

CONTENTS

1	Fun Stuff in the Future	1
2	Feminist Science Studies	3
2.1	Ethics vs. Value: Scientific Responsibilities	3
2.2	Science Studies	5
2.3	Value Systems	6
2.4	Feminist Theory	7
2.5	In Practice	8
2.6	Why should scientists care?	9
i	SCIENTIFIC ECOSYSTEMS	11
3	Scientific Structures and Incentives	13
3.1	Scientific Communication Woes	14
3.2	Access & Pay Walls	15
3.3	Reproducibility and Retraction	16
3.4	Impact Factors and Citations	20
4	Cracking Science Open	23
4.1	Personal Motivations	24
4.2	Literature Access	25
4.3	Data	26
4.4	Code	27
4.5	the interaction of data and code	28
4.6	Open Notebook Science	28
4.7	Issues	29
4.8	Machine readable everything	30
4.9	Chemical case study?	31
5	What's Inside? Fixing Science	33
5.1	Assumptions	34
5.2	values built into the future?	35
5.3	Who is helped and gets t help?	36
5.4	Digital Divides	36
5.5	Issues I'm running up against	39
ii	REPRESENTATION AND ITS DISCONTENTS	41
6	Representation & Science	43
6.1	The trouble with representation	43
6.2	Representation	45
6.3	Which Bodies Are In Research?	49
6.4	Is everybody a super sexist xenophobic jerk?	50
7	Shit I like	51
7.1	TReND In Africa: 3D printed labs, Nairobi, Kenya	51
7.2	Communities using open access	51
7.3	Open Ephys	51
7.4	Green Neuroscience lab, San Diego	51
iii	CASE STUDIES	53
8	Molecular Psychedelics	55
8.1	Psychedelics & Pharmacology	55
8.2	The classical psychedelics	56
8.3	The 5-HT _{2a} receptor	57
8.4	Neuroanatomical Distribution	59

8.5	Functional Selectivity & the 5-HT _{2a} R	60
8.6	5-HT _{2a} signaling	61
8.7	Evidence for Biased Signaling	62
8.8	Model Serotonin systems	65
8.9	Project outline	65
8.10	A Brief Historical Foray into other kinds of uses???	66
9	Open Science & Serotonin	67
9.1	Open Notebooks in the Wild	67
9.2	Technical Discoveries	67
9.3	Surmounting Notebook Challenges	69
10	Bibliometrics and this div	71
11	Reconstructive Neuroscience	73
11.1	Values in Molecular/Biological Psych/neuro research	73
11.2	Values and Power Structures	76
11.3	Moving Forward(?)	77
11.4	A short and selective history of psychedelic drugs	77
11.5	Psychedelics and me (woo)	77
11.6	A cultural compound	79

BIBLIOGRAPHY	81
--------------	----

LIST OF FIGURES

Figure 1	The “classic” current publishing pipeline	14
Figure 2	“Correlation between impact factor and retraction index. The 2010 journal impact factor...is plotted against the retraction index as a measure of the frequency of retracted articles from 2001 to 2010.” ³³	18
Figure 3	This map illustrates the total number of Internet users in a country as well as the percentage of the population that has Internet access.	37
Figure 4	Description -This map presents an overview of broadband affordability, as the relationship between average yearly income per capita and the cost of a broadband subscription.	37
Figure 5	The location of academic knowledge	46
Figure 6	2011 data language comparison	47
Figure 7	Estimated numbers of trials in the International Clinical Trials Registry Platform recruiting participants in low-, lower-middle-, upper-middle- and high-income countries, 2012 (Fig 4. fromViergever et al. ¹⁰⁷)	50
Figure 8	Chemotypes of 5-HT _{2a} agonists ⁷⁶	56
Figure 9	stole from Wikipedia, the general active-inactive cycle of G-protein coupled receptors (GPCRs)	61
Figure 10	5-HT _{2a} pathways, fig 4 from Halberstadt, 2015 ⁴⁷	62
Figure 11	Gender distribution of all works in this div! META.	72
Figure 12		72

LIST OF TABLES

ACRONYMS

NON-SCIENCE STUFF

IP	Intellectual Property
FLOSS	free/libre open source software
GPL	GNU General Public License
GNU	GNUs Not Unix
OS	open science

There'll also be an index of terms, I think, but it's not written yet.

FLOSS free/libre open source software

GPL GNU General Public License, the founding document of the Free Software Movement

OS open science

OA Open Access

APC Article Processing Charge

IF Journal Impact Factor

STEM Science, Technology, Engineering, and Math

DOI Digital Object Identifier

DIY Do It Yourself

HGP Human Genome Project

Tools

WOK *Web of Knowledge*

BLAST Basic Local Alignment Search Tool

SDSS Sloan Digital Sky Survey

Organizations

NCBI National Center for Biotechnology Information

CERN European Organization for Nuclear Research*

HEW Department of Health, Education, and Welfare

IRB Institutional Review Board

USPHS U.S. Public Health Service

PLOS Public Library of Science

OKF Open Knowledge Foundation

OECD Organisation for Economic Co-operation and Development

TREND Teaching and Research in (Neuro)science for Development in Africa

Places

FDA Food and Drug Administration

MIT the Massachusetts Institute of Technology

NIH National Institute of Health

NYU New York University

*derived from the french *Conseil Europeen pour la Recherche Nuclear*

OEAC Other Euro-American Countries, including Australia, NZ, and Canada

ROW "Rest of World", for what that's worth

BRICS Brazil, Russia, India, China, considered the rising economic and scientific powerhouse countries

ROW "Rest of World", for what that's worth

OECD Organisation for Economic Co-operation and Development

UB FOH University of Botswana, Faculties of Humanities

UOM FOS University of Mauritius, Faculties of Science

UCT COMM University of Cape Town, Commerce

UNAM FHSS University of Namibia, Humanities and Social Sciences

SCI Science Citation Index

WOS Web of Science

LHC Large Hadron Collider

SCIENCE

FACS Fluorescence Activated Cell Sorting

GPCRS G-protein coupled receptors

G-PROTEIN guanine nucleotide-binding proteins

RA retinoic acid

5-HT 5-hydroxytryptamine

CNS central nervous system

GDP guanosine diphosphate

GTP guanosine triphosphate

LSD lysergic acid diethylamide

MESCALINE 3,4,5-trimethoxyphenethylamine

OCD obsessive-compulsive disorder

DMT *N,N*-Dimethyltryptamine

DOM 2,5-Dimethoxy-4-methylamphetamine

STP Serenity, Tranquility, Peace

PFC prefrontal cortex

LC locus coeruleus

PET positron emission tomography

HTR head twitch response

DEA Drug Enforcement Administration

PPI pre pulse inhibition

MAOI monoamine oxidase inhibitor

HEKS human embryonic kidney 293 cells

FUN STUFF IN THE FUTURE

Chapter 2 (aka what you just read) describes the theoretical underpinnings behind my Div III, explaining why I believe that science is just as much a cultural construct as any other knowledge project, and as a result, why scientists have a serious responsibility to consider their work in the greater context of social issues.

Sketch of regular book introductions with what chapter is going to be about and why. Not always updated.

Troubling Scientific Systems

Chapter 3 starts where most criticisms of science stem from: the scientific ecosystem, and the ways in which the current system of reward, funding, and prestige distorts the pursuit of truth and knowledge in science.

Chapter 6 continues on a similar theme considering the question of representation within the global scientific community.

Chapter 4 explores the growing and heterogeneous community of open science (OS) advocates, who propose to make science more inclusive, collaborative, and useful, largely via the power of the Internet for sharing. OS is an alluring idea, especially backed with the rhetorical power of “open”; but “open” is not by itself a panacea for the hegemony of scientific establishments.

In Chapter 5, we explore the possible implications of “fixing” science through greater sharing and dissemination of information. This hegemony is not merely theoretical. The proposed ‘solutions’ to the scientific systems’ failures have serious implications, from a science studies and a feminist point of view, on the production and kind of knowledge production. It examines the open science movement with a mind to discover and analyze the values underlying those efforts. Ultimately, I’d propose how a movement hoping to democratize and equalize science desperately needs to consider and account for their values from a (feminist) different standpoint.

Chapter 7 is things I like, that I want to emulate, and projects that have attempted to wrestle with all or some of my issues and succeeded in some measure.

Doing Science Like a Scientist

Chapter ?? is the background to my work – a “purely” scientific description. It describes why I think serotonin systems are important to model and explore, why I care about them, and my attempts to create a way to explore hallucinogenic pharmacology by manipulation of a stem cell line.

Chapter 9 is the follow up to this – it’s a description of my attempts to implement open science proposals into a biological project, and the myriad complications and barriers I’ve surmounted – or not – in doing so. It offers a description of what I think the open science movement is missing on a practical implementation level.

Reconstructive Neuroscience

Chapter 11 is the capstone chapter of sorts. It is critical questions about the links between my own areas of interest – molecular signaling and psychotropic drugs – and gender, environmental concerns, indigenous rights and colonialism, and race relations. While I don't have answers to any of those questions, asking those questions has (already) helped find a myriad of ways in which social factors are fundamental parts of my scientific process and questions. Then there will be a conclusion when I finish my div!

SCIENCE STUDIES, FEMINIST THEORY, CULTURAL STUDIES

Science is empowering technology; science provides a sense of systematic inquiry that satisfies some deep drive to understand and explain the world around us. Science is part of a long and storied heritage of bold exploration, innovation, and human ingenuity.

Science is, simultaneously and harmoniously, a handmaiden to social-technical progress and a crucial strut in the reinforcement of systematic societal inequities. It is both a compelling and evidence-driven narrative about biological and physical realities and a knowledge necessarily developed in and shaped by a social context.

The question that leads scientific philosophy classes: “what is science?” There is not, of course, one easy answer. Moreover, I am more interested in understanding what science *does*, how it moves into the world, shaping and being shaped in the process. “Science” is not any one grand item; for our purposes, it is roughly sketched as

- Science,** a technological systematic enterprise that builds and organizes knowledge in the form of testable explanations and predictions about nature and the universe; *progress*
- Science,** an international weekly science journal, published by the American Association for the Advancement of Science
- Science,** a way of exploring the world from a specific cultural/philosophical/technical viewpoint; a practice and culture and a “culture of no culture”; domination and power relations through knowledge structures

see Longino?

Equally important is that science, whatever it may be, is *made by scientists*. Like Frankenstein and his monster, we, as the producers of scientific knowledge, have the responsibility of taking care for what we make, of making sure our knowledge work goes into the world to do good, not bad.

Which science does this, and allows for positively-valenced work?

Our second is tongue-in-cheek and the third is a concept running counter to dominant narratives of techno/science, so we’ll start with troubling the notion of science as progress and as systematic truth-building exercise.

do I want to use technoscience?
It’s Haraway’s Thing, but it needs clarification if I do

2.1 ETHICS VS. VALUE: SCIENTIFIC RESPONSIBILITIES

The ethical duties and responsibilities of an academic scientist are managed by an Institutional Review Board (IRB); systematically, the Republican party controls research on controversial topics like climate science or stem cell research.

Ethics are part of the limited frame of experimental design and execution. The notions of informed consent, “do no harm”, and the humanity of people are what I would call ethical responsibilities, and are critical and basic scientific practices.

That is not, however, exactly what this dumb Div III is about.

and they were testing
with the Wasserman
reaction!

A classic case of biomedical ethical failure is the Tuskegee Syphilis experiments. In 1932 Tuskegee, Alabama, the U.S. Public Health Service (USPHS) enrolled 400 syphilis-positive black men to observe the “natural” course of untreated, latent syphilis. The study heads began by enticing their participants with explicit promises of free health care and treatment; they tested them for syphilis and concealed the information from their subjects. This led, of course, to the spread of the disease through the local community. To ensure the disease stayed “natural”, the USPHS researchers took steps to prevent their subjects from being seen or treated by local physicians. When the draft came through in 1941 and tested for syphilis, the study leaders supplied the draft board with a list of names to be excluded from treatment; the U.S. Army complied. In 1932, no effective syphilis treatment existed, although it was believed that certain mercury ointments could slow its course. Twenty years into the study, when penicillin *had* become established as an effective syphilis treatment, researchers increased their efforts to prevent interference by the outside world. Halfway through the study, more than 30% of the test group had died *directly* from advanced syphilitic lesions, with many more suffering from secondary complications.⁹ The “study” finally ceased forty years after it started, in 1972, after a whistle-blower publication in the *New York Times* and Congressional hearings.

In 1973, a year after the cessation of the study, the Department of Health, Education, and Welfare (HEW) released a damning report of the ethical failures over the course of the study. The report focused on the (1) lack of treatment, arguing that once penicillin had been discovered, it should have been used and (2) the “informed consent issue”, wherein the report argued men had submitted to *an* experiment, merely without being told what the experiment entailed. This remains the dominant interpretation:

Wikipedia because
it represents
dominant views
of culture/science

“... controversial for reasons related to ethical standards, primarily because researchers knowingly failed to treat patients appropriately after the 1940s validation of penicillin as an effective cure for the disease they were studying.”

Wikipedia on the Tuskegee
Syphilis experiments¹¹⁴

To our modern sensibilities, this was a complete ethical failure on the part of the scientists involved, their funding body, and the hospital. The criticism are founded in notions of what a *good* doctor would have done differently.

These are largely ethical considerations, without regard to the unique cultural context of the experiment. The HEW report elides the deep social structures that *allowed* the Tuskegee experiments to be conceptualized as valid information. Doctors and researchers discounted the socioeconomics of black America, arguing that better medical care could not alter the “evolutionary scheme” of things. The discovery of penicillin had no bearing on their decision to watch the natural course of death proceed. If it had, the men would have been given the (believed to be effective) mercury treatments. Researchers never *intended* to treat these men, because in their (white) eyes, black men were a subhuman species – animalistic, promiscuous, and a fascinating object of research.⁹

All parties were deeply and irrevocably shaped by the anti-black racism in the post-Civil War Jim Crow era that continue, in various

forms, into the modern day. The most critical part of this, for us, is that these researchers genuinely believed in what they were doing.

Reports were also published every two years by JAMA, so like, this wasn't HIDDEN. Many people saw and discussed this thing. Complicity of the scientific establishment

2.1.1 *Constitutive and Contextual Values*

So what happened at Tuskegee? What kind of scientists accidentally worked their way into a position of enough power to enforce racialized binaries?

define modern science

"It is, of course, nonsense to assert the value-freedom of natural science. Scientific practice is governed by norms and values generated from an understanding of the goals of scientific inquiry. If we take the goal of scientific activity to be the production of explanations of the natural world, then these governing values and constraints are generated from an understanding of what counts as a good explanation, for example, the satisfaction of such criteria as truth, accuracy, simplicity, predictability, and breadth. . . they clearly constitute values by which to judge competing explanations and from which norms and constraints governing scientific practice in particular fields. . . can be generated.

Independence from these sort of values, of course, is not what is meant by those debating the value freedom of science. The question is, rather, the extent to which science is free of personal, social, and cultural values, that is, independent of group or individual subjective preferences regarding what ought to be."

Longino, "Science as social knowledge", p. 4 ⁶⁴

The social values underlying the Tuskegee Experiments were not some chance byproduct, a fluke. Scientific inquiry, that peculiar and powerful institution, is Those kinds of values, social and contextual, are the counterpart to the more accepted institutional ones –

clarify notions of relevant values as per Longino's ideas

2.2 SCIENCE STUDIES

Both my historical time line and ideological foundation for science studies starts with Ludwik Fleck's *Genesis and Development of a Scientific Fact*, first published in 1935 pre-WWII Germany.³⁶ A practicing syphilis researcher and pathologist, Fleck proposes scientists as the creators of facts, rather than mere observers; or rather, that the act of observing also creates. He describes how certain *styles* of thinking permeate and circumscribe scientific collectives and the people within them. Scientific knowledge is only accepted as true fact once the evidence been thoroughly vetted, trimmed, mediated, and judged acceptable by experts in the field. This is not just the peer-review that drives science, but the presented facts must fit more-or-less neatly into pre-existing structures of thought.

"Facts" are then not so much realities of the world but interpretations of it, made by collaboration between individual, collective, and evidence;

Expand historical section of science studies to generate a foundation for current critiques. . . more explicit Fleck summary w/- page numbers, quotes

they only take shape in a matrix of other beliefs and discoveries about the world. Like a group of people who together produce an idea where the origin is never really clear, scientific facts are held in a common tension, without distinctly available origin stories.

Fleck and Kuhn and many of their concurrent and subsequent philosophers, historians, and sociologists of science offer compelling arguments that science is, yes, evolution, but not evolution *towards* anything.

Linking paragraph about how dissatisfying it is to deconstruct science without talking about the implications of a value-laden science

2.3 VALUE SYSTEMS

The modern scientific system began in an era of European colonialism, with the major powers sending 'civilizing' missions to the Sino-Japanese coasts, the Indian subcontinent, vast swathes of Africa, South America, North America, Australia and the Indonesian islands. The beginnings of biological classifications and phylogenies and the Scientific Revolution, coinciding with the gentlemen scientists of Darwin's era, are rooted in exploratory voyages and specimen collection by Europeans.

The Scientific Revolution was enabled by and allowed the continuing expansion of European powers into the rest of the world.

For much of early European missions, malaria proved an insurmountable hurdle to the troops of colonial powers. The interior of Africa and the swampy Chinese coast were rife with mosquitos and their disease; troops died due to disease and infection at a rate many times higher than actual warfare. Those same colonial missions of research, proselytizing, or conquering were accompanied by botanical missions. Eventually, Europeans, via the acquired medical knowledge of Jesuit missionaries in South America, came into contact with the Peruvian bark of the cinchona tree, which contains quinine, one of the earliest treatments for malaria. The discovery, classification, and medically-useful malarial treatment allowed the penetration of European troops into hitherto inaccessible areas.

The Scientific Revolution enabled and fed on the expansion of European powers into new territory.

find ref for that-fucking book from the fucking summer

research scientific imperialism, bioprospecting, new forms

Discovery of the 'cure' for malaria (by indigenous tribes in the Amazon, transferred to the Jesuit, and eventually the expanding European empires) allowed European nations to make inroads into tropical areas, as their soldiers were no longer dying at the prodigious rates.

Racism – the peculiar brand of American racism, derived from slave-owners desperate to justify their brutality of human bondage – was created through the collusion of science and society, specifically a science that carefully cataloged and characterized the way black men and women differed, and were therefore lesser, than White slaveholders. Darwin's great proposal of evolution let scientists justify the status quo (White men, White Women, Black men, Black women, in that order) as a mere consequence of natural selection.

That was the 40's and 50's – today, we have genetic surveillance.⁸⁸

We have the sciences of homosexuality: if being gay is a genetic inheritance, then we should be careful to screen our pre-natal children and not allow gay men to donate sperm.. If it's cultural, we should be more careful to police the kind of culture we give our children, carefully

rewrite genetic surveillance, 1000 genomes project

intentionally focused on gay Men because patriarchy

isolating them in heterosexual spaces. We can cure the queers, if only we knew *why* they were homosexual.

The scientific heritage, the accumulated knowledge upon which we build our futures, is not exempt from criticism more commonly leveled at explicitly political institutions. At the same time, the undeniable power of science and technology to do “good” – hormone therapy for medical gender transitions, Internet communities for otherwise isolated activists, the reclamation of environmental sciences by Native communities, technologies that re-enable disabled bodies, pharmaceuticals that prolong lifespans and raise quality of life, and allow people to take control of their reproductive health* – means we need science to keep pushing. Not to mention the insatiable curiosity to understand and the delightful appeal of “basic” research, of discovering something new.

Science is not going away, and nor should it; but to ignore our scientific inheritance, the complicity between science and power, and the role of individual scientists in perpetuating and creating power dynamics is to be neutral in the face of injustice.

2.4 FEMINIST THEORY

“... Questioning representation with a vengeance.”

I now call feminist science studies emerges out of academic feminist and activists against white supremacy, patriarchy, heteronormativity, and ecological destruction working on ways to critique science as a social institution, and using that critique to forge new ways of asking and answering scientific questions.

Feminist science studies is then, like most fields, at confluence of many networks. Donna Haraway’s *Cat’s Cradle: Science Studies, Feminist Theory, Cultural Studies* drew a picture of a field at the intersection of:⁴⁹

“Cultural studies. . . Not culture only as symbols and meanings, not comparative culture studies, but culture as an account of the agencies, hegemonies, counter-hegemonies, and unexpected possibilities of bodily construction. . . Relentless attention to the ties of power and embodiment. . . location and knowledge. Unconvinced by claims about insuperable natural divides between high and low culture, science and everything else, words and things, theory and practice.

Feminist, Multicultural, and Antiracist Theory/Projects. . . situated knowledges, where the description of the situation is never self-evident, never simply “concrete,” always critical; the kind of standpoint with stakes in showing how “gender,” “race,” or any structured inequality in each interlocking specific instance gets built into the world–i.e., not “gender” or “race” as attributes or as properties, but “racialized gender” as a practice that builds worlds and objects in some ways rather than others. . . gender and race are built into practice and have no other reality, no origin, no status as properties . . . questioning representation with a vengeance.

Science Studies. . . reflexivity, constructionism. . . science in the making (not science made), actors and networks. . . science

For a solid history, see Richard-son 2010⁸⁶ for an a+ overview

*Given access and governments that don’t insist on fucking bullshit lookin’ @ you, everybody.

as practice and culture. . . the culture of no culture, the nature of no nature. . . All the disciplines of science studies: history, philosophy, sociology, semiology, and anthropology; but also the formation of science studies out of the histories of radical science movements, community organizing, and policy-directed work. These histories are regularly erased in the hegemonic accounts of disciplinary and interdisciplinary development in the academy and the professions.”

-Donna Haraway, *Cat's Cradle*, p. 66-68

So now that we know what we're dealing with (sort of, although it's a slippery web of concepts), that brings us to: so what? Why bother? Why shouldn't we, as one professor urged me, “cut the sociology, focus on the science”?

2.5 WHAT DOES THIS DO IN A PRACTICAL SENSE?

Because I have to at least try to be an Emma Goldman, not Margaret Sanger.

2.5.1 “Asking Different Questions”

Feminist science studies both allows and demands practicing scientists engagement with more than “just” science. It lets us ask questions of representation in our labs, our literature, and our students: “Where are the women? *Who* is practicing science, and who is deciding what science is important?” This extends to questioning not just gender, but about race, physical ability, nationalities, and other sociological classifications.

Feminist science studies also lets – and again, demands – that we ask questions on another level about the nature of the knowledge produced.

This includes (among many other things),

- an examination of the scientific *construction* of race and gender perpetuated by the perceived objectivity of the sciences^{37,34,27}
- the deep paradoxes involved in the ab/use of women's bodies in pursuit of reproductive technologies^{87,4}
- the shaping of science by gendered and racialized metaphors and languages,^{59,67} and the historical complicity between scientific exploration and colonialism, misogyny, and racism (all at once, not as isolated variables)^{50,84,91}
- challenging the artificial boundaries between “basic research” and nature/culture to explain a rapidly-growing scientific-industrial complex, and then linking basic research to community activism for women's rights and environmental movements.¹⁰²

It asks us to look at science as a practice inseparable from culture, and what that might mean for knowledge and for scientists as the future producers of that knowledge.

Or should extend...

Representationally weak.

2.6 WHY SHOULD SCIENTISTS CARE?

Because feminist science asks questions that are fundamentally geared towards addressing socialized inequalities in science, it can (and has) help scientists take those inequalities into account. Scientists (in theory) care about helping people. It can't help people if it's racist, misogynistic, and not considerate of how work will be ab/used downstream.

rewrite this?
maybe with
sources or more
emotions
do they though?
Still unclear,
there's no fuck-
ing research

2.6.1 *The point of the thesis*

Scientists should care about where their work is coming from and where it's going, and we *need* good – read: concerned and activist – people everywhere if we want social progress. This div is (hopefully) a road map and detailed exploration into doing (good) value-laden science. Figure out *how* to apply all of that stuff to everything else I care about: namely, open science, open neuroscience, molecular neuroscience and then write about what did and did not work.

Part I

SCIENTIFIC ECOSYSTEMS

Here's the thing: science doesn't mean anything until you communicate it to *someone*. Facts only become facts when they're part of a communal decision; more practically, if you "cure cancer", there's not much point unless you get your acclaims, and start pushing your therapy out. The system that has evolved for scientific dissemination today is a network of journals, Internet communications, conferences, emails, and blogs; the rate at which scientific information moves within communities and between scientists and the "public" has increased dramatically, in both speed and scope.

The broad sets initiatives under the [OS](#) umbrella (of which I am a card-carrying member), share a point of view, in which the scientific ecosystem – that network of funding and publishing that underlies the production of knowledge – is suffering from serious problems in dissemination, reproducibility, and efficiency. They propose transparency, greater literature and scientific access, and technological innovation can 'fix' or alleviate those flaws, and improve science as an institution. The "fundamental goals" of open science include:

1. Transparency in experimental methodology, observation, and collection of data.
2. Public availability and re-usability of scientific data.
3. Public accessibility and transparency of scientific communication.
4. Using web-based tools to facilitate scientific collaboration.

Generally, those solutions and/or goals center around digitizing and opening the scientific ecosystem, implementing structures that allow for and incentivize:

1. open access publishing - namely, cost- and licensing-free to full-text published papers and research results
2. open data - publishing raw data pre- or concurrently with paper publication
3. open research - everything else, including, but not limited to:
 - a) code distribution - code for analyses, model generation, etc. should be hosted somewhere accessible
 - b) lab notebooks - tracing the entire research process with all dead ends and kinks included in an accessible (read: digital) form

There's also a hundred other subcategories on the fringes of those overarching categories new systems of distributed, ongoing, or otherwise "open" peer review; community discussion of publications, billed as an "online journal club"; altmetrics to re-allocate scientific credit away from impact factors towards diverse forms of knowledge transmission.

coggle

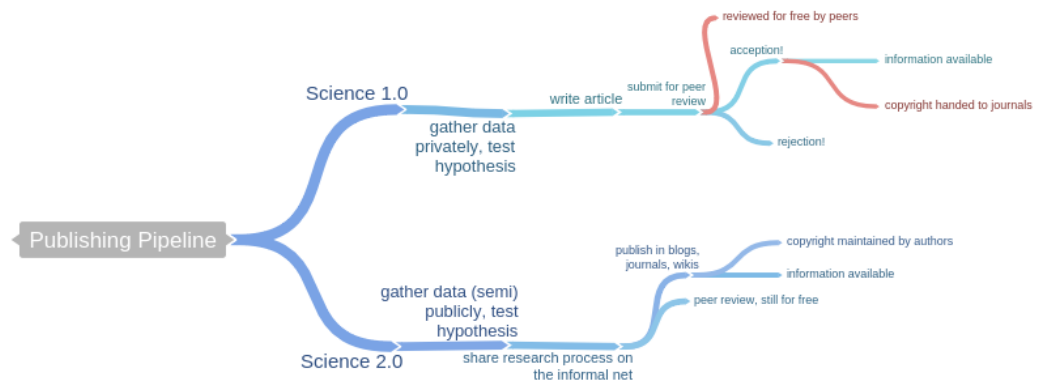


Figure 1: The “classic” current publishing pipeline

3.1 SCIENTIFIC COMMUNICATION WOES

Before we start talking about solutions, it makes sense to identify the problems. To some extent, the OS movement takes these as a given, and move straight to proposing the solution.

3.1.1 The Publishing Pipeline

Publishing in a scientific journal, as the main form of scholarly communication for much of modern Western science, is where most attempts to “fix” science start. The path of research to communication is long, torturous, and winding, requiring abridgement, careful scheming, over-statements of effects, prestige calculations.

rewrite publishing pipeline, history of journals

“Scholarly journals have been at the heart of academic life since the publication of the *Journal des sçavans* and the *Philosophical Transactions of the Royal Society* in the middle of the 17th Century.” -Parker 2013⁸⁰

current goals/what's accomplished w/ publishing

Publishing benefits the scientist predominantly in an indirect sense.

The actual scientific study behind modern journal articles has multiple origin stories; papers arise from a variety of both serendipitous and

- In New Orleans, an opening for an asthma grant, so my PI applied to research asthma in the context of serotonin signaling
- an idea, late at night (Otto Loewi, discovery of acetylcholine)
- previously established work by a lab (routine $X \rightarrow Y \rightarrow Z$)

- within the context of a greater project by the PI (re: translational neuroscience lab?)
- a happenstance observation; (see [Charney et al.](#), serendipity generally!)

Then, after project initiation, scientists collect data, run a set of multiply-envisioned on-the-fly experiments. They “make things work” until there’s a data set with evidence for an effect ($p < 0.05$), or that they’ve successfully answered the question, hopefully with a yes.

rewrite how an idea becomes a paper to be FORMAL

Presumably, then you write the paper – introduction, background, results, discussions, methods, further directions for research – and submit it to a journal of your choice.

linking

Publishers act, although the boundaries are shifting in the digital age, as a clearinghouse and managerial stage. They don’t produce the content, make the figures, or draw the conclusions in papers; Journals and their publishing groups provide, to varying degrees: a measure of typesetting and formatting, editorial work, and a distribution system.

although publishers do provide some value

Authors/labs submit a manuscript (*gratis*); publishers coordinate the peer review of said manuscript, shipping it out to 1-3 other academics in the field. Those academics review the paper, give feedback, and send it back – also *gratis*. During the months of the process, the submitting author can do nothing else with the manuscript (double submissions being verboten). Peer reviewers send it back with recommendations for publishing, the original writer makes revisions, and the journal agrees to publish it. The submitting lab pays a per-figure and/or per-page fee, signs away their copyright, and the journal takes the final work as its own. Then, those submitting and reviewing scientists pay to access the product of their intellectual labors, having given up the legal right to share that knowledge on their own accord.

find ref for current scholarly system

Pre-Internet, the cost of the journal was tied to the costs of printing and physical distribution. With that barrier out of the way, replaced by digital access, it’s harder to see exactly why the major publishers that control the market are still making profit rates between 32%-50%, to the tune

3.2 ACCESS & PAY WALLS

Under the prevailing subscription-based system, commercial publishers own a monopoly over the distribution of scientific research. They charge authors for the publication of their works, then charge the readers subscription, advertising, and online access fees; in addition they retain the copyright of the articles they publish.

95

“Primary literature” is the holy grail of contemporary knowledge. 6 pages of double-column size 10 text in *Nature*, *Science*, or *Cell* represent the cutting edge of scientific research; the foundation for future work, and the hallmark of a great researcher.

I’ve been working from primary scientific literature since my first semester at Hampshire, but it was only a few minutes after my first

Nature is paywalled back to 1867.

The National Institute of Health (NIH) requires funded researchers to deposit after a period of time.

clarify reproducibility VS replication

find ref for more citations for battle post-Ioannidis publication

rewrite Brief sketch of statistical proof and discussion for falseness

lol @ pharma and cultures of molecules/reductions with regard to increasing Food and Drug Administration (FDA) restrictions Both sets of studies were largely based on oncology-directed data

This gets back to local biologies? But in the sense of localized non-controllable environments

Google Scholar searches that I immediately slammed up against pay walls to the papers I wanted.

Data about access and paywalls; idea of a sense of outrage at these monetary barriers to research that is (a) publically funded and (b) all of the writing/production is done by uncompensated scientists.

Most studies in the U.S. and U.K (the strongholds of scientific research generally) are publicly funded research, in part or in whole. "Taxpayer dollars" fund, via the NIH, much of the high-profile, high-impact research that subsequently appears in journals. Taxpayers – your average layperson, or average scientists – then have to pay *again* for access to the produced knowledge, when they paid to fund it.⁹⁵

3.3 REPRODUCIBILITY AND RETRACTION

The principle of the elusive scientific method is replication and reproducibility. Researchers document their methods and results to such an extent that any other researcher is able to reproduce their data independently, or, more often, build experiments atop the results of their colleagues (replication).

Like the access crisis, however, there is a perception of a reproducibility crisis in science. Certainly the most high-profile beginning to the discussion was a 2005 article authored by John Ioannidis, provocatively titled *Why Most Published Research Findings Are False*. The paper outlined a statistical estimate on the likely false positive rate in the published bio-medical literature, an estimate eventually clocking in at >50%.⁵⁴ The publication caused (understandable) uproar, with a statistical "battle of the titans" ensuing that continues today.^{43,55} Statistical debates aside, the gist of the conversations is clear: based purely on statistical considerations, one can expect a percentage of the medical literature to be a false positive (50% according to Ioannidis' calculations, 14% in Jager and Leek's calculations).⁵⁵

This is not just theoretical number-crunching; the 'crisis' has an enormous business and opportunity cost. Biotech and pharmaceutical companies trying to monetize those discoveries demonstrate the practical scope of the problem. The rate of effective translation from basic research into clinical drug treatments has always been low, but the increasing costs of drug development and renewed focus on research reliability has prompted drug companies to join the conversation with data.

The in-house target validation studies run by most bio-medical companies provide a unique data set on the reproducibility of bio-medical research. Amgen's researchers attempted to reproduce the results of 53 high-profile 'landmark' cancer studies over 10 years; results could only be recapitulated in 6 of the cases, an 11% success rate.⁵ Researchers at Bayer tracked the fate of 67 validation projects; in 2/3 of the cases, the validation data was so inconsistent with the published literature that the project was significantly delayed, or more commonly, entirely terminated.⁸³ At Bayer, this did not correlate with fields, experimental conditions, model systems, or journal impact – it's just that most research could not be reproduced at industrial labs.

To temper those sample sizes, two labs (in Berkeley, CA, and Boston, MA) collaborating on a Fluorescence Activated Cell Sorting (FACS) project, discovered that even with identical protocols, they had consistently different results. In a laborious year-long process, the two labs

(or rather, the primary researchers in both labs) isolated the difference in their experimental results to the speed of agitation at one step of the organ isolation process. While the results initially *seemed* irreproducible and incommensurable, their end conclusion was principally that biological research is at such a level of complexity that even minor changes from lab to lab in the microenvironment can “break” an experiment.⁵²

RETRACTION We can explain away the lack of replication with varying degrees of success. Where the literature really gets into trouble is retraction – that is, journals and authors withdrawing published articles, articles that have already been deemed acceptable by peer-review and editorial mandate. Pulling an represents an enormous reputation cost to both journal and author; retraction often leads to firing (or mandatory stepping down) of the editor, and in the longer-term, a distinct downward trend in the citation rate of the author’s former papers. Retraction is serious business for everyone involved, which makes the relatively increasing incidence all the more concerning. In 2008, [Cokol, Ozbay, and Rodriguez-Esteban](#) concluded that*

“...in the period between 1990 and 2006, we found a significant increase ($r = 0.55$, $p = 0.02$) [in retractions]...From these observations, we conclude that retraction rates are still on the rise.

Cokol et al.¹⁷

This trend begs for an answer, which is as of yet still in flux. Some propose the pressure to publish, increasingly important to funding and hiring decisions, hits researchers in a vulnerable spots – pressures to publish increase scientific bias³⁰

“[Two viable interpretations] The first interpretation implies that increasing competition in science and the pressure to publish is pushing scientists to produce flawed manuscripts at a higher rate, which means that scientific integrity is indeed in decline. The second interpretation is more positive: it suggests that flawed manuscripts are identified more successfully, which means that the self-correction of science is improving.”

Cokol et al.¹⁷

Intriguingly, and perhaps tellingly, not only are the rate of retractions increasing, but they’re increasing in the journals we respect the most. In a 2011 *Infection and Immunity* publication, [Fang and Casadevall](#) found a “strikingly robust” correlation between a journal’s “retraction index” and its impact factor (Figure 2).³³

That might not mean the rate of fraud is increasing – rather, the rising retraction rate might actually be due to an increased awareness and responsiveness to misconduct, rather than increased misconduct itself.³¹

[Grieneisen and Zhang](#) examined not just numbers of retractions, but *why* articles were being retracted. Of the 4,449 retracted articles found

*Publishing in *EMBO*, a European journal, plausibly explaining why U.S. metric fiends hadn’t caught on to it.

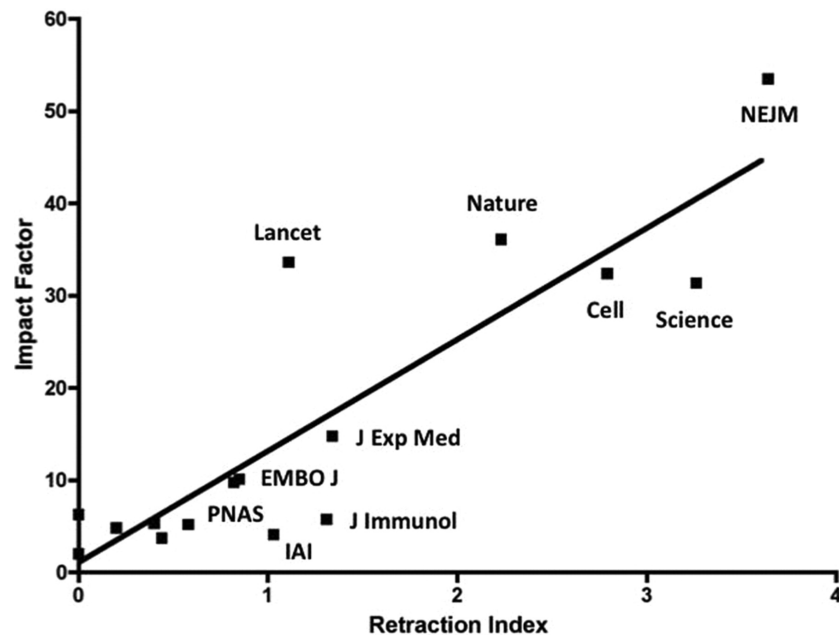


Figure 2: "Correlation between impact factor and retraction index. The 2010 journal impact factor...is plotted against the retraction index as a measure of the frequency of retracted articles from 2001 to 2010."³³

in 42 of the largest bibliographic databases from 1928-2011, retractions were due to:

- 47% alleged publishing misconduct[†]
- 20% alleged research misconduct
- 42% the usage of questionable data or interpretations

stack to >100%
because more than
one reason is often
cited

Of the alleged research misconduct, fifteen individuals accounted for >50% of the retractions. While Grieneisen and Zhang admit the growth in retractions by a factor of 11.36 does exist (excluding repeat offenders, adjusting for literature growth), they assert that research misconduct of the fraud variety underlie most retractions; i.e. the retraction rate is likely due to social factors, not changes in rigor or intentional deception.⁴⁶

Summary re: conflicting evidence, but there is concern, which is more the point.

3.3.1 Statistical Failures: Underpowered and Badly Analyzed Data Sets

everybody is bad at statistics, our stuff is underpowered and selective etc., we don't report data so we can't actually check how much statistics are being done

Power failure: why small sample size undermines the reliability of neuroscience – Button et al.¹²

Puzzlingly High Correlations in fMRI Studies of Emotion, Personality, and Social Cognition (originally Voodoo Correlations in Social Neuroscience) – Vul et al.¹⁰⁸

[†]Peer review and citation RINGS. People making up email addresses. What a fuckin' world.

Willingness to Share Research Data Is Related to the Strength of the Evidence and the Quality of Reporting of Statistical Results – Wicherts et al.¹¹³)

3.3.2 File Drawer Problems, Negative Results, Publication Bias

Publication bias occurs when results of published studies are systematically different from results of unpublished studies. . . Empirical research consistently suggests that published work is more likely to be positive or statistically significant ($P < 0.05$) than unpublished research [according to a cited 1993 study??].

23,58

What happens when something doesn't work? When do we keep pushing, and how do we say "This disproves our hypothesis"? An experiment that is *not* working that *should* work (with regards to the current literature) lays its blame on reagents, on the technical skill of those involved, on the time of year[‡], as seen in – everywhere but the "science" (i.e. the realities of the world). A 1991 *Lancet* issue is usually cited as the first publication to directly point at the issue. Easterbrook, Gopalan, Berlin, and Matthews reviewed a set of clinical research trials, concluding:²⁴

"Studies with statistically significant results were more likely to be published than those finding no difference between the study groups. . . Studies with significant results were also more likely to lead to a greater number of publications and presentations and to be published in journals with a high citation impact factor. An increased likelihood of publication was also associated with a high rating by the investigator of the importance of the study results, and with increasing sample size."

The tendency is often called the "positive publication bias", but it's might be more accurately described as bias towards *interesting* results: a high-profile study refuting another high-profile study in a positive-negative loop is just as exciting as the first positive results were.⁶⁵

The positive is not limited to clinical trials or the eternal scapegoat of psychology: animal research, and fields like ecology, molecular biology, and physics show a similar (if decreasingly prevalent) bias.

One effect of this is the file drawer effect: many studies in a given research area may be conducted but never reported, leading to a set of journal articles wholly unrepresentative of the actual state of affairs. An extreme example: if the null hypothesis is "true", but the 5% of studies that by *chance* show a statistical significance are published while the rest of abandoned data stays in a theoretical file drawer, useless to everyone but the carpenter ants.

The tendency towards significant results come from a combination of social factors and the inherent chance involved in testing biological systems. Scientists are extremely loath to submit a paper with negative results.⁷⁸ Journal editors, especially those in high-impact journals, are less likely to accept them. are more likely to recommend a

find ref for on statistics abuse inbiology, ecology, and physics. And math, if it exists? questionable

[‡]Of course, the time of year *is* a meaningful factor, re: Otto Loewi and acetylcholine in frogs

positive-results paper be published, award positive-results papers better methodological scores, and are more critical and detect more errors in papers with non-significant results.²⁸ Negative results also garner more requests for additional data points and statistical analyses than identical papers with significant results.⁹⁰ Readers are less likely to be interested in hearing about therapies that *don't* work

According to Ioannidis, negative papers are most likely to be suppressed when:^{54,116}

- studies conducted in a field are smaller
- effect sizes are smaller
- there is a greater number and lesser preselection of tested relationships
- there is greater flexibility in designs, definitions, outcomes, and analytical modes
- there is greater financial and other interest and prejudice
- more teams are involved in a scientific field in chase of statistical significance

Whatever the reason, the current journal system, the de facto dissemination system for scholarly production, is not representative of the research that's actually happening. Researchers may spend years trying to duplicate results, since the papers of failures to replicate weren't published. Meta-analyses, papers that use the entirety of collected data in a field to compare results, can only draw on the published data, which has a distinct bias towards significance.

3.4 IMPACT FACTORS AND CITATIONS

“Does the pressure to publish in prestigious, high-ranking journals contribute to the unreliability of science?”

Brembs, Button, and Munafò

Citation is the metaphorical currency of science, a way of paying homage to previous work and making sure scientists receive their proper due. It also functions, in a globalized/linked/connected world, as convertible and real currency. Citation counts now function, however, as a proxy for scientific success, first by those outside the academy, and now as a selection metric for researchers engaged in the “literature deluge”.³⁵

Nominally, choosing papers to read and base future work on is based on relevance and applicability of the literature. There is, of course, a deluge of literature, and it's nigh-impossible to keep up with the flow of information. One technique employed by scientific audiences in deciding where to invest their reading time is the prestige rank of a journal; similarly, when choosing which journal will be the most beneficial venue for their work, those same rankings come into play.

“Most researchers acknowledge an intrinsic hierarchy in the scholarly journals (“journal rank”) that they submit their work to, adjusting not only their submission but their reading strategies accordingly.”¹⁰

“The citation game has created distinct hierarchical relationships among journals in different fields.”¹¹⁶

Qualitatively, the top of the biology journal hierarchy is the *Cell*, *Nature*, and *Science* triumvirate; journals that are instantaneously recognizable and eminently reputable. To get a *Cell* paper is to be immediately taken a little more seriously.[§]

*Presumably physics
and plants as well,
but it seems like
Nature mostly does
bio? I have literally
no idea*

Quantitatively, the journal hierarchy is represented by the Journal Impact Factor (IF), calculated for journals by publishing house? mass-media company Thomson-Reuters, specifically their *Web of Knowledge* (WoK) citation network. The IF was originally proposed as one metric of many to track scientific productivity: a simple mathematical formula reflecting the number of citations of a journal's material divided by the number of citable materials published by that same journal.^{¶60}

$$\text{Impact Factor} = \frac{\text{number of citations}}{\# \text{ citable materials published}} \quad (3.1)$$

"The original intention for the use of the impact factor was to allow comparison between the citation rates of journals. . . This has proven invaluable for researchers and librarians in the selection and management of journals."⁶⁰

That's all well and good, but like with many metrics, it's applied with a widening and indiscriminatory brush. IFs have evolved from one metrics of citation rates to one approximating journal quality overall, on the premise that a higher citation rate of papers indicates higher quality papers.⁶⁰ From there, the journal IF serves as a marker of quality on individual papers and researchers. Eugene Garfield, the first one to describe an IF type system, considers these applications an abuse of a simple equation. Likely yes, but it nonetheless has serious consequences for the scientific ecosystem of research, hiring, grantsmanship, and publishing.

*Metrics immediately
lead to gaming the
system.*

3.4.1 choose their acceptances

... Editors make estimates of likely citations for submitted articles to gauge their interest in publication.¹¹⁶

Journal editors and publishing administrators shape what we see and pay attention to; peer reviewers have to maintain impartiality when reviewing the make-or-break publication of their competitors.

Scientists, especially high-profile and competitive ones, choose carefully which journals they'll submit to. It's a game of saying is this research trendy *and* of high enough quality *and* an original idea *enough* to make it in this high-impact journal or another? A manuscript submission takes months and in the intervening time, the manuscript can't be sent out anywhere else. This means choosing a too high impact journal is a loss of months of publication time; but publishing in a less-cited journal can have serious consequences on tenure decisions, grant applications, and other administrative gambols.¹¹ It also sets up a

*Who thought this
would go well?*

[§]Sources are: my life, everybody's life, a lot of blog posts, general atmosphere. Like, if I see a *Nature* headliner, I'm more likely to be excited and impressed.

[¶]insert time (2 years) and other data

¹¹There's a number of sources denying that IFs are specifically counted in any of these. But they're certainly powerful tokens in the scientific imaginary, from which reviewers of any kind are hardly exempt.

choice along the lines of relevance: should one publish in a high-profile, non-specific journal

They powerfully discriminate against submission to most journals, restricting acceptable outlets for publication.

Moreover, impact factor trumps audience: while a field-specific journal might make your research more visible to people who could use it, it won't have the same on-paper look as a **CNS journals!** (CNS journals!) publication.

effects on the kind of research that gets done and accepted

3.4.2 *Fraud in High Impact journals*

“What is obvious from this equation is that the impact factor depends crucially on which article types Thomson Scientific deems as “citable”—the fewer, the better (i.e., the lower the denominator, the higher the impact factor).

... Because a journal's impact factor is derived from citations to all articles in a journal, this number cannot tell us anything about the quality of any specific research article in that journal, nor of the quality of the work of any specific author. These points become particularly evident by understanding that a journal's impact factor can be substantially affected by the publication of review articles (which usually acquire more citations than research articles) or the publication of just a few very highly cited research papers.

The PLoS Medicine Editors 2006¹⁰⁴

Science is based on building on, reusing and openly criticising the published body of scientific knowledge... For science to effectively function, and for society to reap the full benefits from scientific endeavours, it is crucial that science data be made *open*.

The Panton Principles

pantonprinciples.org, 02/16/2015

Knowledge is open if anyone is free to access, use, modify, and share it — subject, at most, to measures that preserve provenance and openness.

The open definition

opendefinition.org/od, 02/16/2015

When applied to the different “problem” areas of 3, open becomes a ragtag team of co-existing, largely collaborative initiatives.

Science as an institution feels like it’s falling apart (from my perspective) because what’s actually happening is so different from what I thought. Knowledge is limited, disparate, disorganized, and unreliable; it lives behind digital paywalls contrived to keep science in the realm of the fiscally elite and educationally privileged and tucked into papers full of jargon. Science doesn’t replicate well, even when it’s purely 1s and 0s: the reliability of computer programs (to present stimuli, record data, crunch numbers) is limited to the labs that wrote/interact with the program; attempts to getting access to the generative programs fail almost every time. When scientifically-minded readers try to look deeper into statistical manipulations, datasets typically fail to materialize;¹¹³ when they are available, they’re often disorganized and poorly documented.

research conflict between different areas of openness

Fears about tenure, funding, prestige, and scientific sex appeal shape research courses and successes, while academic research is regularly shuttered by the funding whims of the NIH. Research between groups at higher levels feels cutthroat; it’s no longer about the pursuit of truth, but the pursuit of the ability to keep trying. Publishing groups hold an unnatural kind of power, it seems, by determining what *counts* as good, interesting, novel science.

research rise of commercial publishing groups

The solutions to this, or the ones I’ve been taught, rely on the Internet and technical know-how, and are geared towards a generation that grew up on Napster and the Pirate Bay. The vision is one of scientific transparency – making the inner workings of science not just visible, but modular, minable, and usable by anyone who cares to try. I think (of course) that this is the path science *has* take to fulfill the the high-flying ideals of the Mertonian ethos. Open science is not just about using more technology; it’s geared towards reorienting the whole culture of academic research towards a more sharing-and-caring system, whatever that might mean to individuals.

think: is open science good or bad? am i just describing or making a moral judgement?

Open science starts at the end of the chain: long-standing initiatives to make journal articles, the polished final product of scientific research,

find ref for Mertonian ethos

whoops terrifying myself

accessible. Then, it moves deeper, demanding not just the results the authors choose to highlight, but the data powering authorial interpretations. But wait, how did they acquire the data? If they did it with a program, then we need that too. Everything that happens in the academic lab should be like a pharmaceutical lab – tracked, tagged, recorded, and visible.

Note not all specifications apply to all fields; different norms about data, access, code, and process prevail in different areas. Physics, of course, has been a leader in accessible publishing since the founding of the arxiv; crystallographers have been sharing crystallography data since the fields inception. Ecology, on the other hand, is notoriously poor at sharing data (likely due to the incentive structure of the field)

4.1 PERSONAL MOTIVATIONS

The lofty goals of open science have a practical policy implementations. In my own scientific practices, those practical nuts-and-bolts of open access, open code, open data are something I am hyper-aware of; they have directly shaped my own projects and those around me.

Access to literature is immediately applicable – there’s not an academic I know who doesn’t feel the pinch of journal costs. But I want to start with code, actually, because of the surprising and constantly frustrating ways it’s been a problem for me. Surprising because I don’t *do* code scientifically; or at least, I didn’t.

One of facets of this thesis is a self-bibliometrics; that inspiration draws from two papers that examined the gender and geographic distribution of the two scholarly databases, [WoK](#) and JSTOR databases. Both [West et al.’s Role of Gender in Scholarly Authorship](#) and [Larivière et al.’s Global gender disparities in science](#) have enormous potential to help researchers assess the gender imbalance in their own libraries. To my chagrin, however, despite one paper in Public Library of Science ([PLoS](#)), notorious for open policies, and another in *Nature*, which has recently implemented an open code policy, neither set of authors has released any code, publicly or upon request, despite their results being *entirely* dependent on digital data manipulation. If they had released their (even small bits of it) programming, it would have saved me hours of time, given my work a better base to build off, and let me do more.

Journal access is more basic. Nearly all of my papers are adorned by an the Massachusetts Institute of Technology ([MIT](#)) logo, but even then, many humanities and lower-profile scientific journals are behind paywalls. My barriers are largely price-related, but that’s only because I’m not proficient enough as a coder to know how to effectively interact with machine-readable literature.

relationship w/ data

open notebooks?

These scientific issues have been a thorn in my side my entire scientific career, so the discovery of a movement that validates my concern and proposes a mechanism to solve it is alluring and, despite hurdles, something I firmly believe would have changed, for the better, the science I do.

granted, a career
only 5 years long

4.2 LITERATURE ACCESS

Open access scholarly publishing addresses the barriers to accessing peer-reviewed scholarly journal articles. An exclusively digital invention, Open Access (OA) literature is

where does passing off copyright of articles fit in?

“digital, online, free of charge, and free of most copyright and licensing restrictions. Ideally, it removes both removes price barriers (subscriptions, licensing fees, pay-per-view fees, i.e. gratis) and permission barriers (copyright and licensing, i.e. libre).”¹⁰¹

More succinctly, “true” OA literature has free availability and allows unrestricted (re)use.

Subject, at max, to crediting the proper sources in your scientific remix

MONEY AND KNOWLEDGE The debate around access to cultural products usually occurs in the context of “creative” industries. Who has the rights to remix music and movies? What does it mean to re-use characters from published literature for fanfiction? Is pirating software wrong? It depends on who you ask, but the argument against free culture usually boils down to: Intellectual Property (IP) should cost money because the producers need to be paid. Musicians, artists, authors and filmmakers make their living via royalties or direct sale of their work.*

“creative” being a loaded term

Scientific authors and their publishers, on the other hand, occupy a specialized realm where the actual release of knowledge is unaccompanied by any direct movement of money into the author’s pockets. Scientific authors move forward without any expectation of direct payment (“royalty-free literature”); they write for impact, not for money, and because advancing knowledge in their fields also advances their career.¹⁰¹

This puts the debate about open access in a different place than contemporary movements for copyright-free cultural production in other realms; what exactly *are* subscribers paying for?

Scholarly journals provide, of course, a number of services – one list by a publisher at *Science* listed 82 hats a scientific publisher wears, from social media outreach to the care and feeding of peer reviewers to handling to making sure articles disclose all necessary conflicts of interest.² Publishers *also* used to provide delivery of a hard copy of the journal to your local academic library’s doorstep. One assumed subscription costs largely went to the paper-and-ink printing costs; paying substantial fees for ownership of the physical product was only reasonable.

With the advent of digital publishing, the role of journals in adding value to science is muddled. If journal authors aren’t directly paid for their journal submissions, physical costs of production are insignificant, and libraries have downgraded from owning paper copies to leasing digital entities, what are subscription costs really paying for? If all the *other* participants – submitters, publishers, editors – are doing their share of the work for free, why is the publisher still posting profits of 30-40%, in the realm of \$106 million (John Wiley & Sons) and \$1.1 billion (Elsevier)?⁷⁰

Even things like typesetting are now often passed onto submitting authors in a digital era

*Although this is already troubled...fellowships and grants go to the art world etc. And to be clear, I don’t think the copyright terms *there* are really great either.

In moral terms, if the goal of publishing is to disseminate information and advance science, why should other other scientists, or potential scientists, be barred from the universal pool of knowledge by an artificially-constructed digital barrier? When taxpayers fund a great deal of the research, and most contributors aren't directly paid, why not have unrestricted access to the great project of Western science?

4.2.1 *Misconceptions*

Open access literature is not free *gratis* to produce or publish.

"Free is ambiguous. We mean free for readers, not free for producers. We know that open-access literature is not free (without cost) to produce. But that does not foreclose the possibility of making it free of charge (without price) for readers and users."

Open access is not synonymous with universal access. Even after the implementation of OA policies, access barriers remain. Per Murray-Rust:⁷¹

- Filtering and censorship barriers. Many schools, employers, and governments want to limit what you can see.
- Language barriers. Most online literature is in English, or just one language, and machine translation is very weak.
- Handicap access barriers. Most web sites are not yet as accessible to handicapped users as they should be.
- Connectivity barriers. The digital divide keeps billions of people, including millions of serious scholars, offline.

4.2.2 *Implementing Open Access*

implementing open access

4.3 DATA

Data is the heart and soul of science; "let the data speak" is the clarion call in any argument where you just want the *facts*.

data a set of values of qualitative or quantitative variables collected during scientific activities

In open science, the publication of data sets goes hand in hand with the OA. The goals: make data points work harder (i.e. in re-use and meta-analyses) and mean more (i.e. statistical manipulation and the raw numbers available for double checking).

'Pure' data points, collected for non-specific purposes, have been historically important. Mendeleev's proposal for the periodic table of elements was based in part on published data on elemental melting points, colors, and densities.⁶⁹

Murray-Rust on the unexpected uses of open data

More recently, the biggest successes of massive data sets in applied science have been in biology and astronomy.⁹⁹ The Human Genome

find ref for
page number
in mendeleev's

Project ([HGP](#)), declared complete in 2003, has enabled the discovery of over 1,800 disease-related genes. The deposition of the initial genomic sequences into the National Center for Biotechnology Information ([NCBI](#)) databases and the precedent of genomic data-sharing that deposition set has allowed

In astronomy, the Sloan Digital Sky Survey ([SDSS](#))

research fact
sheet on usage
statistics of NCBI

research sloan
digital sky sur-
vey

Meta-analyses Open data extends the useful life of data collections by combining and manipulating datasets, like bio-informatics using the [NCBI](#) datasets to generate phylogenies and genetic analyses. Aggregating datasets allows for more thorough and meaningful meta-analyses (when the appropriate controls are in place, of course).

Statistical reliability Open data hopes to achieve statistical reliability: your table of aggregate numbers becomes much more meaningful when we can manipulate the data ourselves.

4.3.1 *Why We're not doing it*

all from [Pampel and Dallmeier-Tiessen](#)

1. "legal issues",
2. "misuse of data" and
3. "incompatible data types" (Kuipers & Hoeven 2009)
4. "insufficient time" and "lack of funding" (Tenopir et al. 2011).

campbell et al, 2002

In this study that involved about 1,800 life science scientists, they identified two central factors that hinder Data Sharing: "Lack of resources and issues of scientific priority play an important role in scientists' decisions to withhold data, materials, and information from other academic geneticists."

Articles for which the underlying data is shared are more frequently cited than articles for which this is not the case. This is substantiated in studies from genetics (Piwowar et al. 2007; Botstein 2010), astronomy (Henneken & Accomazzi 2011; Dorch 2012) and paleoceanography (Sears 2011).

People are bad at statistics

4.4 CODE

Hardware as well?

Once we move on from hardware, code is how many scientists interact with their data. Programs and scripts control how and when information is collected, what kinds of metadata we can use, how we parse, smooth, and manipulate data, the final presentation of data on our screens and the figures we submit to journals. From computational biology scripts to psychology stimuli, from graphing ecology datasets to standardizing microscope exposures and image processing, code, in a very real way, *is* the science.

rewrite the people who use code are not the people generating the data

rewrite role of code/tech – re: measurements? and measuring

To make sense of scientific data they must be analysed. In all but the simplest cases, this is done by software. The extensive use of software poses problems for the reproducibility of research. To keep research reproducible, it is necessary to publish not only all data, but also the source code of all software used, and all the parametrization used in running this software.

"Talk is cheap. Show me the code." -Linus

find ref for coding errors and analysis

Code is prone to errors. As per Eric Raymond in *The Cathedral and the Bazaar*, "Given enough eyeballs, all bugs are shallow." Like with software development, in the generation and analysis of data using computer code, not all bugs manifest with outward syntactic issues where the code won't *run*. Instead, bugs are type errors, or misplaced loops: semantic errors that systematically and insidiously warp results. Debugging, perhaps in science especially, is non random and biased towards seeking positive, confirmatory results.^{100,81} †

If you generate numbers with code (which, realistically, you do), that code should be open so it can be checked for accuracy.

Code can and *is* re-used. As demonstrated by my desperate attempts to build and extend the work of West et al.¹¹¹ and Larivière et al.⁶² in a bibliometric analysis of gender in publications and I *can't* because they don't *share their fucking code*. The relative speed of science is slow; the speed of a single researcher is even slower. While using the code of others can be a risky proposition, it can also be an important stepping stone to bigger and more advanced projects.

4.5 THE INTERACTION OF DATA AND CODE

Making data freely available will certainly allow others to attempt to replicate the published results using the stated analysis pipeline given the same data. (comment on Stokes¹⁰⁰)

connect code to what code generates in terms of data – Rust on presenting NMR spectra as direct output, not graphical

4.6 OPEN NOTEBOOK SCIENCE

"Open notebook science is the practice of making the entire primary record of a research project publicly available online as it is recorded. This involves placing the personal, or laboratory, notebook of the researcher online along with all raw and processed data, and any associated material, as this material is generated."

-Jean Claude-Bradley

Notebooks are, plausibly, the closest thing to heart and spine of the scientific process. In addition to computer collected data, a good lab notebook tracks the experimenter. Researchers capture their in-progress thoughts, the reasons behind experiments, their day-to-day protocol

†I.e. if you use an int type number in Python, python will round the results. This error will produce approximately accurate results – but certainly not with the calculated specificity, and might introduce other small-but-meaningful errors.

adjustments, notes on dropped tubes or hastily drawn sketches of experiments. Notebooks are ground zero for wet lab science

All of the elements so far of OS – data, methods, conclusion, code – are (theoretically) documented and organized somewhere, in some combination of paper and digital record-keeping. The simplest solution might just be to make notebooks open from the start. In an ideal world, this tracks not only eventually successful projects, but shows other researchers where failure likely lies. A documented and constantly updating notebook makes it easy to trace the more realistic scientific process, one of fits and starts and ad hoc modifications, why *this* Tag was used instead of *that* one, a process where sometimes a single step takes 25 tries. An accessible scientific notebook complicates the eventual scientific paper, giving future researchers a better idea of how reliable results might actually be.

research notebook usage in different fields

origin of phrase for ground zero?

4.6.1 *Open Notebooks in the Wild*

The first open notebook, and the originator of the term, was Jean Claude-Bradley, a chemist, in a blog post in 2006. He started a project called UsefulChem, a project exploring synthesis and testing of anti-malarial compounds in the effort to hasten the search for an effective cure. A paper published out of the project included, as a supplemental material, the entire lab notebook of the project.

The group has also added a similar project on HIV.

A more recent high-profile open notebook scientist Carl Boettlinger, a mathematical ecologist who's maintained an open lab notebook, hosted on Github, since 2010. His work has been written up three times in *Nature* alone (once in 2013, twice in 2014).^{39,68,106}

find ref for open notebooks as supplementary material

rewrite Claude-Bradley, implementations and origins of ONS

4.6.2 *Implementations*

- github
- wikis
- open wetware
- OSF
- zappy lab stuff?

4.7 ISSUES

If Impact Factors and paper publication is as meaningful to academic scientists as the research indicates, publishing data, methods, and notebooks is not a rewarding activity. It does not garner impact, citations, or additional funding; the unit of success remains the journal article, so why should researchers bother?

Open science advocates cry “because it’s the right thing!”, but realistically it’s unreasonable to expect a culture shift *just* because it’s the right thing.

There’s also some reasonable concerns about the practicality of open science in regards to data confidentiality and choices about *which* science to share.

using URLs and hyperlinks with classic thesis

4.7.1 *Citation*

figshare.com
dryad.com

provide exam-
ples of citing
data

Even while other reformers push for more flexible and realistic assessments of scholarly contributions, open science modes can still be slotted into current incentive structures. Code and data can be cited; hosting repositories like **Figshare** or **Dryad** provide Digital Object Identifier (DOI)[‡] for uploaded information and instructions on how to incorporate data citation in a variety of formats.

4.7.2 *Scoops!*

- varies by field (i.e. 10 ecology papers per dataset vs 1 for...other fields)

4.7.3 *Confidentiality of Data*

Obviously metadata should be cleaned. This is an issues largely in clinical trials involving people or interviews. I just. Aren't you working with cleaned up data ANYWAY?

4.7.4 *Which Data do you share?*

IDK SOME OF IT.

4.8 MACHINE READABLE EVERYTHING

4.8.1 *practical issues in data sharing*

Which data, when, and in what format?

A PhD student at the Champalimaud Neuroscience Institute studies cuttlefish feeding habits. As part of the dissertation, she's collected hundreds of hours of video of cuttlefish trials; so far, the raw data occupies two terabytes of hard drive space.

find ref for per-
sonal communi-
cation w/ TT re:
data sharing

Not easily answerable questions, but maybe part of that holding contradictions?

regulations and principles

organizations demanding sharing!

incentives for data sharing

funders ask for it, but hard to actually d

credit for data publication

4.8.2 *Methods*

open source lab reagents? because we buy them for ease of use, not necessarily because we *couldn't* make them ourselves. we'd still buy clean up kits because they're CONVENIENT

[‡]A DOI acts as a permanent short URL for easy and reliable web access; reliable access on the web is, of course, *extremely* tenuous, even for nominally archived and maintained thing. The clash between web technologies and citation networks are a whole other div.

actual reproducibility is...let's be honest, not great with the way methods are currently presented in papers. even in supplemental data (only available online, although typically as a gratis addition).

If methods are supposed to aid in reproducibility, there's some breakdown b

research method
sharing

4.8.3 *but it's hard and i'm a baby!*

"Data curation should be a necessary cost of research, but a very small part if implemented correctly." (comment on boulton 20212)

4.9 CHEMICAL CASE STUDY?

4.9.1 *Case Study*

One of the "giants" in the open science world was the now deceased TEXT AND DATA MINING –

This may appear impossible to understand but it has a fairly regular microstructure and our OSCAR toolkits can make a great deal of sense of it. OSCAR-DATA was originally developed (Experimental data checker: better information for organic chemists) through sponsorship of the Royal Society of Chemistry (Experimental Data Checker Homepage) and is now developed as a standalone data-checker. Simply cutting and pasting the above text into OSCAR-DATA gives the result:⁷¹

Most of the suggestions of from “open science” centers around assumptions about access, knowledge, and distribution. The more interesting and radical ideas toy with re-envisioning whole new systems of scholarly production and communications; the more sedate merely push for scientific knowledge as a public good. The key(s) to this analysis of open science lies in two conceptualizations.

1. **OS advocates are unabashed in their vision of science: help people (and do cool stuff along the way).** this is achieved by both accelerating research and sharing results with more people.

- *In biomedicine:* Jean Claude-Bradley, an open science “giant”, founded his UsefulChem malaria project to accelerate the discovery of malaria cures. Advocates for the publication of *all* clinical trial results push because it is a patient’s right to know the full scientific history of their medication.
- *In geology:* Geology and earth sciences are tightly linked to policy decisions about environmental concerns. In things like “‘Cimategate’ - rooted in the resistance of climate scientists to accede to requests from members of the public for data underlying some of the claims of climate science”⁸, open data could mean the difference between trusting scientific goodwill and the State of Florida’s ban on the phrase global warming.
- more here – physics; ecology; psychology, economics?? what even are other fields? what is science?

find ref for
florida banning
global warming

2. Open science isn’t of course not one unified, realizable vision, **but it is the direction Science, Technology, Engineering, and Math (STEM) fields are moving**, in a way that is not true for free software and analogous open movements.

The [NIH](#), a major funder of research in the U.S., requires all of the published articles based on [NIH](#) funding be made available, free of charge, within one year of publication. The Wellcome Trust, the second largest non-governmental biomedical funding source, also requires scientists make their publications *gratis* accessible. *Nature*, the world’s most high-profile general purpose scientific journal, has recently updated their publication policies to “strongly encourage” data deposition and requires statements about code availability (<http://www.nature.com/authors/policies/availability.html>, accessed 03/25/2015). Some version of open science lies on our horizon.

If that *is* the case, we can start to ask our questions here. If we achieve the stated goals of an open science system, what new problems does that present to the feminist and reconstructive observer and participant? If open science continues on its present course, what values comprise our new, open world? What parts of the current open science ethos should we strive to keep or work to excise?

5.1 ASSUMPTIONS

maybe open science assumptions should be focused on biomed?

rewrite maybe why thought style and paradigms are so important as a phrase? have to choose and stick with one earlier

Teasing out the characteristics of the thought style of open science is one place to start. This set of assumptions guides the formulation of the problem (scientific generation isn't going great!), the plausible solutions (open it up!), and beliefs about what opening it up will yield as consequences.

Science is the *right* kind of knowledge. The major scientific problems are all based around outside institutions of restriction – publishing houses, funding institutes, The State, incentives that prioritize *this* kind of production on scientific projects. The “science” itself, the pipetting or data collection, only needs modification to the extent that it should be automated, modified, and modular.

Open science presumes that perhaps the biggest thing holding science back from solving the problems of disease, death, and dismemberment is scientists. Changing the culture to one of sharing and openness would, necessarily, make the science *faster*. The issue is never scientific production itself, but the speed and how many purposes can we put knowledge to.

OS makes no strides towards more humane science. It offers accessibility as bait, but puts no focus on collecting *different* kinds of information (feminist karyotypes, or examining neglected tropical diseases), or re-shaping the kinds of input we accept into the scientific process.

The semantic web that will search the scientific literature will not draw on academic feminism, even though that is equally text-minable. Semantic web searching to identify high-priority or high-relevance papers

The mythical Public The division between science and layperson is very real in the imaginary realm, and very blurry in the real world.

NEOLIBERALISM?

Prerequisite knowledge In a Do It Yourself (DIY) culture, who has intellectual access to literature/data/code? Making things *open* does not make them “accessible”

Who is producing? of intellectual access issues, the same people will produce (although evidence is that global South scholars do use OA resources)

data overload OKF, open access warriors
neoliberalism?

5.1.1 *But it's okay too!*

- but then you also have data/software carpentry and readme's and good commenting technique
- allows transnational organizing (Iraq Veterans Against The War); expanding biomed knowledge to places where it could be useful in direct opposition to military-bio web

no point in OA literature if it doesn't address your disease

- even though it's not good enough by itself, represents maybe a step towards re-asserting rights of "public" to

5.2 VALUES BUILT INTO THE FUTURE?

5.2.1 *Open, not free*

- political stance
 - Avoids political dedication of *libre* in lieu of open

why was open
and not free?

The open science movement is closely affiliated with the free/libre open source software (FLOSS) movement, and so it's taken as almost a default that the "free" is free as in the French *libre*, not *gratis* as we want our beer.

"The terminology of and factions within this movement are complex, but, in short, "free software" tends to be associated with the ideology of freedom, "open source" with the openness of the development process, and "libre" with those concerned about confusion from the previous two. FLOSS are used as monikers to refer to all of these meanings." (Reagle⁸⁵)

OS draws technologically-minded scientists and engineers, often people with ties to the free and open source software movement. The similarities are non-trivial; since the OS movement grows out FLOSS community, it makes sense to start there.

In FLOSS movement, there's a sharp ideological divide between free/libre and open licenses. Advocates of the libre licensing model use many lines of persuasion, but their focus is libre software as social imperative. User freedom, as laid out in the founding document of the Free Software movement (the GNU General Public License (GPL)) is paramount.

"Open source", on the other term, both as a term and in its associated licensing models, comes from an explicit attempt to side-step the social values and ideological connotations of the term "free software". It instead has a narrow focus on the access to and production of source code - i.e. the 'practical' benefits of distributed production.

Bearing that distinction in mind, as trivial as it may seem, I think the usage of *open* in OS is a valuable point of entry into the ambivalent aspects of open science. OS advocates explicitly or implicitly draw on the FLOSS and free culture movements, knowingly or not, but the chosen movement nomenclature is "open". The same disavowal (or maybe just lack of acknowledgment) of social values seen in open source is apparent in a lot of the open science movement. It's not about science helping (or empowering) people, it's about doing "better" science – more reproducible, more reliable, more powerful (disruptive, even!). Open science is defined almost entirely by the *mechanisms*, in the same way open source is *just* focused on production. Even projects that pitch themselves as a place for citizen scientists can be construed as just a way to shift labor from cheap graduate students to even cheaper laypeople.

A lot of the following ideas draw heavily on analyses of the FLOSS movement, because that's where work has been done to some extent. "Open science" isn't nearly as widely talked about or analyzed.

5.2.2 *return to the glorious past*

Open science proposes a "fix" of sorts, a return to a scientific world marked by honesty and loyalty.

I think that fraud has increased since I came into scientific research 40 years ago, as the challenges of running a successful research laboratory, obtaining funding, and publishing papers likewise have increased. In the not-so-recent past, we did not have cutthroat competition to publish in the most prestigious journals as we do today, and grant funding flowed freely. There was enough reward to go around. The life of a scientist was relatively simple, so there were fewer incentives to cheat.

“So what can we do to return to how things once were?”⁶³

Lineages of open (science)

“The most common narrative about open science tells us that, once upon a time, science was an ethical enterprise: sharing, equality, disinterest and the common good drove the everyday work of scientists. Then evil corporations entered science and changed the rules of the game, patenting life, enclosing the commons, and eventually destroying the willingness to share data, information, and knowledge. But today, so the story goes, we have new tools that together with the old open science spirit can be used to rebel against evil, defeat it and allow scientific knowledge to flow freely again. These tools are open source and open access science, and they can be used to tear down the barriers to the access of scientific knowledge.” (Delfanti, p. 5)

Open science rhetoric draws on a mystical past where information flowed free (“In the 17th century, journal publication *was* open science!”), and in so doing, constructs a seamless narrative where open science is part of every major discovery since Newton. Or whoever, pick your scientist. The construction of an illustrious history lends legitimacy to the moral appeal of the movement.

5.3 WHO IS HELPED AND GETS THE HELP?

5.4 DIGITAL DIVIDES

Lots of new scientific endeavors focus on the internet as an equalizing tool, but realistically, the digital divide is very very clear and doesn't seem to be going away anytime soon.

5.4.1 *Creation and Representation*

Who gets to create?

Generally, white men. In free software communities, men outnumber women to a much greater degree than in more traditional development structures⁷²; presumably, racial and ethnic minorities fare even more poorly, although there's even less data to support that.

find data on representation – see internet blog posts on FLOSS concerns

The dismal representation in FLOSS derives in part from a flawed perception that social stratifications and classifications “don't matter” on the internet. Code is race- and gender-agnostic (except that, for somewhat obvious reasons, it's *not*). Thus, collaborative, decentralized community structures like those in FLOSS usually fail to include any

Internet Population and Penetration

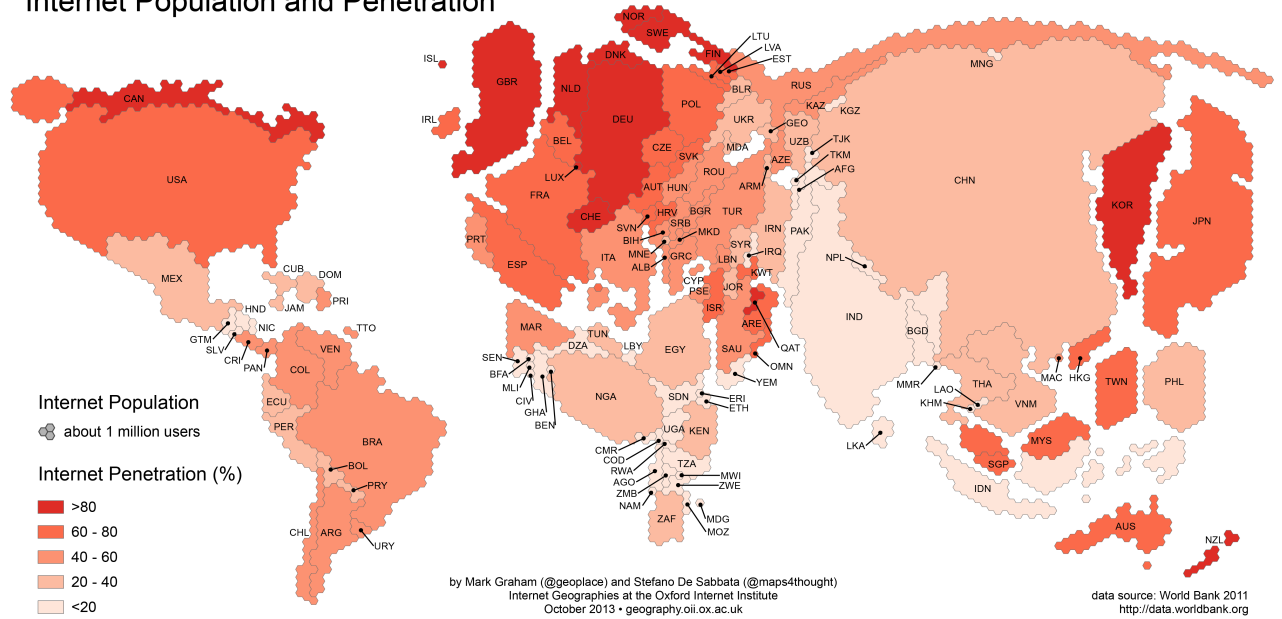


Figure 3: This map illustrates the total number of Internet users in a country as well as the percentage of the population that has Internet access.

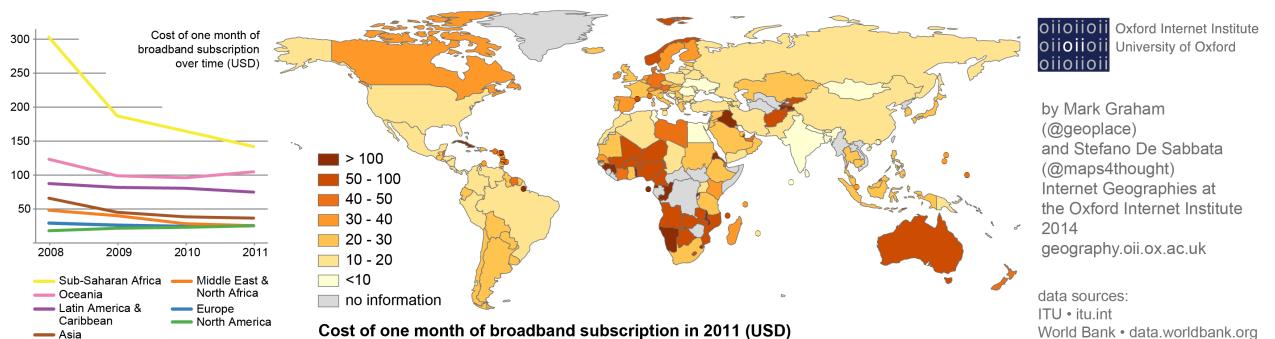
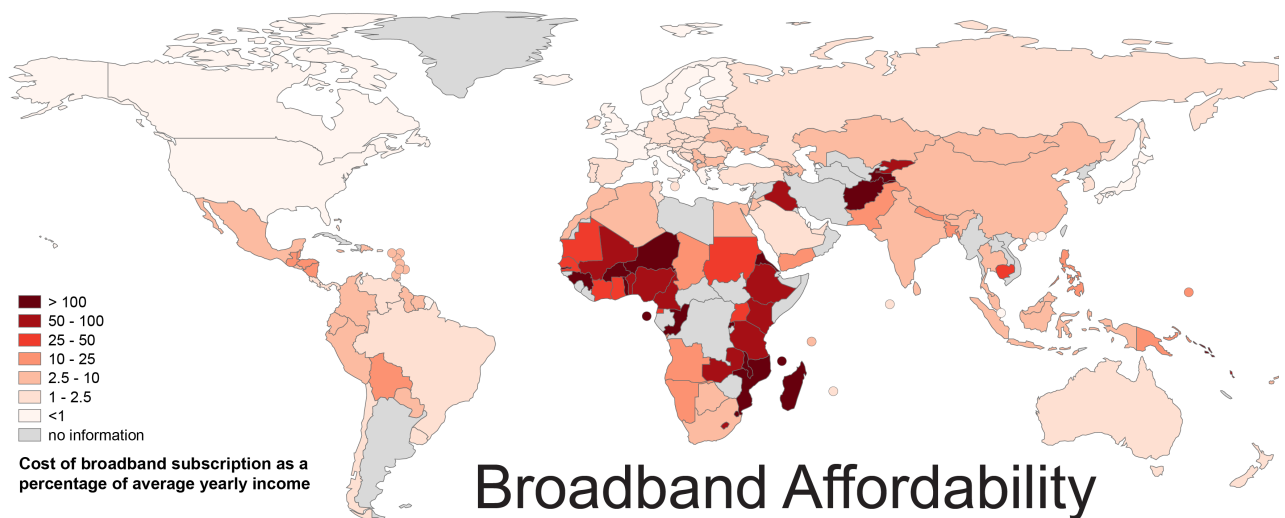


Figure 4: **Description** -This map presents an overview of broadband affordability, as the relationship between average yearly income per capita and the cost of a broadband subscription.

direct safeguards or rules about what kinds of behavior are acceptable. As a result, misogyny and racism run rampant and unchecked.

Whether representation is *worse* in open science than science at large is something I don't know yet, but it's probably fair to say that open science carries professional risks, and women and minorities in the sciences tend to disproportionately suffer for taking risks.

Who is it designed for?

- People with internet access
- technological knowledge
- hardware access, time to build and fiddle with things

/todo[inline]APCs and publishing

5.4.2 Corporate uses of open science

Interestingly, there's been attempts to implement a copyright license similar to the [GPL](#), but with a clause of "only ethical consideration"

Open science, by intent, can be used by anybody for anything. That also means corporate entities can take advantage of the methods, tools, and data released into the public sphere.

In the free software world, corporate uses aren't bad – and here, as well, I don't think they're necessarily *bad*. But they do undercut the "open is good" in the sense that corporations are notorious for only considering the bottom line. That means any usage of open resources is for the bottom line, and not necessarily for whatever heroic potential purpose open data/science advocates had in mind.

5.4.3 Global Definitions of "open" and "free"

Free software and open science are built on European/U.S. legal, moral, and social codes. Probably and definitely an issue, especially when "open science" is supposed to level the playing field but other communities, sciences, etc. aren't actually consulted in how they would like that leveling to be done in the legal sense.

RefsChristian¹⁵, Dahdouh-Guebas et al.¹⁸, Gorelick⁴⁴, Jolliffe⁵⁶

5.4.4 Indigenous sciences and local biologies

Local environments: weather systems

if indigenous sciences are local sciences, specific to the time and place and users involved, then they may not be generalizable to a mythic global community of "scientists".* And *if* we create a system where one of those many sciences is designated as the right one to be spreading, and making access to it the ultimate and only bridge to success, local knowledges are crowded out and erased. Indigenous sciences lose by virtue of what they are – non globalized, local knowledges, with no (monetary, legal) excuse to *not* use globalized standardized bits of (scientific) knowledge.

*Again, *if* science is local, there is no homogeneous global community of science/tists. There isn't one anyway tho.

5.4.5 *Effect of open access publishing on access*

Limited data implies that that OA makes the greatest impact in increasing access and scientific participation globally, and specifically in the “developing” world.

Across sub-fields, the impact of commercial online availability was positive, statistically significant, and on average 40% larger than the OA effect, suggesting that most researchers rely on institutional subscriptions.

The influence of OA was more than twice as strong in the developing world but was less apparent in the very poorest countries where electronic access is limited

Evans and Reimer²⁹, Open Access and Global Participation in Science

What is the influence of publishing OA on relative research impact? It's at least equal – impact factors and citation count remain the same.

Björk and Solomon⁷, Open access versus subscription journals: a comparison of scientific impact

5.4.6 *Digital Divides and Open Access*

“Does open access actually increase access?”

⁹⁸ Do developing countries profit from free books? Discovery and online usage in developed and developing countries compared

If OA is internet enabled (largely it is!), then...broadband matters, and broadband is not equally distributed (as per [Digital Divides, 5.4 on page 36](#))

5.4.7 *Xenophobia & Incentives*

Much of the open science initiatives are focused on incentivizing science as a field for young researchers. This belies, however, *which* young researchers count. The motivations to “improve” science come from a perception that all of the good American students are being pushed out, and foreigners are taking all of the current post-doc positions.

find ref for for quotations about all the bad foreign postdocs

5.5 ISSUES I'M RUNNING UP AGAINST

Am I criticizing open science, open science, or open science?

I can't actually do an anthology of open science in the developing world. I can't catalog all of the grassroots citizen science projects. I can only speak about my concerns and highlight specific projects that are doing well or poorly (by my standards). It is not, by ANY means, definitive or even whole.

Part II

REPRESENTATION AND ITS DISCONTENTS

intro of statistics . This % of women are in science, and this % of burden of disease falls here, probably PAY GAPS?

These are answers to the classic question of representation. How many women and people of color* are in the workforce? How many of the Forbes 500 companies are headed by women?[†] For us, that means questions about who gets to make science, and who gets credit for their work. Which kinds of physical bodies does scientific research choose to include?

In the U.S. and Western Europe, since the rise of a modern social consciousness in the 1960's, the push for more women in science is one of our early introductions to the endemic problems of representation.

maybe link to next section but hopefully stands alone? can be a cleaner transition

rewrite capitalization of different races? which ones?

Although not always men and/or women of color, and with an extremely strong xenophobic bent in the scientific establishment against the 'yellow peril' of South and East Asian immigration

6.1 THE TROUBLE WITH REPRESENTATION

When I sat down with one of my senior professors in Durban, South Africa to talk about my Master's thesis, he asked me why I wanted to write about women resistance fighters.

"Because women made up twenty percent of the ANC's militant wing!" I gushed. "Twenty percent! When I found that out I couldn't believe it. And you know – women have never been part of fighting forces –"

He interrupted me. "Women have always fought," he said.

"What?" I said.

"Women have always fought," he said. "Shaka Zulu had an all-female force of fighters. Women have been part of every resistance movement. Women dressed as men and went to war, went to sea, and participated actively in combat for as long as there have been people."

We Have Always Fought, Kameron Hurley ⁵³

The narratives around the participation of marginalized groups paint a world where those groups have *never* participated in XYZ activity. This accomplishes the complicated task of burying erasure by *our* culture in the invisibility and repression perpetrated by *their* culture. To talk about the absence of women in science and technology over the past 100 years is a disservice to the exceptional individuals who *did* participate. It is not on them, but rather on us, to recognize the histories we tell will, without serious work, elide the many and diverse Black, Brown, and White wo/men/of color. Women have always fought, and it's not their fault we refuse to count them.

rewrite awkward phrasing

*"Women" is not meant as just white ciswomen, but is inclusive of those assigned, identifying as, or read as female, of all races. People of color is not just men of color, but the women of color under the 'double-bind' of racism and sexism.²⁵

[†]24, for a whopping total of 4.8%; and only 1% are black, and *none* are openly gay

The other trouble is more deeply embedded, but fundamental to more adaptable feminist projects. We can ask where are the queers, but queer, like woman or black, is not an inherently meaningful category. Statistical questions about proportions of gendered people, minorities to White, or tall to small reinstate (re-inscribe?) recently developed social relations; race has not always defined us. Analyzing society on a large scale based on these tropes of natural categories presumes their biological and cultural naturalness, and in Donna Haraway's words,

"There is nothing about being 'female' that naturally binds women."

A Cyborg Manifesto, Donna Haraway ⁴⁸

Her argument in *A Cyborg Manifesto* for "building coalitions through affinity, not identity"⁴⁸ is a counterpoint to early feminist beliefs that more women would inherently lead to a more "feminine" and responsible science. To some extent, that's true. Researchers who have to cross gender boundaries might be less likely to presume the existence of "male" and "female" hormones; Black and Brown researchers may be less likely to assume the default of White histories for guiding their research in biological paradigms. But on the whole, there is a divide between the goals of women *in* science i.e. representation and women *and* science

Nonetheless, knowing more about who is making and participating in science is a necessary layer to a revised open/science. The history of science is a line of Great White Men; our current role models continue to be Great White Men. I am incapable of naming, even now, high-profile women scientists. Are there any? Who makes our shit?

Terminology Notes

Terminology matters and I like to be specific, sometimes

Science As the category used here, "science" plays representative to the STEM fields, focusing largely on bio/medical research and clinical applications.

This focus derives largely from where meta-research has been done. Clinical trials are prioritized as study objects, plausibly because the effect is more clear – studying a medicine in only men ignores the other 50% of the population who might succumb to a disease. Testing malaria medications in a "developed" country is clearly not particularly generalizable to a country with a completely different infrastructure. That's just good science; of course clinical research is flawed when different bodies aren't taken into account.

Clinical trials and biological research are also lower on a "Hierarchy of Sciences", which predicts that as we move from simple systems (partial dynamics) to complex (human behavior), researchers are less able to reach theoretical and methodological consensus.³² Said differently, biomedical research has more factors to manage and is thus more susceptible to social critiques. In high-energy physics, it shouldn't really matter where the research capacity is.

- Also, there *is* some representation in clinical research

rewrite phrasing – include non-binary. "You." As LJ put it

find ref for social construction of race

rewrite phrasing – maybe see Banu, Moored Metamorphoses for guide?

rewrite women in & and science

If you're wondering whether this still sucks, why yes! It does.

rewrite this linking paragraph about why I think rep. is still imp

rephrase

to cite Traweek or not?

- It seems plausible that the “harder” fields simply don’t have the capacity to create and be a part of data production at the LHC? ‡
- If you don’t have internet access, you can’t even do bioinformatics. Entire scientific fields are built purely on the internet.

research science
without internet

Global divides There is a widely-acknowledged economic, and corresponding scientific, gap between areas of the world. During the Soviet era, this was a West-East or First/Second/Third world split. In 1949, Harry Truman used the term “areas needing development,” and for many years, the divide was between developed and developing countries.

While the “divide” itself is as porous as any binary, and subject to so many exceptions it’s hardly a rule at all, we need some term to easily paint a picture of the approximate lines of the scientific divide

too casual a reference to fucking binaries?

“Global South” divides the globe along the equator into the economically wealthy (North, plus Australia and New Zealand) and poor (South). While less blatantly judgemental and not a terrible choice, “the South” eliminates the global poor north of the equator, ignores the immense diversity among countries, and continues to define the scope of the world largely around the the G8 nations of the North.

“Majority world” is an alternative was coined by writer and photographer Shahidul Alam. It highlights that the G8 countries making world-shaping decisions actually represent a tiny fraction of humankind.

G8 - France, Germany, Italy, the United Kingdom, Japan, the United States, Canada, and Russia

6.2 REPRESENTATION

The areas of representation I’m interested in exploring are both sides of the research experience, i.e. who is doing research, and what topics and people are their objects of study?

rewrite more on the topics of rep

6.2.1 Counting Heads: Are bibliometrics global?

Bibliometrics or scientometrics is the meta analysis of scientific relationships, to tell us something about the state of the field.

rewrite intro to bibmetrics

The ever-popular Thomson-Reuters [IF](#) is one kind of bibliometric, codifying the citation relationships between papers and journals in a single number. The [IF](#) is generated from the Web of Science ([WoS](#)) database, which tracks just 4% of journals from any given country.¹⁰⁹ That database is, because of its comparative breadth, depth of information, and importance as a filter on the firehose of scholarly literature, an interesting and important source of data for bibliometric analysis.

e.g. WoS includes full author names and institutional affiliation, which will become important

That 4% of included journals/country is something to explore a little bit farther. It’s less innocent than it might appear. If all countries were producing proportionally to their populations, indexing just 4% of journals would be less distressing. You could assume you were catching just the cream of the global intellectual crop. But in reality, nearly all of the most respected journals are published from the U.S. and the U.K.

‡Although this *might* not be the case?

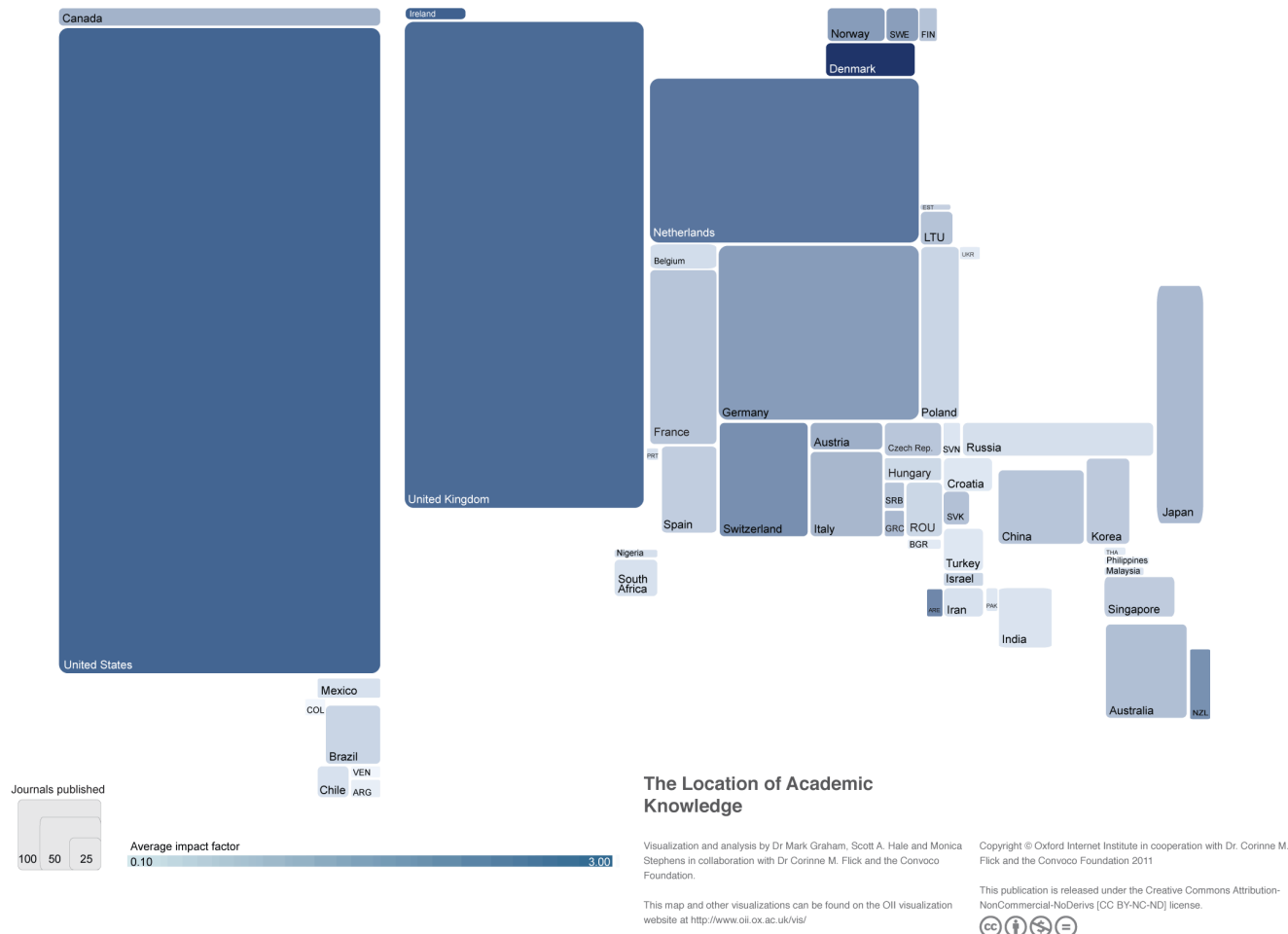


Figure 5: The location of academic knowledge

Figure 5 shows the “location of academic knowledge.” The U.S. and U.K. produce more Science Citation Index (SCI) indexed journals than the rest of the world combined; Switzerland dwarfs by a factor of 3 the entire continent of Africa. Not only do the formerly-colonized countries of the majority world fare poorly in quantity, their citation rates, as measured by the IF, are systematically lower.⁴⁵

rewrite meaning of low impact factor; also cover that if things aren't cited, they can't be seen? maybe this is already clear. but to appear in the SCIE, you have to be cited, even if it's not in a high impact journal

That isn't so surprising in light of the Thomson-Reuters standards for quality and inclusion in SCI indexing, and thus the assignment of an IF. Thomson-Reuters states:

“English is the universal language of science. . . There are many journals covered in Web of Science that publish articles with bibliographic information in English and full text in another language. However, going forward, it is clear that the journals most important to the international research community will publish full text in English. This is especially true in the natural sciences. . .” [emphasis mine]

In terms of “regional” journals:

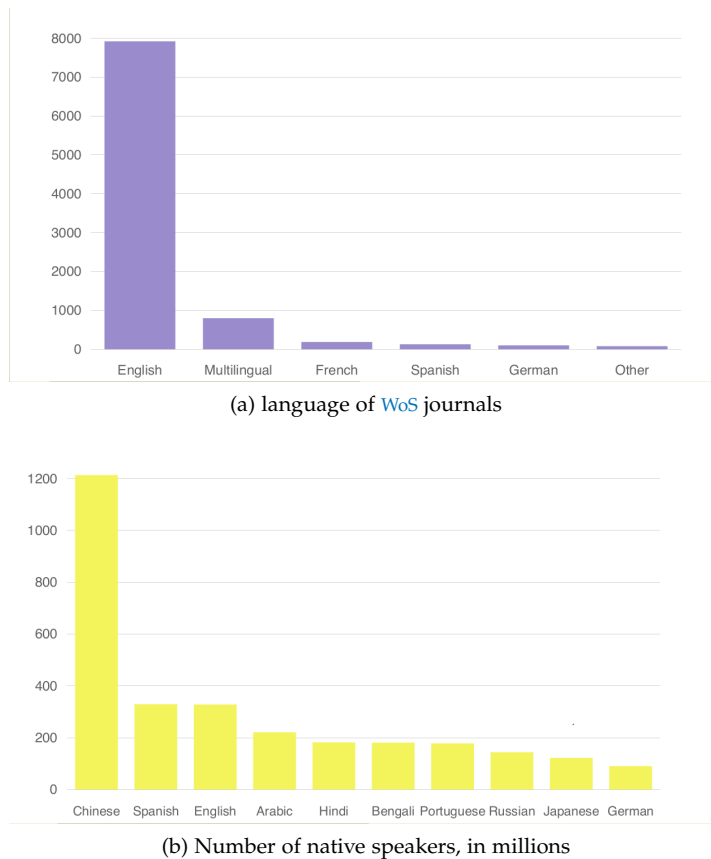


Figure 6: 2011 data language comparison

Thomson Reuters is also interested in excellent regional journals and is able to include a relatively small proportion of these each year.

So the major metric (the [IF](#)), which is linked to the visibility of the literature to authors, essentially does not include locally-specific journals and *requires* English-language publication. It is swamped by journals originating from the U.K. and the U.S. by virtue of their language, so the statistics captured by the massive databases used in many bibliometric studies systematically exclude, for example, most of the scholarship emerging from Brazil.

And now, I think most of our caveats are out of the way. Let's get to numbers! Maybe!

find ref for
brazilian scientific
productivity

rewrite transition

6.2.2 Gender Disparities

"Although there are more female than male undergraduates and graduate students in many countries, there are relatively few female full professors, and gender inequalities in hiring, earning, funding, satisfaction and patenting persist."

Global gender disparities in science, Larivière et al. ⁶²

Since the 1970s and the establishment of equal rights legislation banning outright discrimination against women and minority groups, the fate

rewrite being a
queer in science?

find ref for Leslie

Unsurprisingly,
most of these statis-
tics vary broadly
between fields and
subfields

review "van-
ish box" idea –
women leaving
academia for in-
dustry? maybe in
a longer review?

mention imp. of
author order?

Gender assigned
using Social Security
databases

rewrite and
their conclusions
were...

of marginalized groups in the sciences has improved. in 2011, women received 54% of molecular biology PhDs.

women and people have made progress in representation yay!

The scientific establishments still have a long way to go. Although explicit discrimination is borderline culturally unacceptable in much of the world, gender disparities still exist in more subtle, yet meaningful ways. On average, women publish less often than men; the difference is especially marked in fields with a high research expenditures, like molecular biology and physics.²¹

Many of the studies examining gender disparities are "highly localized, mono-disciplinary, and dated", and often fail to take into account the changing scholarly landscape of increased collaboration and⁶² Larivière et al.⁶² analyzed the relationship between gender and research output (authorship), collaboration extent (co-authorships) and scientific impact of publications (citation count according to the WoS). The authors analyzed >5 million research papers and reviews with more than 27 million involved authors.

in the most productive entries, all articles with women in dominant author positions receive fewer citations than those with men in the same position. Globally, women account for <30% of fractionalized authorship, and are outnumbered by men in first authorship positions at a 1:1.93 ratio. Female authorship is more prevalent in countries or states with lower output. And when a woman is in a prominent position (sole, first-, or last- authorship), papers attract less citations overall, a trend that holds across state and country lines.

Similar trends hold in the JSTOR corpus, in West et al.'s analysis of gender and author order in the corpus of academic papers spanning five centuries and a variety of topics.

6.2.3 Race in the academy

6.2.4 Where are they from?

global population percentages (see WHO? OAEC indices? World Bank?. And landmass areas

In 2004, Sumathipala, Siribaddana, and Patel examined the geographic distribution, via the proxy of institutional affiliation, of authors in five major medical journals over 1999 and 2000 (*BMJ*, *Lancet*, *NEJM*, *Annals of Internal Medicine* & *JAMA*) Their four geographic areas are the:

1. UK
2. USA
3. Other Euro-American Countries (OEAC), e.g. Canada and Australia
4. "Rest of World" (RoW) – grouping together the continents of Asia, South America, and Africa, as well as Eastern Europe and Mexico.

re: independence
– should look
into the devel-
oping culture of
collaboration and
thus the chang-
ing nature of
discrimination or
not

On average, RoW authors contributed 6.5% of the research literature. Of those 151 articles, 68% included a co-author from a developed country in Europe and in North American; 15 original papers in the journals used data from RoW countries with no RoW coauthors. The homogenization of the RoW countries conceals the inequity even there

Numbers are boring,
but wow, are they
depressing.

– the vast majority came from Japan and Israel (countries notable for their military establishments)[§], and only 13% came from China and India, the two most populous countries in the world.¹⁰³

That was 2000, of course, and the boundaries have shifted somewhat. Chinese production has skyrocketed, as well as scientific production in the other Brazil, Russia, India, China (BRICs) countries.

geographic disparities with up-to-date info? besides sugimoto paper

representation by discipline globally?

On the whole, while the dynamics are changing, global representation has not equalized. In southern Africa, despite the rise in absolute terms of published papers, it is falling in comparison to other parts of the world – the research capabilities of Northern institutions, as well as China’s immense research capabilities.⁵¹

6.3 WHICH BODIES ARE IN RESEARCH?

Again, this is *numbers*, not critical analysis. But the data does, in this case, speak for itself. Across the globe, the medical problems most studied are unsurprisingly the problems of the most wealthy and the most privileged. This holds for between poor and rich countries, which, as usual, is also seen along racialized and gendered lines within countries.

link to
(bio)medicalization
of issues?

6.3.1 *The 10/90 problem*

10/90 gap: less than 10% of global spending on health research is devoted to diseases or conditions that account for 90% of the global disease burden.⁴⁰

Health burdens fall differently based on geography, socio-economics, and race:

“... pneumonia, diarrhoea, tuberculosis and malaria, which together account for more than 20% of the disease burden in the world, receive less than 1% of the total public and private funds devoted to health research.”

find ref for
global burden
of disease/this
quote

What this means, practically, that the global burden of disease falls more heavily on low-income countries, and many fewer economic and intellectual resources go towards research on the medical, infrastructural, or – insofar as the global North has already made the steps to alleviate those issues.

Clinical trials of drugs occur in an approximately inverse way to the medical needs of communities. In a 2004 analysis of randomized controlled trials, of 286 trials, 43% addressed 1 of the 35 “leading causes of the global burden of disease”; almost half of the disease weren’t studied at all.⁸⁹

These are largely causes that affect the socioeconomically depressed, which also means disproportionately people, specifically women of color and those in the majority world.

[§]I don’t think the scientific dominance of Japan and Israel is an *accident*, but rather, like the U.S. biomedical-military attachments, a consequence of military aggression and dominance, e.g. Japanese nationalism and Israeli aggression in Palestine.

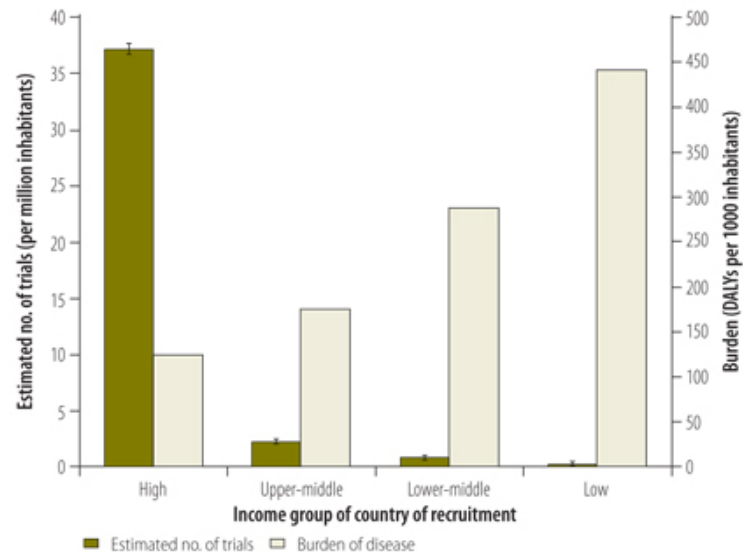


Figure 7: Estimated numbers of trials in the International Clinical Trials Registry Platform recruiting participants in low-, lower-middle-, upper-middle- and high-income countries, 2012 (Fig 4. fromViergever et al. ¹⁰⁷)

6.3.2 Focus on the minority world

whose problems

6.4 IS EVERYBODY A SUPER SEXIST XENOPHOBIC JERK?

probably

Many trends are likely not actually markers of overt discrimination against women in *publishing*, but rather that women aren't making it to the top ranks of science and thus are not in a position to be publishing or collaborating on the most important papers. Age of the investigator may be *the* determining role; older investigators have had more time to build careers, and had systematic advantages in the past.

SHIT I LIKE

7.1 TREND IN AFRICA: 3D PRINTED LABS, NAIROBI, KENYA

The Teaching and Research in (Neuro)science for Development in Africa (TReND) organization

“run[s] a wide range of educational activities, and support the establishment of top-level scientific facilities at several countries across the continent by leveraging large scale, low cost approaches to innovation and research. For this, [they] make use of latest technologies and developments, ranging from open source software and hardware approaches such as 3D printing, online teaching tools, and the use of the cost-effective yet powerful model organism, the fruit fly *Drosophila*.”

They believe

“scientific education is pivotal to the ability of societies to innovate, move forward and integrate within the global society. To date, most developing nations need to import their solutions, innovations and patents from abroad, while losing their most capable minds to Western universities. Therefore we believe that providing top-level education to local elites in their home country is key to enabling developing societies to take their futures into their own hands.”

7.2 COMMUNITIES USING OPEN ACCESS

The Public Lab project builds and publicizes cheap, easy tools to test environmental pollutants. The goal is to encourage and enable people to take control of their environment away from corporations and governments, and to provide data to oversight committees that yes, there *is* an issue.

7.3 OPEN EPHYS

7.4 GREEN NEUROSCIENCE LAB, SAN DIEGO

The Green Neuroscience lab really deserves its own section. It's a lab studying various aspects of neuroscience; it refuses military funding and is a zero emissions lab. They believe in neurodiversity and making neuroscience that empowers. They work with community members and they take their research with a grain of salt.

I *love* the Green Neuroscience lab.

Part III

CASE STUDIES

8.1 PSYCHEDELICS & PHARMACOLOGY

Culturally significant and an touchstone for identity at my (soon to be) alma mater, hallucinogens – psychedelic hallucinogens, drugs inducing a profound qualitative perceptual change – exist in the public and scientific eye as small molecules. They entered the modern scientific frame with with Albert Hoffman's 1938 synthesis of lysergic acid diethylamide (LSD) from ergotamine, a isolated compound from the rye fungus ergot and his accidental discovery, some years later, of the compound's ability to induce profound psychological effects.

In the years since Hoffman's synthesis and 'accidental' discovery, the broad class of drugs exemplified by LSD have been, variously: implicated in CIA coverups and brainwashing; a foundational symbol of counter-culture movements; effective treatment for alcoholism, obsessive-compulsive disorder (OCD), and depression; the inspiration for a number of scientific breakthroughs; as a field of battle for the rights of indigenous rights .

The current shamanistic traditions we know they come from – ayahuasca in the the past and present Amazon river basin, ergot-containing drinks for ancient Greek philosophers. etc.

The current manifestations represent a lineage of psychedelic use predating written history on all inhabited continents: cave paintings in Europe¹, archeological evidence from the desert southwest of what is now Texas and Mexico^{11,26}, and more evidence woo

these drugs have been around a hell a long time, and it's only just now that Western science/culture is beginning to treat them as a potentially meaningful therapeutic substance.

In my own experience and those around, they're either positively life-changing; or not. Some functionally similar signaling mechanism interacts with environment and person to crate this completely unique experience. Part of what's incredible about really any drug experiences is the alturning of how you think – it's a paradigm shift in the most literal sense of the word

originally plants and complexes

research native histories of drugs

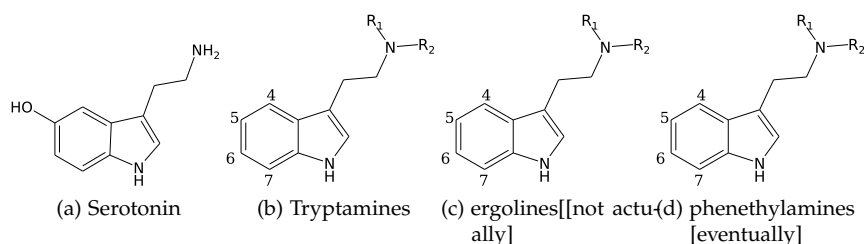
8.1.1 A brief history of scientific psychedelics

Discovered in Switzerland, underwent furious experimentation until they became a Schedule I drug (i.e. no medical usage and dangerous), and have recently started to re-emerge in the scientific literature at specific labs.

rewrite scientific history of psychedelics

8.1.2 Consciousness-raising molecules?

One small piece of the psychedelic puzzle is understanding what happens on a molecular level to induce both short and long term perceptual changes.

Figure 8: Chemotypes of 5-HT_{2a} agonists⁷⁶

Of course, the single-cell and smaller level changes are only one level of the alteration in experiences, and only make meaning in the context of networks of neurons, brain regions, the body, and the environment.

but they're still cool and I still like them. Saying this but in academic language.

8.2 THE CLASSICAL PSYCHEDELICS

For the sake of simplicity, "hallucinogens" here mean serotonergic psychedelics

find ref for receptor binding affinity

too snarky?

rewrite for clarity

find ref for drug lethality

New World?

rewrite for clarity

rewrite hyper selective?

should note somewhere that LSD is less popular than ever haha molly haha is there space for anecdotal voices here?

per herb

Serotonergic hallucinogens are classified according to their chemical structure, addictive potential, lethality or lack thereof, and the ineffable desire of humans to classify everything. They are non-addictive drugs, and users become tolerant after a single effective dose, and must wait some weeks before the drugs are effective again. They are biologically non-lethal, i.e. unlike other common recreational drugs methamphetamines or opiates, an overdose does not affect critical lower-level biological functions like breathing.

The drugs that fit these admittedly-fluid criteria are the classical psychedelics, the most well-known perhaps being the synthetic LSD. LSD has natural analogues in psilocybin, produced by a genus of mushrooms; mescaline, produced in several species of New-World cacti; and among others. The chemical analogues are numerous and endlessly permeable; while most are used as hyper-selective 5-HT_{2a} agonists, they have also percolated out as recreational drugs.

Chemically, they resemble the endogenous serotonin, and fall into one of three main chemotypes. The tryptamines, which closely resemble serotonin, ergolines related to LSD, which can be considered to be rigidified tryptamines, and the phenethylamines (see Figure 8).⁷⁶

Psychological Effects

write re: scales of consciousness

- woioeouoo pretty colors and stuff!
- non lethal, non addictive
- a qualitatively different experience than day-to-day life; a "noetic" perception that the user knows isn't real to the external world, but accepted as 'real' to their internal life
 - "or teaches them an alternate reality"
- radical life changes (pollan article, end of life, terminal illnesses, compulsions, traumatic life events)
- but also not always? ~~~~drugs~~~~

Why Receptors?

Biology's point of entry into molecule-body interactions starts with receptors. Cell-surface receptors bind the molecule and transmit a signal, or act as a channel to allow direct access to the intracellular milieu; alternately, signalling molecules diffuse through the cell membrane and then find intracellular receptors. Measuring and quantifying molecule-receptor interaction lies at the heart of pharmacology. I know this seems like an obvious statement/paragraph but it'll be cleaned up later and it's important to ME. #feminism

ignores transport of the drug to the brain, ingested, diluted and digested

rewrite this awkward sentence

All of the classical psychedelics share a binding affinity for the 5-HT_{2a} receptor normally targeted by 5-hydroxytryptamine (5-HT). LSD and ergoline analogues also bind to some dopamine receptor subtypes and 5-HT₁ receptors, while a phenethylamine like DOI binds seemingly exclusively to the 5-HT_{2a} and 5-HT_{2c} receptors. This shared affinity between the three classes for a single receptor subtype and the subsequent signalling pathways is well-established as the essential component of psychedelic signaling.⁴² (other citations later)

5-HT also has an affinity for the 5-HT_{2a} receptor, but 5-HT hardly results in an alteration of the conscious state.

Drugs have different effects than the things they mimic! Amazing. But even cooler, different drugs have different durations and experiences. The user-reported differences between drug trips can then be explained at least with a model that relies on 5-HT_{2a} activation, tempered by modulatory effects of dopamine and 5-HT_{2c} receptor activation.

Different experiential drug effects are attributed to differences in intracellular signaling cascades, as well as modulation by other receptors and neuron-neuron interaction.

consequence of this theory → idea of a therapeutic "magic bullet"

According to classical concepts of pharmacology, different ligands should only modulate the *quantity* of a signal, but not the *quality*.¹⁰⁵ The 5-HT_{2a} receptor fails to adhere to said concepts: there is evidence for ligand-specific intracellular effects on second messengers, transcription factor activation, receptor de/sensitization, internalization, and recycling, among and other effects on the intracellular environment. In the case of the psychedelics, there are distinct *hallucinogenic* downstream effects in the form of transcriptomic "fingerprints"⁴¹, and specific and preferential activation of second messengers^{42,61}.

find ref for the 100 other studies of these effects

Because biology focuses on the receptor-ligand interactions as the site of action, and downstream effects as the consequence, this is where we pick up. Our area of interest becomes very narrow: the elucidation of the intracellular signaling pathways activated by the stereoelectronic perturbation and conformational movement of specific amino acid residues at the shared binding site of psychedelic hallucinogens, ideally while maintaining the most *in vivo*-like intracellular environment possible. The grand goal remaining, of course, to explain how a small molecule can (sometimes) irrevocably shake loose long-held notions of self and meaning.

Receptors of interest address the 5-HT_{2c}, 5-HT_{1c} and dopamine involvement

8.3 THE 5-HT_{2A} RECEPTOR

Why the 5-HT_{2a} receptor is implicated. Also outline the order of this section? 5-HT receptor, localization of receptor, animal studies...then neuroanatomy, then biased signalling?

maybe LSD as fundamental to discovery of serotonin/receptors?

In humans

There is an extremely strong correlation between 5-HT_{2A}R affinity and hallucinogen potency in humans, as measured by subjective reports post-trip. 5-HT_{2A}R antagonists “ameliorate” (or reduce, mitigate, dampen) both the subjective psilocybin experience and block effects on a variety of neurophysiological measures. In positron emission tomography (PET) studies of binding, the intensity of a psilocybin experience directly correlates to the level of 5-HT_{2A}R occupation.

Unfortunately, the Schedule I status of most known hallucinogens precludes or severely restricts the human element of experimentation; research on the psychedelics is just now picking up^{77,82}

antagonists
ketanserin:5-HT_{2A/C}
risperidone:5-HT_{2A/D2}

differences between PET and fMRI re: Halberstadt and activation areas?

in animals

Psychedelic studies in animals, one could argue, somewhat defeats the point of a consciousness-altering drug experience. Mice, rats, and rabbits can’t report back on their changing views on life, the Universe, and everything; it’s unlikely that they’ll come to terms with their looming decapitation. That said, we can still decapitate them.

“Importantly, although there are some exceptions, almost all the behavioral effects of hallucinogen studies in laboratory animals are mediated by the 5-HT_{2A} receptor. . . 5-HT_{2A} activation is sufficient to produce hallucinogen-like stimulus effects.”⁴⁷

by measurement of behavioral effects

In mice, rats, and rabbits, there are a few mostly-reliable behavioral proxies for hallucinogenic potential. Administration of drugs with known human hallucinogenic potential (typically LSD or DOI) reliably induce several behaviors.

Drug discrimination The most common animal model relies on training rats (and less often, mice or monkeys) to discriminate between a known hallucinogenic drug and a vehicle control; by pressing one lever or the other, the rat “tells” the experimenter “I think this was the training drug” or “I think this was nothing.”⁷⁵ With this, animals can reliably discriminate between drug and control at low dosages that otherwise fail to elicit other overt behaviors; with a more sensitive set-up (drug-drug-vehicle), rats will also reliably discriminate between LSD and its non-hallucinogenic counterpart, lisuride.

Drug discrimination is by far the most subtle of the responses; most of the rest require much higher doses of drug administration to elicit responses.

But seriously, do you think rats try to keep it together?

I know this is true for HTR, but maybe not the rest? re-search.

Head twitch response The head twitch response (HTR) consists of 5-11 shakes of the head (in mice) and trunk (in rats), like that of a wet dog. It is not hallucinogen-specific, inducible by 5-HT precursors and drugs that increase 5-HT release, but the HTR is reliably induced by hallucinogenic and reliably *not* induced by non-hallucinogenic 5-HT_{2A}R agonists.

rewrite differences between organisms in HTR

Prepulse inhibition of startle

“Prepulse inhibition (PPI) refers to the phenomenon where a weak prestimulus presented prior to a startling stimulus will attenuate the startle response; PPI is often used as an

detail: or by blocking with ketanserin/antagonist simultaneously? think so, find ref

operational measure of sensorimotor gating, and reflects central mechanisms that filter out irrelevant or distracting sensory stimuli.”⁴⁷

Interval timing Temporal perception is seriously disturbed by hallucinogens, as any recreational, spiritual, or lab participant could subjectively inform you. In rats and mice, temporal perception can be assessed, again, by training regimens of teaching rats to press levers after certain time intervals have elapsed, or in response to long- and short-duration stimuli. DOI affects performance in both types of trials, while 5-HT_{2a} antagonists rescue the DOI-induced loss-of-function.

find ref for subjective differences in time

ketanserin, volinanserin

exploratory/investigative behavior *nutshell*: measuring the quantitative and qualitative spatial and temporal structure of activity (Behavioral Pattern Monitor, BPM) indicates hallucinogens induce neophobia and specific locomotive/exploratory effects; lisuride vs. LSD induce different behavioral footprints, and as per usual, 5-HT_{2a} antagonists reduce those effects.

rewrite exploratory/investigative behavior in animal models

differences in indoleamines and phenethylamine reaction in rats and mice?

tolerance studies

nutshell version: Ergolines, phenethylamines, and tryptamines show intense and rapid cross tolerance (with the exception of DMT); this tolerance correlates with a significant decline in the density of 5-HT_{2a} receptors and desensitization of the receptors in transfected cell lines.

define desensitization/mechanism

8.4 NEUROANATOMICAL DISTRIBUTION

rewrite literally all of this section to be more concise and because I hate neuroanatomy

“[The 5-HT_{2a} receptor] is expressed in regions of the brain believed to be involved in cognitive processes such as the prefrontal cortex, specifically in pyramidal neurons and interneurons.”⁷³

8.4.1 locus coeruleus

role of the locus coeruleus; source of noradrenergic projections; responsive to (novel or arousing) sensory stimuli; HC enhance responsiveness such that innocuous stimuli drives response; response mediated by 5-HT_{2a}

8.4.2 Prefrontal cortex

in vitro Almost all prefrontal pyramidal neurons express the 5-HT_{2A} receptor, with the receptor localized primarily to the proximal apical dendrites.¹⁹ Approximately 20-25% of the interneurons in the prefrontal cortex (PFC) express 5-HT_{2a}Rs mRNA, largely to be basket and chandelier cells.⁴⁷

rewrite localization of 5-HT_{2a}Rs on neurons

“ Previous studies have shown that activation of 5-HT_{2a}Rs in this region results in a robust increase in spontaneous glutamatergic synaptic activity, and these results have led to

research relevance of basket/chandelier cells?

the widely held idea that hallucinogens elicit their effect by modulating synaptic transmission within the PFC. Rather, they [our data] suggest that 5-HT_{2A}Rs facilitate intrinsic networks within the PFC. Consistent with this idea, we locate a discrete subpopulation of pyramidal cells that is strongly excited by 5-HT_{2A}R activation."⁶

rewrite with my very own words

write re: fMRI, PET data? human-level science, generally, in terms of activation patterns and interactions with other structures

in vivo

interactions with other structures

write interactions with other structures?

8.4.3 Visual Cortex

Visual cortex does stuff because visuals! but I haven't written about it yet

8.5 FUNCTIONAL SELECTIVITY & THE 5-HT_{2A}R

introduce terms of biased signalling/functional selectivity etc

8.5.1 G-protein coupled receptors

GPCRs are an extremely diverse class of heptahelical transmembrane signaling proteins. Approximately 30-40% of pharmaceuticals target 7% of GPCRs³⁸; as a class of proteins, they are prolifically expressed across cell types and species. Ligand binding to the extracellular terminal of GPCRs initiates a conformational change in the protein that transmits through the membrane to interact with a heterotrimeric guanine nucleotide-binding protein (G-protein) complex on the intracellular side.

The G-protein complex consists of a modular configuration of an α -, β -, and γ -subunit.¹¹² In the inactive receptor, all three subunits associate; the α -subunit maintains a bound guanosine diphosphate (GDP). Ligand binding induces a conformational shift in the receptor and consequently the bound G-protein complex. In the classic model of signaling, this leads to the exchange of the α -bound GDP for guanosine triphosphate (GTP), followed by dissociation of the α -subunit and $\beta\gamma$ -complex* from each other while remaining anchored to the membrane. They are free to diffuse laterally and initiate signaling cascades, until termination of signaling by the innate GTPase activity of the α -subunit. The resulting GDP-bound α -subunit re-associates with a $\beta\gamma$ -complex to reform the G-protein complex. (See Fig. 9 on the next page)

The classical model is complicated by lines of evidence that suggest activation can trigger a conformational change without subunit dissociation. However, even without that additional variable, the already established highly-modular structure of the G-protein complex gives it an immensely versatile position; the subunit variations are crucial to tuning, modulating, and transmitting extracellular signals.

rewrite G-protein complications, also find ref

*The γ -subunit is extremely unstable alone, and is thus almost always found in and exerts effects as part of a dimeric $\beta\gamma$ -complex.

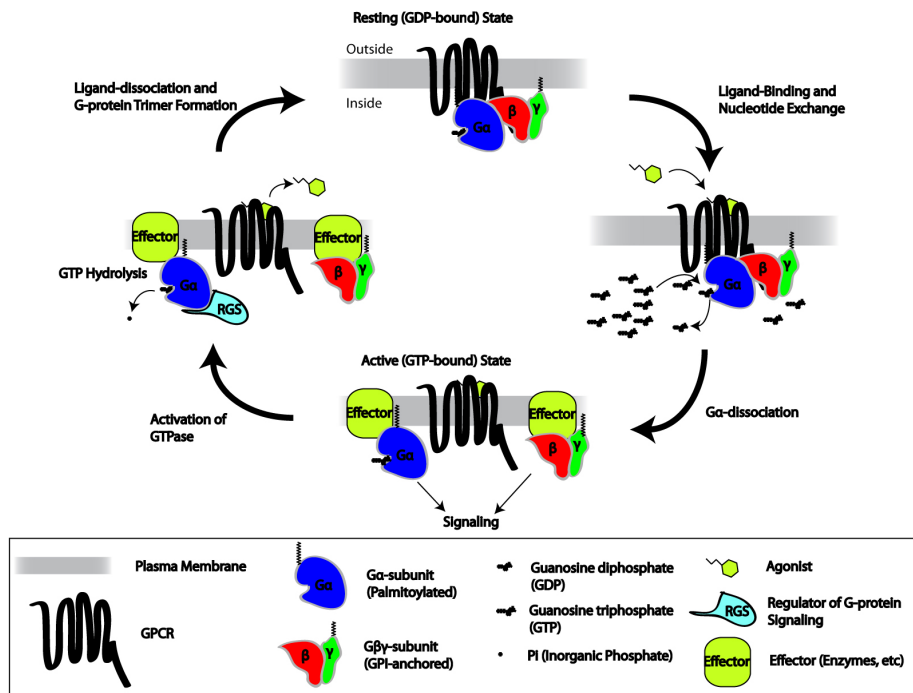


Figure 9: stole from Wikipedia, the general active-inactive cycle of GPCRs

α-SUBUNIT There are sixteen α-subunit genes, and for much of the research on GPCRs, the α-subunits were considered the active functional unit of the α-β-γ complex. The α-subunits that define the basic properties of a heterotrimeric G protein can be divided into four families, $G_{\alpha s}$, $G_{\alpha i}/G_{\alpha o}$, $G_{\alpha q}/G_{\alpha 11}$, and $G_{12}/G_{\alpha 13}$.

more here probably, i.e. what the canonical couplings and functions are, but not in *too* much detail

βγ-COMPLEX The βγ-complex of mammalian G proteins is assembled from a repertoire of 5 β-subunits and 12 γ-subunits.¹³

and yet-undiscovered units

"The βγ-complex was initially regarded as a more passive partner of the G protein α-subunit, thought only to act as a negative regulator. However, it has become clear that βγ-complexes freed from the G protein α-subunit can act as mediators of signalling in their own right."²²

"In the inactive state, the GDP-bound Gα subunit is associated with the obligate Gβγ dimer, which slows the rate of spontaneous GDP release by Gα acting as a guanine-nucleotide dissociation inhibitor."¹³

8.6 5-HT_{2A} SIGNALING

8.6.1 Canonical pathways

The canonical α subunit: $G_{\alpha q/11}$

The 5-HT_{2A}R couples to $G_{\alpha q/11}$ and an unexplored βγ-complex.

"The 5-HT_{2A} receptor couples to Gq and activates phospholipase C (PLC) signaling, resulting in the hydrolysis of

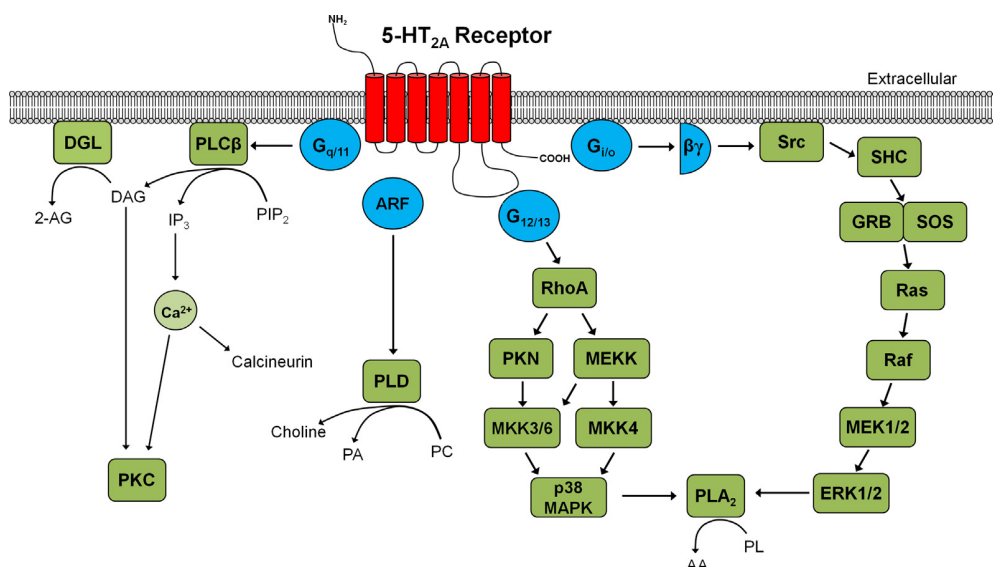


Figure 10: 5-HT_{2A} pathways, fig 4 from Halberstadt, 2015⁴⁷

membrane phospholipids to inositol triphosphate (IP₃) and diacylglycerol, and mobilization of intracellular Ca²⁺...

There is evidence that 5-HT_{2A} is coupled to several non-canonical signaling pathways, including beta-arrestin-2, Src (potentially involving G_{i/o}-associated G subunits), extracellular-regulated kinase (ERK), p38 mitogen-activated protein (MAP) kinase, phospholipase A₂ (downstream from ERK_{1,2} and p38 MAP kinase), Akt, and phospholipase D (dependent on the small G protein ADP-ribosylation factor-1 (ARF1)).⁴⁷

8.7 EVIDENCE FOR BIASED SIGNALING

The weight of evidence for the psychological effects of psychedelics implies activation of the 5-HT_{2A} receptor is crucial; that does not explain how or why. While other receptors have a sort of tuning effect on the quality, duration, and intensity of the drug experience, 2aR activation is the “root note” of a whole chord of potential experiences.

While the interaction of different neurons and receptor activation are and the emergent properties thereof are worth exploring, I’m a molecular biologist, and we focus on single-cell effects. Of these, there’s evidence that the direct intracellular cascades play a role in mediating hallucinogenic effects in the immediate response, in the duration of the trip, and in the longer-term psychological changes as measured by gene and structural changes.

transition to evidence at different levels for biased signalling’s involvement. This WHOLE SECTION is quotes from abstracts because that’s my writing process or whatever. Basically really drafty and I know that.

The first is at the receptor/effector level. It has been demonstrated that some hallucinogens, such as LSD, activate different signaling cascades than 5-HT. For example, at the 5-HT_{2C} receptor, 5-HT binding produces a strong phosphoinositide hydrolysis response, a rise in intracellular calcium levels and phosphorylation of the receptor itself. LSD pro-

duces robust phosphoinositide hydrolysis, however there is no concomitant rise in intracellular calcium and only limited phosphorylation of the receptor⁷³

8.7.1 *Binding Events*

internalization & recycling

de/sensitization

"Waning responsiveness to continuous or repeated stimulation constitutes the phenomenon of desensitization, which pervades biological systems. . . Agonist-induced desensitization involves phosphorylation of G protein-coupled receptors by two currently recognized classes of serine/threonine protein kinases. . .

GRK-mediated receptor phosphorylation facilitates the binding of an inhibitory arrestin protein to the phosphorylated receptor, an event which substantially impairs receptor signaling."

downregulation of receptor production

structural regulation

"Taken together, the present work elucidates novel roles for PSD-95 in regulating the functional activity and intracellular trafficking of 5-HT 2A receptors and possibly other GPCRs."¹¹⁵

"The interaction of the 5-HT 2A and the 5-HT 2C receptor with specific sets of PDZ proteins may contribute to their different signal transduction properties."³

8.7.2 *Electrophysiological events*

8.7.3 *Signalling events*

second-messenger activation

"While lisuride and LSD both act at 2AR expressed by cortex neurons to regulate phospholipase C, LSD responses also involve pertussis toxin-sensitive heterotrimeric G i/o proteins and Src."⁴²

"Alternatively, the reason why lisuride fails to recruit G i/o may have nothing to do with functional selectivity, and could be a consequence of its low intrinsic efficacy at 5-HT 2A."⁴⁷

BETA ARRESTIN INTERACTIONS

"β-arrestins are intracellular proteins that bind to heptahelical receptors and represent a point where such divergences in ligand- directed functional signaling could occur. . . we compared the endogenous agonist, serotonin, to the synthetic 5-HT_{2A}R hallucinogenic agonist (DOI), in mice lacking β-arrestin-2, as well as in cells lacking β-arrestins. In mice,

we find that serotonin induces a head twitch response by a β -arrestin-2-dependent mechanism. However, DOI invokes the behavior independent of β -arrestin-2.

The two structurally distinct agonists elicit different signal transduction and trafficking patterns upon activation of 5-HT_{2A}R, which hinge on the presence of β -arrestins." ^{93,92,94}

receptor reserves

rewrite in your own words

NIH3T3: Swiss mouse embryo, hypertriploid karyotype

"NIH3T3 cells stably expressing the rat 5-HT_{2a}R were used to measure agonist-induced pathway activation. We determined the potency and intrinsic activity of each compound to activate either the PLA 2 pathway or the PLC pathway. Furthermore, the data support the hypothesis of agonist-directed trafficking in NIH3T3-5HT_{2A} cells because **structurally distinct ligands were able to induce preferential activation of the PLC or PLA 2 signaling pathway**. From these data we conclude that structurally distinct ligands can differentially regulate 5-HT_{2A} receptor signal transduction." ⁶¹

Transcriptomic signalling

"We also found that DOI, LSD, and lisuride each induced distinct transcriptome fingerprints in somatosensory cortex that were absent in 5-HT_{2A}R null-mutants".

Moreover, DOI and LSD showed similarities in the transcriptome fingerprints obtained that were not observed with the behaviorally inactive drug LHM. Our results demonstrate that chemicals acting at the 5-HT_{2a}R induce specific cellular response patterns in vivo that are reflected in unique changes in the somatosensory cortex transcriptome." ⁴¹

mice, XY karyotype

HEKs human embryonic 'kidney' cells, XX karyotype

Morphological plasticity

Activation of the 5-HT_{2a} by DOI causes a transient increase in spine size in cultured cortical neurons ⁵⁷

karyotype not specified

8.7.4 long-er term changes

on what time scale?

Receptor modifications

"The receptor binding experiments suggest that phosphorylation of G₁₁ on serine 154 reduces coupling of 5-HT_{2a} receptors, whereas DOI causes down-regulation of 5-HT_{2a} in addition to the phosphorylation-induced uncoupling of G_{α11} to 5-HT_{2A} receptors. . .

These data suggest that DOI causes phosphorylation of G_{q/11} in vivo and could thereby contribute to the desensitization of 5-HT_{2A} receptors." ⁹⁶

gene expression

Both single-doses and chronic administration lead to long-term changes in gene expression and plasticity in the mammalian brain^{74,66}

8.8 MODEL SEROTONIN SYSTEMS

Those signaling pathways have been investigated in a variety of systems. This is by no means a comprehensive overview, but studies on hallucinogens have occurred in a number of different systems.

1. Humans: with psilocybin, LSD, and MDMA
 - a) fMRI, EEGs,
 - b) interviews of subjective experience
2. Rats: LSD + many other drugs
 - a) global RNA extraction to look @ gene transcription
 - b) staining to see receptor expression
3. primary neurons? (pretty sure)
4. Oocytes with mGlu & 2a receptors: LSD, lisuride, psilocin
 - a) to study signaling & colocalization
5. CHO cells expressing a fluorescent 5-5-HT_{2a} receptor and variants

Obviously, 1 is the most full bodied “system”, but we can’t look at short term neuronal changes, and imaging studies have all the flaws of imaging studies.

2 has problems. Largely cost, and scale, and I can’t use them at Hampshire, and it’s harder to study specific receptors in specific cells on a tiny temporal basis.

3 are expensive and hard to maintain and dumb.

(4) and 5 both suffer from what seems to me fatal flaws – cells express different internal proteins and matrices. Undifferentiated cell lines won’t have the same signaling pathways set up to receive signals from a receptor; what’s the point in studying signaling pathways, receptor dynamics, or gene transcription in a set of cells that likely is incapable of accurately reproducing the full breadth of signaling pathways

rewrite neuroimaging sucks

8.8.1 Frustrations with model systems?

differences between mouse, human, and rat

8.9 PROJECT OUTLINE

1. Clone the receptor from rat cDNA into a plasmid that is also expressing a large fluorescent protein (GFP), an antibiotic resistance gene, and promoter region to force expression of the DNA.
2. Transfect HEKs to test expression of the construct, and then into P19 mouse stem cells
3. Induce neuronal-like differentiation into the transfected P19s, and see if the cell is capable of reconstructing a dendrite with localized serotonin receptors

8.9.1 *Why am I doing this @ Hampshire?*

Because I wanted to write a div about more than “just” science, I opted to work at Hampshire. Our money and our model systems are limited; I also won’t be getting DEA approval, so I can’t work directly with psychedelic drugs.

8.9.2 *Resources*

P19 stem cells, which are known to differentiate into relatively poorly-characterized neuron-like cells when cultured with a micro-molar concentrations of retinoic acid (RA).

The trick for us, however, is not just the production of neuronal cells, but neurons expressing the 5-HT_{2a} receptors, with the machinery of GPCRs fully intact and functional.

as far as cancerous, genetically manipulated, and traumatized rat cells can be “normal”

8.9.3 *P19s*

P19s are derived from embryonal teratocarcinoma cells, from behind the testes of XY-karyotype mice. They are immortal and easy to maintain, retaining pluripotency under normal cell culture conditions. With RA application and minor modification of culture conditions, P19s differentiate into central nervous system (CNS) cells, including glia, neurons, and fibroblast-like cells.⁷ Studies of this differentiation pathway have elucidated a number of genes important for neural development,¹¹⁰ and they’re an established model system for exploring embryonic differentiation of neuronal cells.

8.10 A BRIEF HISTORICAL FORAY INTO OTHER KINDS OF USES???

Mayans and the Inca and merchant men, oh my.

Open notebook science has been described as the “epitome of open” and a “revolution” in scientific opportunities.

It’s also (I think) the easiest for an undergraduate biologist to implement. I don’t publish, yet, so I can’t publish any papers open access. I don’t generate a lot of data or have data sets, so publishing a data note for others to analyze is out of the question, and of course, since I’m not publishing I can’t publish supplemental data.

So, starting from scratch, making all of my lab work openly accessible is the first and easiest way to implement open science. My efforts were inspired and guided by other proponents and practitioners of an Open Notebook methods.

9.1 OPEN NOTEBOOKS IN THE WILD

With that, I’ve been keeping my online notebook more or less in sync with my physical lab work since the first entry on July 15, 2014. All the entries are time stamped and track revisions, and are written in human-readable HTML Markdown.

The bulk of this project is currently located at a Github repository (<https://github.com/kathleenleeper/workhorse>) and detailed there.

Although the current systems may be undergoing some fairly large revisions in the next month

9.2 TECHNICAL DISCOVERIES

A large part of my goal with documenting my scientific process was to access its feasibility on a large scale, and for those who weren’t already deeply invested in open science. What would be required for open notebooks to become common place? What would happen if they were? What do we lose when we go digital, and what do we gain?

9.2.1 Frustrations

1. The pure technical set up takes too much time. To mimic Carl Boettger’s Github-hosted and tracked site, it took a not-insignificant technical investment of time into exploring options and figuring out how to use the tools. There’s no good guide to getting your standard wet lab “pure” biologist set up with Jekyll and Github to build a site from scratch like I did.
2. It’s clear from my efforts to keep the digital version up with the paper version that any digital notebooks *need* automatic integration; they’re otherwise unsustainable and always a little behind the times.
 - a) Because paper notes don’t translate perfectly to typed text (see ??), it’s frustrating and tiring to have to re-type and revisit a protocol run just earlier, and translate from paper to digital.

- b) The lack of *drawing* abilities is a serious hindrance; annotation via text is significantly less effective than writing in red pen next to it
 - c) Writing up negative results is *annoying* and feels *useless*. Trouble shooting procedures is incredibly tedious; having to write up and explain your attempt and subsequent failure time and again is far from encouraging. I would venture to say the increased feeling of failure upon revisiting the entry is one of the most demoralizing things
3. While there are tablet and smart phone options, a basic laptop is simply not as versatile for note taking as a paper notebook. Computers can't get wet; you can't prop them against a beaker on a crowded lab bench.
- a) This also relates to the sketching and informal drawing that happens in lab notebooks – quick calculations, arrows between protocols, annotations of protocols on the fly as you mis-time, forget, or mix up steps.
4. Studies have shown time again that physically writing notes helps students retain knowledge better than typing them. Similarly, I do more careful checking of protocols and the steps I have to follow when I'm writing them, rather than just reading and following a protocol from a typed page.
5. Some advocates claim that knowing your work flow could be examined at any time – an ever-present Potential Big Brother – makes you more likely to be careful with your records and scientific choices
- a) good to consider other people reading it, but i find it doesn't really change my choices in lab work – not my top focus
 - b) dissemination is not a high priority

Can cite this if people feel strongly

9.2.2 Celebrations

There are, of course, many benefits, although I'm not sure I'm taking full advantage of them yet. Some that have already proved immensely useful, and in fact often saved serious time for me.

1. Full text searching of entries, by date, content, and tag. This reduces the time spent flipping back and forth between physical pages, trying to figure out when exactly a sample was taken and the conditions it was processed with (Did you elute that DNA sample in TE, H₂O, or elution buffer?)
2. It's very easy to share and talk about my project – because the repository and site are accessible from my smart phone, I can pull out data and explain the state of my lab work almost anywhere, quickly, efficiently, and with a minimum of fuss.*

*This is mostly useful when John is upstairs on the 3rd floor and I forget to bring my notebook up when I ask him questions, but it's also been used when I'm traveling and unexpectedly meet someone who's interested. And then I have something to show *right then*.

3. Because I've already documented everything (mostly), I never have to *remember* small details that take up mental space. I'm never at a loss of which bands in a gel correspond to which samples – because I annotate my gels as soon as I get them, so that I can update the protocol with the results immediately.
4. Version control of files. It's easy to ask a computer to compare many different runs of the same protocol and show you differences in the protocols (assuming you've entered all the relevant information), which helps in comparing why an experiment may not have replicated properly.
 - a) Version control of *protocols*, where if you modify a protocol, it's easy to add a note saying why. This would be very helpful for a collaborator of mine, who might wonder why a given protocol deviated from the lab standard in seemingly idiosyncratic ways.
5. Metrics on my lab entries. It's very easy to generate maps and time lines of processes; to see how many times and when my work has been done. I can run self-improvement metrics on myself

I'm not saying they're not idiosyncratic, but at least now there's some accountability for why changes were made and when.

Or at least prove to my committee how much work I am or am not doing

9.3 SUGGESTIONS FOR SURMOUNTING NOTEBOOK CHALLENGES

Some thoughts: Since being open is *not* the same as being accessible, transparent, or even useful (re: [Slee](#), *Notes against openness*); anything that wants to accomplish those goals needs a lot more thought and planning. I think open notebooks are only a small component of what sharing procedures is; said differently, “notebooks” need redefining. The open, accessible, etc. notebook online is identical in terms of words, graphics, etc. to my paper notebook – in many instances, it's even better. It is not, however, *complete*. No one would ever look at my paper notebook and be able to coherently trace protocols as they evolved; at least, not without my help. A direct transfer of notebook pages to web pages doesn't help the situation.

rewrite These might belong in the earlier section? Or the earlier sections analyzing OS belongs here

I think a more ideal situation is *not* a transfer of paper to electronic. Rather, multiple layers of publication - namely, including methods. Real protocols, but protocols as you might write them out for someone in your lab running an experiment for you, instead of bite-sized uber-simplified “Procedures were performed as described previously.” Following an open lab notebook with nothing else is hard; using it as a reference to supplement a larger work sounds like an incredible resource.

BIBLIOMETRICS AND THIS DIV

My own stuff?

I ran bibliometrics (with python, code available at a github repo that I haven't totally made yet).

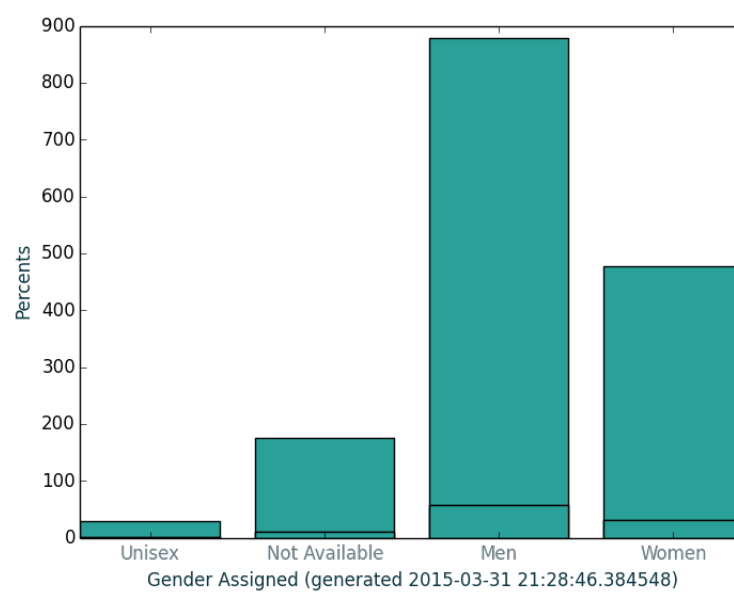


Figure 11: Gender distribution of all works in this div! META.

Figure 12

What I cover – or have done – with my year of Division III is specific to me. My interests in OA and open science comes from conversations about software freedoms and technology my first few weeks on campus. I started with psychedelics because they lay so cleanly at the intersection of my personal experiences and the kinds of questions I thought biology could answer. I started with feminist theories and ways of (re) constructing the world with academic feminism because the disconnect between my labwork and the social movements that constitute our lives made a gap so great I thought I might fall into it.

These links are inherent to the particular shape and path of my life; they are an accidental and serendipitous collaboration of topics. The previous godawful pages is one way of slicing a knowledge system that prioritizes certain kinds of knowledge distribution and making, certain kinds of structural/layered analysis, and specific biological phenomena.

This chapter is ideally more of recollection and a plan to go forward. Gender is no longer an additional layer of analysis tucked at the end of the scientific section; it was always there. Access to literature and code were/are fundamental parts of writing this; who wrote my software and what choices they made, and what values they did/not consider have already shaped the rest of this piece.

11.1 VALUES IN MOLECULAR/BIOLOGICAL PSYCH/NEURO RESEARCH

If, per technoscience (Latour as in Clarke et al.¹⁶, /2011), technoscience means that “pure” research – e.g. psych because they are pharmacologically interesting – cannot be independent from their practical applications in therapies and on people. Similarly, one might say that research on climate science is intrinsically interwoven with the planets residents. Physics research is (as, to be fair, most science are) is interwoven with technologies like ultrasound (an alternately powerful but gendered tool) or weapons of communication and destruction.

if this is the “century of biology” (presumptuous, given that it is 2015 not *even* a quarter of the way through) and biology is increasingly molecular biology driven –

11.1.1 Biomedicalization

technoscience indicates explicit move past the conceptual separation of science and technology. We argue that these two domains are co-constitutive; thus challenging the notion of “pure forms” of scientific/technological research independent from practical applications

biomedical features increasingly biological-scientific aspects of the practices of clinical medicine; that is, technoscientific practices of basic life science (“bio”) are increasingly part of applied clinical – now bio-medicine

is mol. bio molecules or genetics? does it include molecular-receptor interactions?

medicalization the processes through which aspects of life previously outside the jurisdiction of medicine come to be construed as medical problems

biomedicalization [Clarke et al.](#)'s term for the "increasingly complex, multisited, multidirectional processes of medicalization that today are being both extended and reconstituted through the emergent social forms and practices of a highly and increasingly technoscientific biomedicine. We signal with the "bio" in biomedicalization the transformations of both the human and nonhuman made possible by such technoscientific innovations as molecular biology, biotechnologies, genomization, transplant medicine, and new medical technologies. That is, medicalization is intensifying, but in new and complex, usually technoscientifically enmeshed ways. The extension of medical jurisdiction over health itself (in addition to illness, disease, and injury) and the commodification of health are fundamental

inpractice dynamics

1. major political economics shifts
2. new focus on health and risk and surveillance biomedicines
3. technoscientization of biomed
4. transformations of the production, distribution, and consumption of biomed knowledges
5. transformations of bodies and identities

the three main areas in which the technoscientization of biomedicine manifest are computerization and data banking; molecularization and geneticization of biomedicine and drug design; and medical technology design, development, and distribution.

Biomedicalization practices emphasize transformations largely through immediate high-tech interventions not only for treatment but increasingly also for health maintenance, enhancement and "optimization" – the growing sense of individual obligation or responsibility to literally "make the best" of oneself

asserts that these constitute the rise of a "culture of life" within which developments in the biological sciences are encouraging the move away from concerns with humans in society and social salvation and toward ideals of individual perfectibility and enhancement. For example, Singh and Rose (2006, pp. 97) ask: "Can individuals resist/access the pharmaceutically powered drive toward perfection; is their personal agency sufficient to resist/access enhancing drugs, especially if they are very young, or poor, an ethnic minority, a convicted felon – or, for that matter, if they are students at elite competitive universities?"

Moreover, an array of counter-trends against both medicalization and biomedicalization has gained momentum since

World War II. These varied “pushbacks” include ongoing critiques of medicine, medicalization, and biomedicalization; people seeking help from beyond the boundaries of biomedicine, thereby expanding American medical pluralism; understanding patienthood as an increasingly fraught state; the elaboration of health social movements resistant to medicalization and biomedicalization; patient and related movements against specific forms of biomedicalization; a (re)emergent public discourse that “more (bio)medicine is not necessarily better”; and a growing discourse attempting to articulate “appropriate” levels and forms of biomedical intervention from the beginnings to the end of life (somewhat akin to the “appropriate technology movement”)

“Reductionism” is a bit of a catch all term that I should probably explore more. The Western scientific traditions is entirely focused on reducing systems to their smallest working unit,, with the intention of finding out one “answer” and threading it into many other answers to form a kind of tapestry of knowledge. The reduction and simplification of systems roughly correlates with the notion of “pure” sciences, pure being perceived as better, “harder”, and (incidentally, of course) more masculine. In the biological sciences, and in the neurosciences, reductionism is:

- generally a trend in the biological sciences – maybe due to perception of increased objectivity/hardness (a la physics and chemistry).
- Somewhat inherent to “neuroscience”, since the ultimate goal is to reduce function/cognition to a set of circuits/cells/meaningful small and completely circumscribed/understood units.
- Where does it come from?
- What goals are there and how does reductionism accomplish them for us? What is good and not good about applications to neuro? Can and should cell studies be used to “answer” or explore questions about cognition? What do we lose when we “solve” disease in vitro?
- Personalized medicine; or personalized neuroscience is still a way of reducing the individual to the cellular and genomic information, without accounting for personhood. Personalized medicine” is not actually personalized; it’s genomic. Relying on genetic information to give meaningful information about health care and responses is hardly specific to an individual’s needs and abilities, as we’d like a feminist science to be.

11.1.2 *De-legitimizing other knowledges*

Erowid: Informal and formal knowledges The re-introduction of psychedelics into the clinic is also paired with a systematic devaluing of recreational users, and a low-key but distinct disdain for traditional usages (at least in the formalized literature).

In reality, however, hallucinogens have amazingly well-documented and supportive informal communities. Taking psychotropics is, for

many, a spiritual and deeply-prepared for experience. Users are often hyperaware of the chemical effects, interactions with medical conditions or other drugs, how to set scenes, how to guide their mental state in meaningful ways – in short, expert and specific knowledge more typically associated with discerning scientists than hippies in the woods.

But hippies in the woods may know a lot more about how to *use* those drugs than scientists who have never experienced them and treat them solely as tools in a molecular toolkit.

indigenous science

11.2 VALUES AND POWER STRUCTURES

11.2.1 *Present Day*

ecological destruction

green chemistry

Biomedicalization of social problems

ADDICTIONS rat city and addiction and treatment

PTSD

END OF LIFE ANXIETY

DEPRESSION

indigenous rights

NATIVE AMERICAN CHURCH

COMPLEXITY OF INDIGENOUS RIGHTS not the same from one group to another (i.e. brazilian shamans & commerce vs spiritual usages in n. amer)

localization

Not the same across continents – only know history of like, Mexico/N. America. And what about the swiss?

11.2.2 *historical*

colonialism

Psychedelic use in Mexico was pushed down by the Spanish conquerors; it existed in small, isolated villages. In the 50s and 60s, the first (white, male, and then white, female) pilgrims from the United States made their way to isolated Mexican villages to first take drugs in the spiritual shamanic context, and then started using them recreationally, for days at time.

Now, ayahuasca experiences can be bought and sold in South America – which turns out to be okay, from an appropriative standpoint, because those services were always part of the indigenous economy. The Western/Northern feminist trope is to instantly assume indigenous

businesses are violations, which seems like another recreation of the noble savage.

gendered knowledges

As per Londa Schiebinger's *Feminist history of colonial science*, women often held botanical and plant knowledge because of the distribution of gender roles. When colonialism showed up in the Americas and in Africa, the subsequent destruction and theft of that knowledge fell/was principally from *women*.

plurality of cultures (see complexity of rights, above)

11.2.3 *devaluing non scientific knowledges*

so what if we don't count erowid?

11.3 MOVING FORWARD(?)

1. doing activism on the side?
2. policy work for systematic solutions
3. scrape/analyze all of erowid
4. gendered/racialized research
5. access to drugs
6. communicate scientific information better?
7. ending D.A.R.E.
8. include cell karyotypes
9. in methods include derivations of drugs?

11.4 A SHORT AND SELECTIVE HISTORY OF PSYCHEDELIC DRUGS

11.5 PSYCHEDELICS AND ME (WOO)

Writing about psychedelics draws on two conflicting desires.

One to be scientific, cite my sources, to draw entirely on clean-cut, statistically significant research

Talking about the subjective experience of psychedelics seems a slippery anecdotal path, unless I'm drawing on the qualitative interviews and quantitative brain-imaging studies performed at the Vollenweider lab in Zurich, or the accounts of LSD and psilocybin as psychotherapy adjuncts at New York University (NYU) and Johns Hopkins University. To use sources from outside the peer-reviewed literature doesn't just feel academically unsound, it cuts at some essential notions I maintain and struggle to complicate about the necessary qualities of controls, peer review, and a sense of separation between experimenter and experimentees.

two acknowledge and *explicitly* draw on personal stories of drug experiences in a way the research literature does not

find ref for studies

In reality, I've learned much more about the communities of and around drug experiences them from the Erowid vaults, voluntary stories, and conversations.

standpoint theory seeing from the bottom is the "better" or more objective viewpoint. Correlates roughly to the "lived experience" of grassroots feminist organizing.

In the case of OA, even writers saying "Access isn't an issue" cannot convince me because for *me*, access is an issue – and knowing that means I am more prone to being critical and more qualified to provide counterpoints to statistical arguments with observations about behavior about me and my institution.

An elementary application of standpoint theory, with regards to access.

But realistically, the underlying drive and psychedelic research *isn't* peer reviewed. I *know* drug experiences are sometimes deeply meaningful experiences. That knowledge, gleaned from personal experiences and stories I've heard, is something I bring to case studies, lends support to discussions of addictions, means I can draw on flesh-deep knowledge to fill in the outlines made by science. but that's not something I can *say* in a scientific paper.

The *experience* of psychedelics is also, of course, not something that should enter Scientific Writing from a personal point of view; but just as familial or personal experiences with cancers inspire research into the biological underpinnings, psychedelic researchers don't just happen upon these drugs.

langlitz on the unspoken kinds of knowing in psych research

Shame – maybe? There's also a distinct feeling of shame, to some extent "Well, yes, I'm at Hampshire College, and I'm really interested in the biology of psychedelics, because wow, drug trips!" Interacting with drugs means tie dye prints and smoky dorm rooms, or out-of-touch artists and creatives. Psychedelics mean emotions and subjectivity; the personality of the user is closer to the surface than most sciences. Serious scientists should restrain themselves to less squishy areas, at least if they want to stay serious.

If they must study psychedelics, LSD is no longer the drug of the 60s communes. It is a highly specific 5-HT_{2A}/D_{1/2} antagonist; psilocin isn't the active component of a mushrooms, but a compound to be tagged and tracked in an fMRI scanner.

Sharing Experiences People want to share their stories. Making LSD and mushrooms a primary component of how I introduce my interests has garnered incredible stories, of yes demons and colors, but also of deep realizations and moments that altered individual perceptions of themselves and their goals.

how many people use drugs? percentage wise?

I regret not formally interviewing people about how they interact with drugs and incorporating those stories into this section. For better or for worse, drug use – and psychedelics specifically – have and continue to shape the people and relationships around me.

11.6 A CULTURAL COMPOUND

Psychotropic drugs have a rich and important history of spiritual and mental use in nearly every human culture. For most of human history, cultures have sought with the help of native pharmacological agents. Although reduced scientifically to their chemical structure in the labs funded by the NIH and Swiss agencies, most of compounds derive from different cultural heritages. Peyote (active ingredient: mescaline)* has historically been used by the Native American church, a right they successfully fought for in court. Ayahuasca (active ingredient: *N,N*-Dimethyltryptamine (DMT) combined with a monoamine oxidase inhibitor (MAOI)) is a traditional South American drug.

Source for ergot and historical significance

Psychedelic experiences existed in indigenous cultures globally, the same indigenous cultures threatened by an ever-rising tide of globalized economies and corporate states.

including experiences Is plasticity and all of the mechanistically interesting signaling mechanisms relevant if the experience isn't included? Hallucinogens are notoriously sensitive to situation – or rather, individual interpretations of a situation.

translation or transformation The quality (and thus long term effects) of a psychotropic experience is created through the *interplay* between environment and individual; like facts, it doesn't wholly reside in either, or even at the mere intersection. Trying to pull that out in a lab environment, is, as Fleck describes, not just a translation of information from one knowledge realm to another, but a full fledged transformation such that the ayahuasca in the lab is only nominally related to ayahuasca in (shamanistic) practice.[†]

I'm a little conflicted about the relevance of this section, but I also am really excited about it, and the possibilities for re-envisioning how I could do cultural molecular neuroscience. Talk to Otto's friend about his experiences? And access?

in the sense that it teaches about GPCRs and how to target them, yes?

*A comparison of the plant/spiritual context to the chemical structure should go here to demonstrate how we separate them out. With an analysis of the rights of traditional groups to use those drugs [re: NA church lawsuits], and also the danger of deforestation and environmental destruction to *traditional* methods of harvesting plants – making them only available with clinical approval – and chemical synthesis methods, which probably contribute to pollution and destruction.

[†]Anne Fausto-Sterling, and many others, talk about knowledge outside the academy – communal, social, and indigenous knowledges.

REFERENCES

- [1] Brian P. Akers, Juan Francisco Ruiz, Alan Piper, and Carl A. P. Ruck. A prehistoric mural in Spain depicting neurotropic psilocybe mushrooms?1. *Economic Botany*, 65(2):121–128, February 2011. ISSN 0013-0001, 1874-9364. doi: 10.1007/s12231-011-9152-5. (Cited on page 55.)
- [2] Kent Anderson. UPDATED – 82 things publishers do (2014 edition), October 2014. (Cited on page 25.)
- [3] Carine Bécamel, Sophie Gavarini, Benjamin Chanrion, Gérard Alonso, Nathalie Galéotti, Aline Dumuis, Joël Bockaert, and Philippe Marin. The serotonin 5-HT_{2a} and 5-HT_{2c} receptors interact with specific sets of PDZ proteins. *Journal of Biological Chemistry*, 279(19):20257–20266, May 2004. ISSN 0021-9258, 1083-351X. doi: 10.1074/jbc.M312106200. (Cited on page 63.)
- [4] Katherine Beckett. Choosing cesarean: Feminism and the politics of childbirth in the United States. *Feminist Theory*, 6(3):251–275, December 2005. ISSN 1464-7001. doi: 10.1177/1464700105057363. (Cited on page 8.)
- [5] C. Glenn Begley and Lee M. Ellis. Drug development: Raise standards for preclinical cancer research. *Nature*, 483(7391):531–533, March 2012. ISSN 0028-0836. doi: 10.1038/483531a. (Cited on page 16.)
- [6] Jean-Claude Béïque, Mays Imad, Ljiljana Mladenovic, Jay A. Gingrich, and Rodrigo Andrade. Mechanism of the 5-hydroxytryptamine 2A receptor-mediated facilitation of synaptic activity in prefrontal cortex. *Proceedings of the National Academy of Sciences*, 104(23):9870–9875, June 2007. ISSN 0027-8424, 1091-6490. doi: 10.1073/pnas.0700436104. (Cited on page 60.)
- [7] Bo-Christer Björk and David Solomon. Open access versus subscription journals: a comparison of scientific impact. *BMC Medicine*, 10(1):73, July 2012. ISSN 1741-7015. doi: 10.1186/1741-7015-10-73. (Cited on page 39.)
- [8] Geoffrey Boulton. Open your minds and share your results. *Nature*, 486(7404):441–441, June 2012. ISSN 0028-0836, 1476-4687. doi: 10.1038/486441a. (Cited on page 33.)
- [9] Allan M. Brandt. Racism and research: The case of the Tuskegee syphilis study. *The Hastings Center Report*, 8(6):21, December 1978. ISSN 0093-0334. doi: 10.2307/3561468. (Cited on page 4.)
- [10] Björn Brembs, Katherine Button, and Marcus Munafò. Deep impact: unintended consequences of journal rank. *Frontiers in Human Neuroscience*, 7, 2013. ISSN 1662-5161. doi: 10.3389/fnhum.2013.00291. (Cited on page 20.)
- [11] Jan G Bruhn, Peter AGM De Smet, Hesham R El-Seedi, and Olof Beck. Mescaline use for 5700 years. *The Lancet*, 359(9320):1866,

- May 2002. ISSN 01406736. doi: 10.1016/S0140-6736(02)08701-9. (Cited on page 55.)
- [12] Katherine S. Button, John P. A. Ioannidis, Claire Mokrysz, Brian A. Nosek, Jonathan Flint, Emma S. J. Robinson, and Marcus R. Munafò. Power failure: why small sample size undermines the reliability of neuroscience. *Nature Reviews Neuroscience*, 14(5):365–376, April 2013. ISSN 1471-003X, 1471-0048. doi: 10.1038/nrn3475. (Cited on page 18.)
- [13] Theresa M. Cabrera-Vera, Jurgen Vanhauwe, Tarita O. Thomas, Martina Medkova, Anita Preininger, Maria R. Mazzoni, and Heidi E. Hamm. Insights into g protein structure, function, and regulation. *Endocrine Reviews*, 24(6):765–781, December 2003. ISSN 0163-769X. doi: 10.1210/er.2000-0026. (Cited on page 61.)
- [14] Noah D. Charney, John J. Castorino, Megan J. Dobro, and Sarah L. Steely. Embryo development inside female salamander (*ambystoma jeffersonianum-laterale*) prior to egg laying. *PLoS ONE*, 9(3):e91919, March 2014. ISSN 1932-6203. doi: 10.1371/journal.pone.0091919. (Cited on page 15.)
- [15] Gideon Emcee Christian. Open access initiative and the developing world. SSRN Scholarly Paper ID 1304665, Social Science Research Network, Rochester, NY, 2008. (Cited on page 38.)
- [16] Adele E. Clarke, Laura Mamo, Jennifer R. Fishman, Janet K. Shim, and Jennifer Ruth Fosket. Biomedicalization: Technoscientific transformations of health, illness, and u.s. biomedicine. *American Sociological Review*, 68(2):161, April 2003. ISSN 00031224. doi: 10.2307/1519765. (Cited on pages 73 and 74.)
- [17] Murat Cokol, Fatih Ozbay, and Raul Rodriguez-Esteban. Retraction rates are on the rise. *EMBO Reports*, 9(1):2, January 2008. ISSN 1469-221X. doi: 10.1038/sj.embor.7401143. (Cited on page 17.)
- [18] Farid Dahdouh-Guebas, Jennifer Ahimbisibwe, Rita Van Moll, and Nico Koedam. Neo-colonial science by the most industrialised upon the least developed countries in peer-reviewed publishing. *Scientometrics*, 56(3):329–343, 2003. (Cited on page 38.)
- [19] J. De Almeida and G. Mengod. Quantitative analysis of glutamatergic and GABAergic neurons expressing 5-HT2a receptors in human and monkey prefrontal cortex. *Journal of Neurochemistry*, 103(2):475–486, October 2007. ISSN 1471-4159. doi: 10.1111/j.1471-4159.2007.04768.x. (Cited on page 59.)
- [20] Alessandro Delfanti. *Biohackers: The Politics of Open Science*. Pluto Press, London, May 2013. ISBN 9780745332802. (Cited on page 36.)
- [21] Jordi Duch, Xiao Han T. Zeng, Marta Sales-Pardo, Filippo Radicchi, Shayna Otis, Teresa K. Woodruff, and Luís A. Nunes Amaral. The possible role of resource requirements and academic career-choice risk on gender differences in publication rate and impact. *PLoS ONE*, 7(12):e51332, December 2012. doi: 10.1371/journal.pone.0051332. (Cited on page 48.)

- [22] Denis J. Dupré, Mélanie Robitaille, R. Victor Rebois, and Terence E. Hébert. The role of $g\beta\gamma$ subunits in the organization, assembly, and function of GPCR signaling complexes. *Annual review of pharmacology and toxicology*, 49:31–56, 2009. ISSN 0362-1642. doi: 10.1146/annurev-pharmtox-061008-103038. (Cited on page 61.)
- [23] Kerry Dwan, Douglas G. Altman, Juan A. Arnaiz, Jill Bloom, An-Wen Chan, Eugenia Cronin, Evelyne Decullier, Philippa J. Easterbrook, Erik Von Elm, Carrol Gamble, Davina Ghera, John P. A. Ioannidis, John Simes, and Paula R. Williamson. Systematic review of the empirical evidence of study publication bias and outcome reporting bias. *PLoS ONE*, 3(8):e3081, August 2008. doi: 10.1371/journal.pone.0003081. (Cited on page 19.)
- [24] Phillipa J. Easterbrook, R Gopalan, Jesse A. Berlin, and David R. Matthews. Publication bias in clinical research. *The Lancet*, 337(8746):867–872, April 1991. ISSN 0140-6736. doi: 10.1016/0140-6736(91)90201-Y. (Cited on page 19.)
- [25] Editors of the Harvard Educational Review. Symposium: Unraveling the double bind: Women of color in STEM. *Harvard Educational Review*, 81(2), 2011. (Cited on page 43.)
- [26] Hesham R. El-Seedi, Peter A.G.M. De Smet, Olof Beck, Göran Possnert, and Jan G. Bruhn. Prehistoric peyote use: Alkaloid analysis and radiocarbon dating of archaeological specimens of lophophora from texas. *Journal of Ethnopharmacology*, 101(1-3):238–242, October 2005. ISSN 03788741. doi: 10.1016/j.jep.2005.04.022. (Cited on page 55.)
- [27] George T. H Ellison, Andrew Smart, Richard Tutton, Simon M Outram, Richard Ashcroft, and Paul Martin. Racial categories in medicine: A failure of evidence-based practice? *PLoS Med*, 4(9): e287, September 2007. doi: 10.1371/journal.pmed.0040287. (Cited on page 8.)
- [28] Gwendolyn B. Emerson, Winston J. Warme, Fredric M. Wolf, James D. Heckman, Richard A. Brand, and Seth S. Leopold. Testing for the presence of positive-outcome bias in peer review: a randomized controlled trial. *Archives of internal medicine*, 170(21): 1934–1939, 2010. (Cited on page 20.)
- [29] J. A. Evans and J. Reimer. Open access and global participation in science. *Science*, 323(5917):1025–1025, February 2009. ISSN 0036-8075, 1095-9203. doi: 10.1126/science.1154562. (Cited on page 39.)
- [30] Daniele Fanelli. Do pressures to publish increase scientists’ bias? an empirical support from US states data. *PloS one*, 5(4):e10271, 2010. (Cited on page 17.)
- [31] Daniele Fanelli. Why growing retractions are (mostly) a good sign. *PLoS medicine*, 10(12):e1001563, 2013. (Cited on page 17.)
- [32] Daniele Fanelli and Wolfgang Glänzel. Bibliometric evidence for a hierarchy of the sciences. *PLoS ONE*, 8(6):e66938, June 2013. doi: 10.1371/journal.pone.0066938. (Cited on page 44.)

- [33] Ferric C. Fang and Arturo Casadevall. Retracted science and the retraction index. *Infection and Immunity*, 79(10):3855–3859, October 2011. ISSN 0019-9567, 1098-5522. doi: 10.1128/IAI.05661-11. (Cited on pages [iii](#), [17](#), and [18](#).)
- [34] Anne Fausto-Sterling. The bare bones of race. *Social Studies of Science*, 38(5):657–694, October 2008. ISSN 0306-3127. doi: 10.1177/0306312708091925. (Cited on page [8](#).)
- [35] Alessandro Figà-Talamanca. Strengths and weaknesses of citation indices and impact factors. *Quality assessment in higher education*, pages 83–88, 2007. (Cited on page [20](#).)
- [36] Ludwik Fleck. *Genesis and Development of a Scientific Fact*. University of Chicago Press, Chicago, August 1981. ISBN 9780226253251. (Cited on page [5](#).)
- [37] Joan H. Fujimura and Ramya Rajagopalan. Different differences: The use of ‘genetic ancestry’ versus race in biomedical human genetic research. *Social Studies of Science*, 41(1):5–30, December 2010. ISSN 0306-3127. doi: 10.1177/0306312710379170. (Cited on page [8](#).)
- [38] Stephen L. Garland. Are GPCRs still a source of new targets? *Journal of Biomolecular Screening*, page 1087057113498418, August 2013. ISSN 1087-0571, 1552-454X. doi: 10.1177/1087057113498418. (Cited on page [60](#).)
- [39] Virginia Gewin. Turning point: Carl boettiger. *Nature*, 493(7434):711–711, January 2013. ISSN 0028-0836, 1476-4687. doi: 10.1038/nj7434-711a. (Cited on page [29](#).)
- [40] Global Forum for Health Research (Organization). *The 10/90 report on health research, 2000*. Global Forum for Health Research, Geneva, Switzerland, 2000. ISBN 2940286019 9782940286010. (Cited on page [49](#).)
- [41] Javier González-Maeso, Tony Yuen, Barbara J. Ebersole, Elisa Wurmbach, Alena Lira, Mingming Zhou, Noelia Weisstaub, Rene Hen, Jay A. Gingrich, and Stuart C. Sealfon. Transcriptome fingerprints distinguish hallucinogenic and nonhallucinogenic 5-hydroxytryptamine 2a receptor agonist effects in mouse somatosensory cortex. *The Journal of neuroscience*, 23(26):8836–8843, 2003. (Cited on pages [57](#) and [64](#).)
- [42] Javier González-Maeso, Noelia V. Weisstaub, Mingming Zhou, Pokman Chan, Lidija Ivic, Rosalind Ang, Alena Lira, Maria Bradley-Moore, Yongchao Ge, Qiang Zhou, Stuart C. Sealfon, and Jay A. Gingrich. Hallucinogens recruit specific cortical 5-HT2a receptor-mediated signaling pathways to affect behavior. *Neuron*, 53(3):439–452, February 2007. ISSN 0896-6273. doi: 10.1016/j.neuron.2007.01.008. (Cited on pages [57](#) and [63](#).)
- [43] Steven Goodman and Sander Greenland. Assessing the unreliability of the medical literature: a response to "why most published research findings are false. *Johns Hopkins University, Dept. of Biostatistics Working Papers*, February 2007. (Cited on page [16](#).)

- [44] Root Gorelick. Indigenous sciences are not pseudoscience. *Ideas in Ecology and Evolution*, 7(1), May 2014. ISSN 1918-3178. doi: 10.4033/iee.v7i1.5150. (Cited on page 38.)
- [45] Mark Graham, Scott A. Hale, and Monica Stephens. *Geographies of the World's Knowledge*. Oxford Internet Institute, London, convoco! edition, 2011. (Cited on page 46.)
- [46] Michael L. Grieneisen and Minghua Zhang. A comprehensive survey of retracted articles from the scholarly literature. *PLoS One*, 7(10):e44118, 2012. (Cited on pages 17 and 18.)
- [47] Adam L. Halberstadt. Recent advances in the neuropsychopharmacology of serotonergic hallucinogens. *Behavioural Brain Research*, 277:99–120, January 2015. ISSN 0166-4328. doi: 10.1016/j.bbr.2014.07.016. (Cited on pages iii, 58, 59, 62, and 63.)
- [48] Donna J. Haraway. A cyborg manifesto: Science, technology, and socialist-feminism in the late twentieth century. In *Simians, Cyborgs and Women: The Reinvention of Nature*, pages 435–467. Routledge, New York, New York, 1991. (Cited on page 44.)
- [49] Donna Jeanne Haraway. A game of cat's cradle: Science studies, feminist theory, cultural studies. *Configurations*, 2(1):59–71, 1994. ISSN 1080-6520. doi: 10.1353/con.1994.0009. (Cited on page 7.)
- [50] Sandra Harding. Postcolonial and feminist philosophies of science and technology: convergences and dissonances. *Postcolonial Studies*, 12(4):401–421, December 2009. ISSN 1368-8790. doi: 10.1080/13688790903350658. (Cited on page 8.)
- [51] Trotter Henry and Kell Catherine. *Seeking Impact and Visibility: Scholarly Communication in Southern Africa*. African Minds, June 2014. ISBN 9781920677510. (Cited on page 49.)
- [52] William C. Hines, Ying Su, Irene Kuhn, Kornelia Polyak, and Mina J. Bissell. Sorting out the FACS: A devil in the details. *Cell Reports*, 6(5):779–781, March 2014. ISSN 2211-1247. doi: 10.1016/j.celrep.2014.02.021. (Cited on page 17.)
- [53] Kameron Hurley. 'we have always fought': Challenging the 'women, cattle and slaves' narrative. *A Dribble of Ink*, May 2013. Editor: Moher, Aidan. (Cited on page 43.)
- [54] John P. A. Ioannidis. Why most published research findings are false. *PLoS Med*, 2(8):e124, August 2005. doi: 10.1371/journal.pmed.0020124. (Cited on pages 16 and 20.)
- [55] Leah R. Jager and Jeffrey T. Leek. An estimate of the science-wise false discovery rate and application to the top medical literature. *Biostatistics*, 15(1):1–12, January 2014. ISSN 1465-4644, 1468-4357. doi: 10.1093/biostatistics/kxt007. (Cited on page 16.)
- [56] Bob Jolliffe. Aligning the ideals of free software and free knowledge with the south african freedom charter. *First Monday*, 11(7), 2006. (Cited on page 38.)

- [57] Kelly A. Jones, Deepak P. Srivastava, John A. Allen, Ryan T. Strachan, Bryan L. Roth, and Peter Penzes. Rapid modulation of spine morphology by the 5-HT_{2a} serotonin receptor through kalirin-7 signaling. *Proceedings of the National Academy of Sciences of the United States of America*, 106(46):19575–19580, November 2009. ISSN 0027-8424. doi: 10.1073/pnas.0905884106. (Cited on page 64.)
- [58] Nicola Jones. Sneak test shows positive-paper bias. *Nature News*, September 2009. ISSN 0028-0836. doi: 10.1038/news.2009.914. (Cited on page 19.)
- [59] Evelyn Fox Keller. Gender and science: Origin, history, and politics. *Osiris*, 10:26–38, 1995. (Cited on page 8.)
- [60] Andrew P. Kurmis. Understanding the limitations of the journal impact factor. *The Journal of Bone & Joint Surgery*, 85(12):2449–2454, December 2003. ISSN 0021-9355, 1535-1386. The impact factor, a simple mathematical formula reflecting the number of citations of a journal’s material divided by the number of citable materials published by that same journal, has evolved to become one of the most influential tools in modern research and academia. The impact factor can be influenced and biased (intentionally or otherwise) by many factors. Extension of the impact factor to the assessment of journal quality or individual authors is inappropriate. Extension of the impact factor to cross-discipline journal comparison is also inappropriate. Those who choose to use the impact factor as a comparative tool should be aware of the nature and premise of its derivation and also of its inherent flaws and practical limitations. (Cited on page 21.)
- [61] Deborah M. Kurrasch-Orbaugh, Val J. Watts, Eric L. Barker, and David E. Nichols. Serotonin 5-hydroxytryptamine_{2a} receptor-coupled phospholipase c and phospholipase a₂ signaling pathways have different receptor reserves. *Journal of Pharmacology and Experimental Therapeutics*, 304(1):229–237, January 2003. ISSN , 1521-0103 (Online). doi: 10.1124/jpet.102.042184. (Cited on pages 57 and 64.)
- [62] Vincent Larivière, Chaoqun Ni, Yves Gingras, Blaise Cronin, and Cassidy R. Sugimoto. Bibliometrics: Global gender disparities in science. *Nature*, 504(7479):211–213, December 2013. ISSN 0028-0836, 1476-4687. doi: 10.1038/504211a. (Cited on pages 24, 28, 47, and 48.)
- [63] Stephen G. Lisberger. Sound the alarm: Fraud in neuroscience. *Cerebrum: the Dana Forum on Brain Science*, 2013, May 2013. ISSN 1524-6205. (Cited on page 36.)
- [64] Helen E. Longino. *Science as social knowledge: values and objectivity in scientific inquiry*. Princeton University Press, Princeton, N.J., 1990. ISBN 0691073422. (Cited on page 5.)
- [65] Hendrika J. Luijendijk and Xander Koolman. The incentive to publish negative studies: how beta-blockers and depression got stuck in the publication cycle. *Journal of Clinical Epidemiology*, 65(5):488–492, May 2012. ISSN 0895-4356. doi: 10.1016/j.jclinepi.2011.06.022. (Cited on page 19.)

- [66] David A. Martin, Danuta Marona-Lewicka, David E. Nichols, and Charles D. Nichols. Chronic LSD alters gene expression profiles in the mPFC relevant to schizophrenia. *Neuropharmacology*, 83: 1–8, August 2014. ISSN 00283908. doi: 10.1016/j.neuropharm.2014.03.013. (Cited on page 65.)
- [67] Emily Martin. The egg and the sperm: How science has constructed a romance based on stereotypical male-female roles. *Signs*, 16(3):485–501, April 1991. ISSN 0097-9740. (Cited on page 8.)
- [68] Amanda Mascarelli. Research tools: Jump off the page. *Nature*, 507(7493):523–525, March 2014. ISSN 0028-0836, 1476-4687. doi: 10.1038/nj7493-523a. (Cited on page 29.)
- [69] Dmitry Ivanovich Mendeleyev, George Kamensky, and Thomas H. (Thomas Henry) Pope. *The principles of chemistry*, volume 2. London ; New York : Longmans, Green, 1905. Part 2. (Cited on page 26.)
- [70] Heather Grace Morrison. *Freedom for scholarship in the Internet age*. PhD thesis, Communication, Art & Technology: School of Communication, 2012. (Cited on page 25.)
- [71] Peter Murray-Rust. Open data in science. *Serials Review*, 34(1): 52–64, 2008. (Cited on pages 26 and 31.)
- [72] Dawn Nafus. ‘patches don’t have gender’: What is not open in open source software. *New Media & Society*, 14(4):669–683, June 2012. ISSN 1461-4448, 1461-7315. doi: 10.1177/1461444811422887. (Cited on page 36.)
- [73] Charles D. Nichols and Elaine Sanders-Bush. Serotonin receptor signaling and hallucinogenic drug action. *Heffter Rev Psychedelic Res*, 2:73–79, 2001. (Cited on pages 59 and 63.)
- [74] Charles D. Nichols and Elaine Sanders-Bush. A single dose of lysergic acid diethylamide influences gene expression patterns within the mammalian brain. , *Published online: 06 November 2001*; | doi:10.1016/S0893-133X(01)00405-5, 26(5):634–642, May 2002. doi: 10.1016/S0893-133X(01)00405-5. (Cited on page 65.)
- [75] David E Nichols. Hallucinogens. *Pharmacology & Therapeutics*, 101(2):131–181, February 2004. ISSN 01637258. doi: 10.1016/j.pharmthera.2003.11.002. (Cited on page 58.)
- [76] David E. Nichols. Structure–activity relationships of serotonin 5-HT_{2a} agonists. *Wiley Interdisciplinary Reviews: Membrane Transport and Signaling*, 1(5):559–579, September 2012. ISSN 2190-4618. doi: 10.1002/wmts.42. (Cited on pages iii and 56.)
- [77] David J. Nutt, Leslie A. King, and David E. Nichols. Effects of schedule i drug laws on neuroscience research and treatment innovation. *Nature Reviews Neuroscience*, 14(8):577–585, August 2013. ISSN 1471-003X. doi: 10.1038/nrn3530. (Cited on page 58.)
- [78] Carin M. Olson, Drummond Rennie, Deborah Cook, Kay Dickersin, Annette Flanagan, Joseph W. Hogan, Qi Zhu, Jennifer Reiling, and Brian Pace. Publication bias in editorial decision making.

- JAMA*, 287(21):2825–2828, June 2002. ISSN 0098-7484. (Cited on page 19.)
- [79] Heinz Pampel and Suenje Dallmeier-Tiessen. Open research data: From vision to practice. *Opening Science*, February 2014. doi: 10.1007/978-3-319-00026-8_14. (Cited on page 27.)
- [80] Michael Parker. The ethics of open access publishing. *BMC Medical Ethics*, 14(1):1, April 2013. ISSN 14726939. (Cited on page 14.)
- [81] Russ Poldrack. russpoldrack.org: Anatomy of a coding error, February 2013. (Cited on page 28.)
- [82] Michael Pollan. The trip treatment, February 2015. (Cited on page 58.)
- [83] Florian Prinz, Thomas Schlange, and Khusru Asadullah. Believe it or not: how much can we rely on published data on potential drug targets? *Nature Reviews Drug Discovery*, 10(9):712–712, September 2011. ISSN 1474-1776. doi: 10.1038/nrd3439-c1. (Cited on page 16.)
- [84] Marcus G. Raskin and Herbert J. Bernstein. *New Ways of Knowing: The Sciences, Society, and Reconstructive Knowledge*. RI Innactive Titles, Totowa, N.J, June 1987. ISBN 9780847674633. (Cited on page 8.)
- [85] Joseph Reagle. “free as in sexist?” free culture and the gender gap. *First Monday*, 18(1), December 2012. ISSN 13960466. (Cited on page 35.)
- [86] Sarah S. Richardson. Feminist philosophy of science: history, contributions, and challenges. *Synthese*, 177(3):337–362, December 2010. ISSN 0039-7857, 1573-0964. doi: 10.1007/s11229-010-9791-6. (Cited on page 7.)
- [87] Dorothy E. Roberts. Race, gender, and genetic technologies: A new reproductive dystopia? *Signs: Journal of Women in Culture and Society*, 34(4):783–804, June 2009. ISSN 0097-9740. doi: 10.1086/597132. (Cited on page 8.)
- [88] Dorothy E. Roberts. Collateral consequences, genetic surveillance, and the new biopolitics of race. *Howard Law Journal*, 54(567), 2011. (Cited on page 6.)
- [89] Paula A. Rochon, Azad Mashari, Ariel Cohen, Anjali Misra, Dara Laxer, David L. Streiner, Julie M. Dergal, Jocalyn P. Clark, Jennifer Gold, and Malcolm A. Binns. Relation between randomized controlled trials published in leading general medical journals and the global burden of disease. *CMAJ : Canadian Medical Association Journal*, 170(11):1673–1677, May 2004. ISSN 0820-3946. doi: 10.1503/cmaj.1031006. (Cited on page 49.)
- [90] Sara Rockwell, Bruce F. Kimler, and John E. Moulder. Publishing negative results: The problem of publication bias. *Radiation Research*, 165(6):623–625, June 2006. ISSN 0033-7587. doi: 10.1667/RR3573.1. (Cited on page 20.)

- [91] Londa Schiebinger. Feminist history of colonial science. *Hypatia*, 19(1):233–254, 2004. (Cited on pages 8 and 77.)
- [92] Cullen L. Schmid. *Differential regulation of serotonin 2A receptor responsiveness by agonist-directed interactions with beta-arrestin2*. PhD thesis, The Ohio State University, 2011. (Cited on page 64.)
- [93] Cullen L. Schmid and Laura M. Bohn. Serotonin, but not n-methyltryptamines, activates the serotonin 2a receptor via a -arrestin2/src/akt signaling complex in vivo. *Journal of Neuroscience*, 30(40):13513–13524, October 2010. ISSN 0270-6474, 1529-2401. doi: 10.1523/JNEUROSCI.1665-10.2010. (Cited on page 64.)
- [94] Cullen L. Schmid, Kirsten M. Raehal, and Laura M. Bohn. Agonist-directed signaling of the serotonin 2a receptor depends on β -arrestin-2 interactions in vivo. *Proceedings of the National Academy of Sciences*, 105(3):1079–1084, January 2008. ISSN 0027-8424, 1091-6490. doi: 10.1073/pnas.0708862105. (Cited on page 64.)
- [95] Victoria Shelton. Scientific research: The publication dilemma, 2005. (Cited on pages 15 and 16.)
- [96] Ju Shi, Katerina J. Damjanoska, Rakesh K. Singh, Gonzalo A. Carrasco, Francisca Garcia, Angela J. Grippo, Michelle Landry, Nicole R. Sullivan, George Battaglia, and Nancy A. Muma. Agonist induced-phosphorylation of α_{11} protein reduces coupling to 5-HT_{2a} receptors. *Journal of Pharmacology and Experimental Therapeutics*, 323(1):248–256, October 2007. ISSN , 1521-0103 (Online). doi: 10.1124/jpet.107.122317. (Cited on page 64.)
- [97] Tom Slee. FutureEverything: Notes against openness, March 2013. (Cited on page 69.)
- [98] Ronald Snijder. Do developing countries profit from free books? discovery and online usage in developed and developing countries compared. *Journal of Electronic Publishing*, 16(1), 2013. ISSN 1080-2711. doi: <http://dx.doi.org/10.3998/3336451.0016.103>. (Cited on page 39.)
- [99] Mark Stalzer and Chris Mentzel. A preliminary review of influential works in data-driven discovery. *arXiv:1503.08776 [cs]*, March 2015. (Cited on page 26.)
- [100] Mark Stokes. Brain box: Biased debugging, February 2013. (Cited on page 28.)
- [101] Peter Suber. Open access overview focusing on open access to peer-reviewed research articles and their preprints, December 2013. (Cited on page 25.)
- [102] Banu Subramaniam. Moored metamorphoses : A retrospective essay on feminist science studies. *Signs*, 34(4), 2009. (Cited on page 8.)
- [103] Athula Sumathipala, Sisira Siribaddana, and Vikram Patel. Under-representation of developing countries in the research literature: ethical issues arising from a survey of five leading medical journals. *BMC Medical Ethics*, 5(1):5, October 2004. ISSN 1472-6939. doi: 10.1186/1472-6939-5-5. (Cited on pages 48 and 49.)

- [104] The PLoS Medicine Editors. The impact factor game. *PLoS Med*, 3(6):e291, June 2006. doi: 10.1371/journal.pmed.0030291. (Cited on page 22.)
- [105] Jonathan D. Urban, William P. Clarke, Mark von Zastrow, David E. Nichols, Brian Kobilka, Harel Weinstein, Jonathan A. Javitch, Bryan L. Roth, Arthur Christopoulos, Patrick M. Sexton, Keith J. Miller, Michael Spedding, and Richard B. Mailman. Functional selectivity and classical concepts of quantitative pharmacology. *Journal of Pharmacology and Experimental Therapeutics*, 320(1):1–13, January 2007. ISSN , 1521-0103 (Online). doi: 10.1124/jpet.106.104463. (Cited on page 57.)
- [106] Richard Van Noorden. Data-sharing: Everything on display. *Nature*, 500(7461):243–245, August 2013. ISSN 0028-0836, 1476-4687. doi: 10.1038/nj7461-243a. (Cited on page 29.)
- [107] Roderik F Viergever, Robert F Terry, and Ghassan Karam. Use of data from registered clinical trials to identify gaps in health research and development. *Bulletin of the World Health Organization*, 91(6):416–425C, May 2013. ISSN 0042-9686. doi: 10.2471/BLT.12.114454. (Cited on pages iii and 50.)
- [108] Edward Vul, Christine Harris, Piotr Winkielman, and Harold Pashler. Puzzlingly high correlations in fMRI studies of emotion, personality, and social cognition. *Perspectives on Psychological Science*, 4(3):274–290, May 2009. ISSN 1745-6916, 1745-6924. doi: 10.1111/j.1745-6924.2009.01125.x. (Cited on page 18.)
- [109] Caroline S. Wagner and Shing Kit Wong. Unseen science? representation of BRICs in global science. *Scientometrics*, 90(3):1001–1013, March 2012. ISSN 0138-9130, 1588-2861. doi: 10.1007/s11192-011-0481-z. (Cited on page 45.)
- [110] Yi Wei, Thomas Harris, and Geoffrey Childs. Global gene expression patterns during neural differentiation of p19 embryonic carcinoma cells. *Differentiation; Research In Biological Diversity*, 70(4-5):204–219, June 2002. ISSN 0301-4681. (Cited on page 66.)
- [111] Jevin D. West, Jennifer Jacquet, Molly M. King, Shelley J. Correll, and Carl T. Bergstrom. The role of gender in scholarly authorship. *PLoS ONE*, 8(7):e66212, July 2013. doi: 10.1371/journal.pone.0066212. (Cited on pages 24, 28, and 48.)
- [112] Nina Wettschureck and Stefan Offermanns. Mammalian g proteins and their cell type specific functions. *Physiological Reviews*, 85(4):1159–1204, October 2005. ISSN 0031-9333, 1522-1210. doi: 10.1152/physrev.00003.2005. Heterotrimeric G proteins are key players in transmembrane signaling by coupling a huge variety of receptors to channel proteins, enzymes, and other effector molecules. Multiple subforms of G proteins together with receptors, effectors, and various regulatory proteins represent the components of a highly versatile signal transduction system. G protein-mediated signaling is employed by virtually all cells in the mammalian organism and is centrally involved in diverse physiological functions such as perception of sensory information, modulation of synaptic transmission, hormone release and actions, regulation of cell contraction and migration, or cell growth

and differentiation. In this review, some of the functions of heterotrimeric G proteins in defined cells and tissues are described. (Cited on page 60.)

- [113] Jelte M. Wicherts, Marjan Bakker, and Dylan Molenaar. Willingness to share research data is related to the strength of the evidence and the quality of reporting of statistical results. *PLoS ONE*, 6(11):e26828, November 2011. doi: 10.1371/journal.pone.0026828. (Cited on pages 19 and 23.)
- [114] Wikipedia contributors. Tuskegee syphilis experiment, March 2015. Page Version ID: 649911724. (Cited on page 4.)
- [115] Zongqi Xia, John A. Gray, Beth A. Compton-Toth, and Bryan L. Roth. A direct interaction of PSD-95 with 5-HT_{2a} serotonin receptors regulates receptor trafficking and signal transduction. *Journal of Biological Chemistry*, 278(24):21901–21908, June 2003. ISSN 0021-9258, 1083-351X. doi: 10.1074/jbc.M301905200. (Cited on page 63.)
- [116] Neal S Young, John P. A Ioannidis, and Omar Al-Ubaydli. Why current publication practices may distort science. *PLoS Med*, 5(10): e201, October 2008. doi: 10.1371/journal.pmed.0050201. (Cited on pages 20 and 21.)