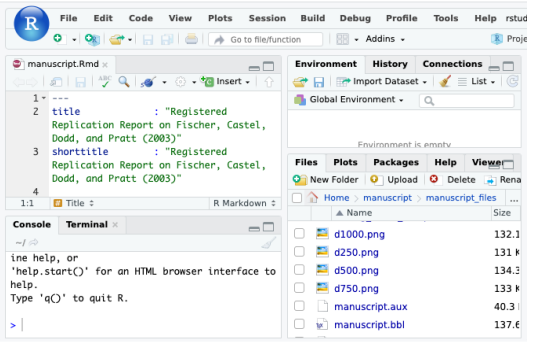

- We found absolutely no evidence for the original finding...
- And we found no evidence that the additional manipulations, that people thought might *modulate the size of the attentional cuing effect*, modulated the size of the effect...
- Now psychological scientists can move on from this finding and no longer accept it as established fact, but a lot of resources might have been wasted studying this non-existent effect.
- And this finding is by no means a unique case! There's likely to be many zombie findings in psychology

The lab report

The lab report is designed to be part of your training to do better science by introducing you to the idea of pre-registration!

- The lab report will present a *research plan* for an experiment
- The expected length with be around 1000–1500 words (with a maximum allowable length of 2000 words)

The research plan will address one of two questions

1. Is buying "green" (i.e., environmentally friendly) products driven by status motives?
2. Do women find men more attractive in conjunction with the colour red?

Links to two studies that have addressed this question can be found on Canvas

Structure of the lab report

The lab report will be written in the style of a journal article[1], but with only three sections: An introduction, a methods section, and a strengths limitations section

Introduction

1. Thesis statement: What is your research question?
2. Background: What is the context for the research question, and what do we already know?
3. Hypothesis: Based on this background, what do you expect to happen in your experiment?

[1] Take not of the style of the journal articles you read for your research and try and emulate the style

Structure of the lab report

Method

1. Participants: Who will take part in the research?
2. Materials: What kind of tests or measures will be administered, and how do they work?
3. Procedure: What instructions will be given to participants, what will participants do, and will the tasks be administered in a specific order?
4. Design: What variables will be included? Will it be a between-groups or within-subject design?

Structure of the lab report

Strengths and Limitations (Discussion)

1. What are the strengths of your design: For example, will it be able to tell you something about *causation*?
2. What will the results *not* be able to tell you about your research question?
3. Will this study need a follow-up study?

Introduction

Your introduction will give the background to your research question.

Things you should consider include:

- Why are you studying this? Why is it important?
- What previous work has been done on this topic?
- What are your hypotheses?
- How does your hypothesis relate to the research design?

Methods / Study plan

In the methods/study plan section, you'll describe how you plan to do the study.

Things you should consider include:

- Who will the participants be? Specific gender or background? How will they be selected?
- What materials or stimuli will you use? Will you show specific kinds of pictures? Have particular types of cues?
- What kind of design will you use? Will participants be split into groups or not?
- What are your independent and dependent variables and how were they operationalised?
- What procedure will you use to collect the data? Will you test participants in groups or individually? In a lab or the field?

Strengths and limitations

In the Strengths and limitations section you'll reflect on some of the strengths and weaknesses of your study idea.

Things you should consider include:

- What are the advantages of your study design over others? Does your design allow you to say more about causes or mechanisms?
- What are some of the weaknesses? How would it be improved? Does it need a follow-up experiment?

The research questions

The two options for topics are:

1. Is buying "*green*" products driven by status motives?
2. Do women find men more attractive in conjunction with the colour *red?*

You'll be designing a study to address one of these questions, but don't just say you're going to do exactly the same thing as one of papers listed on CANVAS

On CANVAS, there are some links to background reading and some examples of studies that have addressed these or similar questions...

To do well, you'll need to read more than just the papers on CANVAS

How many more?

- It's not about a number! You need to read enough to provide adequate context for your question
- People with the highest grades last year cited around 10 papers, but just having lots of citations didn't guarantee a good mark!

Things to keep in mind...

Defining your dependent and independent variables

- What are you measuring and what are you manipulating

Operationalising variables

- How will you define exactly what you're going to be measuring and manipulating

Design

- Will your study involve examining multiple groups (a *between-subjects* design) or only one group (a *within-subjects* design)

Things to keep in mind...

Confounds

- Are there any nuisance variables that you need to control for?
- For example, variable that might vary systematically with your IV and influence your DV but are not the thing you're actually interested in manipulating
- For example, if you're interested in differences in memory recall performance between males and females but it so happens that all your males are elderly while all your females are young then this is an example of age being a confound

Keep your study simple!

Thinking of some brilliantly unique study is really difficult, so instead focus on the basics

1. Read the papers on CANVAS and look for any *obvious limitations* (the authors might even mention them!)
2. Think of a small change you can make to address that limitation
3. Or think of a small change you can make to the papers on CANVAS to extend them

The markers are looking for how well you understand the topics covered in this course

This means they want to know things about design, variables, measurement, operationalisation, confounds, causation, and research methods.

Focus on getting these things right!

Formatting, citations, etc

There's a link on CANVAS to Prof Andy Field's lab report writing guide

This contains lots of useful information about how to structure a lab report, how to cite your sources, and how to write reference lists.

Read this! It will be super useful

The references and report should be in APA-Style. The Purdue Online Writing Lab is a great resource for APA style, so it's worth checking out!

Good luck!

And don't worry if you find the lab report difficult. Everyone will find it difficult!

For most of you this will be your first experience doing something like this, but you'll only learn how to do it by doing it!

If you need help with your writing and research skills then check out the Study Skills link on Canvas.

And finally!

Don't forget about the weekly quizzes!

There's still a lot of people not doing them!