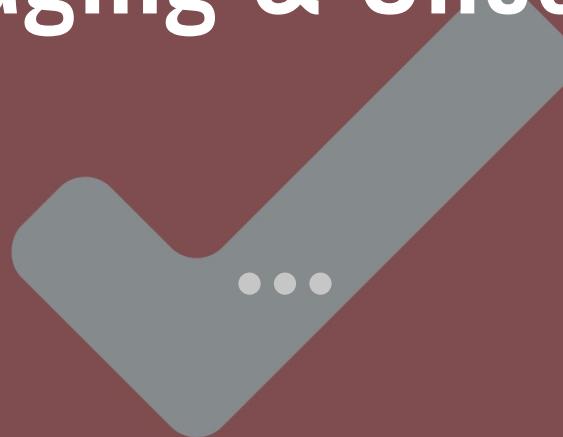


Introduction to Pre-Registration in Neuroimaging & Unconference



Marissa Laws & Junaid S Merchant
Brainhack DC 2020

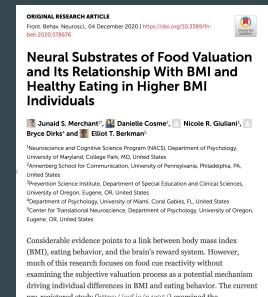
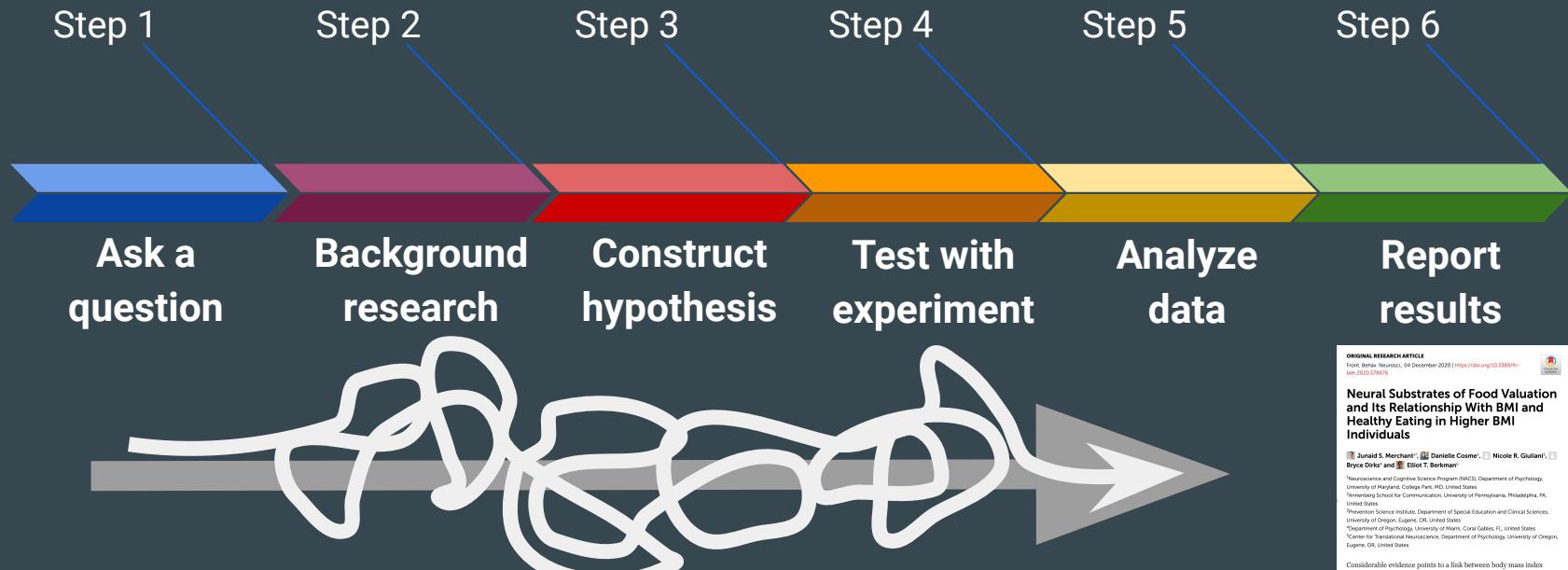
Slides adapted with thanks
from Dr. Jessica Flannery

Overview

- ❖ What is a preregistration?
- ❖ Why do it?
- ❖ What are some practical considerations and challenges, especially for neuroimaging?
- ❖ Discussion

What is a preregistration?

The “Scientific Method”



What is a preregistration?

- ❖ “A time-stamped, read-only version of your research plan created before you begin data collection.”
-Dasapta Erwin Irawan
- ❖ “It’s the introduction and methods section of your future paper.” - Chris Gorgolewski

What is a preregistration?

Typically includes:

- ❖ Background & motivation (can be brief or extensive)
- ❖ Hypotheses & predictions
- ❖ Models
 - Population, sampling, exclusion criteria
 - Measures taken, independent & dependent variables
 - ROIs
 - Confounds
 - Feature definition (e.g., “functional connectivity is defined as...”)
- ❖ Analysis plan
 - Statistical techniques and algorithms
 - Multiple comparison correction plan
- ❖ At what stage you are completing the preregistration

When can you do one?

- Prior to, during, or even after data collection (esp. helpful for neuroimaging)



Preregistration:
A Plan, Not a Prison

Preregistration vs. Registered Report

When the research plan undergoes **peer review before results are known**, the preregistration becomes part of a Registered Report



Stage 1
Peer Review

Stage 2
Peer Review



Why do a preregistration?

- Ultimately....to improve your science



The Reproducibility Crisis

Essay

Why Most Published Research Findings Are False

John P. A. Ioannidis

2005. *PLoS Medicine*, 2(8), e124. doi: 10.1371/journal.pmed.0020124

"There is increasing concern about the reliability of biomedical research, with recent articles suggesting that up to 85% of research funding is wasted."

Bustin, S. A. (2015). The reproducibility of biomedical research: Sleepers awake! *Biomolecular Detection and Quantification*

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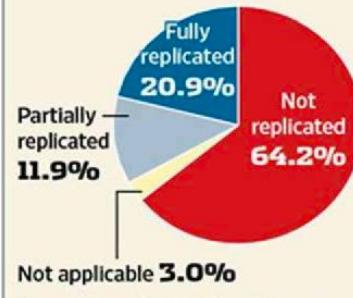
Advanced Search

Research: increasing value, reducing waste

Published: January 8, 2014

No Cure

When Bayer tried to replicate results of 67 studies published in academic journals, nearly two-thirds failed.



Source: Nature Reviews Drug Discovery



NATURE | NEWS

First results from psychology's largest reproducibility test

Slideshare: Dorothy V. M. Bishop

Four key factors leading to poor reproducibility

Low power

Publication bias

P-hacking

HARKing



Studies on preregistrations

nature > news > article

NEWS · 24 OCTOBER 2018

First analysis of 'pre-registered' studies shows sharp rise in null findings

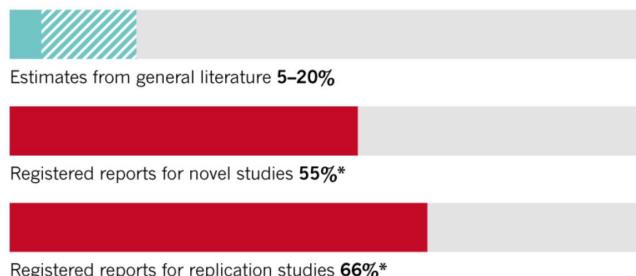
Logging hypotheses and protocols before performing research seems to work as intended: to reduce publication bias for positive results.

Mat

REGISTERED REPORTS CUT PUBLICATION BIAS

Pre-registering research protocols in a 'registered reports' format could lead to less publication bias skewed towards positive results. Studies that pre-register their protocols publish more negative findings that don't support their hypothesis, than those that don't.

HYPOTHESES NOT SUPPORTED BY RESEARCH PAPERS (%)



©nature

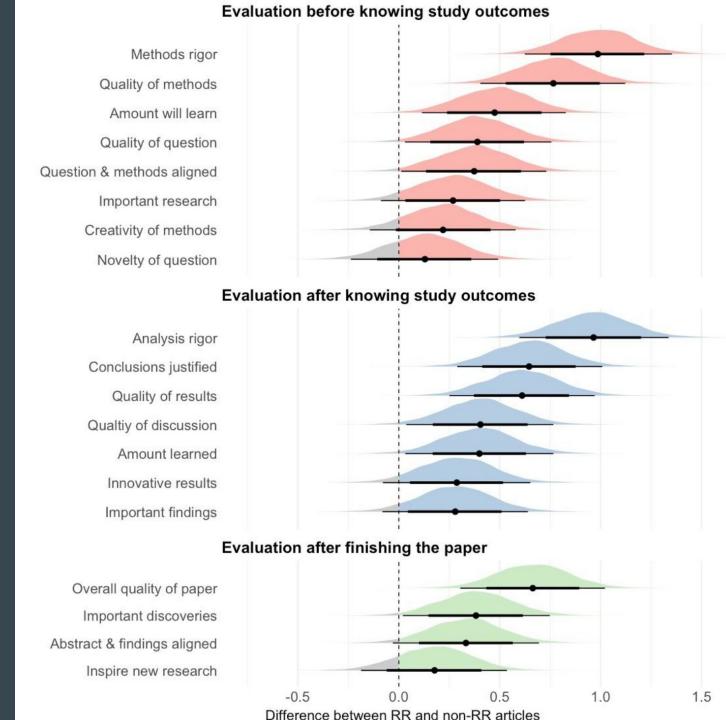
*Sample size: 296 hypotheses across 113 studies in biomedicine and psychology

Source: Allen, C. & Mehler, D. Preprint at PsyArXiv <https://psyarxiv.com/3czyt> (2018).

Research Quality of Registered Reports Compared to the Traditional Publishing Model

AUTHORS

Courtney Soderberg, Timothy Errington, Sarah Schiavone, Julia Bottesini, Felix Singleton Thorn, Simine Vazire, Kevin Esterling, Brian Nosek



Why do a preregistration?

- ❖ Improve Your Science
 - Increase chance of reproducibility
 - Keep yourself accountable
 - Distinction bw confirmatory vs. exploratory
- ❖ Protect Yourself
 - From file drawer problem
 - From “Reviewer 2”
- ❖ Foster collaborations
 - Help streamline collaborative projects upfront
- ❖ Faster dissemination
 - Bring conversation to public earlier
- ❖ Get Badges!



Why do a preregistration?

Incentives to Preregister



You can receive a **Preregistered Badge** for preregistering your research *before* you begin your study. Visit cos.io/badges for more information and to see which journals currently issue badges.



Confirmatory vs Exploratory Analyses



"A PLAN, NOT A PRISON"

Confirmatory vs. Exploratory Analysis

Context of confirmation



- Traditional hypothesis testing
- Results held to the highest standards of rigor
- Goal is to minimize false positives

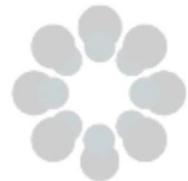
P-values interpretable

Context of discovery



- Pushes knowledge into new areas/ data-led discovery
- Finds unexpected relationships
- Goal is to minimize false negatives

P-values meaningless





Slides from Jenn Pfeifer



Conclusion: Both/And, not Either/Or

- We need both more rigor in confirmatory analyses, and more value accorded to exploratory analyses
- Use preregistration/RRs to constrain researcher degrees of freedom and increase transparency, reproducibility
- Learn how to conduct and review exploratory work on its own merits (which are vast)



Practical considerations, challenges, & misconceptions:

- What should I include?
- Where / how can I post it? *We can discuss any of these!*
- When is it visible to the public?
- What about unplanned discoveries?
- How will I know all of the decisions that I will have to make?
- How do I make my preregistration actually useful?
- How do I get my collaborators / PI / lab on board?
- What are other challenges specific to neuroimaging?
- Will this take too long?
- Can someone scoop my ideas?
- Isn't it easy to cheat?

Resources to help you get started

- Dr. Jessica Flannery's fMRI pre-registration template materials: <https://osf.io/6juft/>
- Page of resources from the Center for Open Science:
<https://www.cos.io/initiatives/prereg>
- Document from Max Planck with loads of information on pre-registrations:
[Preregistration: What? Why? How?](#)
- Registered Reports Guidelines from Neuroimage:
[YNIMG_Guidelines_for_authors_1.docx](#)

Examples

- ❖ Templates of OSF registration: <https://osf.io/zab38/>
 - OSF challenge template: <https://osf.io/jea94/>
- ❖ Templates: <https://osf.io/t6m9v/>
 - Paper with template: [Pre-Registration in Social Psychology—a Discussion and Suggested Template](#)
- ❖ Examples: <https://osf.io/h9k8n/>
 - fMRI example: <https://osf.io/x4uyn>
- ❖ Marissa's preregistration! <https://osf.io/693tm/>
- ❖ Junaid's preregistration: <https://osf.io/n4c95/>

Further reading

- [Why Most Published Research Findings Are False](#)
- [Research Preregistration 101](#)
- [The preregistration revolution](#)
- [More and more scientists are preregistering their studies. Should you?](#)
- [Research Quality of Registered Reports Compared to the Traditional Publishing Model](#)
- [Registered Reports in Human Brain Imaging](#)
- [Author guidelines for registered reports trial in NeuroImage](#)
- [First analysis of ‘pre-registered’ studies shows sharp rise in null findings](#)
- [A Fruitful Rendezvous at SIPS: Neuroimagers Meet Study Preregistration Advocates](#)
- [A manifesto for reproducible science](#)

Extra slides

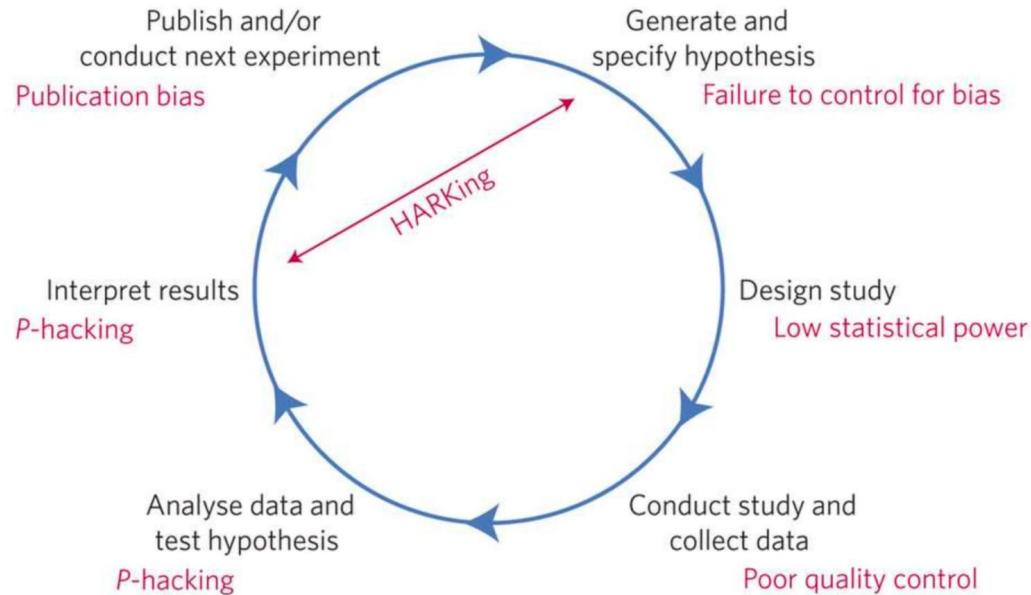
Common challenges for neuroimaging

- ❖ Number of Decisions
 - Decisions within each preprocessing step
 - Data inclusion/exclusion as new issues arise in pipelines
- ❖ Time Course
 - Longitudinal MRI studies can span several years
 - Preregistration not as commonly possible prior to beginning study
- ❖ Power Calculation
 - Common power calculation (e.g., G-Power) do not work
 - Simulations much harder to do with complex study design
- ❖ Spatial specificity
 - E.g. What do you mean by “dACC”?
- ❖ Multi-project collaborations
 - How much do you include off of a larger study with many collaborators?
 - What’s included for prior knowledge of data set?

Some “hacks” for neuroimaging

- ❖ Number of Decisions
 - BIDS & BIDS apps help version control and keep container on analyses
 - Standardized pipelines
 - Contingency plans
- ❖ Time Course
 - Can amend your preregistration with justification for change
 - This includes RR, with editor permission. May need to go back out to review.
- ❖ Power Calculation
 - NeuroPowerTools: <http://neuropowertools.org/>
 - fMRIpower: <http://fmripower.org/>
- ❖ Spatial specificity
 - Anatomical definition, use coordinates from prior study, or neurosynth definition
- ❖ Multi-project collaborations
 - Make a larger project on OSF and all preregistrations go under the project
 - State prior papers off dataset (better yet link to their prereg!)
 - State your prior knowledge of dataset
 - State how prior information will influence results

Different types of bias



Thought experiment:

You have submitted a paper to Current Biology evaluating effect of computer games on dyslexia

How likely is your paper to be accepted if you report:

- 20 participants; beneficial effect of intervention, $p < .05$
- 20 participants; group difference is non-significant
- 200 participants; group difference is non-significant

- <http://deevybee.blogspot.co.uk/2013/03/high-impact-journals-where.html>

Where / how can I post it?

- ❖ Open Science Framework
 - <https://osf.io/>
 - Free to join
 - Add collaborators
 - Getting started: http://help.osf.io/m/registrations
- ❖ AsPredicted.org
 - <https://aspredicted.org/>
 - Free to join
 - Add collaborators

Prereg Challenge: This is the preregistration form for the Center for Open Science's Preregistration Challenge (this form can also be used outside the Challenge). You will be asked a series of questions to ensure that your sampling, design, and analysis plans are solidified prior to beginning your study. Publications that preregister with this form may be eligible for a \$1,000 prize.

Open-Ended Registration: You will be asked to provide a narrative summary of what is contained in your project. There is no minimum character length. *This form is not a valid submission for the Preregistration Prize.*

Registered Report Protocol Preregistration: This form is intended for those who have received an "in-principle acceptance" for a registered report from a journal (see <https://cos.io/rr>). You will be asked to provide your accepted protocol manuscript, the journal name, and the date of in-principle acceptance. *This form is not a valid submission for the Preregistration Prize.*

AsPredicted Registration: This form is a straightforward preregistration form in which you will be asked eight questions based on procedures from [AsPredicted.org](#). *This form is not a valid submission for the Preregistration Prize.*

OSF-Standard Pre-Data Collection Registration: You will be asked if data collection is underway and if you have looked at your data already. You will be provided an opportunity to post other comments about your project. *This form is not a valid submission for the Preregistration Prize.*

Replication Recipe (Brandt et al., 2013): Preregistration: This form is intended for use when conducting a replication. You will be asked a series of questions about the study you intend to replicate. *This form is not a valid submission for the Preregistration Prize.*

Replication Recipe (Brandt et al., 2013): Post-Completion: This form is intended for use upon completion of a replication study, as outlined by Brandt et al., "The Replication Recipe: What Makes for a Convincing Replication?" You will be asked to answer a series of questions about the outcomes of your replication and how they compare to the original study. *This form is not a valid submission for the Preregistration Prize.*

Preregistration in Social Psychology (van't Veer & Giner-Sorolla, 2016): Preregistration: This form is intended for use when conducting a preregistration. You will be asked to fill out the elements for a preregistration as described in: van't Veer & Griner-Sorolla (2016). *This form is not a valid submission for the Preregistration Prize.*

Limitations to preregistrations

- ❖ A preregistered plan does NOT make it:
 - a good plan
 - a complete plan
 - automatically successful in combating problems
- ❖ Transparency updating doesn't get rid of fork paths!
- ❖ Doesn't "weigh in" on meaning of a p-value
 - It can make them more meaningful, but unclear whether that really is the ultimate goal or whether there is a larger p-crisis to address
- ❖ Doesn't address "measurement crisis"
 - Puts more focus on correcting replication versus better theory and measurement, which may also not be the ultimate goal

How to optimize your preregistration

- ❖ Reduce hidden decisions with standardized pipelines
 - E.g. <https://bids-apps.neuroimaging.io/>
- ❖ Treat it like a registered report!
 - Seek feedback where you can
- ❖ Include all possible data and code
- ❖ Try simulations (work through potential problems/produce model code)!
- ❖ Include a more detailed introduction (forcing more intensive lit review)
- ❖ Spend time of thinking through the theoretical basis of the question
 - Are there earlier steps you need to take? (is your project based on weak theory?)
 - Do you have solid evidence you are measuring what you think you are? (may help awareness of “measurement crisis”)

REMAINING DIFFICULTIES?

- ▶ All collaborators may not agree with preregistration
- ▶ Existing projects have existed without BIDS
- ▶ Time commitment up front
 - ▶ Can be harder to justify if many of these decisions likely need to be amended by the time of analysis
- ▶ Registered Reports will likely need to evolve to acknowledge some of these inherent difficulties
- ▶ What are others that come up for people?

REMAINING DIFFICULTIES?

- ▶ All collaborators may not agree with preregistration
 - ▶ Cite some recent initiatives from NIH.
 - ▶ Cite higher citation counts for prereg and null result findings
- ▶ Existing projects have existed without BIDS
 - ▶ Choose transparency, link with supplemental details of your pipeline.
- ▶ Time commitment up front
 - ▶ It shifts where time is spent (heavier front load, but lighter back load) and arguably reduces time in the long run (e.g., protects against requests to run endless additional models)

FAQs

Can't someone “scoop” my ideas?

1. Date-stamped preregistrations make your claim verifiable.
2. By the time you've preregistered, you are ahead of any possible scooper.
3. Embargo your preregistration.



FAQs

Isn't it easy to cheat?

1. Making a “preregistration” after conducting the study.
2. Making multiple preregistrations and only citing the one that “worked.”



FAQs

Isn't it easy to cheat?

1. Making a “preregistration” after conducting the study.
2. Making multiple preregistrations and only citing the one that “worked.”

While fairly easy to do, this makes fraud **more intentional**.

Preregistration helps keep you honest to **yourself**.

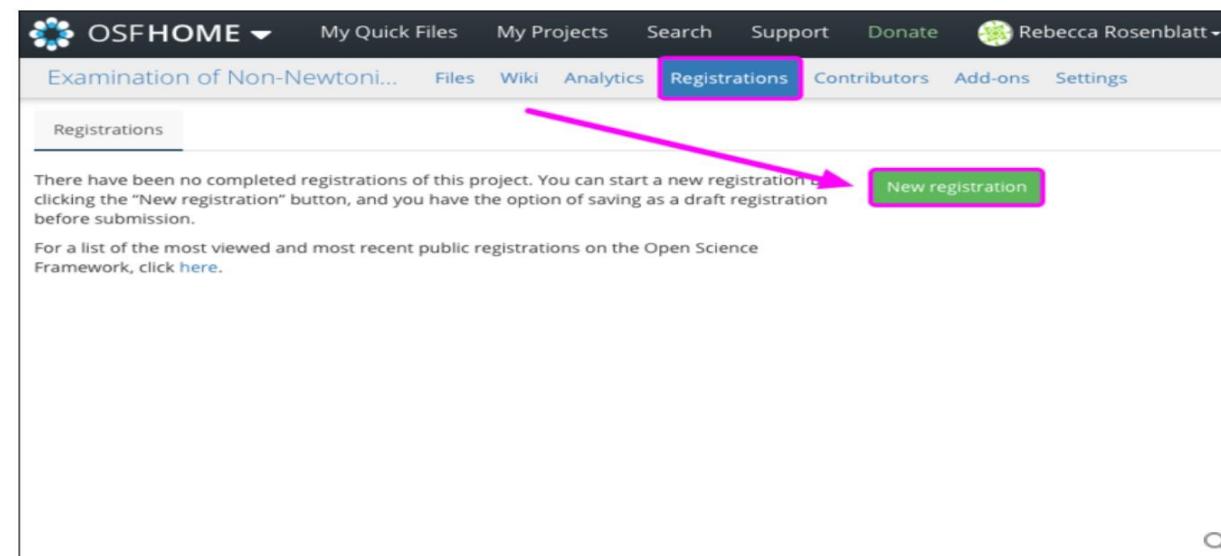
QUICK WALK-THROUGH FROM OSF

1. Create a registration

First, log in to the OSF.

Then go to the project for which you want to create a registration. On your "Project Overview" page, click the **Registrations** tab in the gray navigation bar.

In the "Registrations" tab, click the **New registration** button.



<http://help.osf.io/m/registrations/l/524205-register-your-project>

Or see step by step: <https://osf.io/sgrk6/>

QUICK WALK-THROUGH FROM OSF

2. Choose a registration form

Choose the registration form that you want to use. You can hover over the **i** symbol to read a short description of each form. See the [Registration Forms help guide](#) for more detailed information.

When you've selected the form you want to use, click the **Create draft** button. Depending on the registration form you choose, you may be asked to read the registration's terms.

Register X

Registration creates a frozen version of the project that can never be edited or deleted but can be withdrawn. Your original project remains editable but will now have the registration linked to it. Things to know about registration:

- Ensure your project is in the state you wish to freeze before registering.
- Consider turning links into forks.
- Registrations can have embargo periods for up to four years. If you choose an embargo period, the registration will automatically become public when the embargo expires.
- Withdrawing a registration removes the contents of the registrations but will leave behind a log showing when the registration was created and withdrawn.

Continue your registration by selecting a registration form:

Prereg Challenge i

Open-Ended Registration i

AsPredicted Preregistration i

Registered Report Protocol Preregistration i

OSF-Standard Pre-Data Collection Registration i

Replication Recipe (Brandt et al., 2013): Pre-Registration i

Replication Recipe (Brandt et al., 2013): Post-Completion i

Pre-Registration in Social Psychology (van 't Veer & Giner-Sorolla, 2016): Pre-Registration i

Cancel Create draft

QUICK WALK-THROUGH FROM OSF

3. Fill out the registration form

The various forms ask you to input some data about the state of your project and why you're creating the registration.

You can save your progress and revisit it later by clicking the **Save as Draft** button. This button will be at the bottom left of every page in the registration form. Learn more about saving your registration form as a draft at [Save Your Registration Form as a Draft](#).

Once you've completed the registration form, click the **Preview for submission** button. If the registration form is more than 1-page long, this button will be at the bottom right of the last page.

The screenshot shows the OSF registration form interface. At the top, there's a navigation bar with links for OSFHOME, My Quick Files, My Projects, Search, Support, Donate, and a user profile for Rebecca Rosenblatt. Below the navigation bar, the title "Examination of Non-Newtoni..." is visible, along with links for Files, Wiki, Analytics, Registrations, Contributors, Add-ons, and Settings. The main content area is titled "Edit draft registration". It contains a "Summary (optional)" section with a text input field and a descriptive text: "Provide a narrative summary of what is contained in this registration, or how it differs from prior registrations.". At the bottom of the form, there's a message "Last auto-saved: Mon Dec 18 2017 13:41:08 GMT-0500 (EST)". Below this, there are two buttons: "Save draft" on the left and "Preview for submission" on the right. A large pink arrow points from below to the "Save draft" button, and another pink arrow points from above to the "Preview for submission" button.

QUICK WALK-THROUGH FROM OSF

4. Preview and register

Look over your registration form to make sure that all of the information you provided is correct. Please note that upon registering your project, you won't be able to make changes to your registration form.

If you'd like to make changes to your registration form, click the **Continue editing** button.

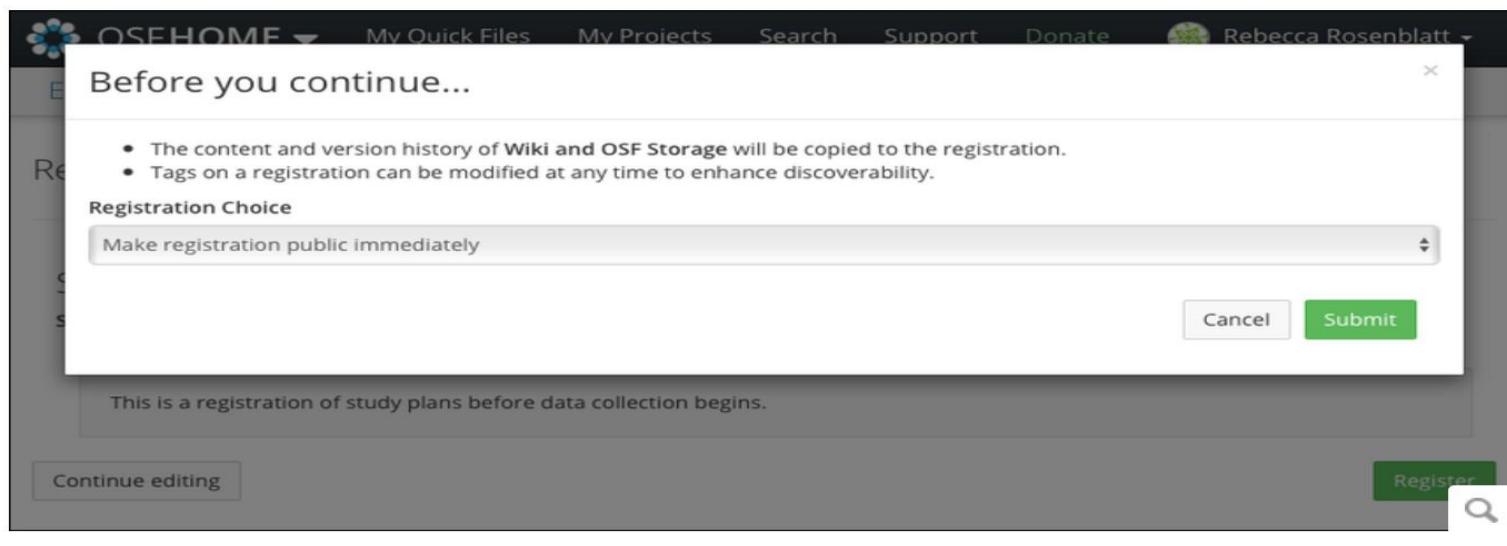
Or, if you're happy with your submission, click the **Register** button

The screenshot shows the OSF registration interface. At the top, there's a navigation bar with links for OSFHOME, My Quick Files, My Projects, Search, Support, Donate, and a user profile for Rebecca Rosenblatt. Below the navigation bar, the page title is "Examination of Non-Newtonian...". Underneath the title, there are links for Files, Wiki, Analytics, Registrations, Contributors, Add-ons, and Settings. The main content area has a heading "Register". Below it, there's a "Summary" section with a sub-section titled "Summary:" and a descriptive text: "Provide a narrative summary of what is contained in this registration, or how it differs from prior registrations." A text input box contains the placeholder text: "This is a registration of study plans before data collection begins." At the bottom of the page, there are two buttons: "Continue editing" on the left and "Register" on the right. A pink double-headed arrow is overlaid on the page, pointing between the "Continue editing" and "Register" buttons.

QUICK WALK-THROUGH FROM OSF

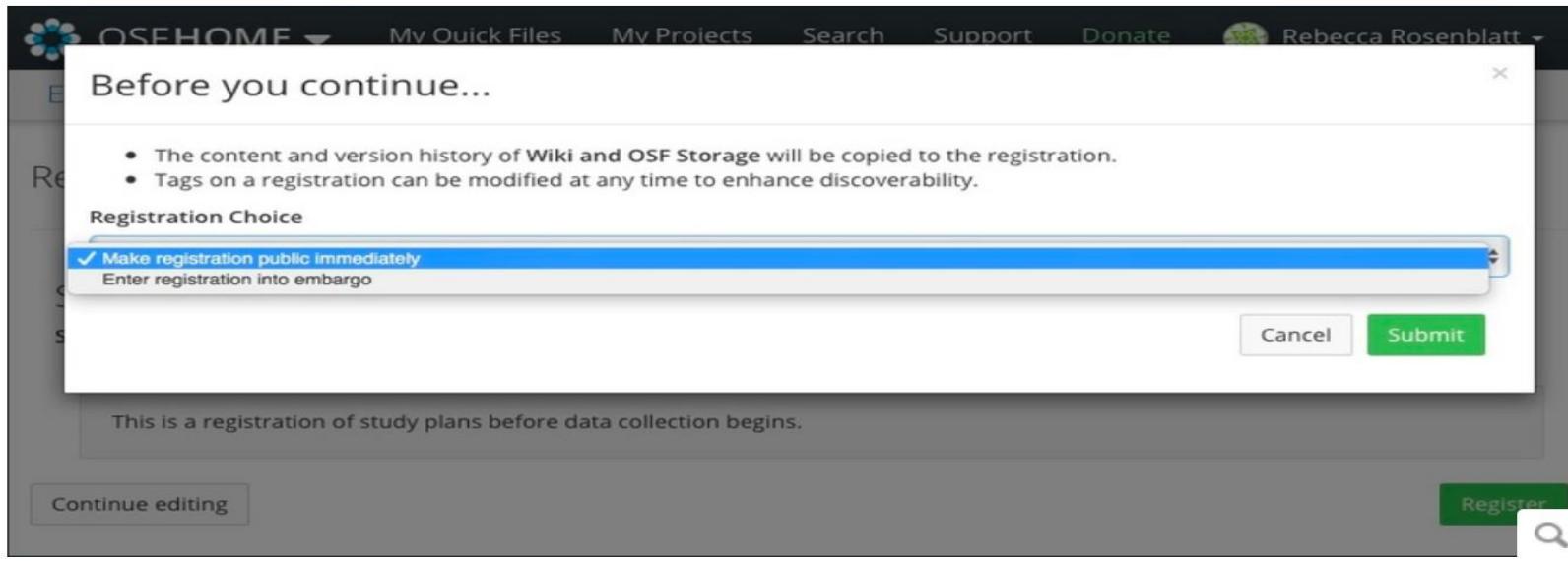
5. Choose your privacy settings

Before you submit your registration, a final modal will appear that allows you to choose your privacy settings.



QUICK WALK-THROUGH FROM OSF

Click inside the "Registration Choice" menu. Then choose to either make your registration **public immediately** or to **embargo it for up to 4 years**.



QUICK WALK-THROUGH FROM OSF

If you choose to enter your registration into an embargo, the "Embargo End Date" box will appear below the "Registration Choice" menu.

Click inside the "Embargo End Date" box, and a calendar will appear from which you can select the date that you want to end the embargo.

The screenshot shows a modal window titled "Before you continue..." on the OSF homepage. The window contains two sections: "Registration Choice" and "Embargo End Date". The "Registration Choice" section has a dropdown menu set to "Enter registration into embargo". The "Embargo End Date" section features a calendar for June 2018. The date "16" is highlighted, indicating it as the selected end date. At the bottom right of the modal are "Cancel" and "Submit" buttons, with "Submit" being green. In the background, the OSF homepage is visible, showing navigation links like "My Quick Files", "My Projects", "Search", "Support", "Donate", and a user profile for "Rebecca Rosenblatt". The footer of the page includes links for the Center for Open Science, social media integration ("Socialize" with Twitter, Facebook, and Google+ icons), and various project and guidelines.

Before you continue...

Registration Choice

Enter registration into embargo

Embargo End Date

June 2018

Sun	Mon	Tue	Wed	Thu	Fri	Sat
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

Cancel Submit

Center for Open Science

Home
Reproducibility Project: Psychology
Reproducibility Project: Cancer Biology
TOP Guidelines
Donate

Socialize

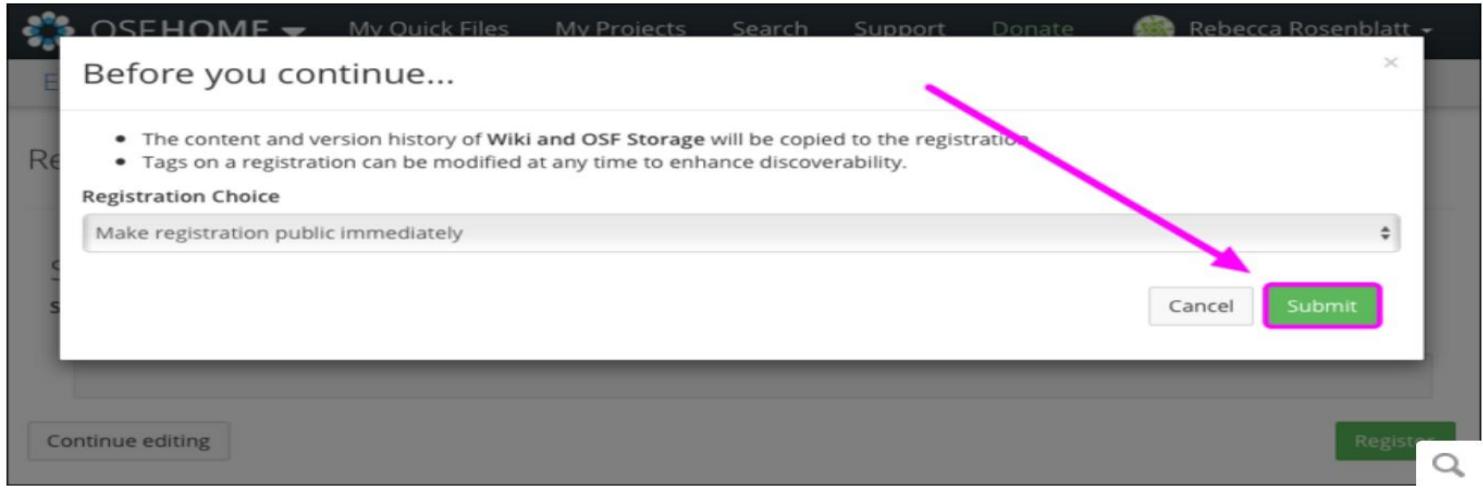
Twitter Facebook Google+

OSF

Status
Contact
FAQ/Guides
API
Source Code

QUICK WALK-THROUGH FROM OSF

When you're ready to finalize your registration, click the **Submit** button.



QUICK WALK-THROUGH FROM OSF

6. Approve or cancel your registration

When a project is registered, all administrators on the project are notified via email and given the opportunity to approve or cancel the registration by clicking the corresponding link in the email.

The registration goes into effect

- *either* when all administrators have approved the registration
- *or* when 48 hours have passed (whichever comes first)

If one administrator disapproves the registration, the registration is cancelled. You will be notified via email if an administrator disapproves the registration.

