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ACRONYMS

NON-SCIENCE STUFF

IP Intellectual Property

FLOSS free/libre open source software

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

GPL GNU General Public License

GNU GNUs Not Unix

OS open science

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

CIA Central Intelligence Agency

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

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

Places

FDA Food and Drug Administration

MIT the Massachusetts Instiitute of Technology

NIH National Institute of Health

NYU New York University

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

GPCR G-protein coupled receptor

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

GWAS Genome Wide Assocation Study

PTSD PostTraumatic Stress Disorder

1

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 disseminatin of information. This hegemony is not merely theoretical. The proposed 'solutions' to the scientific systems's 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 d 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!

2 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.

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.[10] The "study" finally ceased forty years after it started, in 1972, after a whistle-blower publication in the *New York Times* and Congressional hearings.

and they were testing with the Wasserman reaction!

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 experiments[120]

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 f 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.[10]

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 governd 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 cmpeting 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 vajues, that is, independent of group or individual subjective preferences regarding what ought to be."
>
> Longino , "Science as social knowledge", p. 4 [70]

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.[37] 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.

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

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

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.

find ref for that-fucking book from the fucking summer

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

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.[93]

rewrite genetic surveillance, 1000 genomes project

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

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 curiously 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.

For a solid history, seeRichardson 2010[91] for an a+ overview

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:[53]

> "**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

*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.

Or should *extend...*

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),

Representationally weak.

- an examination of the scientific *construction* of race and gender perpetuated by the perceived objectivity of the sciences[38,35,28]
- the deep paradoxes involved in the ab/use of women's bodies in pursuit of reproductive technologies[92,5]
- the shaping of science by gendered and racialized metaphors and languages,[64,73] and the historical complicity between scientific exploration and colonialism, misogyny, and racism (all at once, not as isolated variables)[54,89,97]
- 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.[108]

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.

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 fucking 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

3 SCIENTIFIC STRUCTURES

In the history and sociology and feminism of science, we talk about science as gift economy, or a commons of knowledge. The scientific project "builds on the shoulders of giants"; the intense, methodological, and highly-specific technoscientific answers we seek in scientific inquiry are atoms, if you will, in the molecules of theories. To stand on those shoulders, we need communication – we collaborate within buildings and between labs, we maintain social ties that influence gifts of stem cell lines and antibodies, we go out to bars at conferences, we track the ever-cresting wave of published academic research. Science is yes, the experiment, but the experiment and information gathered by others goes hand in hand.

Moreover, scientific progress is essentially meaningless unless it's communicated ("success in conveying one's ideas or in evoking understanding in others.") In the philosophical tradition of Ludwik Fleck's work, facts only emerge from a community process of discussion and assessment.[37] In a more practical sense, there's no benefit in synthesizing the mythological cure for cancer unless you (a) get community credit for your and/or (b) cancer patients, y'know, receive the magic drug.

Science has always been tied to the communication networks of researchers and amateurs, although the altruism of that communication is certainly questionable. The 1665 establishment of the first journal, the *Philosophical Transactions of the Royal Society of London*, "aimed at creating a **public record** of original contributions to knowledge,"[50] was a bi-annual periodical of "letter-excerpts, reviews and summaries of recently-published books, and accounts of observations and experiments from European natural philosophers", a money-losing endeavor until the middle of the 20th century.[39] That was the "original" journal.

Today, the structures of scientific communication today number over 25,000 journals, along with an ever-expanding and specializing network of conferences, blogs, uncountable Internet based communications, and tweets, to name a few. The rate at which scientific information moves within communities and between scientists and the "public" has increased dramatically, in both speed and scope. Like most other institutions no longer limited to the mail system and the printing press, the advent of Internet and the increasing role of digital technologies has a transformative effect on communication, and thus science itself.

the politics of "life itself"

This communications transformation takes on long-known issues with the new potential for technological solutions. Scientific communication has always been limited, in both the scope and application, and underwritten by concerns about prestige rather than progress. Academic scientific work has been constrained by funding issues; an increasingly competitive academic environment where only 1 in 10 PhD recipients will find a stable (i.e. tenured) job in their academic field ; outside pressures that lead to data fudging; an increasing amount scientific spin on what an experiment has actually accomplished and a decreasing amount of purely exploratory research.

what kind *of progress?*

research phd and jobs

The criticism of production of knowledge is reaching a fever pitch of excitement about fraud, funding, reproducibility, access, and a flock of other issues. The scientific ecosystem has been metaphorically thrust into the punishing light of the democratizing Internet, and it turns out science isn't the foolproof method our 7th grade biology teachers said it was. And they certainly don't follow the scientific method.

3.1 CYCLES OF SCIENCE

At every step of even the canonical research cycle, communication with and from other researchers plays a role (see Table 1). It is impossible to participate in academic-scientific discourse without both intellectual and financial access to the communication. The blocks along the way are numerous and multi-sited.

rewrite transition

The research cycle itself consists of 5 steps, with interpolations and cross threads between each.

1. The idea; hypothesis generation, asking the question of scientific or funder-driven interest
   - 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->Y->Z)
   - within the context of a greater project by the PI (re: translational neuroscience lab?)
   - a happenstance observation; (see Charney et al., serendipity generally)
2. Set up the preliminaries of funding and approval by the relevant boards; obtain laboratory space and/or a grad student
3. Collecting data, running a set of multiply-envisioned on-the-fly experiments. "Make things work" until there's a meaningful data set; in "softer" sciences, enough evidence for an effect ($p < 0.05$) against the null hypothesis.
4. Writing and rewriting of the paper – introduction, background, results, discussions, methods, further directions for research – and submit it to a journal of your choice.
5. Wait for the inevitable rejection from the Big Journal, re-submit. Eventually, publish.

The concerns around a scientific transformation travel up along all steps of the research cycle, starting with publishing and journals access.

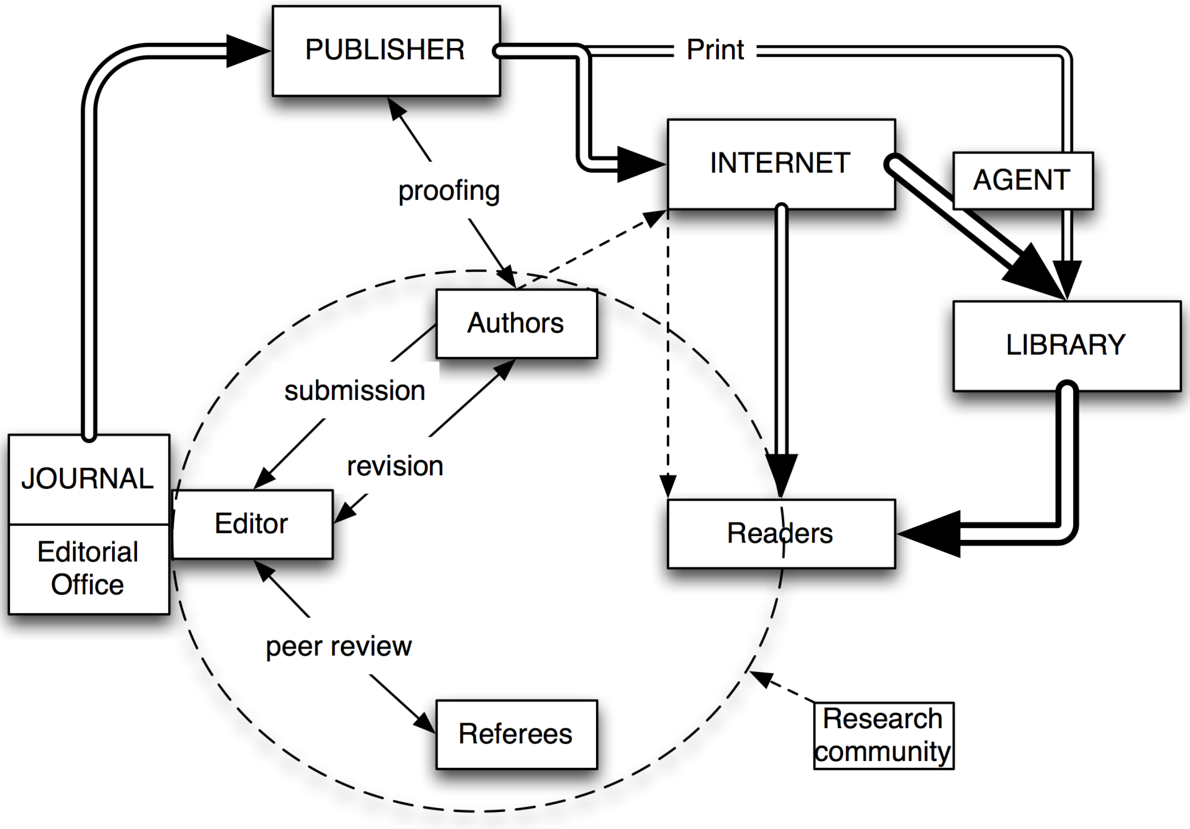
THE PUBLISHING PIPELINE Publishing in a scientific journal, as the main form of scholarly communication for much of modern Western science, is where most attempts to "fix" science start.

current goals/what's accomplished w/ publishing

Publishing benefits the scientist predominantly in an indirect sense, although certainly not an altruistic one:

SCIENTIFIC ACTIVITY	COMMUNICATION REQS.
idea discovery hypothesis generation	awareness lit. review informal discussion
funding/approval	lit review
conduct research	awareness
disseminate results	formal publication informal dissemination

Table 1: communication requirements in research cycle



(a) The publishing cycle

> "...the superficially most important reason given for publishing was to disseminate the results, [but] the underlying drivers were funding and furthering the author's career."

Publication also establishes precedence, and therefore scientific respect. Like the public registry provided by Henry Oldenburg's *Philosophical Transactions of the Royal Society of London* in 1665, researchers in the current day "treat articles and published journals ... as registers of intellectual property whose functions are close to that of a land registry. In effect, journals record the ownership titles (articles) and they define limits and boundaries."[50]

linking

although publishers do provide some *value*

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.

Authors/labs submit their 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. 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, publishers also wore the hat of printer; subscription costs were tied 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 of 100 million dolla's.

rewrite ending

3.2 ACCESS & PAY WALLS; OR, THE STORY OF THE ACCESS CRISIS

> 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.
>
> [102]

The 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.

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.[102]

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

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).

clarify reproducibilty VS 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%.[59] The publication caused (understandable) uproar, with a statistical "battle of the titans" ensuing that continues today.[46,60]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).[60]

find ref for more citations for battle post-Ionnidis publication

rewrite Brief sketch of statistical proof and discussion for falseness

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.

lol @ pharma and cultures of molecules/reductionsm

with regard to increasing Food and Drug Administration (FDA) restrictions

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.[6] 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.[88]. 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.

Both sets of studies were largely based on oncology-directed data

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 principically 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.[57]

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

RETRACTION We can explain away the lack or 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. [18]

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 bias [31]

> "[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. [18]

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 1). [34]

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. [32]

Grieneisen and Zhang examined not just numbers of retractions, but *why* articles were being retracted. Of the 4,449 retracted articles found 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. WhileGrieneisen and Zhang admit the growth in retractions by a factor of 11.36 deos exist (excluding repeat offenders,

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

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

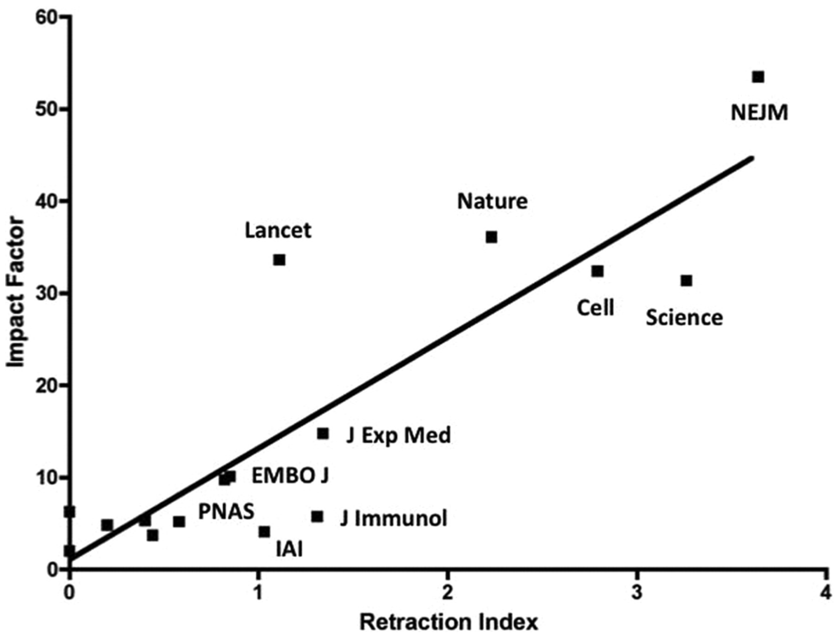


Figure 1: "Correlation between impact factor and retraction index. The 2010 journal impact factor...is plotted against the retraction index as a measure of the frequency of retracted articles from 2001 to 2010."[34]

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.[49]

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.[13]
>
> *Puzzlingly High Correlations in fMRI Studies of Emotion, Personality, and Social Cognition* (originally *Voodoo Correlations in Social Neuroscience*) – Vul et al.[114])
>
> *Willingness to Share Research Data Is Related to the Strength of the Evidence and the Quality of Reporting of Statistical Results* – Wicherts et al.[119])

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??].

24,63

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 reagants, 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 publicaiton to directly point at the issue. Easterbrook, Gopalan, Berlin, and Matthews reviewed a set of clinical research trials, concluding:[25]

> "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 ften 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.[71]

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.

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

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.[?] Journal editors, especially those in high-impact journals, are less likely to accept them. are more likely to recommend a 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.[29] Negative results also garner more requests for additional data points and statistical analyses than identical papers with significant results.[95] Readers are less likely to be interestedinterested in hearing about therapies that *don't* work

According to Ioannidis, negative papers are most likely to be suppressed when:[59,121]

- studies conducted in a field are smaller
- effect sizes are smaller
- there is a greater number and lesser preselection of tested relationships

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

- 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".[36]

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."[11]

> "The citation game has created distinct hierarchical relationships among journals in different fields."[121]

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

[§]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.

reflecting the number of citations of a journal's material divided by the number of citable materials published by that same journal.[¶] [65]

$$\text{Impact Factor} = \frac{\text{number of citations}}{\#\,\text{citable materials published}} \tag{3.1}$$

> "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."[65]

Metrics immediately lead to gaming the system.

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.[65]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.

3.4.1 *choose their acceptances*

> ...Editors make estimates of likely citations for submitted articles to gauge their interest in publication. [121]

Who thought this would go well?

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.[||] It also sets up a 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

¶insert time (2 years) and other data

|| There'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.

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 2006[110]

4 CRACKING SCIENCE OPEN

> 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 becomesa ragtag team of co-existing, largely collaborative initiatives.

research conflict between different areas of openness

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;[119] when they are available, they're often disorganized and poorly documented.

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?

find ref for Mertonian ethos

whoops terrifying myself

Open science starts at the end of the chain: long-standing initiatives to make journal articles, the polished final product of scientific research, accessible. Then, it moves deeper, demanding not just the results the authors choose to highlight, but the data powering authorial interprations. 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 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)."[107]

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.[107]

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.[3] 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 wnership 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)?[76]

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:[77]

- 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.[75]

find ref for page number in mendeleev's

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.[105] The Human Genome

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

research fact sheet on usage statistics of NCBI

In astronomy, the Sloan Digital Sky Survey (SDSS)

research sloan digital sky survey

Meta-analyses Open data extends the useful life of data collections by combining and manipulating datasets, like bio-informatians 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 fromPampel 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

n 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

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.[106,86] †

find ref for coding errors and analysis

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.[117] and Larivière et al.[67] 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. (cmment onStokes[106])
>
> connect code to what code generatesi 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

research notebook usage in different fields

origin of phrase for ground zero?

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* Taq 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.

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.

find ref for open notebooks as supplementary material

The group has also added a similar project on HIV.

rewrite Claude-Bradley, implementatons and origins of ONS

A more recent high-profile open notebook scientist Carl Boettinger, 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).[41,74,112]

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?

using URLs and hyperlinks with classic thesis

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.

4.7.1 *Citation*

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

figshare.com

dryad.com

provide examples of citing data

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 Champlimaud 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 personal communication 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 reagants? 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:[77]

5 WHAT'S INSIDE? FIXING SCIENCE

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"[9], 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 abut 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 reshaping the kinds of input we accept into the scientific process.

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

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

- 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." (Reagle[90])

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?"[69]

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 an 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 t 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 structures[78]; 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

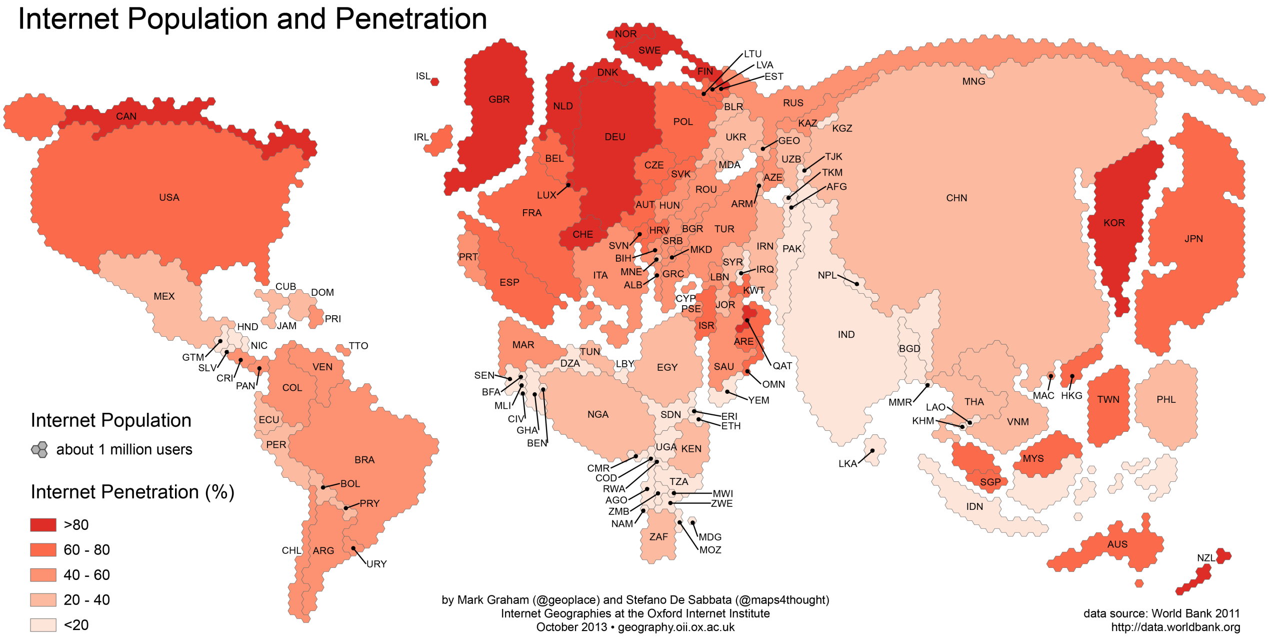


Figure 2: This map illustrates the total number of Internet users in a country as well as the percentage of the population that has Internet access.

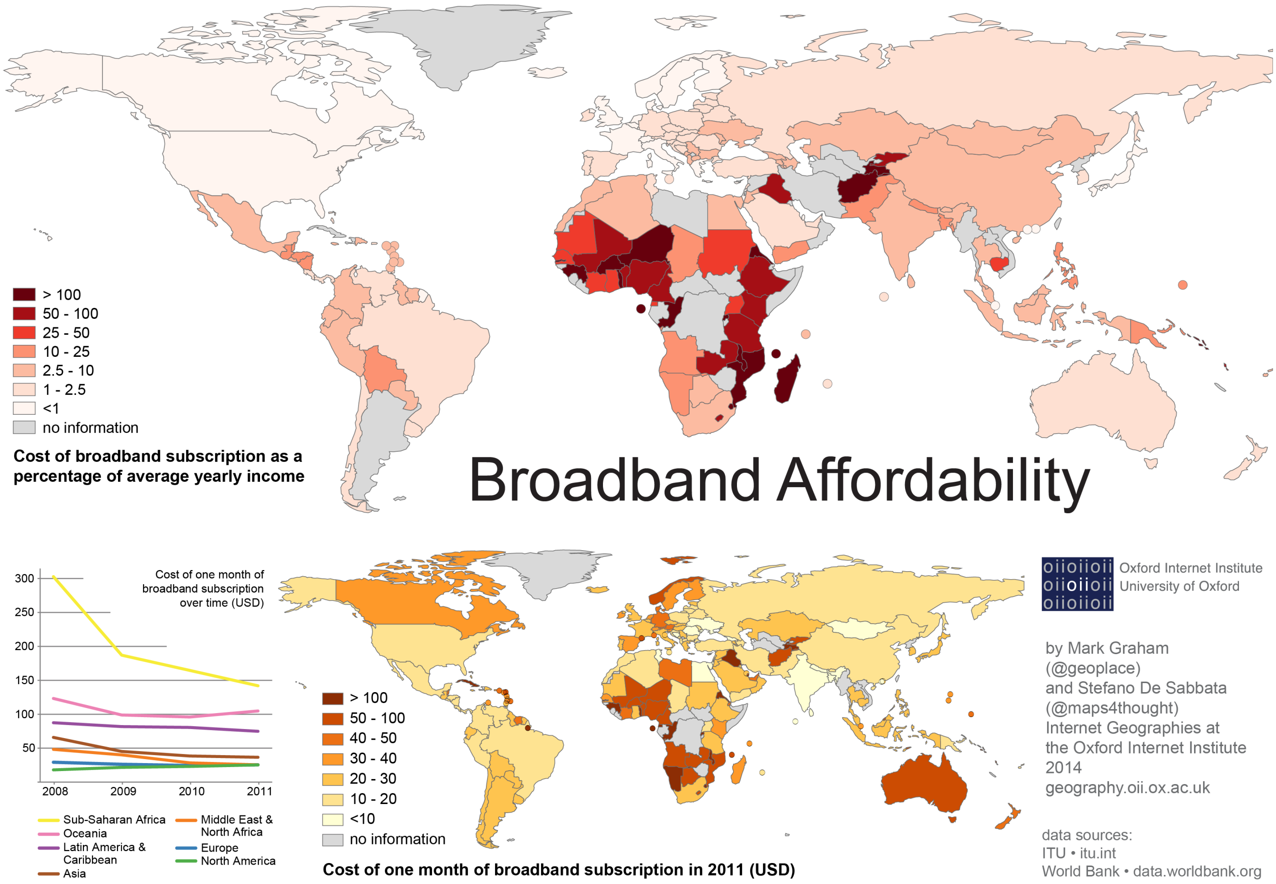


Figure 3: **Description** -This map presents an overview of broadband affordability, as the relationship between average yearly income per capita and the cost of a broadband subscription.

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
- technogical 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.

Refs*Christian*[16], *Dahdouh-Guebas et al.*[19], *Gorelick*[47], *Jolliffe*[61]

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 Reimer[30], 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 Solomon[8], Open access versus subscription journals: a comparison of scientific impact

5.4.6 *Digital Divides and Open Access*

> "Does open access actually increase access?"
>
> [104] 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 38)

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

6 REPRESENTATION & SCIENCE

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?

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

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

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 [58]

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. [26]

† 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,

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

find ref for social construction of race

> "There is nothing about being 'female' that naturally binds women."
>
> *A Cyborg Manifesto*, Donna Haraway [52]

Her argument in *A Cyborg Manifesto* for "building coalitions through affinity, not identity" [52] 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

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

rewrite women in & 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?

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

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

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 particualrly 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.

rephrase

Clinical trials and biological research are also lower on a "Hierarchy of Sciences", which predicts that as we move from simple systems (partical dynamics) to complex (human behavior), researchers are less able to reach theoretical and methodological consensus.[33] 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.

to cite Traweek or not?

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

- 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? ‡
- Ii 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.

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

"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.

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 sicentific 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.[115] 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?

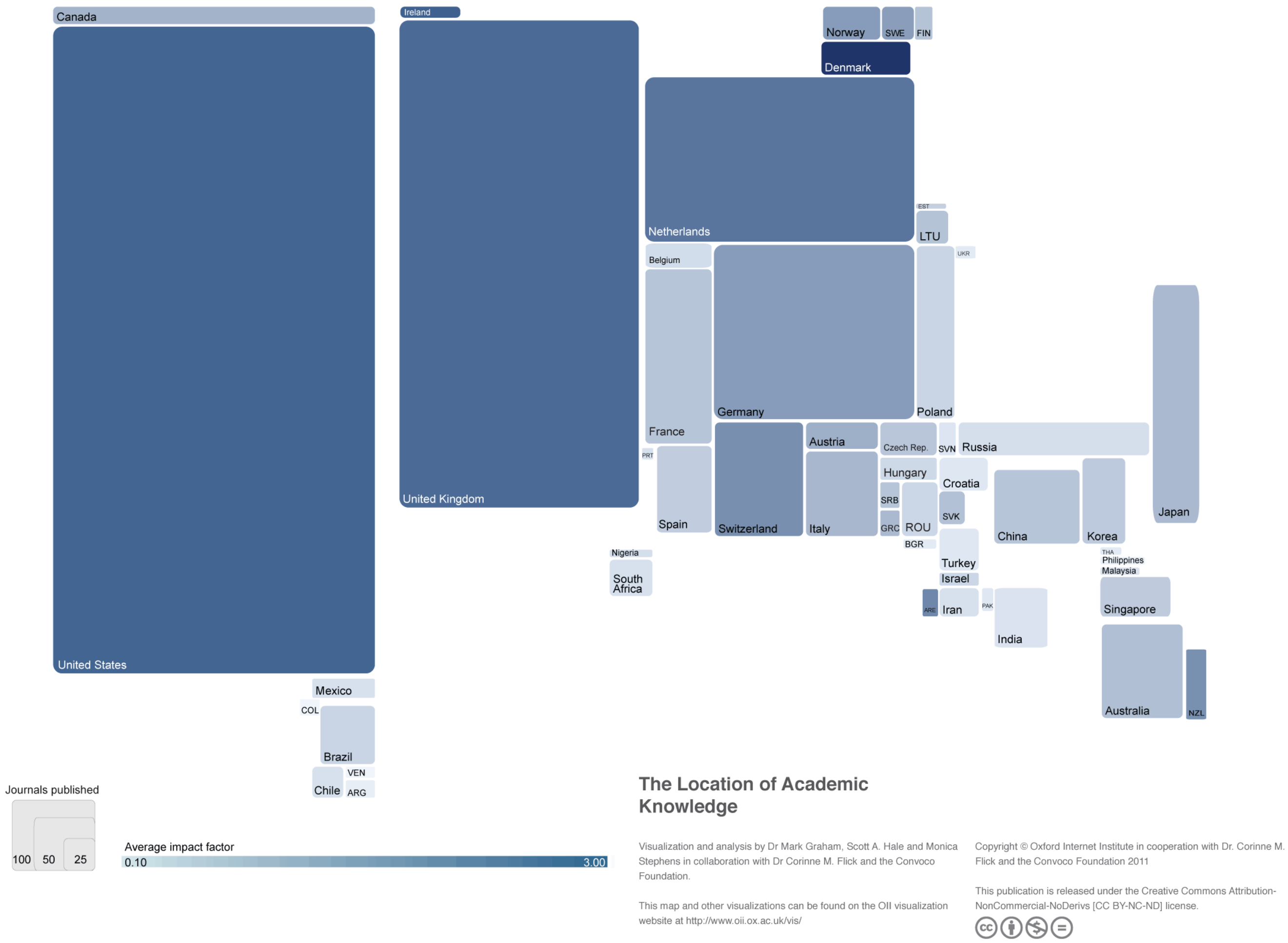


Figure 4: The location of academic knowledge

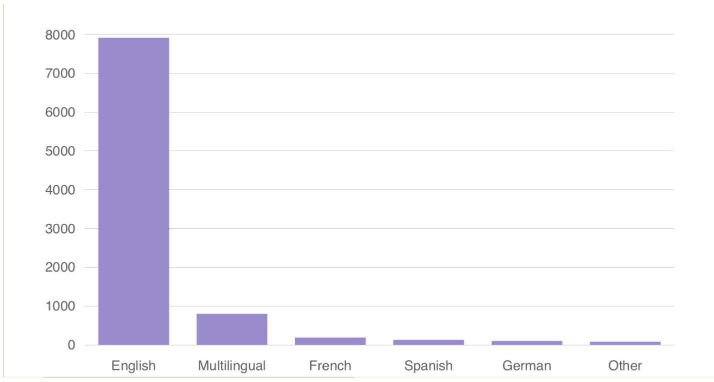
Figure 4 sho the "location of academic knowledge." The U.S. and U.K produce more Science Citation Index (SCI) indexed journals than the rest of the world combined; Switzerland dwarfs by a factor of 3 the *entire* continent of Africa. Not only do the formerly-colonized countries of the majority world fare poorly in quantity, their citation rates, as measured by the IF, are systematically lower.[48]

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

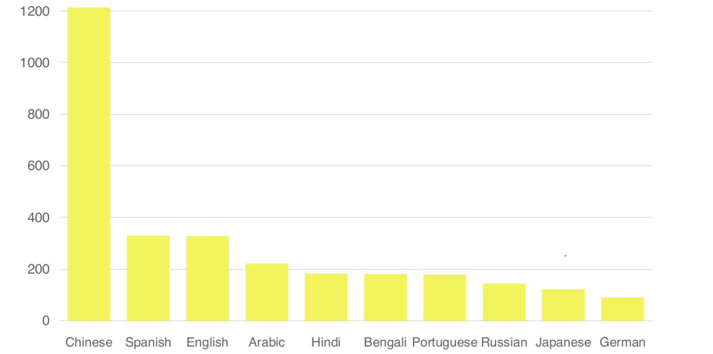
That isn't so surprising in light of the Thomson-Reuters standards for quality and inclusion in SCI indexing, and thus the assignment of an IF. Thomson-Reuters states:

> "*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:



(a) language of WoS journals



(b) Number of native speakers, in millions

Figure 5: 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.

find ref for brazilian scientific productivity

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

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. [67]

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

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!

Unsurprisingly, most of these statistics vary broadly between fields and subfields

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.[22]

review "vanish box" idea – women leaving academia for industry? maybe in a longer review?

mention imp. of author order?

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 and[67] Larivière et al.[67] 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.

Gender assigned using Social Security databases

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 an 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.

rewrite and their conclusions were...

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 instituational 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 developing culture of collaboration and thus the changing 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.[109]

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 .[55]

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.[43]

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.[94]

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.

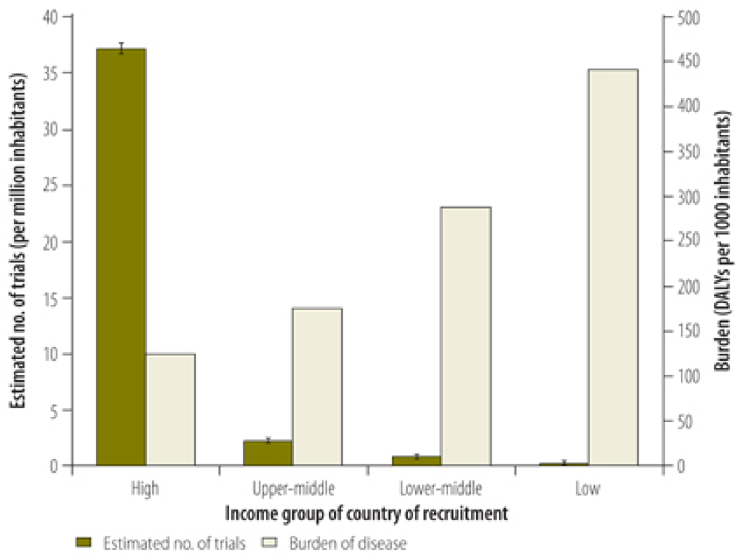


Figure 6: Estimated numbers of trials in the International Clinical Trials Registry Platform recruiting participants in low-, lower-middle-, upper-middle- and high-income countries, 2012 (Fig 4. fromViergever et al. [113])

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.

7 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 goals 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 issues.

7.3 OPEN EPHYS

7.4 GREEN CHEMISTRY

7.5 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 MOLECULAR PSYCHEDELICS

psychedelics "mind manifesting"

psychedelics serotonin agonists

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 accidental ingestion in 1943 of lysergic acid diethylamide (LSD), synthesized in 1938 from ergotamine.

In the 72 years since Hoffman's discovery of mind-altering properties of LSD, the cultural and scientific relevance of the psychedelic drugs has swung wildly. They have been variously: implicated in CIA coverups and brainwashing; a foundational symbol of counter-culture movements; effective treatment for alcoholism, obsessive-compulsive disorder (OCD), anxiety, and depression; the inspiration for the discovery of a major neurotransmitter; as a field of battle for the rights of indigenous rights.

references for roles f LSD

The current scientific space for psychedelics is anticipated by human use predating written history. In Europe, prehistoric cave paintings in Spain depict mushrooms, thought to be of the genus *Psilocybe*[2]. In North America, archeological evidence of mushrom usage and surviving spiritual traditions from the desert southwest of what is now Texas and Mexico abounds[12,27,101]. A Japanese folktale from the 11th century references "laughing mushrooms" and the hallucinatory/mood-altering effects after consumption.[96] Recipes for the "soma" of the ancient Indo-Aryan Rigveda, the ambrosia of the gods, draw on over one hundred ingredients that produce a concoction of psychoactive alkaloids.[68] In South America, a thriving ayahuasca-shamanistic tradition in the deep Peruvian rainforests is busy modern commerce[56]; across the ocean on the western coast of Africa, the Bwiti disciplines in Gabon and Cameroon employ the iboga plant as a center of spiritual practice.

find ref for ibogaine/bwiti

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.

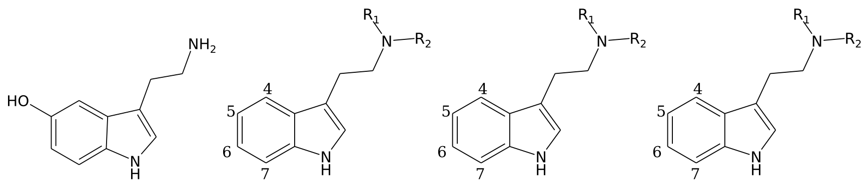
rewrite scientific history of psychedelics

72 years later...

Consciousness-raising molecules

In 1942, the neurosciences were still 20 years in the future.[1] Genetics was in its relative infancy, and would not really start gaining steam until the late 50s and 60s.

Psychedelic research was largely focused on (a) psychological effects, i.e. the use of LSD and mescaline as model psychoses, or the potential



(a) Serotonin (b) Tryptamines (c) ergolines[[not actually] (d) phenethylamines [eventually]

Figure 7: Chemotypes of 5-HT_{2A} agonists[83]

for serious therapeutic progress or (b) the synthesis of increasingly complex related drugs.

70 years later, biology is very different. We can track very specifically what happens to bodies on molecular- and cellular-levels, enough to understand that the long-term spiritual effects reported by some psychedelic users is likely matched by dendritic spine growth on neurons.

We can explore more precisely how the consciousness alteration is traced to biological mechanisms of receptors, signalling, and networks.

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.

8.1 THE CLASSICAL PSYCHEDELICS

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

find ref for receptor binding affinity

Serotonergic hallucinogens – psychedelics – are classified according to their chemical structure, or lack thereof. They are non-addictive drugs, and users become tolerant after a single effective dose. 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.[81]

Pharmacologically, all of the classical psychedelics exert their main effect throughb inding a subtype of serotonin receptor, the 5-HT_{2A} receptor. Structurally, psychedelics resemble the endogenous 5-hydroxytryptamine (5-HT), aka serotonin, and fall into one of three main chemotypes: tryptamines, which most closely resemble serotonin, ergolines which can be considered to be rigidified tryptamines, and the phenethylamines (see Figure 7).[82]

research popularity of drugs

psilocin = metabolized psilocybin

find ref for DMT prevalence

New World?

should note somewhere that LSD is less popular than ever haha molly haha

The most well-known of the chemicals is likely the synthetic ergoline LSD, an ergoline. The tryptamines psilocin and *N*,*N*-Dimethyltryptamine (DMT) are the active component of the *Psilocybe* mushroom genus and endogenous to most plants, respectively.Mescaline, a phenethylamine, is produced in several species of New-World cacti. The chemical analogues are numerous and endlessly permeable; while most are used in research as highly specific 5-HT_{2A} agonists, they have also percolated out as recreational drugs. Ibogaine is somewhat of an outlier: although it shares the same tryptamine core, ibogaine also has an set of substituents that lend it activity at NMDA receptors as well as 5-HT_{2A}Rs. *

*At the border of the classical psychedelics is **MDMA!** (MDMA!), which shares properties of both mescaline and the sometimes-toxic amphetamines.

LIGAND CLASSIFICATION	CELL RESPONSE
fulll agonists	maximal
partial agonists	submaximal r
inverse agonists	reduction of basal sigalling
neutral antagonists	no signalling, occupies the receptor and thus block agonist effects

Figure 8: the classic classifications of agonists, as described inUrban et al., 2007[111]

Receptors

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

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

Classical pharmacology has, for 50 odd years, relied on a model of characterizing ligands by the functional effects of target interaction. The effects are governed by (1) affinity, i.e. the strength of the chemical bond between ligand and receptor and (2) efficacy, the propery that allows bound ligands to produce a response. The result of this model has led to the classification scheme of Communication in the research cycle Intrinsic activity is the measure of the stimulus per receptor molecule produced by a ligand. More simply, the classical quantitative pharmacology assumes if molecule X binds with an affinity Y, the receptor will always transduce a signal of quality and strength Z in a system-independent fashion.[111]

The practical implications of this classic model is the possibility of variety in the *quantity* of a response, but not in the *quality*. Thus, a full exogenous agonist is expected to activate the signalling pathways to the same level as the endogenous ligand.

5-HT$_{2A}$ receptor signalling is one of the foremost examples of ligand-receptor interactions, what's called alternately "**biased signalling**", "biased agonism", "functional selectivity", or "agonist-directed trafficking". By and large, agonist activity and signalling pathways doesn't track with the notion of intrinsic efficacy. All of the classical psychedelics share a binding affinity for the 5-HT$_{2A}$ receptor. This affinity across the three chemical classes for a single receptor subtype and the subsequent signalling pathway activation is well-established as the essential component of psychedelic signaling.[42,81,45] (other citations later) They are all partial agonists (see binding affinities), but elicit ligand-specific intracellular effects.

Intracellular effects are measured by quantities and types of second messenger release, transcription factor activation s, rates and amount of receptor de/sensitization, internalization, and recycling, among thers.

Table 2: binding affinities

In the case of the psychedelics, there are distinct *hallucinogenic* downstream effects in the form of transcriptomic "fingerprints"[44], and specific and preferential activation of second messengers[45,66].

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 that then leads to psychedelic experiences, 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

8.2 THE MOLECULAR SITE OF ACTION

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

antagonists
ketanserin:5-HT$_{2A/C}$
risperidone:5-HT$_{2A}$/D$_2$

There is an extremely strong correlation between 5-HT$_{2A}$R affinity and hallucinogen potentency 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$_{2A}$ occupation.

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

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[84,87]

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,

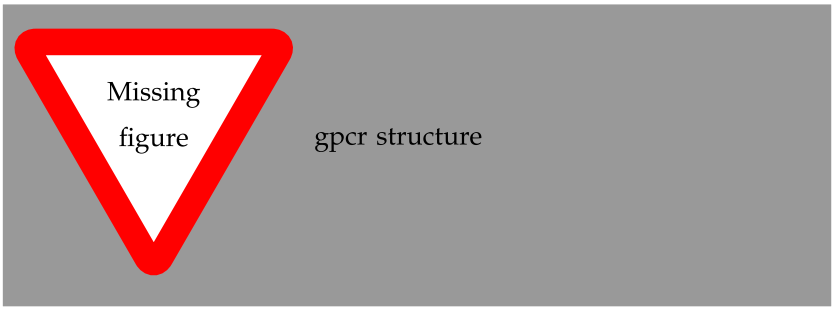


Figure 9

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."[51]

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.

8.3 5-HT$_{2A}$R STRUCTURE

8.3.1 *GPCRs*

The 5-HT$_{2A}$ receptor is a G-protein coupled receptor (GPCR), one of an extremely diverse class of heptahelical transmembrane signalling proteins. As a protein class, GPCR are prolifically expressed across cell types and across species, and are the endogenous targets of numerous hormones, neurotransmitters, chemokines, local mediators, and sensory stimuli.[14] 30-40% of current pharmaceuticals target just 7% of the available receptor targets.[40]

famous GPCRs? sonic hedgehog, for example

The breadth of GPCR functionality is due to their unique signalling capabilities. Ligand binding to the extracellular terminal of a GPCR initiates a conformational change in the protein, modifying the interaction between the intracellular side and an attached heterotrimeric guanine nucleotide-binding protein (G-protein) complex.

rewrite dumb intro sentence

The G-protein complex consists of an α-, β-, and γ-subunit. In the unbound receptor, the three subunits associate with each other; the α-subunit maintains a bound guanosine diphosphate (GDP) The α- and β- units also bind with the intracellular terminal of the protein and hold the complex. In the classic model, the conformational shift induced by ligand binding causes 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. 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

[†] 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.

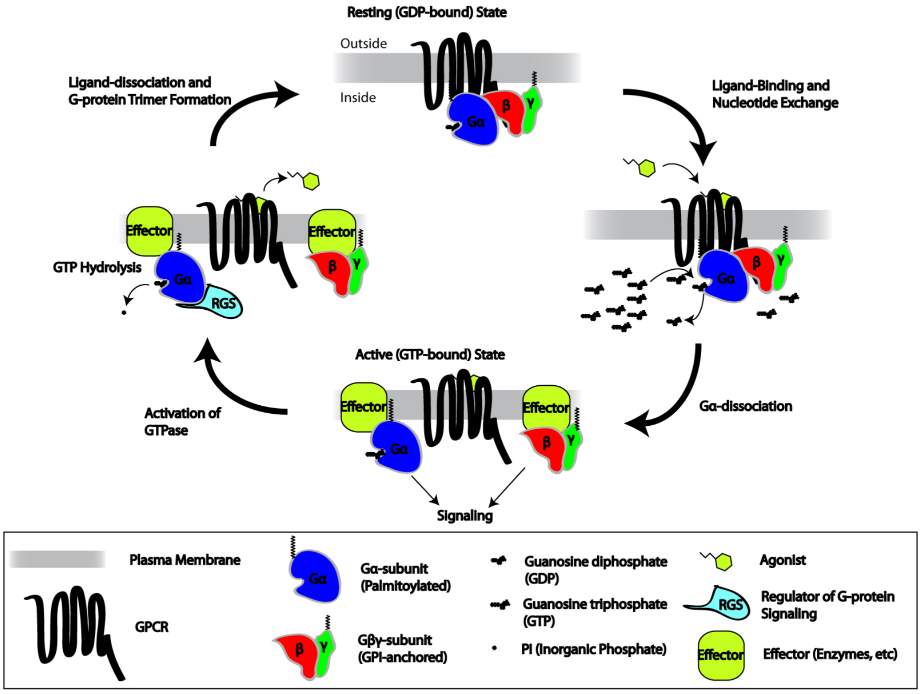


Figure 10: stole from Wikipedia, the general active-inactive cycle of **GPCRs!**

re-associates with a βγ-complex to reform the G-protein complex, completing the cycle.[118](See Figure 10)

The classical model is complicated by lines of evidence that suggests 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

8.3.2 *5-HT$_{2a}$ Structure*

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, $G_{\alpha s}$, $G_{\alpha i}/G_{\alpha o}$, $G_{\alpha q}/G_{11}$, 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.[14]

"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."[23]

"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."

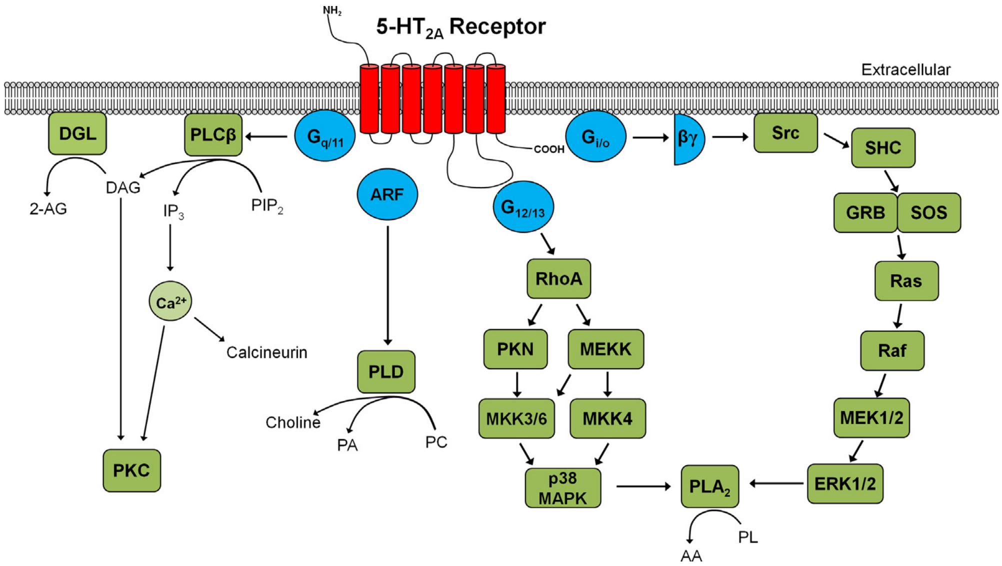


Figure 11: 5-HT_{2a} pathways, fig 4 from Halberstadt , 2015[51]

8.3.3 *Canonical activation 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 membrane phospholipids to inositol triphosphate (IP 3) and diacylglycerol,and mobilization of intracellular Ca $^{2+}$...
>
> 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 A 2 (downstream from ERK 1,2 and p38 MAP kinase), Akt, and phospholipase D (dependent on the small G protein ADP-ribosylation factor-1 (ARF1))".[51]

8.4 BIASED SIGNALLING

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-HT2C receptor, 5-HT binding produces a strong phosphoinositide hydrolysis response, a rise in intracellular calcium levels and phosphorylation of the receptor itself. LSD produces robust phosphoinositide hydrolysis, however there is no concomitant rise in intracellular calcium and only limited phosphorylation of the receptor[79]

8.4.1 *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**."[?]
>
> **"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.**"[4]

8.4.2 *Electrophysiological events*

8.4.3 *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."**[45]
>
> "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."[51]

BETA ARRESTIN INTERACTIONS

> "ß-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 ß-arrestin-2, as well as in cells lacking ß-arrestins. In mice, we find that serotonin induces a head twitch response by a ß -arrestin-2-dependent mechanism. However, DOI invokes the behavior independent of ß -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 ß-arrestins."[99,98,100]

receptor reserves

> "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."[66]

rewrite in your own words

NIH3T3: Swiss mouse embryo, hypertriploid karyotype

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."**[44]

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[62]

karyotype not specified

8.4.4 *long-er term changes?*

on what time scale?

Receptor modifications

> "The receptor binding experiments suggest that phosphorylation of G 11 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 $G_{\alpha 11}$ 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."[?]

gene expression

Both single-doses and chronic administration lead to long-term changes in gene expression and plasticity in the mammalian brain[80,72]

I know all the authors on this paper, so maybe an interesting point bring up? also I made some of that! i.e. qPCR data

8.5 ANIMAL MODELS OF DRUGS

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."[81] 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.

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

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

I know this is true for HTR, but maybe not the rest? research.

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$_{2A}$ agonists.

rewrite differences between organisms in HTR

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

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 operational measure of sensorimotor gating, and reflects central mechanisms that filter out irrelevant or distracting sensory stimuli."[51]

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 qualitiative 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 exploratry/investigative behavior in animal models

differences in indoleamines and phenethylamine reaction in rats and mice?

tolerance studies

nutshell version: Ergolines, phenetheylamines, 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

8.6 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. "[79]

8.6.1 *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$_{2a}$

8.6.2 *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.[20] Approximately 20-25% of the interneurons in the prefrontal cortex (PFC) express 5-HT$_{2A}$ mRNA, largely to be basket and chandelier cells.[51]

rewrite localization of 5-HT$_{2a}$Rs on neurons

research relevance of basket/chandelier cells?

> " Previous studies have shown that activation of 5-HT$_{2A}$ receptors in this region results in a robust increase in spontaneous glutamatergic synaptic activity, and these results have led to 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$_{2a}$Ractivation."[7]

rewrite with my very own words

in vivo

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

interactions with other structures

write interactions with other structures?

8.6.3 *Visual Cortex*

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

8.7 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.

rewrite neuroimaging sucks

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

8.7.1 *Frustrations with model systems?*

differences between mouse, human, and rat

8.8 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

8.8.1 *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.

8.8.2 *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"

8.8.3 *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.[?] Studies of this differentiation pathway have elucidated a number of genes important for neural development,[116] and they're an established model system for exploring embryonic differentiation of neuronal cells.

9 OPEN SCIENCE & SEROTONIN

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.

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

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

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 Boettinger'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.

Can cite this if people feel strongly

4. Studieshave 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

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, H_2O, 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.

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

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

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 redefinining. 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.

10 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).

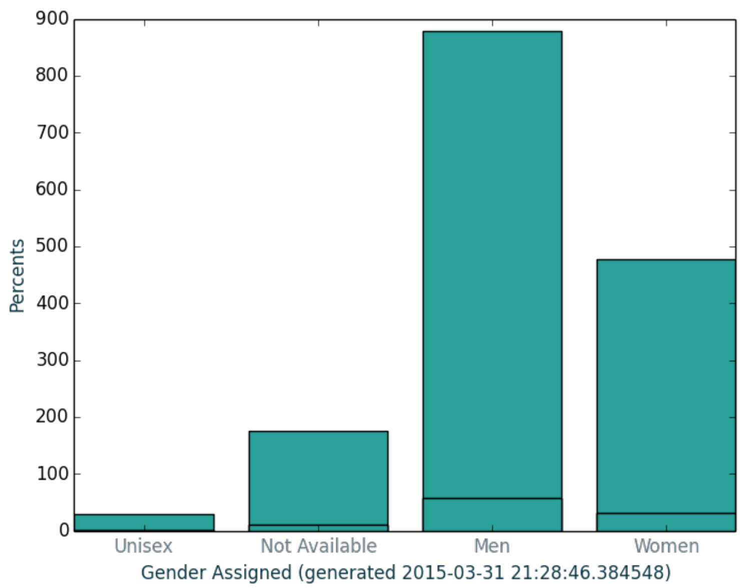


Figure 12: Gender distribution of all works in this div! META.

Figure 13

11 RECONSTRUCTIVE NEUROSCIENCE

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 asnswer. 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 serendipitious 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

Per Latour as in Clarke and Shim [17], 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 intrinsinically interwoven with the planet's residents. Physics research is interwoven with technologies like ultrasounds (an alternately powerful but gendered and reproductive in/justice tool), or weapons of communication and destruction.

This is f course the central premise of Herb's work under a codified name

if this is the "century of biology" and biology is more realistically molecular biology– .

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

molecular biology tactics to understand and place organismal-biological complexity at an atomic-molecular level scale; i.e. looking at diseases, cognition, sensations, natural selection, reproduction, organism movement as the product of the central dogma of molecules (proteins, RNA, DNA)

Then the processes of "technoscientific biomedicalization"

"...medicalization and biomedicalization need to be complicated. They can refer to "medical miracles" that wondrously alleviate pain and suffering as well as *overpromoting their value."* [17]

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

biomedicalization 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 medicine

In other words, deviations from the norm is now not just a psychiatric issue of bad morals or childhood influences, as the diagnos but a chemical problem to be solved by chemical means.

article on the decreasing importance of the DSM and increasing biological explanations for psych

write about Leary and specific scientifichistories of psychs?

history of research on addiction treatment

what about chemists? early histories of syntheses

Psychedelics, upon theirtheir initial scientific appearance (Timothy Leary's spiritual explorations, the Central Intelligence Agency (CIA)'s mind-control attempts Project MKUltra, early attempts at reducing addictions) focused on medical-military applications, with the belief that the subjective experience was key to their outcomes. Regardless of their goals, the projects were not molecularly-focused.

The biomedicalization of psychedelics (like many drugs) allow psychedelics new clinical/medical configuration and applications. Most of the serotonergic hallucinogens are Schedule I drugs; the U.S. government's official stance is:

1. The drug or other substance has a high potential for abuse.

2. The drug or other substance has no currently accepted medical use in treatment in the United States.

3. There is a lack of accepted safety for use of the drug or other substance under medical supervision.

increasingly biological-sicentific aspects of clinical medicine, processes by which aspects of life previously outside the jurisdiction of medicine come to be construed as medical problems

despite years of effort, psych. research has only re-emerged after the 'decade of the brain'

why did they THINK psychs would work?

The increasing use of these drugs and the revival of psychedelic research is (possibly?) tied to the trends of pharmacologically-mediated interventions into the lives of those with PostTraumatic Stress Disorder (PTSD), addictions, and depression. Changing medical boundaries – what is andla is not **ADHD!** (ADHD!), and the increased focus on the mind as a site of intervention – give psychedelics a new biomedical effect; not for their consciousness-altering properties, but rather for their specific signalling pathways. The quest is not to cure alocholism through enlighment, but to specifically biomedically mediate the complex interactions of "natural" chemical makeup and interactions with alcohol.

feminist personalized medicine?

personalized and precision medicines The new place of psychedelics as chemical rather than psyche manipulations fits nicely in with a growing trend. Personalized medicine relies on genomic information to tailor medical treatments and drug cocktails.Precision medicine, recently announced as a major initiative by President Barack Obama, is

> "...an emerging approach for disease treatment and prevention that takes into account individual variability in genes, environment, and lifestyle for each person." (http://www.nih.gov/precisionmedicine/, accessed 04/08/2015)

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.

For psychedelics, we might reference the discipline of pharmacogenetics.

11.1.1 *De-legitimizing other knowledges*

The re-introduction of psychedelics into the clinic/lab seems to go hand-in-hand with a systematic devaluing of recreational users, at least in the formalized literature and the public/media's eyes.

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.

http://www.erowid.org

Erowid The "non-profit, harm reduction organization" "documenting the complex relationship between humans and psychoactives" is likely the number one resource for recreational (and self-medicating) users of psychoactive drugs. They have a dizzying and expansive archive of peer-reviewed scientific literature (marking it paywalled or not), pharmacological information, health risks, well-documented testimonies on drug use (other drugs in use, dosage, time and duration of experience, mental/physical health histories, *ad. infinitum*).It is a mix of hard scientific information about binding affinities and drug interactions, practical usage and safety information (both pharmacologically and mentally), proposals for chemical syntheses, meditations on spirituality, cultural histories, law and policy suggestions, art pieces and so on; a tremendous resource built by and for psychoactive communities.

Langlitz's post-market pharmacovigilance – this comes out of obviously deep distrust of the medical system – every man for himself – desire to synthesize information oneself and make *own* body decisions.

Erowid does not, unlike the scientific literature, paint the potential of psychoactives with a one-sided brush. Users post good experiences and bad; some say it is very important to them personally, but with the large and constant caveat of 'mileage may vary'. In many ways, I think the information on Erowid is much more realistically oriented – towards clinical applications – than the nominal cutting edge of science. It neither makes grand claims about everybody's experiences nor relegates psychoactives to the realm of the purely dangerous Schedule I.

indigenous science

Like the dismissal of amateur science – or at least the non-acknowledgement, the use, during literally all of recorded human history, is a footnote to the real research. Despite centuries of commerce underlying the shamanistic-therapeutic ayahuasca ceremonies,[56]

and thus reinforcement of academic-casual hierarchies

11.2 VALUES AND POWER STRUCTURES

11.2.1 *Present Day*

Ecological destruction

When we say these plants and compounds have cultural histories, what that means is that they literally – grow or grew some where. To become a major treatment option, those plants either have to be produced on a massive scale (reducing genetic diversity, bringing in issues of labor movements and ethics) or synthesized (bringing in green chem. issues). Moreover,

Biopiracy should psychedelics be patentable?

Biomedicalization of social problems

The framing of the problem affects the solution, and vice versa. (Bio)medicalization of mental health can be empowering – attributing clinical depression to a chemical imbalance can be a helpful way to move forward, instead of blaming theselves.

addiction Similarly, alcoholism as a disease implies the possibility of healing and the movement of blame from individual choices to a genetic inheritance and accident of environment.

It also, however, reduces a psychological-bio-life-complex of chemical/societal/habitual dependency to a one-off treatment. Heroin is one of the most addictive substances, and the most destructive. The standard "treatment" is another drug – methadone, which blocks the same receptors to inhibit cravings. Methadone is equally addictive and in many ways just as destructive; the only difference is that users or their insurance company pay the state instead of cartels. The biomedical disease model of addiction implies a pharmaceutical cure.

If, on the other hand, we frame heroin addiction as a social concern – one that users are driven to by a lack of options and by a lack of satisfying community interactions – the solution becomes quite different. Like the recidivism rate of prisons in Norway versus the U.S., taking care to place users back into supportive and meaningful environments is often an effective way to help them cope with the psychological toll of addictions.

Even earlier, addiction is often the results of restrictive societal

> "n other words, if you don't want to quit—and if you don't have a new life purpose like promoting an addiction cure (!) or at least some social support—ibogaine won't do much more than any other type of detox. It's not exactly nothing to have a psychedelic experience and come through detox without suffering physical withdrawal. But that's not all you need to end most addictions."

ADDICTIONS rat city and addiction and treatment

TRAUMA: PTSD Resembles stress symptoms categorized in the 50's; largely associated with combat, but also occurs in civilian trauma cases (rape, childhood abuse)

END OF LIFE ANXIETY largely duplicates the experiences religion offers to some people; cultural distrust/fear of death

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 LondaSchiebinger'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 destructin 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 qualitiative 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.

find ref for studies

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

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.

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.

how many people use drugs? percentage wise?

11.6 a cultural compound

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?

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 structurein 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: 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.

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

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

*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.

such that the ayahuasca in the lab is only nominally related to ayahuasca in (shamanistic) practice.[†]

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

[1] Joelle M. Abi-Rached and Nikolas Rose. The birth of the neuromolecular gaze. *History of the human sciences*, 23(1):11–36, 2010. (Cited on page 57.)

[2] 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 57.)

[3] Kent Anderson. UPDATED – 82 things publishers do (2014 edition), October 2014. (Cited on page 27.)

[4] Carine Bécamel, Sophie Gavarini, Benjamin Chanrion, Gérard Alonso, Nathalie Galéotti, Aline Dumuis, Joël Bockaert, and Philippe Marin. The serotonin 5-HT2a and 5-HT2c 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 64.)

[5] 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.)

[6] 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 17.)

[7] 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 67.)

[8] 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 41.)

[9] 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 35.)

[10] Allan M. Brandt. Racism and research: The case of the tuskegee syphilis study. *The Hastings Center Report*, 8(6):21, December 1978. ISSN 00930334. doi: 10.2307/3561468. (Cited on page 4.)

[11] 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 21.)

[12] 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 57.)

[13] 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 19.)

[14] 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 pages 61 and 62.)

[15] 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 14.)

[16] 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 40.)

[17] Adele E. Clarke and Janet Shim. Medicalization and biomedicalization revisited: Technoscience and transformations of health, illness and american medicine. In Bernice A. Pescosolido, Jack K. Martin, Jane D. McLeod, and Anne Rogers, editors, *Handbook of the Sociology of Health, Illness, and Healing*, pages 173–199. Springer New York, New York, NY, 2011. ISBN 978-1-4419-7259-0, 978-1-4419-7261-3. (Cited on page 77.)

[18] 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 18.)

[19] 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 40.)

[20] 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 67.)

[21] Alessandro Delfanti. *Biohackers: The Politics of Open Science*. Pluto Press, London, May 2013. ISBN 9780745332802. (Cited on page 38.)

[22] 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 50.)

[23] Denis J. Dupré, Mélanie Robitaille, R. Victor Rebois, and Terence E. Hébert. The role of gβγ 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 62.)

[24] 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 Ghersi, 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 20.)

[25] 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 20.)

[26] 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 45.)

[27] 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 57.)

[28] 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.)

[29] 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.)

[30] 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 41.)

[31] 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 18.)

[32] Daniele Fanelli. Why growing retractions are (mostly) a good sign. *PLoS medicine*, 10(12):e1001563, 2013. (Cited on page 18.)

[33] 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 46.)

[34] 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, 18, and 19.)

[35] 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.)

[36] Alessandro Figà-Talamanca. Strengths and weaknesses of citation indices and impact factors. *Quality assessment in higher education*, pages 83–88, 2007. (Cited on page 21.)

[37] Ludwik Fleck. *Genesis and Development of a Scientific Fact*. University of Chicago Press, Chicago, August 1981. ISBN 9780226253251. (Cited on pages 5 and 13.)

[38] 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.)

[39] Aileen Fyfe, Julie McDougall-Waters, and Noah Joseph Moxham. Philosophical transactions: 350 years of publishing at the royal society (1665–2015). Technical report, The Royal Society, London, 2014. (Cited on page 13.)

[40] 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 61.)

[41] 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 31.)

[42] Richard A. Glennon, Milt Titeler, and J. D. McKenney. Evidence for 5-HT2 involvement in the mechanism of action of hallucinogenic agents. *Life Sciences*, 35(25):2505–2511, December 1984. ISSN 0024-3205. doi: 10.1016/0024-3205(84)90436-3. (Cited on page 59.)

[43] 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 51.)

[44] 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 60 and 65.)

[45] 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 59, 60, and 64.)

[46] 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 17.)

[47] 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 40.)

[48] Mark Graham, Scott A. Hale, and Monica Stephens. *Geographies of the World's Knowledge*. Oxford Internet Institute, London, convoco! edition, 2011. (Cited on page 48.)

[49] 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 18 and 19.)

[50] Jean-Claude Guédon. *In Oldenburg's long shadow: librarians, research scientists, publishers, and the control of scientific publishing*. Association of Research Libraries, Washington, D.C., 2001. ISBN 0918006813 9780918006813. (Cited on pages 13 and 16.)

[51] 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, 61, 63, 64, 66, and 67.)

[52] 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 46.)

[53] 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.)

[54] 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.)

[55] Trotter Henry and Kell Catherine. *Seeking Impact and Visibility: Scholarly Communication in Southern Africa*. African Minds, June 2014. ISBN 9781920677510. (Cited on page 51.)

[56] Gayle Highpine. Unraveling the mystery of the origin of ayahuasca, February 2013. (Cited on pages 57 and 79.)

[57] 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.)

[58] 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 45.)

[59] John P. A. Ioannidis. Contradicted and initially stronger effects in highly cited clinical research. *JAMA*, 294(2):218–228, July 2005. ISSN 1538-3598. doi: 10.1001/jama.294.2.218. (Cited on pages 17 and 20.)

[60] 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 17.)

[61] 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 40.)

[62] 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-HT2a 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 65.)

[63] Nicola Jones. Sneak test shows positive-paper bias. *Nature News*, September 2009. ISSN 0028-0836. doi: 10.1038/news.2009.914. (Cited on page 20.)

[64] Evelyn Fox Keller. Gender and science: Origin, history, and politics. *Osiris*, 10:26–38, 1995. (Cited on page 8.)

[65] 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 22.)

[66] Deborah M. Kurrasch-Orbaugh, Val J. Watts, Eric L. Barker, and David E. Nichols. Serotonin 5-hydroxytryptamine2a 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 60 and 65.)

[67] 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 26, 30, 49, and 50.)

[68] Marco Leonti and Laura Casu. Soma, food of the immortals according to the bower manuscript (kashmir, 6th century a.d.). *Journal of Ethnopharmacology*, 155(1):373–386, August 2014. ISSN 03788741. doi: 10.1016/j.jep.2014.05.029. (Cited on page 57.)

[69] 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 38.)

[70] 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.)

[71] 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 20.)

[72] 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 66.)

[73] 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.)

[74] 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 31.)

[75] 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 28.)

[76] Heather Grace Morrison. *Freedom for scholarship in the Internet age*. PhD thesis, Communication, Art & Technology: School of Communication, 2012. (Cited on page 27.)

[77] Peter Murray-Rust. Open data in science. *Serials Review*, 34(1): 52–64, 2008. (Cited on pages 28 and 33.)

[78] 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 38.)

[79] 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 64 and 67.)

[80] 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 66.)

[81] David E Nichols. Hallucinogens. *Pharmacology & Therapeutics*, 101(2):131–181, February 2004. ISSN 01637258. doi: 10.1016/j.pharmthera.2003.11.002. (Cited on pages 58, 59, and 66.)

[82] David E. Nichols. Structure–activity relationships of serotonin 5-HT2a agonists. *Wiley Interdisciplinary Reviews: Membrane Transport and Signaling*, 1(5):559–579, September 2012. ISSN 2190-4618. doi: 10.1002/wmts.42. (Cited on page 58.)

[83] David E. Nichols. The end of a chemistry era.... dave nichols closes shop, November 2012. Publication: Erowid Extracts. (Cited on pages iii and 58.)

[84] 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 60.)

[85] 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 29.)

[86] Russ Poldrack. russpoldrack.org: Anatomy of a coding error, February 2013. (Cited on page 30.)

[87] Michael Pollan. The trip treatment, February 2015. (Cited on page 60.)

[88] 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 17.)

[89] Marcus G. Raskin and Herbert J. Bernstein. *New Ways of Knowing: The Sciences, Society, and Reconstructive Knowledge*. Rl Innactive Titles, Totowa, N.J, June 1987. ISBN 9780847674633. (Cited on page 8.)

[90] Joseph Reagle. “free as in sexist?” free culture and the gender gap. *First Monday*, 18(1), December 2012. ISSN 13960466. (Cited on page 37.)

[91] 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.)

[92] 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.)

[93] Dorothy E. Roberts. Collateral consequences, genetic surveillance, and the new biopolitics of race. *Howard Law Journal*, 54(567), 2011. (Cited on page 6.)

[94] 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 51.)

[95] 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.)

[96] James H. Sanford. Japan's "laughing mushrooms". *Economic Botany*, 26(2):174–181, April 1972. ISSN 0013-0001. (Cited on page 57.)

[97] Londa Schiebinger. Feminist history of colonial science. *Hypatia*, 19(1):233–254, 2004. (Cited on pages 8 and 81.)

[98] 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 65.)

[99] 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 65.)

[100] 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 65.)

[101] Richard Evans Schultes. Antiquity of the use of new world hallucinogens. *The Heffter Review of Psychedelic Research*, 1, 1998. (Cited on page 57.)

[102] Victoria Shelton. Scientific reseach: The publication dilemma, 2005. (Cited on page 16.)

[103] Tom Slee. FutureEverything: Notes against openness, March 2013. (Cited on page 73.)

[104] 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 41.)

[105] Mark Stalzer and Chris Mentzel. A preliminary review of influential works in data-driven discovery. *arXiv:1503.08776 [cs]*, March 2015. (Cited on page 28.)

[106] Mark Stokes. Brain box: Biased debugging, February 2013. (Cited on page 30.)

[107] Peter Suber. Open access overview focusing on open access to peer-reviewed research articles and their preprints, December 2013. (Cited on page 27.)

[108] Banu Subramaniam. Moored metamorphoses : A retrospective essay on feminist science studies. *Signs*, 34(4), 2009. (Cited on page 8.)

[109] 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 50 and 51.)

[110] The PLoS Medicine Editors. The impact factor game. *PLoS Med*, 3(6):e291, June 2006. doi: 10.1371/journal.pmed.0030291. (Cited on page 23.)

[111] 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 pages iii and 59.)

[112] 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 31.)

[113] 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 52.)

[114] 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 19.)

[115] 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 47.)

[116] 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 69.)

[117] 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 26, 30, and 50.)

[118] 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 62.)

[119] 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 25.)

[120] Wikipedia contributors. Tuskegee syphilis experiment, March 2015. Page Version ID: 649911724. (Cited on page 4.)

[121] 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, 21, and 22.)