Guardians 2024 Conference

Proceedings of the 3rd Annual Guardians of Truth and Integrity Conference

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Contents

Guardians 2024 Program

Guardians Conferences ask the question "*Who are the Guardians of Truth and Integrity?*" and discuss the use of mis-information, dis-information, anti-information, caco-information, and mal-information (S. K. Taswell, Athreya, et al. 2021) in science, engineering, and medicine. Guardians 2024 was held on October 9th as an online event with 5 invited speakers:

- Natalie Burke, Common Health Action, Washington DC
- Philip Koch, Colorado School of Mines, Golden CO
- Maggie Mulqueen, Brookline MA
- Joshua Rubin, University of Michigan, Ann Arbor MI
- Olivia Sagan, Queen Margaret University, Edinburgh UK

who discussed this year's focus theme of *people talking to people with civility, courtesy, tolerance, and respect*. The workshop began with recognition of Mr. Peter Ash as our 2024 Guardian of Truth and Integrity.

Guardians 2024 Opening Session

- 09:00 Julie Neidich, Honoring our BHAVI 2024 Guardian: Peter Ash (2024 Guardian slides and video)
- 09:15 Peter Ash, Under the Same Sun: Changing Hearts and Minds about Albinism (Learn More about UTSS and 10 years of UTSS)

Invited Talks

- 10:00 Maggie Mulqueen, What Does Care Look Like in 2024? Caring for Others in Times of Dissent and Distress (video, edoc)
- 11:00 Philip Koch, Holding Their Feet to Our Fires: Rural Emergency Services and the Struggle to Serve in the Face of Ignorance and Corruption (slides, video, edoc)
- 12:00 Natalie Burke, The Journey Towards Health Equity: Taking Uncomfortable Steps to Change Hearts and Minds (slides, video, edoc)
- 13:00 Joshua Rubin, Musical Chairs for Darvomanics: How Anti-Learning Systems Enable Systemic Abuses of Power in Academia and What We Can Do Together to Help Them Learn (slides, video, edoc)
- 14:00 Olivia Sagan, Loneliness, Social Cohesion and the Role of Art Making (slides, video, edoc)

Technical Talks

- 15:00 Micha Burkhardt, UOL Germany, Quantifying Similarities between fMRI Processing Pipelines for Efficient Multiverse Analysis (slides, video, edoc)
- 15:20 Pan-Jun Kim, HKBU Hong Kong, Long-Term Innovative Potential of Genetic Research and its Suppression (slides, video)
- 15:40 Adam Craig, BHAVI USA, From Open Review to Reproducible Review: FAIR Metrics Analysis of Peer Reviews for Brain Informatics Literature (slides, video, edoc)

Guardians 2024 Closing Session

- 16:00 Carl Taswell, BHAVI USA, Reproducibility, Validity, and Integrity in Scholarly Research: Questions Seeking Answers (slides, video, edoc)

All slides and recordings of the talks are also available at Guardians 2024 Program. Background references on reproducibility, validity, and integrity for the Guardians Conferences include Craig, Ambati, et al. (2019); Athreya, S. K. Taswell, et al. (2020); S. K. Taswell, Triggle, et al. (2020); S. K. Taswell, Athreya, et al. (2021); Craig, Lee, et al. (2022); C. Taswell (2022); Athreya, Craig, et al. (2023); C. Taswell (2023).

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Honoring our BHAVI 2024 Guardian: Peter Ash

BHAVI Awards Committee

BHAVI 2024 Guardian: Peter Ash, MA

BHAVI Awards Committee

Brain Health Alliance, Ladera Ranch CA, USA

BHAVI Symposium online 9 October 2024

Peter Ash and Friends

"People with Albinism: Not Ghosts But Human Beings"

United Nations Office of the High Commissioner on Human Rights

"Meet the Champions of the Albinism Cause: Discover inspirational stories told by persons with albinism, their supporters assisting them medically and those advocating for their human rights." albinism.ohchr.org
UnderTheSameSun.com
Peter Ash, Founder

Honoring Mr. Peter Ash

BHAVI 2024 Guardian of Truth and Integrity: We honor and thank

Mr. Ash as our 2024 Guardian in recognition of his devoted service to people with albinism in support of the health and wellbeing of these individuals who face discrimination and death in countries around the world. Hearing about atrocities committed against children with albinism in Tanzania, Mr. Ash founded Under the Same Sun. The work of this charitable organization helps to save lives of these children with albinism. As a person with compassion for humanity who cares for others and who has albinism himself, Mr. Ash began his mission of helping children in Tanzania. His organization Under the Same Sun has created safe places to learn and given new life to these children. Mr. Ash has worked to bring the plight of those with albinism to the United Nations and to advocacy groups across Africa and the world. His work has saved lives and provided hope, education, opportunities, and a brighter future for people with albinism.

People with Albinism Face:

- Staring strangers
- Ostracism and bullying
- Rejection by their families
- High risk of skin cancer (Wright et al. 2014)
- Risk of becoming victims of murder in countries where people believe a person with albinism is a ghost or bad luck
- Risk of being murdered for profiteering *to sell their body parts*

The Genetics of Albinism

- People with albinism have skin and hair without pigments like melanin, the biochemical that creates the variety of color tones we see across humanity. Albinism may be associated with a visual impairment relating to a lack of pigment in the eyes. (Liu et al. 2021; Federico et al. 2023; Galli et al. 2023)
- Most causes of albinism are genetic and almost all of those are *autosomal recessive* in inheritance. The birth of a child with albinism should not target the mother, causing her to be 'rejected' by the family, since both parents must be carriers of a pathogenic variant. (Montoliu et al. 2013; Fernández et al. 2021)
- Some people with forms of albinism have partial loss of pigment and have lighter colored hair, eyes, and skin than their family.
- Other pigmentary disorders, including vitiligo, are not strictly genetic, but may be caused by contributing factors related to the immune system and environment.

Autosomal Recessive Inheritance

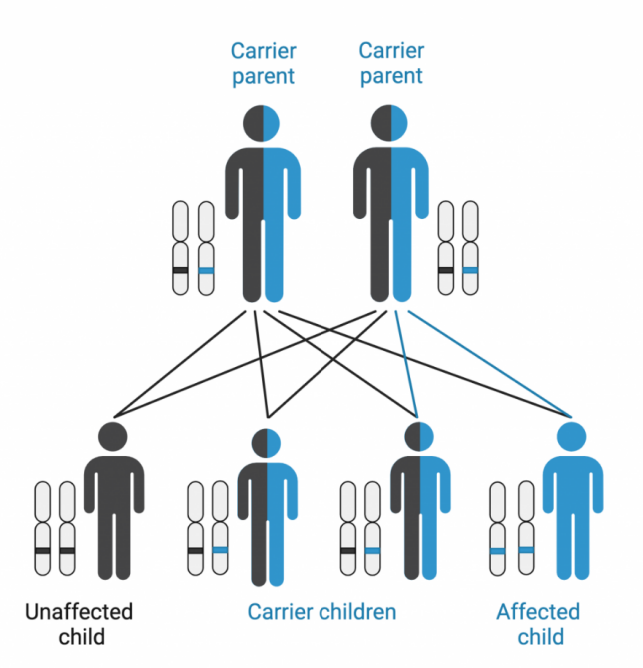

Diagram by Melissa Hardy reprinted CC BY-NC.

- If both partners are carriers of a pathogenic variant in the *same* disease gene, there is a 25% chance with each pregnancy of having a child affected with the disease.
- If both partners are carriers of a variant in *different* disease genes, there is very low increased risk to have a child affected with either disease, although the child can be a carrier for one disease, or the other, or both. (There are some digenic presentations!)
- Males and females are equally likely to be carriers and are equally likely to have the disease.

Peter Ash, a Short Biography

- Peter Ash was born in Montreal, Canada, the youngest son of three siblings. One of his older brothers also has albinism.
- He obtained a Bachelor of Arts degree in theology from Peace River Bible College and a Master of Arts degree in counseling from Providence Theological Seminary. He worked as a pastor and as an entrepreneur and businessman. Along the way, he moved to Vancouver, married, and became a father.
- In 2008, he read about the killings of people with albinism in Tanzania. The compelling video evidence documented by newswoman Vicky Ntetema about the horrific trade of body parts from murdered people with albinism sparked Mr. Ash's activism.
- Within a year, he was in Tanzania advocating for people with albinism. His work spread across Africa and around the world.

Peter Ash, a Gallery

Vitiligo

- People with vitiligo (Jan et al. 2023) may face the same ostracism and discrimination as people with albinism.
- Michaela DePrince was born in Sierra Leone and was put in a cruel orphanage as a toddler after her mother died. She was called a word that meant she was the least of the orphans due to her pigmentation.
- She was adopted by an American family along with her best friend from the orphanage.
- She became a celebrated ballerina with the Boston Ballet, the Dance Theatre of Harlem, and the Dutch National Ballet.
- Unfortunately, she died at age 29 in September 2024.

Michaela DePrince, Ballerina (1995–2024)

The United Nations and African Albinism Network

- The advocacy of Peter Ash and Under the Same Sun brought the plight of people with albinism, especially those in Africa, to the United Nations.
- Over the past 11 years, Under The Same Sun has brought together a global association of advocacy groups including the United Nations.
- The African Albinism Network grew out of that association of advocacy groups.
- Note that albinism is not solely found in Africa, although there are more carriers of some types of albinism who are of African descent.
- Albinism can be found around the world.

The Global Alliance for Albinism

January 2020, Paris France

Advocacy for Albinism

- Under The Same Sun
- Learn More about Under The Same Sun
- 10 Years of Under The Same Sun
- Africa Albinism Network
- Global Albinism Alliance
- UN Champions of Albinism
- Urgent Calls for Protection (2024/06/19)
- US NLM on Albinism
- UK NHS on Albinism

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What Does Care Look Like in 2024? Caring for Others in Times of Dissent and Distress

Maggie Mulqueen

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What Does Care Look Like in 2024? Caring for Others in Times of Dissent and Distress*

Maggie Mulqueen†

Commentary

Human connection is foundational to good mental and physical well-being, so when we take care of others, we are effectively also taking care of ourselves. The most valuable skill in caring for another person is the capacity to listen so that person experiences feeling heard. Enhancing our listening skills is critical to staying connected to one another despite the cacophony of disinformation and vitriol infecting our lives.

One component of care that is often overlooked in our culture is the power of listening–listening to each other and to ourselves. Being able to listen is hard when you live in a culture which emphasizes talking and winning the argument. In Frank Bruni's recent book, *The Age of Grievance* (Bruni 2024), he discusses how we shut out opposing points of view when we feel aggrieved and in our echo chambers filter information for agreement. Increasingly we live in a world that does not value facts. Expressions of feelings are often pronounced as facts and protected speech. To question someone's feelings or views can be a dangerous thing in this fraught atmosphere. Living in a world with cancel culture has a chilling effect on many of us in prominent positions where bad reviews can derail a career.

It can be hard to listen to someone if they are spewing lies and vitriol. It also rarely feels productive because the ground rules for good communication are ignored or worse violated. Being the loudest or most righteous person in the room doesn't equate to being heard.

Furthermore, if we remain silent in the face of such hate, we worry that our silence will be interpreted as agreement. This can lead to a no-win position of either joining the argument or leaving the conversation. Neither position is usually rewarding. And so, we limit who we are willing to talk with and listen to.

But knowing that human connection is essential to mental and physical well-being, how can we reach across this divide? What does it take to breach the gap between speaking and feeling heard? If what we want is to care for another person, what are the essential components of effective listening?

There needs to be genuine interest in hearing what the person wants to say. We've all had the experience of speaking to someone who is obviously just biding their time until they get to speak. The work on psycholinguistics by Deborah Tannen (1999) does an excellent job of outlining how varies speech patterns and norms set people up to have or not have effective communication.

So, how do we communicate our care? First, we must be trustworthy. If its confidential material being shared, are we prepared to keep confidentiality? For example, as a psychologist I am a mandated reporter if someone threatens self-harm or harm to others. I educate my patients about these legal obligations before I invite people to share with me.

If there are limits to our ability to listen, we must outline those at the beginning. Be it time constraints or topics or ways of speaking that impede our willingness or capacity to listen we should set the boundaries from the start. If part of the goal for communication is to learn, then it behooves us to risk being honest with each other.

Creating the space to listen, being present for another person does not mean denying our own needs or state of being. Whether it is a therapy session or a casual conversation with a friend, it is important to acknowledge whatever constraints we might have to engage in a conversation.

It is essential that we do not confuse listening with agreement. Too often what people want from a listener goes beyond understanding to acceptance or agreement. With that as the implied expectation, it is no wonder we find ourselves in echo chambers.

Am I asking to be heard or agreed with? That is a question we need to be honest with ourselves about and ask the same of the speaker.

In *Mistakes Were Made but Not by Me*, Tavris and Aronson (2020) illuminate the significant impact of people doubling down on what they believe rather than listening to contrary facts. Their examples of how this impacts the judicial system and police behavior are chilling. In their work they discuss how people move to more extreme positions to protect an initial response rather than remain open to new information which could change their minds. When we feel a need to justify our opinion or explain ourselves, we tend to double down on our initial position rather than moderate our stance. By being genuine and open, I can listen to another person and try to understand their feelings and their position, but I am not bound to agree with them.

Listening is not problem solving. Too often to show we care we think we need to do something. Often that leads to the opposite effect. Rather than feeling heard, we feel patronized or worse. When I have had a bad day the last thing I want is for my husband to tell me how I could have done better. In time I might look for suggestions but initially I want to feel heard and be comforted. Comforting someone is actually doing something and usually brings you closer whereas problem solving sets up a power dynamic of one person being seen as smarter than the

*Presented 2024-10-09 at Guardians 2024 with video.

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other.

There are ways to listen that reduce the burden on others. For example, when someone is grieving, I don't expect them to initiate the first contact. I might offer to bring a meal or send a card and make myself available for a walk. By offering my presence I hope to ease their burden, not solve their problem. When we draw close to one another and feel listened to, heard, the relationship is usually strengthened and deepened. With this closeness comes connection.

Consistency in showing up for another builds the progression toward closeness. This is why we long for a physician who knows us, not just one who can read the MRI correctly. It is also why my long-term patients value our relationship so deeply, because I know who they are talking about and can remind them of things from their past that are having an impact today.

Two important truisms in psychology are: anxious people can't listen, and neither can enraged people. Therefore, before any listening can happen, the emotional state of the person needs to be attended to first. Failing to do so leads to a failure to communicate. Once the doctor tells you that you have cancer, the rest of the discussion is worthless until the emotional impact of the diagnosis is addressed. Or if you have a two-year-old in a full-on tantrum, you know your words are not important at that moment. It is our ability to use our voice and body to offer calm that will help break the spell.

Turning to the impact of communication through texts and social media, it can be much harder to listen well without the added input of body language and tone of voice. Disembodied communication, to say nothing of anonymous communication, lends itself to taking extreme positions because there are few to no natural guard rails. Therefore, it is rife for misunderstanding and hurt feelings. It is also much less clear how to end these "conversations". The pressure to respond immediately and succinctly also alters how we listen to one another. The use of emojis is a poor substitute for the sound of someone's laugh or the ache in someone's voice.

Setting expectations in these milieus is again essential for improving our ability to listen and to be heard. Hard as it might be to believe we don't have to always have our phones on and respond to every message in less than a minute. We have a role in creating the expectations others have of us regarding our availability.

Unfortunately, the prevailing model in our culture is to conceptualize care as an either/or. Either I can take care of myself, or I can take care of others. For those of us in the helping profession, this dichotomy is especially harmful. Burnout, depression, and substance abuse are very real concerns because of the self-sacrifice that is often lauded as best practice.

But if we don't listen to ourselves, we limit how well we can listen to others. It needs to be a both/and. I listen to myself because I value myself and my needs. I try to only offer what I can give without resentment. How well I can listen to myself is an indicator of my own ability to take care of my needs. Listening to myself might involve asking others for help.

One way to help us to listen to ourselves is to take time. Rather than immediately agreeing to do something when asked, I always ask for some time to think it over. This allows me to decide if my desire to do or not do something is based on my own true feelings. Is my knee-jerk reaction to say yes based on flattery for being asked or is a no coming from a place of fear and maybe I want to challenge the limitations I am putting on myself.

There are gender and racial components to what I am discussing. Our expectations regarding who listens and who talks are steeped in cultural norms that are unhealthy and discriminatory. We need more research to look at how our patterns of listening and talking are impacting mental health and physical well-being.

Being listened to has been shown to be a significant intervention of its own. This serendipitous finding from my research as discussed in *On Our Own Terms: Redefining Competence and Femininity* (Mulqueen 1992), set the course for my own development as I pursued my career in psychotherapy.

Being a good listener aligns with my values. It is something I strive for on a daily basis both personally and professionally. It is hard work at times and takes effort and patience. But I am rewarded when I see the impact I have had on others and when I receive the understanding and knowledge that I am truly known and cared about by those willing to listen to me. To outsiders it might look like I am not doing much, but I know from experience that the quality of my relationships is the deepest joy and accomplishment of my life.

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Holding Their Feet to Our Fires: Rural Emergency Services and the Struggle to Serve in the Face of Ignorance and Corruption

Philip Koch

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Holding Their Feet to Our Fires: Rural Emergency Services and the Struggle to Serve in the Face of Ignorance and Corruption*

Philip S. Koch and the BHAVI Guardians Committee†

Commentary

At the Guardians 2024 Conference, I provided a narrative on the overlooked world of emergency services in rural areas. As a professor at the Colorado School of Mines and a volunteer professional firefighter, I examined many of the challenges faced by rural emergency services, and the impact of societal ignorance and political corruption on their operations.

I began by introducing the concept of a 'parallel universe' where emergency services operate. This universe, though integral to public safety, often remains invisible to the general populace. I highlighted the disparity in the public recognition of military personnel versus emergency service workers, despite the latter frequently facing dangerous (even existential) situations more often than the former.

The immediate backdrop for my presentation was the Quarry Fire near Denver in Colorado (Wertz et al. 2024), a stark reminder of the perilous work undertaken by emergency services even near major urban areas. Providing important education about the significant risks wildland fires pose, I also noted that these fire events occur frequently in the Rocky Mountains and across the entire West. These inherent risks are too often unnecessarily exacerbated by organizational failures.

My dual role as an academic and a firefighter provide me an unusual perspective on the issues at hand. I serve in two fire protection districts in Colorado: Elk Creek FPD (2024a) under Fire Chief Jacob Ware and Hartsel FPD (2024) under Fire Chief Brian Cook. Elk Creek FPD is a 'combination' district staffed by both paid and volunteer firefighters, whereas Hartsel FPD is served by volunteers except for its Fire Chief.

I underscored the financial challenges faced by rural fire departments, noting the high costs of equipment and the necessity for replacing vehicles and other essential equipment after limited periods of time due to safety requirements. Most fire departments in Colorado are organized as fire protection districts (FPDs), defined as "a special district which provides protection against fire by any available means and which may supply ambulance and emergency medical and rescue services" (Colorado Legislature 2023, p. 4). These FPDs are allowed under Title 32 of the Colorado Revised Statutes to levy taxes on property within their boundaries – upon the concurrence of the citizens served. The FPDs' Fire Chiefs provide operational oversight, while an elected Board of Directors oversees each District's funds and strategic direction. The crux of my argument revolved around the problematic and politicized nature of this management oversight by the Directors. Effective management requires either prior knowledge of the subject matter or a willingness to learn it on the job. Too many Board members lack this expertise, leading to mismanagement and inefficiency. I criticized the notion that a manager can manage anything, advocating instead for a better-informed and fact-based approach to governance especially by those who wish to serve the community as elected FPD Directors.

I lamented the politicization of elections for FPD board members, which have become local microcosms of US national politics. I identified two extremes among Board members and candidates: those with deep experience with a desire to foster the common good, and political hacks with no interest in learning or understanding the subject matter. This latter group, which I termed "corrupt", poses significant dangers to public safety for the community of residents who live in the FPDs.

In defining corruption, I distinguished between 'financial corruption' and 'moral corruption'. The latter, I argued, involves obstructing those who selflessly serve the public—with interference by the obstructionists motivated by desire for their own personal or political gain. I noted that Elk Creek FPD has experienced significant problems due to such corruption, endangering both firefighters and, more importantly, the population they serve.

I provided specific examples of the problems caused by corrupt board members. These individuals use their positions to promote personal agendas, such as preventing development within the District (over which FPDs have no say), rather than addressing real issues that are part of the FPD's responsibility for public safety, such as dealing with the increasing frequency, complexity, acuity, and overlap of fire incidents and other emergencies, as well as rising costs. I highlighted the importance of mutual-aid agreements with neighboring Districts, noting that Elk Creek draws more aid in this manner than it provides, effectively being subsidized by the tax payers in its neighboring FPDs.

The solution proposed by Chief Ware and his fellow Fire Chiefs, also supported by my colleagues and me, was Consolidation (Elk Creek FPD 2024b): a process aimed at combining three FPDs (in this case Elk Creek, Inter-Canyon, and North Fork Fire) to reduce overhead, streamline processes slowed by mutual aid and to increase the tax base. This solution would allow for the hiring of more full-time firefighters, improving response times and overall efficiency. However, this proposal met with resistance from an uninformed and politically motivated Board

*Presented 2024-10-09 by Philip Koch at Guardians 2024 with slides and video. This summary of his presentation prepared by the BHAVI Guardians Committee and then revised by Philip Koch.

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member and his supporters.

I detailed the campaign of misinformation and disinformation waged by the opponents of Consolidation. These individuals, via fliers and continual social-media posts as well as emails to a large, private group of readers, spread false claims about increased response times and resource reallocations, violated election laws, and engaged in smear campaigns against firefighters and their Fire Chiefs. Despite these efforts, the overall combined electorate of the three FPDs voted in favor of Consolidation. However the Elk Creek FPD electorate itself narrowly rejected it, causing the proposal to fail overall.

In the aftermath, emergency services continue to struggle with the same structural and operational challenges already noted. I emphasized the need for informed and proactive citizen involvement to address these issues. I and a group of concerned citizens conducted an after-action review of the Consolidation election process in order to identify lessons learned and strategies and tactics for future efforts. This review highlighted the importance of protecting the Elk Creek FPD's trademarked logo (misappropriated by the opposition during the Consolidation initiative), defining the field of play, reaching out through personal networks, exposing dirty tricks immediately, and providing a detailed strategic plan.

My colleagues and I are now advocating for Unification (Elk Creek FPD 2024c) a similar process to Consolidation, also proposed by Chief Ware and his fellow Fire Chiefs, and with virtually identical organizational results. Because there would be no associated increase in property-tax rates, Unification does not require voter approval. Instead only approval by the respective Boards is required. This proposal has garnered preliminary support from the three Boards of Directors and shows promise in addressing the structural challenges faced by the FPDs wishing to merge. Unification would result in lower taxes for Elk Creek and one other district, matching the lowest property-tax rate of the three merging FPDs related to fire and other emergency services.

I concluded by emphasizing the importance of listening to experts and prioritizing public safety over political agendas. I highlighted the dedication of my fellow emergency service workers, who put their lives on the line for the greater good of the community. Despite our challenges, the support and appreciation from the community for firefighters and other emergency services staff motivate us to continue our vital work — many of us, as volunteers, expect and receive absolutely no financial compensation.

My presentation (slides and video) at the Guardians 2024 Conference examined critical issues facing rural emergency services. I called for informed and proactive citizen involvement, emphasizing the need for fact-based governance as well as the dangers of political interference. Advocacy by the Fire Chiefs, and my fellow citizens and colleagues for Unification provides a hopeful path forward, aiming to enhance public safety and support the dedicated individuals who, as career or volunteer emergency responders, serve their communities selflessly.

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The Journey Towards Health Equity: Taking Uncomfortable Steps to Change Hearts and Minds

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The Journey Towards Health Equity: Taking Uncomfortable Steps to Change Hearts and Minds*

Natalie Burke and the BHAVI Guardians Committee†

Commentary

At the Guardians 2024 conference, Natalie Burke delivered a thought-provoking presentation on health equity, emphasizing the importance of addressing uncomfortable truths to achieve meaningful change. Burke, an advocate for health equity, shared a compelling narrative that highlighted the systemic inequities in healthcare, especially those affecting African-American women and infants. She urged the audience to embrace discomfort as a necessary precursor to transformation.

Burke began her talk with a stark illustration of health inequities by recounting a study conducted at a hospital, which revealed a troubling disparity in the rates of vaginal birth after cesarean section (VBAC) among different racial groups. Over a twelve-month period, while white, Latina, Asian, and Native American women had successful VBACs, not a single African-American woman experienced a VBAC at the same hospital. This discrepancy, Burke noted, raises significant questions about the underlying causes of such inequities and underscores the urgent need for systemic change.

Burke's approach to addressing these issues is grounded in Jack Mezirow's adult learning theory of perspective transformation, which posits that when individuals know, think, and believe something different, they are compelled to act differently (Mezirow 1978). She emphasized the importance of appealing to both the head and the heart, combining logic, data, and facts with compelling arguments rooted in fairness and justice. This dual approach, she argued, is essential for fostering perspective transformation at individual, organizational, and societal levels.

Burke shared her personal background as the child of Jamaican immigrants, which has significantly shaped her perspective on health equity. She recounted how her grandparents, who had never faced issues accessing quality healthcare in New York, encountered significant barriers after moving to Georgia. This experience sparked her curiosity about the factors that influence health outcomes and motivated her to pursue work in health equity.

Central to Burke's argument is the concept of social identity and its impact on health outcomes. Social identity, she explained, is defined by the groups to which individuals belong and plays a crucial role in shaping experiences of privilege and oppression. Burke highlighted the process of social categorization, identification, and comparison, which often leads to disparate valuations of different groups and contributes to systemic inequities associated with intergroup conflicts (Tajfel 1981).

Burke addressed the discomfort that often accompanies discussions of privilege and oppression, urging the audience to differentiate between discomfort and safety. She emphasized that privilege is not a matter of personal choice but is conferred by societal structures. Conversely, oppression occurs when more powerful groups target less powerful ones to maintain social, economic, and political dominance.

To illustrate the pervasive nature of these inequities, Burke provided historical examples of public policies rooted in social identity, such as the state-sanctioned extermination of Native Americans and the Chinese Exclusion Act. These policies, she argued, have long-lasting impacts on marginalized communities and continue to shape contemporary experiences of privilege and oppression.

Burke also discussed the distinction between health disparities and health inequities. While disparities are merely differences in health status or outcomes between groups, inequities are disparities resulting from systemic, preventable, avoidable, and unjust policies and practices. Health inequities, therefore, represent actionable areas where systemic change can lead to improved health outcomes.

A poignant example Burke provided was the difference in breast cancer survival rates among women of different races. While biological predispositions explain some disparities, inequities arise from differential access to early detection, medications, and clinical trials. These inequities are rooted in social identity and systemic barriers, highlighting the need for targeted interventions.

Burke cited Camara Jones's definition of health equity as the assurance of conditions for optimal health for all people, emphasizing that each person's health potential is different (Jones 2000). She distinguished between equality, which focuses on sameness, and equity, which involves meeting people's needs where they are. Using an image from the Robert Wood Johnson Foundation, Burke illustrated how equitable design can ensure that everyone, regardless of their abilities, can navigate the same intersection effectively.

The pursuit of health equity, Burke argued, requires providing all people with fair opportunities to achieve their full potential (Braveman et al. 2017; CDC 2024). She addressed the common pushback against the notion of fairness, asserting that fairness is not subjective but measurable based on whether individuals, families, communities, and populations have what they need to achieve the best possible outcomes.

Burke highlighted the human predisposition toward fairness, which

*Presented 2024-10-09 by Natalie Burke at Guardians 2024 with slides and video. This summary of her presentation prepared by the BHAVI Guardians Committee.

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she attributed to early human interdependence. However, she noted that prejudice, in-group bias, and unconscious bias often counteract this predisposition. These biases, when combined with power, lead to systemic inequities and discrimination. Burke defined power as the ability to define reality for oneself and others, a concept that is crucial in understanding how biases manifest in healthcare.

To illustrate the impact of biases in healthcare, Burke shared an example from a nursing textbook that perpetuated harmful stereotypes about different racial and ethnic groups' responses to pain. Such biases, when internalized by healthcare professionals, can significantly impact patient care and outcomes. She emphasized the importance of addressing these biases and providing healthcare workers with the tools to recognize and disrupt them.

Burke also discussed the concept of moral injury, which occurs when individuals face situations that violate their moral code, leading to trauma. In healthcare, moral distress arises when clinicians know the ethical and equitable course of action but are powerless to act due to systemic barriers (Sukhera et al. 2021). Over time, this leads to moral injury, contributing to burnout and the exodus of healthcare workers.

Race-based medicine, Burke argued, is a significant driver of health inequities. She provided historical examples, such as the experiments conducted by J. Marion Sims on enslaved Black women (Wall 2006; Spettel and White 2011) and the racially biased algorithms in modern medical devices like spirometers and pulse oximeters (Obermeyer et al. 2019; Anderson et al. 2021). These biases, rooted in pseudoscience, continue to affect healthcare delivery and exacerbate disparities, as evidenced during the COVID-19 pandemic.

Burke concluded her talk by outlining steps to achieve health equity. She called for embracing the complexity of social identity, fostering meaningful relationships across different identities, and equipping individuals with the language and tools to address bias and racism. Additionally, she emphasized the need to re-examine race-based algorithms and teach the history of how systemic inequities have developed.

Ultimately, Burke's message was one of hope and action. She invoked the metaphor of seeds buried by oppressive systems, suggesting that awareness and conversation can lead to transformative change. By addressing the uncomfortable truths about health inequities, Burke urged the audience to commit to creating a more equitable healthcare system for all.

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Musical Chairs for Darvomanics: How Anti-Learning Systems Enable Systemic Abuses of Power in Academia and What We Can Do Together to Help Them Learn

Joshua Rubin

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Musical Chairs for Darvomanics: How Anti-Learning Systems Enable Systemic Abuses of Power in Academia and What We Can Do Together to Help Them Learn*

Joshua Rubin†

Commentary

Academic healthcare systems ostensibly aspire to become Learning Health Systems (LHSs) that improve outcomes as a byproduct of experience (Etheredge 2007). Yet, major systemic problems in academic medicine, academia, and elsewhere persist because structures and incentives that engender anti- learning systems are interwoven into the cultural fabric of these organizations (Bravo-Moreno 2022). Divergent issues including sexual predation, racism, antisemitism, plagiarism, quashing free speech, trampling on the rights of patients, and more proliferate at universities in spite of well-funded efforts aimed at addressing such challenges (Svrluga 2022).

These persistent problems can be understood as all fruits of the same poisonous tree of systemic abuses of power. They all represent the same monster surreptitiously wearing different masks. Indeed, when the people occupying seats of power change over time, but the problems persist, we bear witness to a game of musical chairs for darvomanics who cause harmful consequences.

Fortunately, one promising solution emerges from harnessing the transformative magnetism of moral courage. It is worth investing in research (and advocacy) vis-a-vis the cultures, structures, incentives, and power dynamics in such ecosystems that engender the potential to unleash such moral courage in individuals and to render it contagious.

Professionally, I work in the field of advancing LHS (Friedman, J. Rubin, and Sullivan 2017). To oversimplify, LHSs engender seamless learning and continuous improvement by analysis of data from experiences to generate knowledge of 'what works best', coupled with the mobilization of such actionable knowledge to inform decisions affecting health and to empower the people making these decisions (Friedman, J. Rubin, Brown, et al. 2015). I have done this work as the executive director of a philanthropic foundation founded by a self-made entrepreneur and World War II veteran who was the godfather of the LHSs vision, as a co-founder of one nonprofit organization focused on advancing this incipient global LHSs movement anchored in multistakeholder consensus Core Values, as a co-founder of another nonprofit organization building LHSs for mental health in particular, and as a staff and faculty member in a first-of-its-kind basic science department dedicated to the transdisciplinary science of LHSs at a prominent academic medical center (J. C. Rubin, Silverstein, et al. 2018).

Historically, I viewed my role as helping systems that simply did not learn effectively from experiences ('non-learning systems') to learn how to learn better (Fassbender 2019). However, over the past several years, I have recognized what I have termed 'anti-learning systems', whereby the organizational cultures, power dynamics, and incentive structures seem to actively align to surreptitiously prevent systemic learning. It is almost as if these anti-learning systems go through the enumerated consensus Core Values bonding together the LHSs movement and deliberately violate many of them, while paying lip service to ostensible continuous improvement (J. Rubin 2018).

Dr. Carl Taswell, a director at the Brain Health Alliance, coined the term *darvomanic* (Taswell et al. 2022) to characterize the people who end up abusing power in such systems. DARVO is an acronym standing for "Deny, Attack, Reverse Victim and Offender roles" (Freyd 1997; Harsey and Freyd 2020). Linking DARVO with the psychiatric term mania, completes the painting of the picture. There is a pattern in certain organizations where abusers of power utilize DARVO, and the corresponding systems promoting them to such powerful positions, exhibit little capacity for self-correction.

Three recommendations hold the potential for every individual aspiring to make a difference in environments where systemic abuses of power are rampant to engender change. The first stems from announcements one often hears at airports and on public transportation: if you see something, say something. As a corollary, it is important that one not let themselves be gaslit into doubting their own senses when something intuitively seems awry to them. The second involves simply being there for fellow human beings who find themselves at the receiving end of systemic abuses of power. The third entails taking what one is talented at professionally or personally and utilizing such skills to help to make an impact.

On the topic of gaslighting, in early 2022, following the long-overdue termination of an abuser of power who rose to be the president of a large public research university, I listened to a number of individuals spanning the institutional power hierarchy, and then crafted an email for dissemination. In one part of the email, I noted: "Well over half a century ago, Dr. Solomon Asch researched the cognitive, emotional, and behavioral effects on individuals of pressure to conform. His famed social psychology studies, known colloquially as the Asch conformity experiments, illuminated the power of perceived social pressure of groups to drive individual conformity and submission. Variations on these experiments also revealed the extraordinary potential of an in-

*Presented 2024-10-09 at Guardians 2024 with slides and video.

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dividual to stand up when they realize that they do not stand alone. One of Dr. Asch's most highly-cited publications is titled, *Studies of independence and conformity: I. A minority of one against a unanimous majority.* These studies by Dr. Asch guide us on a path forward; we need not submit and we need not conform." (Asch 1956)

Elsewhere in that email, I noted that, "the Regents' termination letter to (the university president) chastises him for the evidenced chasm between his lofty words and his reprehensible actions. Pulling the lens back, where questioning is quashed, where diversity of thought is stifled, where power trumps compassion, where trite virtue signaling is seen as holier than actually making a difference, and where faculty and staff and even learners are routinely gaslighted into seeing opacity as transparency, such chasms can grow largely out of sight. In contrast, when principles in our consensus Core Values for LHSs and our shared MCBK Manifesto are operationalized in sociotechnical infrastructures and cultures anchored in learning, the radiant sunlight of truth indeed becomes the best disinfectant." (J. Rubin and Friedman 2014)

In the book, *Armies of Enablers: Survivor Stories of Complicity and Betrayal in Sexual Assaults*, law professor Amos Guiora explores systemic abuses of powers at universities (Guiora 2020). Personally, I have experience advocating for and with survivors of mass sexual assaults and other systemic abuses of power (I have volunteered for almost two decades for a nonprofit organization supporting survivors of sexual trauma, and I served as the president of its board of directors for over seven years). Indeed, within systems that engender such ubiquitous (yet surreptitious) abuses of power, everywhere one turns, they encounter "Armies of Enablers" who are cogs in the machine producing such toxic and horrific (yet largely concealed) outcomes.

I have fused research and advocacy vis-a-vis issues such as sexual predation, antisemitism, racism, patients' rights, and stifling of free speech. These tragedies represent the same monster surreptitiously wearing different masks. An eye-opening experience for me came in 2022 when I returned to my old suburban public high school over a quarter century after I gave my valedictorian speech. I realized that the same types of abuses of power (in this particular case, enabling and endeavoring to cover up for harms perpetrated against special needs students and their families) persisted even though every teacher and administrator I knew had since left; these were system problems demanding system solutions. This experience informed research, social entrepreneurship, and advocacy for and with survivors of abuses of power at universities. My advocacy journey has taken me to US federal government agencies and to the halls of US Congress as well.

Closely related to this advocacy work, I am leading a synergistic effort, with extraordinary collaborators, to endeavor to envision and catalyze a novel academic discipline (and complementary international movement) fusing system sciences, learning health sciences, and other social sciences (J. C. Rubin and Ocepek 2024). Among other things, this transdisciplinary and multistakeholder effort aims to study and address what Dr. Taswell described as a "global pandemic of darvomania" (Taswell et al. 2022).

One insightful question I have been asked regarding this work that jumped out at me was querying how I was able to do all this and not get fired. Importantly, I have been consistently transparent about what I am doing and why. A key element of my job itself is to help organizations that do not routinely learn and improve from experience, to become learning systems. My job is also to advance the stated mission of the organization where I work. Every piece of my advocacy inside and outside of my organization relates to these themes (J. Rubin 2017). In that sense, organizations are better off in the long run if people within them who see something awry ultimately say something and do something. In the future, when such organizations are one day looking back and authoring their respective stories, self-correcting from within is far more compelling than being forced to do so from the outside after resisting (Nowak 2011). Indeed, when we each say to ourselves that something is wrong, so somebody should say something and somebody should do something, we must also recognize at the same time that each of us is somebody and that each of us has the capacity to make a difference, even if we seem to be Davids struggling against Goliaths (Gladwell 2015). We also need to remind ourselves that bravery is contagious. The solution to these systemic issues is anchored in the transformative magnetism of moral courage.

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Loneliness, Social Cohesion and the Role of Art Making

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Loneliness, Social Cohesion, and the Role of Art Making*

Olivia Sagan and the BHAVI Guardians Committee†

Commentary

At the Guardians 2024 Conference, Olivia Sagan, a professor of psychology at Queen Margaret University in Edinburgh, delivered an insightful presentation on the intricate relationship between loneliness, social cohesion, and the role of art making. Drawing on her extensive research and phenomenological approach, Sagan offered a comprehensive analysis of how art making can serve as a potent tool for alleviating loneliness and fostering social cohesion within communities.

Sagan began by contextualizing the rising interest in loneliness within the social sciences, noting that this concern parallels an increasing focus on weakening social cohesion (Sagan 2023). Both phenomena, she argued, pose significant threats to well-being and are complexly intertwined with trust and agency (Nyqvist et al. 2016). Despite the inconclusive evidence, there is a growing consensus around the potential of art making to mitigate loneliness and enhance social cohesion (McGrath and Brennan 2011; Perkins et al. 2021).

Central to Sagan's argument was the work of political philosopher Hannah Arendt and contemporary interpretations of her theory of loneliness (Arendt 1973; Arendt 2018). Arendt's insights provide a framework for understanding how art making can be efficacious in community building by facilitating the processes of being seen and showing oneself. This, Sagan posited, can alleviate loneliness and strengthen both individual agency and social cohesion.

Loneliness, now considered a "global health crisis" (Hayden-Nygren 2019) and "behavioral epidemic" (Jeste et al. 2020), has captivated both academic and popular imagination for over two decades. It is widely recognized as a critical public health issue with health policies and interventions being developed (Batanova et al. 2024). However, Sagan highlighted several limitations in the current literature. Much of the research tends to depoliticize loneliness, framing it as a personal failure rather than acknowledging its socio-economic dimensions and the broader societal trends that contribute to it (McLennan and Ulijaszek 2018). This medicalization of loneliness further impedes the recognition that robust, integrated, and holistic approaches are necessary to address public health problems.

Sagan also pointed out the problematic stereotypes and assumptions prevalent in loneliness research, such as the tendency to present loneliness as a universally understood and homogeneously experienced concept. This overlooks the potential role of social contagion and the cultural context of loneliness (Van Staden and Coetzee 2010). Moreover, there is a significant gap in research on loneliness among minoritized communities and populations with severe mental illness or those living in poverty (Leigh-Hunt et al. 2017).

Importantly, Sagan emphasized the philosophical and psychoanalytic perspectives on loneliness that are often neglected in contemporary formulations. For instance, Carl Jung's assertion that loneliness arises from being unable to communicate the things that seem important to oneself (Jung 1965) prefigures modern understandings of epistemic trust (Li et al. 2023). Additionally, psychoanalysts such as Melanie Klein have explored the developmental value of nurturing the capacity to be alone, suggesting a creative side to the experience of loneliness (Garvey 2023).

Sagan's discussion then shifted to the role of art making in mitigating loneliness and promoting social cohesion. She referenced the growing body of evidence showing that arts participation can enhance well-being and social engagement (Fancourt and Finn 2019; Sajnani and Fietje 2023). Art making, she argued, should be central to community building rather than being a peripheral activity. This principle remains especially relevant in the context of the well-being economy, which emphasizes human and ecological well-being over material growth (Seaford 2011; Fuchs et al. 2021).

Sagan underscored the historical and contemporary significance of art in health, noting that the use of artistic media in healthcare and communities can lead to a variety of positive health outcomes (Law 2012; Kleisiaris et al. 2014; Lenette et al. 2015). The practice of arts in health, which operates on a social model of health and well-being, has seen significant growth and recognition since the inaugural issue in 2009 of *Arts & Health* as a scholarly journal for this interdisciplinary field (Camic et al. 2009).

In examining the connection between art making, social cohesion, and loneliness, Sagan highlighted the importance of participatory community arts projects. These projects can promote social cohesion by fostering bridging and bonding connections among individuals, which are crucial for building social capital (Putnam 2000; Putnam 2020). Art making as a communal activity can lead to increased understanding, tolerance, communication, and authentic personal interaction, thereby reducing social exclusion and enhancing mutual respect and empathy (Matarasso 1997; Bowman 2015).

Sagan's reanalysis of data from her studies on community arts activity revealed that art making facilitates connection on multiple levels: connection to oneself, to others, to the artwork, to trust, and to disclosure and showing. Participants described how art making allowed them

*Presented 2024-10-09 by Olivia Sagan at Guardians 2024 with slides and video. This summary of her presentation prepared by the BHAVI Guardians Committee.

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to explore and express their inner experiences, leading to a sense of validation and recognition. This process of being seen through one's art, and the subsequent feedback and validation from others, was crucial for mitigating feelings of loneliness and fostering a sense of agency and belonging.

Drawing on Hannah Arendt's concept of agency, Sagan argued that art making enables individuals to appear as unique selves in the world, thereby counteracting the isolation and vulnerability that contribute to loneliness. This appearance in the world, facilitated by art making, fosters a sense of collectivity and agency, which are essential for social cohesion and democratic participation (Arendt 1973; Lucas 2019).

Sagan concluded her talk by emphasizing the need for interdisciplinary approaches to loneliness that incorporate insights from philosophy, psychoanalysis, political science, and the arts. She called for the development of inclusive and localized art making initiatives that can nurture quality interactions and foster social cohesion. Such initiatives, she argued, are vital for promoting well-being and human flourishing in contemporary society. In the subsequent discussion during the Q&A session, Sagan addressed several pertinent questions.

Carl Taswell raised the issue of the economic challenges faced by arts programs and the need to monetize the benefits of art making to ensure their sustainability. Sagan acknowledged the difficulty of quantifying the impact of art making but highlighted studies that have shown symptom reduction and decreased healthcare utilization as a result of arts participation. She cautioned, however, against reducing the value of art making to purely economic terms, emphasizing the broader social and psychological benefits.

Julie Neidich inquired about the distinction between being alone and experiencing loneliness. Sagan elaborated on the importance of differentiating between solitude, which is often positive and chosen, and loneliness, which is a more complex and negative emotional state. She highlighted the potential benefits of loneliness, such as increased creativity and self-reflection, and the importance of understanding the nuanced experiences of individuals.

Olivia Sagan's presentation (slides and video) at the Guardians 2024 Conference provided a comprehensive and thought-provoking exploration of the role of art making in addressing loneliness and promoting social cohesion. Her interdisciplinary approach and emphasis on the phenomenological experiences of individuals offered valuable insights into the complex interplay between art, loneliness, social cohesion, and the well-being of communities.

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Quantifying Similarities between fMRI Processing Pipelines for Efficient Multiverse Analysis

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Quantifying Similarity between Graph-Theoretic Resting-State fMRI Data Processing Pipelines for Efficient Multiverse Analysis*

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Abstract

Multiverse analysis aims to enhance the robustness and replicability of scientific findings by testing research hypotheses through multiple, well-justified analysis pipelines. However, the multiverse of pipelines is often large making exhaustive evaluation computationally infeasible. Thus, a key goal is to approximate the multiverse by sampling a manageable number of pipelines for robustness analysis. For such an approximation, it is necessary to quantify the similarity between analysis pipelines and guide pipeline sampling by these similarities. To this end, we first used meta-analytic data from Kristanto et al. (2024) on fMRI processing pipelines collected from a representative set of papers. Using this meta-analytic data, we propose a Graph Convolutional Network (GCN)-based approach combined with Deep Graph Infomax (DGI) to assess pipeline similarity. Graph-based embeddings were computed using unsupervised learning and subsequently used to derive pipeline features. Pipeline similarity was then quantified via Euclidean distance. Traditional similarity measures, namely Jaccard, Hamming and Levenshtein distances were also computed based on the meta-analytic data for comparison. Clustering analysis revealed consistency across the GCN, Hamming, and Levenshtein measures. Similarity measures based on Hamming and Levenshtein distances treated all processing steps identically, thus biasing them towards pipelines with identical step lengths. In contrast, the GCN-based measure generated distinct features for each step, allowing each to contribute differently to the pipeline similarity measure. Second, we compared the meta-analytically derived pipeline similarity measures with similarity measures obtained from multiverse analysis conducted on empirical data using resting-state fMRI measures from the Human Connectome Project. The comparison showed satisfactory results for the proposed approach, which aims to replace empirical similarity with meta-analytic similarity estimates for computationally efficient multiverse analysis in graph-theoretic fMRI research. These findings will inform future studies aimed at validating meta-analytic pipeline similarity measures based on empirical similarity estimates, providing a solid basis for the development of computationally feasible and valid multiverse analyses.

Keyphrases

Resting-state fMRI, multiverse analysis, data processing pipeline, graph neural network, similarity metric.

Contents

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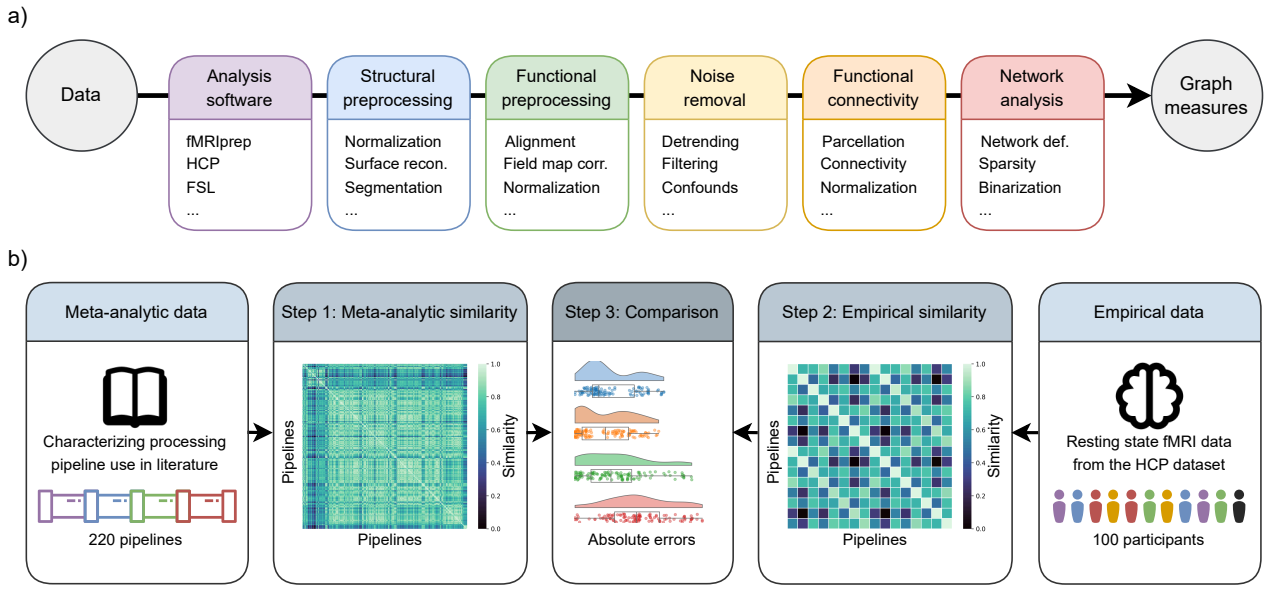

Figure 1: Pipeline Data: 220 graph analytical fMRI preprocessing/analysis pipelines were derived from literature. In total, these pipelines contain 61 distinct analysis steps, which can be grouped into six conceptual categories: Analysis software, structural preprocessing, functional preprocessing, noise removal, functional connectivity estimation, and network analysis.

Introduction

In many fields of computational science, researchers face a plethora of arbitrary yet defensible decisions when designing studies and analysing data. Given this multiplicity of decisions, also known as the many *researcher's degrees of freedom*, particular choices can inadvertently introduce bias and contribute to the ongoing replication crisis in science (Simmons et al. 2011). This issue is particularly pronounced in cognitive neuroscience, where the complexity of neuroimaging data requires extensive preprocessing and analysis pipelines to handle the inherent noise and complexity of the data (Kristanto et al. 2024). Consequently, methodological choices were shown to impact the robustness of results (Botvinik-Nezer et al. 2020), highlighting the need for more thorough data analysis practices.

In light of these challenges, there have been increasing calls to address the robustness of findings in scientific research (Open-Science-Collaboration 2015; Frias-Navarro et al. 2020), and to prioritize statistical replicability over narrative appeal (Huber et al. 2019). Rather than only reporting a subset of the findings in line with a planned story, researchers are urged to prioritize transparency, replicability, and methodological rigor to improve the credibility of findings. This shift in focus is critical for advancing the field, ensuring that results are not only compelling but also robust.

Towards such a shift, multiverse analysis has recently been proposed as an approach to enhance the robustness of research findings (Steegen et al. 2016; Del Giudice and Gangestad 2021). In contrast to just performing (and reporting) a single analysis, multiverse analysis involves running statistical tests over a wide range of specifications. This approach not only reveals whether different specifications lead to similar results but also offers exploratory insights. For instance, hidden structures in the data could include patterns such as latent clusters, nonlinear relationships, or variable interactions that become visible only under certain analytical choices. Additionally, the methods analysed may reveal clusters depending on the characteristics of the data, such as sensitivity to noise or differences in model assumptions. However, implementing multiverse analysis can be computationally expensive, especially in fields like neuroimaging research, where a vast number of analytical decisions are available. To address this challenge, a recent study proposed an active learning approach for multiverse analysis (Dafflon et al. 2022). This approach creates a search space of pipelines by running all analysis pipelines on a subset of the data and quantifies their similarity based on the outputs (e.g., graph measures derived from fMRI data). An active learning algorithm then samples and tests a small subset of pipelines from the search space. Specifically, the algorithm uses these samples to model associations between pipeline features such as analytical decisions, and research outcomes (e.g., predicting cognitive scores from brain data). This allows the algorithm to infer outcomes for the remaining pipelines in the search space without running them.

While promising, this method has limitations. For example, constructing the search space requires running all pipelines on a subset of the data, which may be computationally infeasible for large pipeline spaces. In addition, the same data cannot be used to construct the search space and test hypotheses without introducing bias due to circular analysis strategies. Thus, when the sample size is small, loss of data for the main analysis becomes a problem, reducing statistical power. Developing alternative methods to construct the search space without these limitations is therefore a key focus for multiverse analysis research, especially in computationally intensive fields or when large samples are unavailable.

Related research has also sought to address the issue of low robustness and replicability with neuroimaging pipelines. For example, almost two decades ago, Strother (2006) already highlighted that inconsistencies in testing environments and performance metrics hinder the generalisability of findings, and advocated for balanced approaches that not only evaluate isolated analytical steps but also the entire pipeline. More recently, studies such as Bowring et al. (2022) and Luppi et al.

(2024) have systematically evaluated sources of variability and benchmarked pipeline performance to enhance consistency and robustness in neuroimaging research. However, as the active learning approach, these methods require running all pipelines on the data of a given study, which is computationally intensive. This limitation becomes particularly problematic for multiverse analyses involving large numbers of pipelines, where computational feasibility is a key concern.

To overcome these limitations, we propose replacing the computationally expensive and data-intensive process of constructing a search space of pipelines with a similarity measure based on the configuration of the analysis pipelines as used in the literature. Instead of running pipelines on subsets of data, this approach uses information about the analysis steps and pipeline similarities based on how they are used and reported in the literature for addressing similar research questions. In this context, the 'configuration' of a pipeline refers to the sequence and specific choices of analysis steps that constitute the pipeline, such as preprocessing, feature extraction, and statistical modeling. Step-based pipeline similarity derived from meta-analytic data has garnered attention as a way to streamline multiverse analyses and integrate results efficiently. For instance, it has been suggested that the number of pipelines in a multiverse analysis could be reduced by grouping similar ones, based on the assumption that similar pipelines produce similar outcomes (Cantone and Tomaselli 2024). However, whether this assumption holds true remains an empirical question, as individual analysis steps can decisively alter the data.

Traditional similarity measures used for sequences, such as Jaccard, Hamming, and Levenshtein distances, each have specific strengths and limitations in assessing the similarity of pipelines effectively (Jaccard 1901; Hamming 1950; Levenshtein 1966). For example, Hamming distance detects localised differences by counting mismatches at corresponding positions. Levenshtein distance accounts for edits like substitutions, insertions, and deletions, making it more flexible, but it treats steps as isolated and ignores their relationships. Jaccard similarity measures overlap between sets of elements but disregards the order and structure of sequences. Thus, while these measures are effective for identifying differences or shared components, they might fail to capture the broader, structural relationships that often define processing pipelines as they are not just linear sequences but represent interconnected processes where the order and interdependence of steps carry significant meaning. Traditional similarity measures overlook this global context, making them less effective for accurately comparing pipelines in complex domains like fMRI data processing.

Building on these efforts, we introduce a novel method for assessing pipeline similarity using a Graph Convolutional Neural Network (GCN) combined with Deep Graph Infomax (DGI; Veličković et al. (2018)). Our approach generates graph-based embeddings to capture the relationships between processing steps across entire pipelines by using meta-analytic data indicating how frequently the pipelines are used in the literature. These embeddings are concatenated to form feature representations of pipelines, enabling similarity measurement based on Euclidean distance. Unlike traditional measures, this approach accounts for the structural and contextual relationships between processing steps. We applied this approach to a meta-analytic dataset of 220 fMRI analysis pipelines derived from the literature (Kristanto et al. 2024), estimating their similarity by using features such as the frequency and order of processing steps. To evaluate our approach, we compared the GCN-based similarity measure with traditional measures (Jaccard, Hamming, and Levenshtein distances). We analysed the behavior of these measures and highlighted their differences in the context of comparing fMRI processing pipelines. Additionally, we conducted an empirical multiverse analysis using data from 100 participants of the Human Connectome Project (HCP; Van Essen et al. (2013)). This allowed us to benchmark the GCN approach against empirical results, demonstrating that the GCN-based similarity measure shows promising results by capturing some (but not all) patterns in the data. The present study thus highlights the potential of GCN-based meta-analytic similarity measures for efficient multiverse analysis in computationally intensive fields like neuroimaging. We will discuss how such GCN-based measures can be integrated into frameworks to reduce computational costs, improve methodological rigor, and enhance the robustness of scientific findings.

Methods

The primary aim of this study is to systematically explore algorithms for quantifying the similarity of fMRI processing pipelines based on their analysis steps, as applied in the literature (Kristanto et al. 2024). Specifically, we investigate how different similarity measures, including traditional metrics and a novel Graph Convolutional Network (GCN) based approach, capture patterns of consistency and discrepancy across pipelines. To validate these measures, we compare their estimates to empirical similarity derived through a multiverse analysis using real data.

fMRI Experimental Data

For the empirical multiverse analysis to be compared with the meta-analytic similarity, we used minimally processed data from the publicly accessible Human Connectome Project (HCP) Young Adult dataset (https://www.humanconnectome.org/study/hcp-young-adult). This dataset comprises healthy individuals aged between 22 and 35 years, from which we randomly selected 100 individuals for subsequent analysis. From these, we used the openly available resting-state time-series data, which was cleaned through the HCP minimal processing pipeline (Glasser et al. 2013) and parcellated into 400 cortical regions of interest using the Schaefer et al. (2018) atlas.

fMRI Data Processing Pipelines

The analysis pipelines and associated meta-analytic data characterizing their applications in the literature used in the present study were derived from a systematic literature review, which specifically focused on graph-based methods for fMRI studies (Kristanto et al. 2024). The comprehensive review identified a total of 61 distinct preprocessing and analysis steps commonly employed across studies, with 17 of these steps representing often debated options such as data scrubbing, brain parcellation, or spatial smoothing, which can significantly influence the outcome of fMRI analyses. We grouped the steps based on their functional contribution to processing pipelines to outline the common workflow across pipelines. These groups are: Analysis software, structural preprocessing, functional preprocessing, noise removal, functional connectivity definition, and network analysis (Figure 1a). In total, 220 pipelines were derived, which in the present study serve as the core underlying data for the meta-analytic similarity measures. We emphasize that the list of pipelines used in this study, albeit aiming at different research questions, share a common goal, which is to estimate graph measures from functional connectivity. The meta-analytic data on fMRI processing pipelines contain the following node and edge relevant information: Steps in the pipeline and the frequency of their usage in

the literature, functional group to which the step belongs (e.g., software selection, structural or functional preprocessing, etc., see also Figure 1a), neighboring steps to which a step is connected, the number of studies in the literature that used a corresponding pair of processing steps consecutively, incoming connections (in-degree), outgoing connections (out-degree).

Traditional Similarity Measures

We first derive similarity measures from three well-established metrics in machine learning and bio-informatics: The Jaccard Index as well as Hamming and Levenshtein distances.

Jaccard Index: The Jaccard index quantifies the proportion of data processing steps that are shared between pipelines (Jaccard 1901). By representing each pipeline as a set of steps, the ratio of the size of the intersection (i.e., the common steps between two pipelines) to the size of the union (i.e., all the unique steps across the two pipelines) is calculated. For example, consider two sets of steps: $A = \{1, 2, 3\}$ and $B = \{2, 3, 4, 5\}$. The intersection $A \cap B$ contains the common steps $\{2, 3\}$, and the union $A \cup B$ contains all unique steps $\{1, 2, 3, 4, 5\}$. The Jaccard index is calculated as:

$$J(A, B) = \frac{|A \cap B|}{|A \cup B|} = \frac{2}{5} = 0.4 \quad (1)$$

It is important to note that the Jaccard index does not account for the order of elements, meaning that it only considers the presence or absence of elements within the sets, regardless of their sequence.

Hamming Distance: The Hamming distance quantifies the dissimilarity between two pipelines by comparing the sequences of processing steps (Hamming 1950). Each pipeline is represented as an ordered sequence, and the Hamming distance is defined as the number of mismatched steps between two pipelines when they are aligned step-by-step. For example, consider two binary strings representing processing steps: '10101' and '10011'. The Hamming distance between these strings is 2, because they differ at the third and fifth positions. Similarly, if two pipelines have identical steps but in different orders, the Hamming distance will be non-zero, reflecting these positional discrepancies.

This metric is particularly useful in scenarios where the order of steps is critical to the outcome. We use the complement of the distance as a measure of similarity. Unlike the Jaccard index, which only considers the presence or absence of steps, the Hamming distance accounts for the order of the steps by calculating the number of positions at which the corresponding steps in two pipelines differ.

Levenshtein Distance: The Levenshtein distance estimates the distance between two pipelines by measuring the minimum number of single-step edits required to transform one pipeline into the other (Levenshtein 1966). These edits can include substitutions, insertions, or deletions of processing steps. For example, the Levenshtein distance between the strings 'kitten' and 'sitting' is 3, as it involves two substitutions ('k' $\rightarrow$'s' and 'e' $\rightarrow$ 'i') and one insertion ('g' at the end). Unlike the Hamming distance, the Levenshtein distance accounts for sequences of different lengths by incorporating these insertion and deletion operations. The Levenshtein distance thus provides a way to assess how similar or different two pipelines are, considering both the order of steps and the specific modifications needed to align one sequence with the other. This metric is particularly useful in scenarios where small differences between pipelines—such as an extra step or a substituted processing method—can have significant implications.

Moreover, we also implemented the Damerau-Levenshtein distance in our analysis, which is an extension of the Levenshtein distance that additionally accounts for adjacent transpositions (i.e., swapping two neighboring elements). This extension is particularly relevant in scenarios where adjacent transpositions are a common source of variation between sequences. However, we found highly similar results as with the traditional Levenshtein distance (a correlation value of 1 between both distance measures). Results for the Damerau-Levenshtein distance are available in the supplementary Python notebooks.

Table 1: Pipeline decisions for multiverse analysis. HCP: Human Connectome Project, WM/CSF: White matter and cerebrospinal fluid regressors.

Pipeline Step	Parameter(s)
Preprocessing	HCP minimal processing pipeline
Cleaning	None
	6-parameter movement, WM/CSF
	Global signal regression
	All combined
Temporal filtering	None
	Band-pass (0.01 - 0.1 Hz)
Parcellation	Schaefer 400
Network construction	Discard negative, 50% density
Graph measure	Global efficiency

Graph Convolutional Network (GCN)

We propose a new way of measuring the similarity between analysis pipelines, which utilizes a Graph Convolutional Network (GCN) combined with Deep Graph Infomax (DGI). Unlike traditional methods, this approach encodes each analysis step in the pipeline as a distinct feature vector, with information provided both by the step itself and by external features (such as its functional group as depicted in Figure 1; see Section for details). The GCN also learns from neighboring steps in the pipeline by aggregating information from adjacent nodes, allowing the model to capture relationships between steps. This enables the model to weigh each step differently based on its role and connections in the pipeline, which in turn influences the similarity scores between pipelines. An advantage of this method is that it reflects both the presence of steps and how they are used in detail, making it more representative of real-world differences in processing pipelines.

Network Construction: The aggregate of the analysis pipelines derived from the literature can be analysed as a weighted and directed graph. Here, the nodes of the graph are the individual processing steps in the pipeline (e.g., spatial normalization, motion regression, parcellation), and the weighted directed edges are the number of studies in the literature that used the corresponding pair of processing steps consecutively. We also included nodal features, namely the frequency of a step (number of studies that applied the step), its incoming connections (in-degree), outgoing connections (out-degree), individual identity, and a group identity (e.g., structural or functional preprocessing, functional preprocessing, noise removal).

The GCN was then combined with the DGI algorithm to learn node representations for the fMRI processing pipeline in an unsupervised manner. The GCN generated initial embeddings by aggregating information from each node's neighbors, capturing local structural and feature information. DGI then refined these embeddings by introducing corrupted versions of the graph and training the model to distinguish between true and corrupted data (Veličković et al. 2018). This pro-

Table 2: Multiverse Analysis Pipeline Configurations. GSR: Global signal regression, WM/CSF: White matter and cerebrospinal fluid regressors.

Pipeline	Step i+1	Step i+2	Step i+3
Pipeline 1	Parcellation: Schaefer 400	Confounds: none	Band-pass filtering
Pipeline 2	Parcellation: Schaefer 400	Confounds: none	No filtering
Pipeline 3	Parcellation: Schaefer 400	Confounds: GSR	Band-pass filtering
Pipeline 4	Parcellation: Schaefer 400	Confounds: GSR	No filtering
Pipeline 5	Parcellation: Schaefer 400	Confounds: motion + WM/CSF	Band-pass filtering
Pipeline 6	Parcellation: Schaefer 400	Confounds: motion + WM/CSF	No filtering
Pipeline 7	Parcellation: Schaefer 400	Confounds: GSR + motion + WM/CSF	Band-pass filtering
Pipeline 8	Parcellation: Schaefer 400	Confounds: GSR + motion + WM/CSF	No filtering
Pipeline 9	Confounds: none	Parcellation: Schaefer 400	Band-pass filtering
Pipeline 10	Confounds: none	Parcellation: Schaefer 400	No filtering
Pipeline 11	Confounds: GSR	Parcellation: Schaefer 400	Band-pass filtering
Pipeline 12	Confounds: GSR	Parcellation: Schaefer 400	No filtering
Pipeline 13	Confounds: motion + WM/CSF	Parcellation: Schaefer 400	Band-pass filtering
Pipeline 14	Confounds: motion + WM WM/CSF	Parcellation: Schaefer 400	No filtering
Pipeline 15	Confounds: GSR + motion + WM/CSF	Parcellation: Schaefer 400	Band-pass filtering
Pipeline 16	Confounds: GSR + motion + WM/CSF	Parcellation: Schaefer 400	No filtering

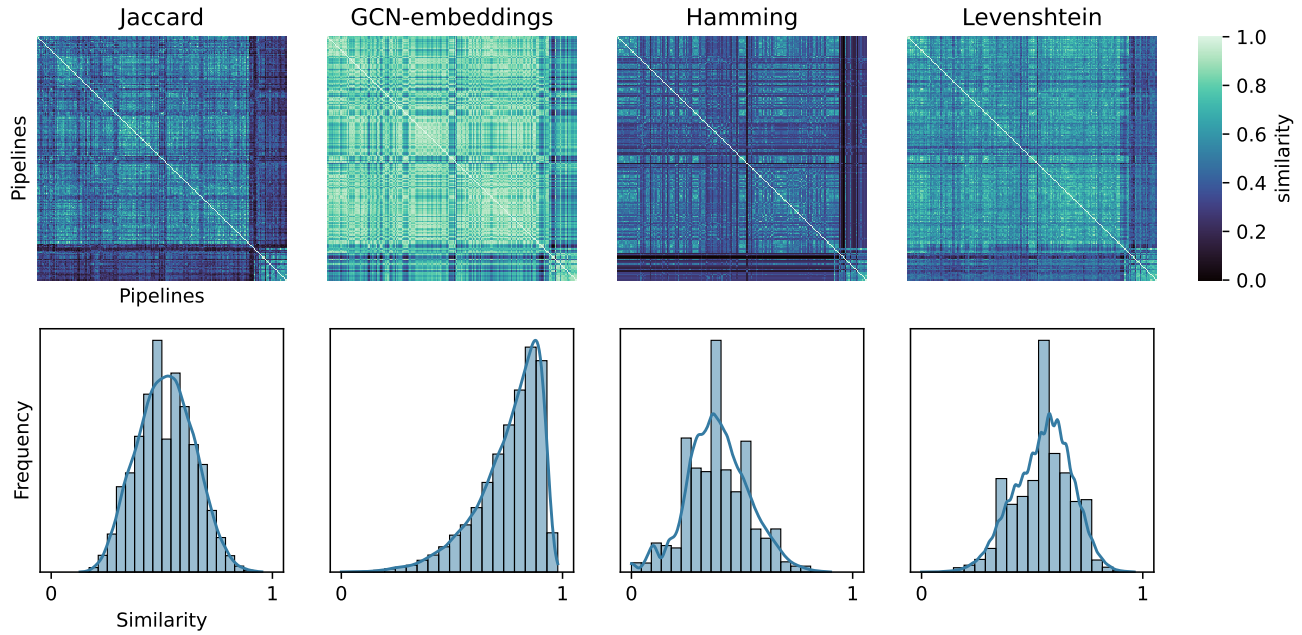

Figure 2: Similarity and distribution of similarity values for the different measures. K-means clustering was performed for the embedding similarity (mean) and all other matrices were ordered accordingly. The figure highlights a considerable overlap between measures.

cess maximizes mutual information between node embeddings and high-level summaries of the graphs, resulting in robust and informative representations for downstream tasks like the proposed estimation of pipeline similarity. As the number of layers in a GCN increases, the network aggregates information from nodes that are increasingly distant in the graph. We chose to use a single layer for our network architecture to focus on local relationships between processing steps only, which helps reduce the influence of distant, potentially less relevant connections. This approach is particularly useful given that not all combinations of processing steps are valid in an analysis pipeline, and focusing on local interactions helps to mitigate the risk of capturing implausible sequences in the embeddings.

Embedding Aggregation: The output embeddings of a GCN correspond to the neurons in its output layer. However, since fMRI processing pipelines vary in length, aggregating these embeddings into a consistent format is a challenge. To preserve the sequential nature of the pipelines, we apply Dynamic Time Warping (DTW), which measures similarity between temporal sequences, allowing for flexible, non-linear alignment of steps and accounting for differences in pipeline length or step ordering (Sakoe and Chiba 1978). Notably, DTW was implemented by treating consecutive steps as being one unit of time apart in sequences. This approach is thus similar to the implementation of Levenshtein distance, with the important distinction that, in DTW, each step is represented by embeddings learned during GCN training, whereas in Levenshtein distance, steps are simply represented by their discrete labels. To distinguish this GCN-based similarity measure from the network itself, we will refer to it as "GCN-embeddings".

In detail, the trained GCN generates embeddings for each node (pro-

cessing step), where each embedding is a vector corresponding to the network architecture (e.g., a 32-dimensional vector for a single-layer network with 32 neurons). Each pipeline is represented as a list of these embeddings, with the length of the list matching the number of steps in the pipeline. After aggregating the step embeddings into pipeline features, we computed the similarity between pipelines using Euclidean distance.

Normalization Across Measures

To facilitate the comparison between similarity measures, all measures were transformed and scaled into a common scale ranging from 0 (completely dissimilar) to 1 (completely similar):

$$Similarity(D_{ij}) = 1 - \frac{D_{ij} - \min(D)}{\max(D) - \min(D)} \tag{2}$$

with D being the distance matrix for each measure (GCN-embeddings, Jaccard index, Hamming distance, and Levenshtein distance).

Empirical Multiverse Analysis

As a final analysis, we conducted a real-data multiverse analysis to establish an empirical ground truth for pipeline output similarity. This ground truth served as a benchmark to compare the performance of the previously introduced similarity measures. Due to the computational challenges of performing a comprehensive multiverse analysis across all structural and functional preprocessing steps, we focused on the later stages of a standard graph analysis pipeline. Using minimally preprocessed data from the HCP Young Adult dataset, we randomly selected 100 individuals for subsequent analysis. For these individuals, we computed the graph measure, global efficiency, across different analysis pipelines as shown in Table 1. The multiverse analysis was implemented using the Comet toolbox (Burkhardt and Giessing 2024), which provides an integrated framework for functional connectivity, graph analysis, and multiverse analysis.

Analysis pipelines begin with identical preprocessing steps (the HCP minimal processing pipeline; Glasser et al. (2013)) but differ in their noise reduction strategies, which included four confound regression options (none, 6-parameter movement + white matter (WM) + cerebrospinal fluid (CSF), global signal, and both combined) as well as two filtering strategies (none, band-pass filtering between 0.01 and 0.1 Hz). Additionally, we altered the order of data cleaning and parcellation, resulting in two configurations: cleaning performed before parcellation or after. Since the total number of pipelines is the Cartesian product of these decisions, the multiverse comprised 16 pipelines ($2 \times 4 \times 2$).

The remaining parameters were kept consistent across all pipelines. This included parcellation, temporal detrending, calculating functional connectivity using Pearson correlation, constructing graph networks (removing negative correlations and thresholding to 50% density of the network), and computing global efficiency for each participant. To estimate similarity between pipelines, we computed the Pearson correlation of global efficiency values between pairs of pipelines across individuals, resulting in a 16×16 empirical similarity matrix. This matrix was used as a ground truth reference to evaluate the proposed similarity measures, which estimated similarity based solely on the steps in the pipelines without running them on real data.

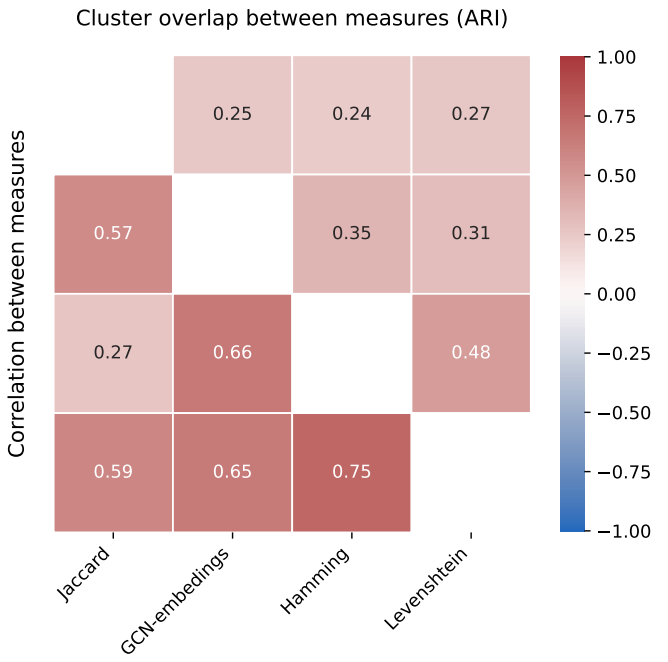

Figure 3: Correlation and Adjusted Rand Index (ARI) matrices between similarity measures. Most measures share a reasonable amount of variance. The adjusted rand index (ARI) is highest for methods which take the order of steps into account (DTW, Hamming, and Levenshtein).

Results

Comparative Analysis

We first trained the GCN and computed pipeline similarity based on the pipeline features. The training of the model is shown in the supplementary Python notebooks. Next, we computed pipeline similarity using other measures (Jaccard index, Hamming distance, and Levenshtein distance). We then compared the similarity estimates as shown in Figure 2. It becomes clear that there is a considerable overlap between the measures, as indicated by the moderate to high correlation between them (Figure 3). Interestingly, GCN-embeddings shows reasonably high correlation with Hamming ($r = .66$) and Levenshtein ($r = .65$). Further, the distributions of the similarity estimates show considerable differences. Similarity estimates derived from GCN embeddings are left-skewed and thus generally show higher similarity between pipelines. Hamming and Levenshtein distances display less smooth characteristics compared to the other methods, and the Jaccard index based similarity measures appear normally distributed.

Cluster Overlap

A more nuanced understanding of the resulting similarity matrices from different methods can be obtained by using the Adjusted Rand Index (ARI) (Hubert and Arabie 1985). ARI is a measure of the agreement between partitions obtained from a clustering approach. For this comparison, each similarity matrix was clustered into four groups, with the optimal number of clusters determined using the elbow criterion (see accompanying Python notebook for details). As shown in Figure 3, the ARI values were highest for DTW, Hamming, and Levenshtein, meaning that the three measures that account for the step order in the pipelines also show the highest cluster overlap.

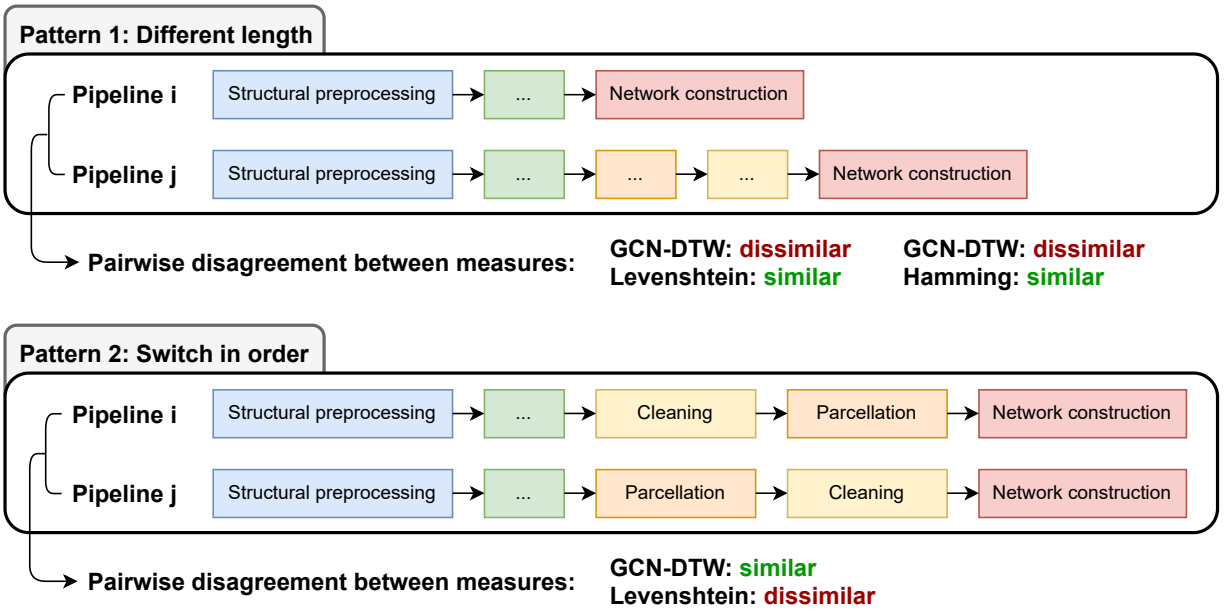

Figure 4: Differences between measures. Measures were evaluated in more detail by observing pairs of pipelines which show highest disagreement between measures. Only pipelines which consider the order of the steps were included. Two distinct patterns emerge. Top: Pattern 1 concerns pipelines of different length. Comparing GCN-embeddings to Levenshtein, GCN-embeddings considers such a pair of pipelines to be more dissimilar, while Levenshtein considers these pipelines to be more similar. The same pattern holds when comparing GCN-embeddings to Hamming. Bottom: Pattern 2 concerns a switch in order between cleaning and parcellation. GCN-embeddings considers these pipelines to be more similar, while Levenshtein considers these pipelines to be more dissimilar.

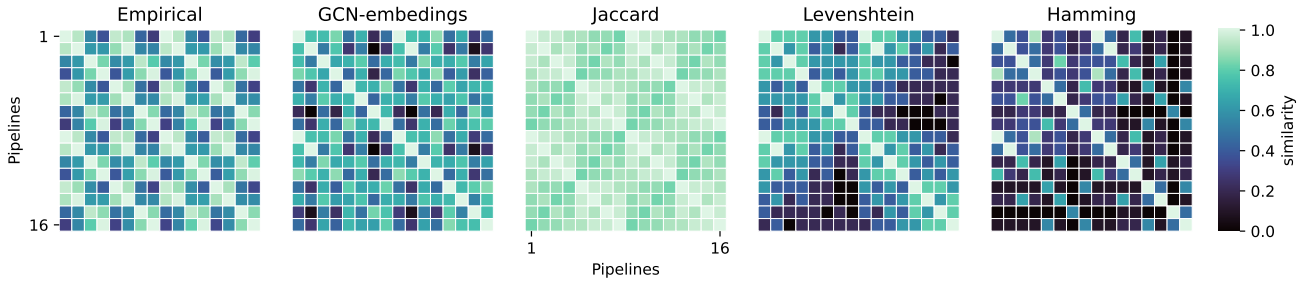

Figure 5: Similarity estimates from pipelines as listed in Table 2. Empirical similarity estimates show a strong grid-like pattern, which can be attributed to global signal regression. The ordering of steps (cleaning before or after parcellation) does not show a noticeable influence. Comparing the empirical similarity to the predicted similarities showed that all measures fail to pick up on this pattern, but mostly group pipelines into blocks of 4 (performing/not performing confound regression for motion, WM, and CSF). Please refer to the multiverse_summary.csv file in the supplementary materials for a detailed description of the pipelines.

Differences between Pipelines

Given the above findings, we further examined the emerging patterns produced by these three measures. We were particularly interested in pairs of pipelines where the similarity values computed by these measures were highly different. We therefore performed a pairwise comparison between the three similarity measures (i.e., GCN-embeddings vs. Hamming, GCN-embeddings vs. Levenshtein, and Hamming vs. Levenshtein) by using their similarity matrices shown in Figure 2. For each pair, we then extracted the 10 items with the highest absolute difference, that is, the 10 pairs of pipelines for which the measures most highly disagree in their similarity estimate. To account for a potential bias in the GCN, we repeated the entire process (including re-training of the GCN) 10 times resulting in 100 pairs of pipelines for each pairwise comparison.

We then investigated the origin of the differences in similarity estimates and found two distinct patterns (Figure 4). The first pattern emerged from the pairs of pipelines with different length. For the 100 pairs of pipelines for which GCN-embeddings and Levenshtein most highly disagree, the average difference in length was 10.01 processing steps, with GCN-embeddings judging the pair of pipelines to be less similar in all 100 cases. The same pattern can also be observed in the pairwise comparison between GCN-embeddings and Hamming. There, the average difference in pipeline length was 6.85, with GCN-embeddings considering such pipelines to be less similar in 62 out of 100 times. These results indicated that the Hamming-based measure was less

sensitive to these pipeline pairs compared to the GCN-embeddings measure. It is important to note that while these pipeline pairs differed in length, a significant portion of their steps were identical. Specifically, they shared minimal preprocessing pipelines from the Human Connectome Project, including identical steps for structural and functional preprocessing. The primary differences lay in subsequent noise reduction steps. This similarity in the early, substantial portion of the pipelines may explain why the Hamming distance identified these pairs as more similar than GCN-embeddings. In GCN-embeddings, each step is represented by its own embedding. Some steps may have larger embeddings than others, potentially leading to the identification of these pipeline pairs as less similar.

The second pattern highlighted a switch in order between brain parcellation and steps related to noise removal such as temporal filtering and motion regression. More specifically, we evaluated this order by assessing whether cleaning was performed in a high dimensional brain space (voxel level or high-resolution surface mesh), or on parcellated brain signals (groups of voxels/vertices clustered together into functionally distinct brain regions). This pattern emerged in 14% of comparisons between GCN-embeddings and Hamming, in 46% of comparisons between GCN-embeddings and Levenshtein, but in 0% of comparisons between Hamming and Levenshtein, indicating that the GCN-embeddings measure is robust to this pattern. Further, the comparison between GCN-embeddings and Levenshtein revealed that pairs of pipelines with this pattern were seen as more similar by GCN-embeddings and less similar by Levenshtein.

Empirical Multiverse Analysis

To evaluate the effectiveness of the meta-analytic pipeline similarity measures, we compared them with empirical similarity obtained by running pipelines on real MRI data as described in Methods). A total of 16 analysis pipelines were applied to the HCP dataset, and their empirical similarities were computed.

Figure 5 shows the empirical as well as the predicted meta-analytic similarity matrices of the analysis pipelines listed in Table 2. For the empirical similarity, a grid-like pattern becomes apparent. This can be attributed to global signal regression (GSR). Pipelines with GSR (Pipelines 3, 4, 7, 8, 11, 12, 15, 16) demonstrated high similarity to one another but low similarity to pipelines without GSR (pipelines 1, 2, 5, 6, 9, 10, 13, 14), and vice versa. Although not a particular focus of the present study, this finding once again outlined the significant impact of GSR on analysis pipeline results. The meta-analytic similarity estimates failed to pick up on this pattern, but more closely picked up the pattern of performing/not performing confound regression for motion, WM, and CSF signals. This lead to blocks of 4 being more pronounced in their estimates, which are most visible for Hamming, but also for GCN-embeddings and Levenshtein. Notably, the order of performed steps (first 8 vs. second 8 pipelines) did not play a major role for differences in similarity. For example, pipelines performing cleaning after parcellation (Pipelines 1, 2, 5, 6) were highly similar to pipelines performing cleaning before parcellation (Pipelines 9, 10, 13, 14).

Finally, we computed the absolute errors between the empirical and meta-analytic pipeline similarities. Figure 6 displays the distribution of absolute errors for each measure. GCN-embeddings showed the lowest median absolute error (MAE) of 0.18, with Jaccard (MAE = 0.23), and Levenshtein (MAE = 0.26) trailing closely behind. Hamming showed a substantially higher MAE of 0.45. Please refer to the supplementary Python notebooks for element-wise error matrices. Despite their reasonable performance, all measures failed to capture the influence of critical processing steps (in this case GSR) on pipeline similarity. We will later discuss potential extensions to GCN-embeddings method, informed by empirical evidence, to better account for the substantial influence of certain processing decisions on pipeline performance.

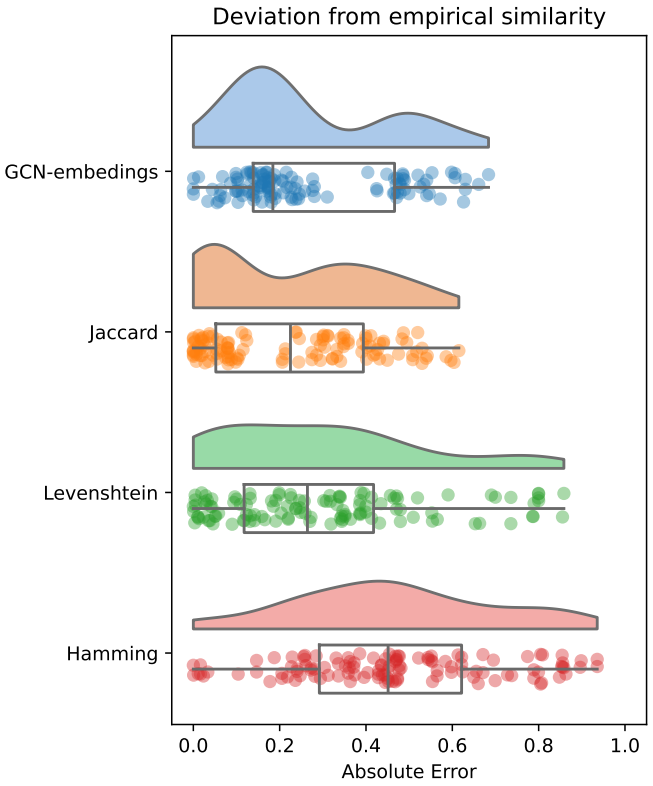

Figure 6: Comparison to ground truth. Comparing the estimated similarity between analysis pipelines to the ground truth from multiverse analysis, GCN-embeddings displays the lowest median absolute error (MAE) of 0.18. Jaccard (MAE = 0.23) and Levenshtein (MAE = 0.26) also produce similar estimates, while Hamming (MAE = 0.45) shows a considerably worse performance.

Discussion

In the present study, we elaborated on measuring similarity between processing pipelines in the context of multiverse analysis for fMRI studies, where pipelines involve complex sequences of steps. We introduced a novel meta-analytic pipeline similarity measure based on a Graph Convolutional Network (GCN) and compared it to traditional measures like Jaccard index, Hamming distance, and Levenshtein distance. Unlike these traditional measures, our GCN-based approach (GCN-embeddings) allows for varying contributions from different steps when computing pipeline similarities. Put simply, while traditional measures treat all steps equally, GCN-based measures assign individual weights to different steps. We expected that this would enable GCN-based measures to capture both consistent and distinct similarity/dissimilarity patterns in pipelines compared to the traditional measures.

We examined the similarity between GCN-embeddings and other traditional measures. Figures 2 and 3 show that the pipeline similarity estimates of GCN-embeddings overlap with those of other measures, suggesting that a GCN-based approach can also capture relevant pat-

terns. Moreover, a detailed analysis comparing pipeline partitions obtained by these measures revealed that GCN-embeddings was more consistent with Hamming and Levenshtein similarity measures but not with the Jaccard index. This finding was expected, as GCN-embeddings, Hamming, and Levenshtein consider the order of steps when calculating pipeline similarity.

It is important to clarify that the focus of the present work was not to validate pipelines for specific cognitive neuroscience hypothesis testing efforts. Instead, we relied on a meta-analytic dataset consisting of pipelines designed for different research purposes, unified by the common aim of estimating graph measures from functional connectivity. The primary contribution of this study was the development of a computationally efficient framework for quantifying pipeline similarity, which is critical for subsampling the multiverse of analytical decisions in a manageable and representative way, allowing researchers to explore variability across pipelines without requiring the exhaustive evaluation of all possible combinations.

Therefore, the validity of specific pipelines to test a particular hypothesis in cognitive neuroscience and its interpretations is outside the scope of this work. Instead, our focus was to assess whether meta-analytic data on the use of pipelines across multiple individual studies in graph-theoretic fMRI analyses can be used to effectively estimate pipeline similarity that approximates well empirical similarity measures, and which could be used to design multiverse analyses and efficient sampling from the multiverse in situations where the multiverse cannot be computed exhaustively but only approximated. While the present work advances methods for multiverse analysis, future studies could expand upon this framework by integrating hypothesis-specific considerations and further validating the approach in the context of specific cognitive neuroscience experimental paradigms. For now, the approach is aimed to serve as a methodological tool to facilitate efficient subsampling and variability assessment within the multiverse, independent of the specific experimental context.

Patterns in Similarity Discrepancies

Through a more in-depth analysis focusing only on the similarity measures that take the order of processing steps into account, we identified patterns in how these measures distinguish similar and dissimilar analysis pipelines. We focused on pairs of pipelines that exhibited the greatest discrepancies in similarity values computed by these measures. The first pattern was found in pipeline pairs that have different length. For example, two pipelines might use the Human Connectome Project (HCP) minimal preprocessing pipeline in earlier steps, but differ in length in the later part of the pipeline for cleaning or network construction. Hamming and Levenshtein score such pairs as highly similar due to the large number of common steps, while GCN-embeddings assigns a lower similarity score. This can be explained by examining processing step embeddings computed by the GCN, where steps related to network reconstruction have higher weights (mean embedding values, see supplementary Python notebook) compared to other earlier steps in the pipeline. Thus, pipelines with different network reconstruction steps would be less similar even if they share many other earlier steps. Second, comparing GCN-embeddings and Levenshtein, discrepancies were also found in pipeline pairs that differed in when cleaning steps (e.g., temporal filtering, motion regression) were employed. One pipeline might perform cleaning after brain parcellation, while others might do so before. Levenshtein considered these less similar due to the difference in order, and because it treated all steps equally. However, GCN-embeddings assigned them higher similarity because the weights it computed for brain parcellation and cleaning steps (e.g., temporal filtering, motion regression) were similar (mean embedding values, see supplementary Python notebook). Thus, these pipelines were considered more similar, despite their different sequence of steps, based on their embeddings. Importantly, the embeddings of a step also capture information about its neighbours, suggesting that similarity in embeddings implies that these steps may have an overlap in common neighbours.

Empirical Comparison

Comparing the meta-analytic similarity measures (using features characterizing their use in the literature) with empirical measures in a small multiverse of 16 pipelines revealed that GCN-embeddings performed, in terms of absolute error, comparably to traditional measures such as Levenshtein and Hamming distances. However, none of the methods — including GCN-embeddings — were able to adequately capture the substantial influence of global signal regression (GSR) on empirical similarity, underscoring a key limitation in current approaches: the inability to fully account for individual analysis steps with disproportionate effects on the outcome. In contrast, GCN-embeddings (as well as Jaccard and Levenshtein distances) was more sensitive to differences in pipeline lengths caused by variations in the number of individual steps within specific categories (in this case cleaning). These differences are amplified by the current coding schemes in which certain pipeline categories, like cleaning, may include a varying number of steps.

Implications and Future Directions

The findings of the present study suggest that GCN-based meta-analytic similarity measures may serve as a simple foundational tool for incorporating prior knowledge from an extensive literature into multiverse analysis frameworks. While the proposed method does not yet fully capture the effects of influential individual analysis steps, it already generates valuable information with relatively low computational effort. Future work is required to validate GCN-embeddings (or other GCN-based approaches) with larger and more comprehensive multiverse analyses and examine its consistency with empirically derived similarity measures. Establishing robust empirical ground truths will enable the refinement of the GCN, such as exploring deeper architectures to better capture global features across pipelines. Incorporating contextual information on the level of individual analysis steps, informed by expert knowledge about disproportionately influential steps, could also enhance the ability of the algorithm to distinguish meaningful differences between pipelines. Finally, automating the extraction of pipelines from literature would expand the meta-analytic dataset used here significantly, facilitating more robust training and testing of the model.

Broader Impact

While our study was primarily focused on quantifying pipeline similarity within the context of fMRI, its broader implications extend to addressing potential "fallacies and pitfalls" in other life science research domains (Hecker et al. 2023) that rely on complex data preprocessing, such as Positron Emission Tomography (PET) (Naseri et al. 2024), Electroencephalography (EEG) (Jacobsen et al. 2024), or genome-wide association studies (GWAS) (Hecker et al. 2023). This approach, by enabling a deeper understanding of how different processing and analysis choices can subtly affect results, promotes greater transparency

and reproducibility in such computational disciplines. Such enhanced understanding can help mitigate the risk of drawing misleading conclusions due to pipeline variability, a common pitfall in data-intensive research. Our work contributes to the broader goal of improving the validity and integrity of scientific findings in these research areas that rely on complex, multidimensional data.

Study Limitations

First, the meta-analytic dataset used in this analysis was limited to 220 pipelines, constraining the scope of the analysis. Automating the extraction of pipelines from the literature would address this limitation. Second, parameter-level differences in steps (e.g., specific software package, type of brain parcellation, number of motion regressors, or filtering options) were not considered, despite their known influence on results (Parkes et al. 2018; Luppi et al. 2024). Including these factors in future analyses is essential, though this was infeasible in the current study as this would lead to a sparse network, which would hinder the training of the GCN. Third, the empirical comparison was limited to a small multiverse of 16 pipelines with significant overlap in steps due to the HCP preprocessing pipeline. Expanding the analysis to a more diverse and larger set of pipelines would provide deeper insights into the behavior of the proposed measures.

Another avenue for improvement involves ensuring a uniform number of steps across pipelines, as this could enable fairer comparisons between methods and potentially reduce absolute error. Standardizing step representations, such as collapsing all noise reduction strategies under a single step with specific options (e.g., "Noise Reduction: GSR, None, or Both"), could improve performance. Such an approach would also require data sets from the literature to follow a consistent coding scheme, ensuring that all steps are comparable across pipelines.

Conclusion

The present study highlights the importance of quantifying pipeline similarities as a step toward improving the efficiency of multiverse analysis and developing tools for enhanced reproducibility in computationally intensive research workflows. By integrating step embeddings and sequential characteristics, GCN-based methods provide a simple framework to inform future algorithm development. While the current GCN-based similarity measure does not yet fully address variability (e.g. due to particularly influential analysis steps), its ability to generate valuable prior knowledge with low computational effort makes it a promising foundation for future advancements in this area.

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Conflicts of Interest

The authors have no personal, professional, or financial conflicts of interest to declare.

Availability of Code and Data

Code and data to run the analyses included in this study are available at github.com/metascience-uol/GCN-pipelines. The meta-analytic data on pipelines was openly published by Kristanto et al. (2024). The empirical data used to validate the meta-analytic pipeline similarity measures are part of the Human Connectome Project which can be requested for scientific use at humanconnectome.org/study/hcp-young-adult.

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Long-Term Innovative Potential of Genetic Research and its Suppression

Pan-Jun Kim

Genetic research:
Long-term innovative potential & its suppression

Pan-Jun Kim

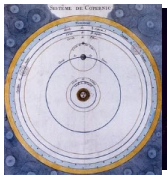
Department of Biology, HKBU

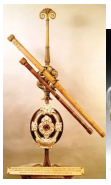
Junghun Chae, WooJoong Kim, Woochul Jung, Dawoon Jeong, Roktaek Lim, Manoj Chamlagain, Giju Jung, Juneil Jang, Jae Won Lee, Nam Kyu Kang, Kwangryul Baek, Jonghyeok Shin, Ye-Gi Lee, Hyun Gi Koh, Chanwoo Kim, Sangdo Yook, Allen Ka Loon Cheung, Yong-Su Jin (UIUC), Hyejin Youn (Northwestern), Cheol-Min Ghim (UNIST)

Scientific revolution





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Refs: http://en.chinaculture.org
https://www.britannica.com
https://www.worldhistory.org
https://www.heritage-print.com

Fitness landscape

Centralized: Rapid climbing, but near the local peak

Diversity-driven: Suboptimal exploration, but to the global peak

These days …


NIH
National Institutes of Health
Turning Discovery Into Health


NSF
National Science Foundation
WHERE DISCOVERIES BEGIN


Research Grants Council 研究資助局


nature
Science
Cell
PNAS

Commercial pressure:
Short-term returns & risk aversion

The Review of Financial Studies

Missing Novelty in Drug Development*

Joshua Krieger
Harvard Business School

Danielle Li
MIT Sloan and NBER

Dimitris Papanikolaou
Kellogg School of Management

Investigate Midwest

ENVIRONMENT

BP cuts funding for 'most promising' biofuel

by August 20, 2015 Why you can trust Investigate Midwest

Commercial pressure:
Short-term returns & risk aversion

How about the case of genetic research?

Ref: Depositphotos

Paper vs. Patent

Paper: Only few % company-funded for each gene

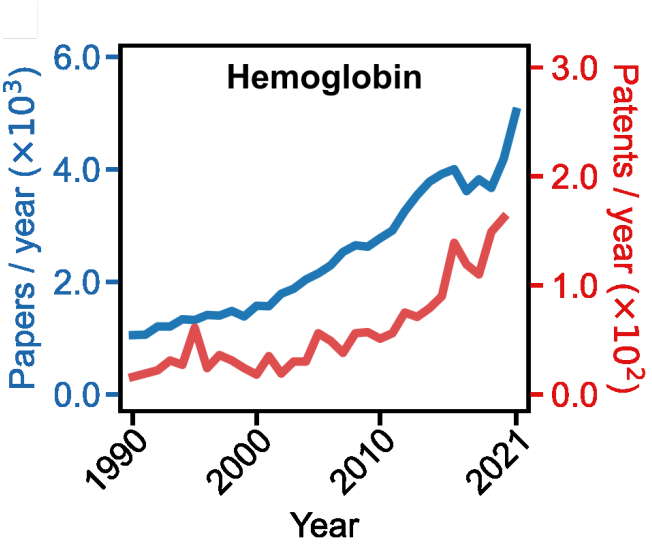
Patent: >70% company-assigned for each gene
→ Mostly driven by industry

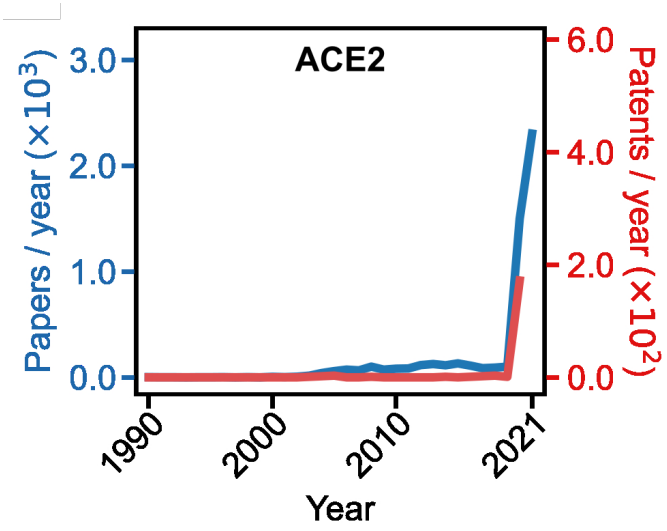
Datasets

Various bio- and medical areas, about 20M papers and patent families (US, China, Europe).

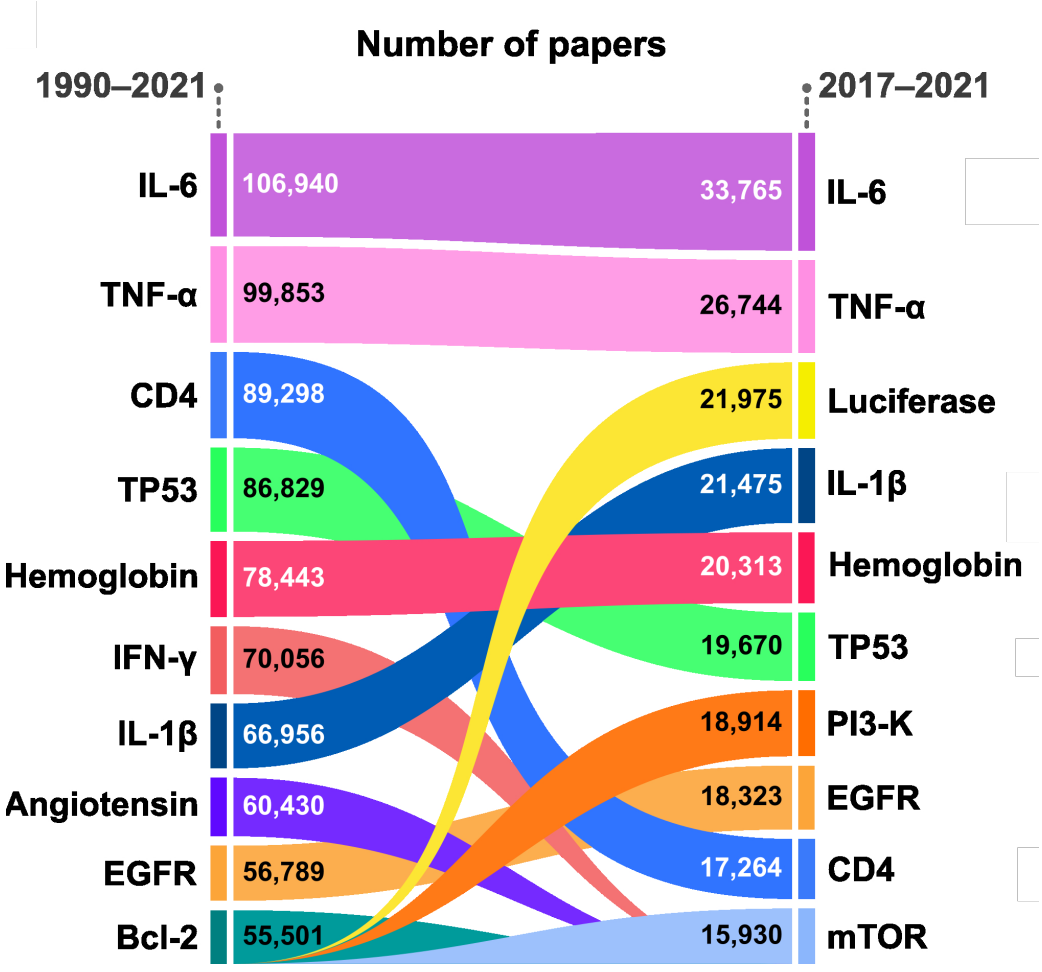
Genes for protein production (UniProtKB/Swiss-Prot)

Paper vs. Patent

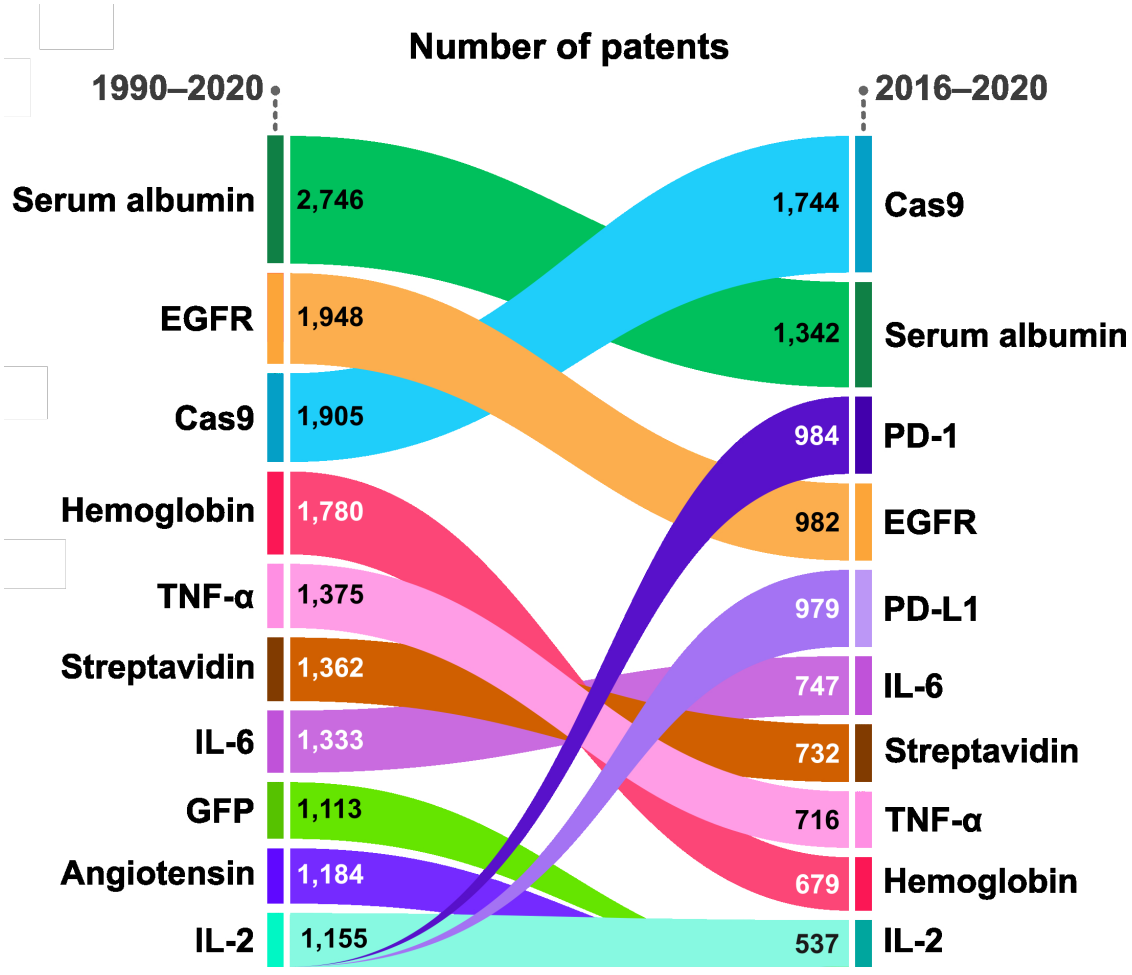




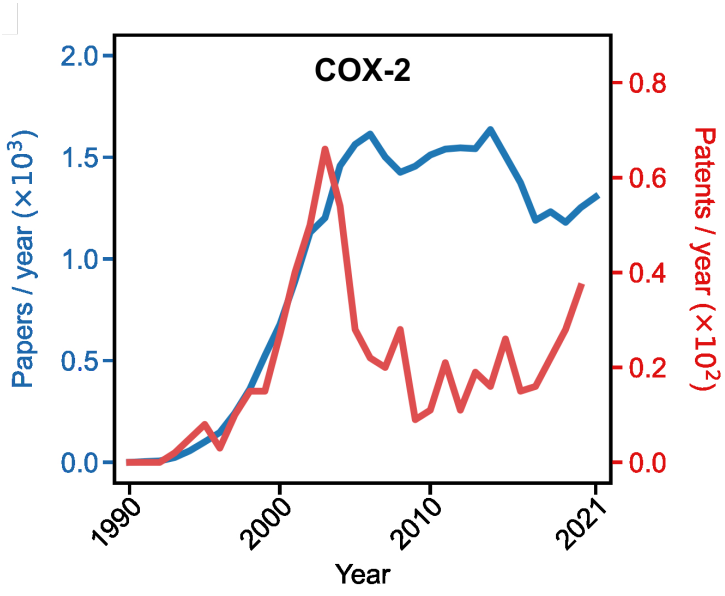
Top 10 genes in papers

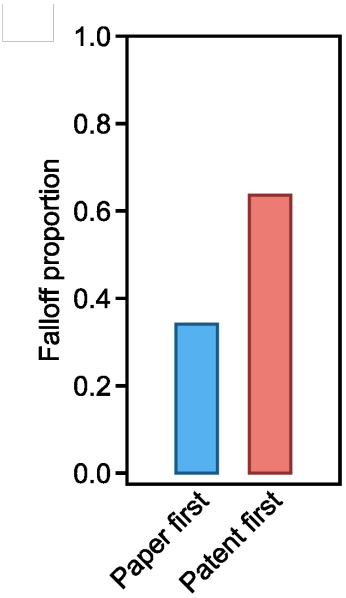


Top 10 genes in patents

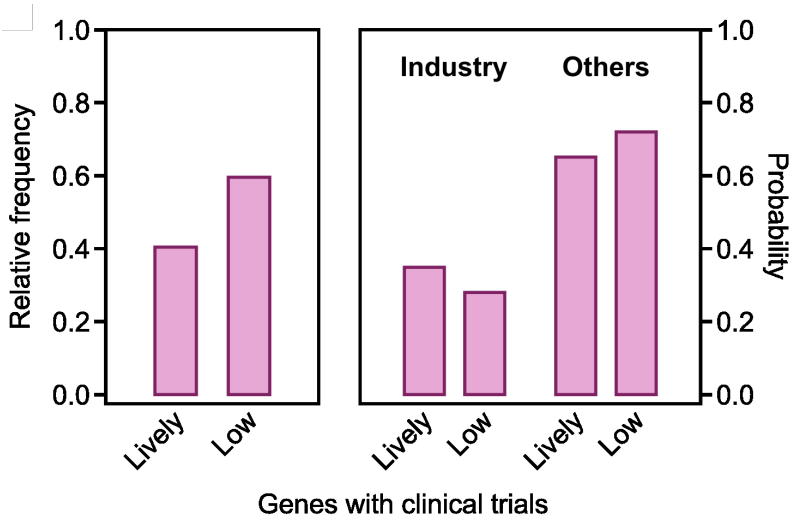


Industry interests vs. scientific research



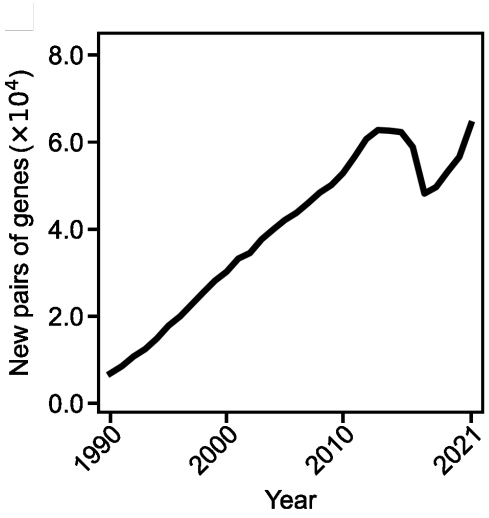


Industry interests vs. scientific research



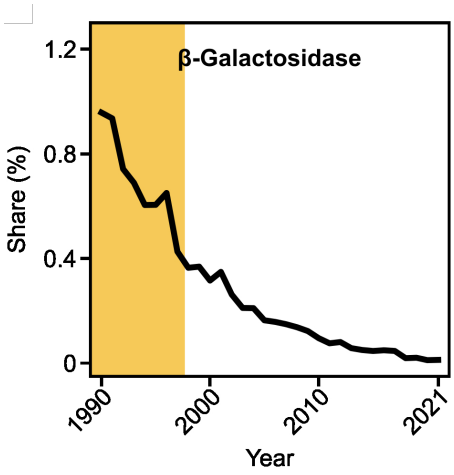
Genes with clinical trials:

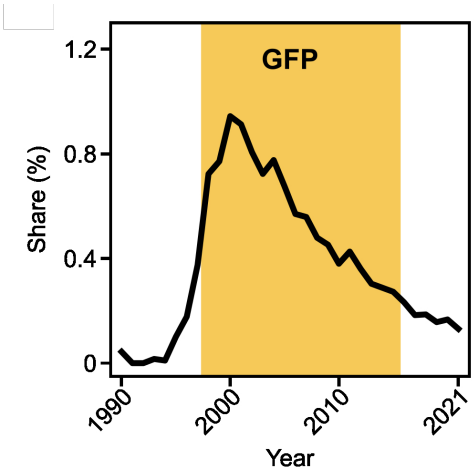
Example of the pursuit of impactful works

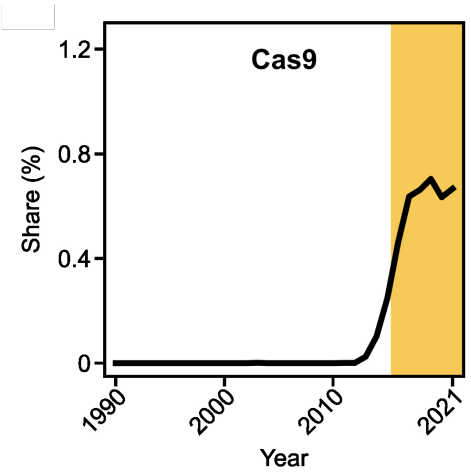


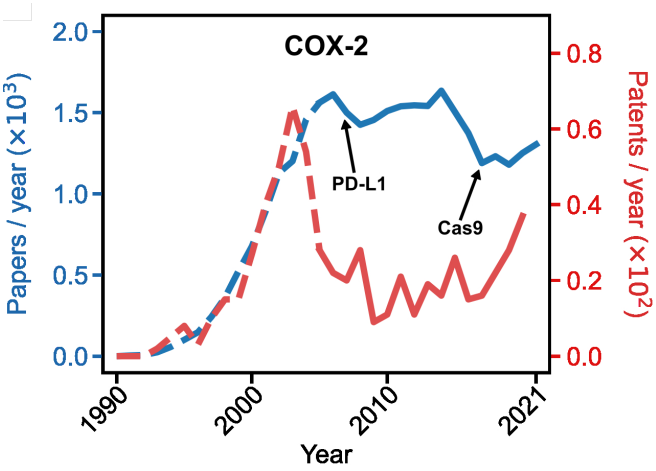
New combinations of genes

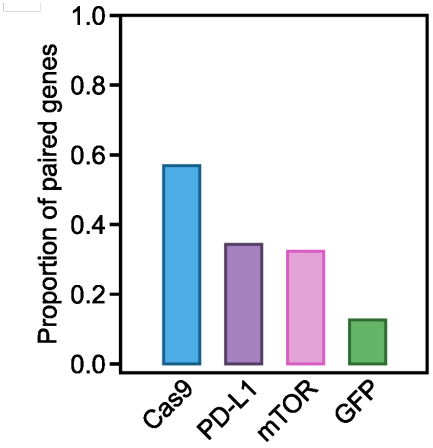
→ Innovative attempts.









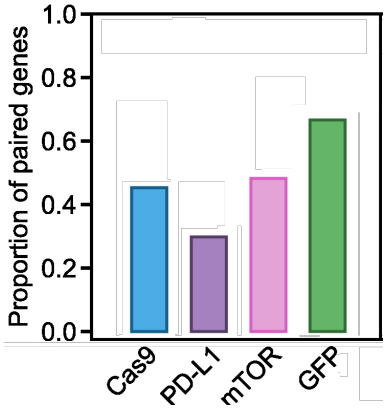


Long-term exploration continues after the patent falloff.

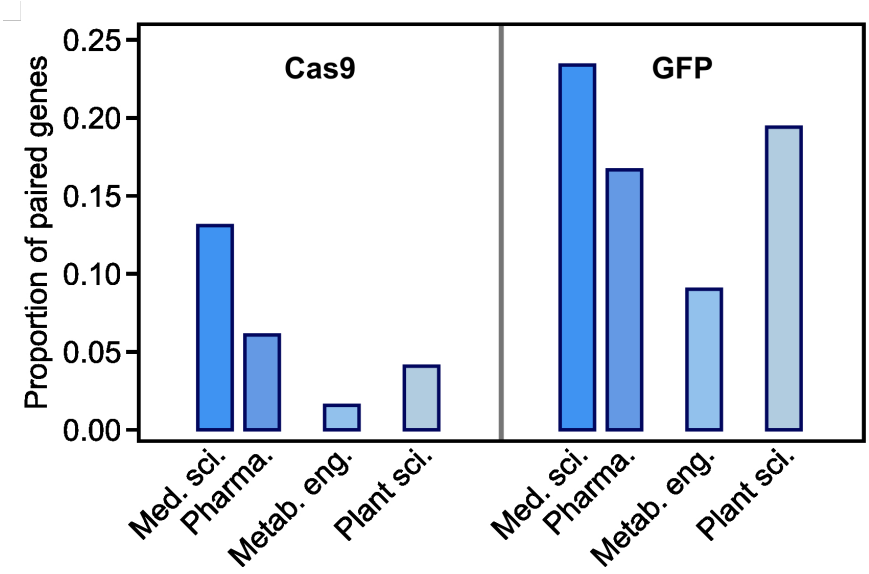
What if commercial pressure propagates from industry to scientific activities outside?

→ **Movel gene pairs lost.**

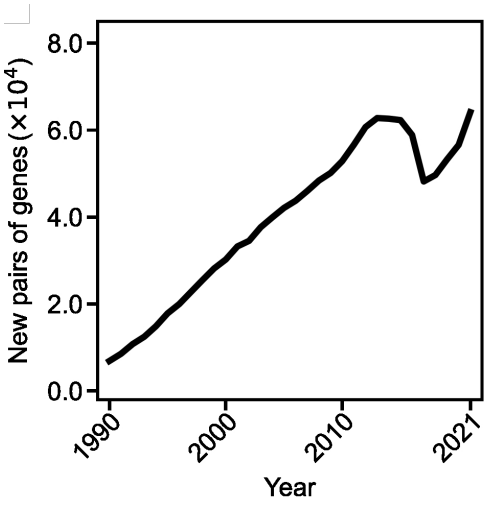
→ **Cost of over-reliance on commercially-driven research.**

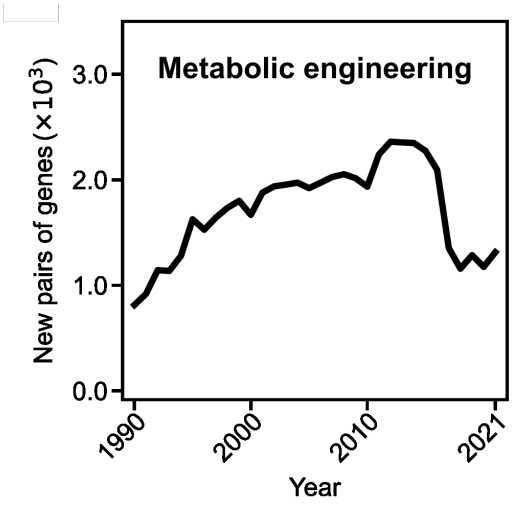


Fields of highly commercial focus



Proportion of genes in each thematic category, paired in the early stage





New pairs of all genes

→ Warning for low innovation vitality

Despite the perceived positive role of commercial pressure in technology progress …

POLICY FORUM

ARTIFICIAL INTELLIGENCE

The growing influence of industry in AI research

Industry is gaining control over the technology's future

By Nur Ahmed[1,2], Muntasir Wahed[3], Neil C. Thompson[1,2]

of talent, we see that industry is winnin
contest. Data on North American uni

884 3 MONTH 2023 • VOL 379 ISSUE 6635 science.org SCIENCE

Any implications?

From Open Review to Reproducible Review: FAIR Metrics Analysis of Peer Reviews for Brain Informatics Literature

Adam Craig, Carl Taswell

BRAINIACS
BRAIN IMAGING AND COMPUTING SCIENCES

2024 Volume 5
Issue 2 Edoc QA6A795A3

From Open Review to Reproducible Review: FAIR Metrics Analysis of Open Peer Reviews for Brain Informatics Literature*

Adam Craig and Carl Taswell†

Abstract

Brain informatics helps researchers discover and derive new insights from existing data and metadata in brain sciences, medicine, and healthcare, making the documentation of information methods, platforms, and data sources in scholarly meta-research especially important in this field. Evaluation of new reports by expert peer reviewers remains essential to maintaining the integrity of this published research, but determining the best way to assess the quality of these peer reviews has not been addressed adequately and poses an open question about what should be open peer review. Previously, we proposed the paradigm of reproducible peer review, in which a second reviewer should be able to draw on the same factual claims as the first reviewer in order to reach the same conclusion. We introduced a new family of metrics for peer reviews as an extension of the existing families of Fair Attribution to Indexed Reports (FAIR) Metrics to evaluate how well reviewers attributed the claims substantiating their recommendations to the original sources of that information. However, we only demonstrated this new family of FAIR Metrics on five example peer reviews. We report here the results of FAIR Metrics analyses of published open peer reviews on 14 brain informatics articles. These analyses demonstrate the value of the FAIR Metrics by highlighting ways in which the brain informatics community can improve the reproducibility of the peer review process. We call for open peer review that emphasizes references to or quotes from the specific passages of the work under review, indication of which standards of the publication venue the work meets or fails to meet, and citation of the literature when drawing on prior knowledge of the problem domain.

Keyphrases

Brain informatics, open peer review, PORTAL-DOORS Project, PDP-DREAM Ontology, FAIR Metrics, NPDS Cyberinfrastructure.

Contents

*Presented 2024-10-09 at Guardians 2024 with slides and video.

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Introduction

Peer review in brain informatics

As early as 2007, various authors, including Zhong et al. (2007) and Taswell (2007); Taswell (2009), were highlighting both the potential of brain informatics as an emerging field that leverages artificial intelligence to aid humans in solving problems related to brain health as well as the dependence of that emergence on the availability of well-curated data and knowledge resources on the internet and web. Since the 19th century, peer-reviewed journals have played an increasingly important role as sources of such information (Burnham 1990). However, few studies have systematically assessed the effectiveness of peer review at maintaining the quality of these resources (Jefferson et al. 2002), and the lack of clear standards for accountability of editors and reviewers and justification for recommendations or decisions has become an impediment to fully realizing the social good that peer review can achieve (Tennant and Ross-Hellauer 2020). Open peer review serves as a possible solution to the limitations of current practice. Because journals cannot guarantee that the quality of peer review will be satisfactory for a given purpose, they should publish the reviews alongside the articles so that readers can decide for themselves (Wolfram et al. 2020). While this move toward increased open transparency can create more opportunities for public discussion and debate of the merits of reports and the quality of the review process, it alone is not sufficient to address the lack of systematic standards. We previously proposed a further step toward establishing clear and systematic community standards that we call reproducible peer review: The reviewer should support their recommendation with sufficient factual claims, each clearly attributed

to a source, such that a second reviewer can follow their reasoning and arrive at the same recommendation (Craig, Lee, et al. 2022).

FAIR Metrics for peer review

For reproducible peer review to gain traction as a standard of excellence, and not just a catchy phrase, the reproducibility of peer reviews must be measurable. To that end, we recently introduced a family of FAIR Metrics for peer review of peer reviews at two recent IEEE Conferences (Craig and Taswell 2024b; Craig and Taswell 2024a). These metrics draw on similar principles that we have previously used to guide the design of the family of FAIR Metrics for adherence to good citation practices when searching, citing, and discussing the historical record of publishined literature in a scientific field (Craig, Ambati, et al. 2019; Craig, Athreya, et al. 2023). Most importantly, the metrics should measure how well the authors support reproducibility by clearly attributing claims to their sources, and whether claims are equivalent when they convey the same meaning, regardless of wording or paraphrasing. Furthermore, it is not enough for the results of the reviews to be reproducible. The evaluator must record the details of the FAIR Metrics analyses in a transparent and explainable manner. To support this approach with an objective method, we created a module of the PDP-DREAM Ontology with classes and properties useful for creating machine-readable semantic records of the analyses (Craig, Athreya, et al. 2023). We subsequently extended this module to enable creation of records of FAIR Metrics analyses of peer reviews of scientific reports (Craig and Taswell 2024b). The PDP-DREAM Ontology is a formal ontology that codifies the DREAM Principles, the design principles that guide the PORTAL-DOORS Project, but it also supports the inclusion of smaller modules for such specific purposes (Craig and Taswell 2021).

The key distinction between the family of FAIR Metrics for research reports and the family of FAIR Metrics peer review of peer reviews focuses on the practical reality that we do not expect peer reviews to introduce novel ideas. Thus, we focus only on how well a review supports its recommendations with factual claims properly attributed to their sources (Craig and Taswell 2024b). Additionally, we separate claims into types based on the subject of the claim and thus the kind of attribution needed: claims about the work under review, about the publication venue, or about the problem domain to which the reviewed work or venue relates.

In the previous work, we demonstrated use of FAIR Metrics with five example reviews (Craig and Taswell 2024b): one simple example review of a fictional paper, two reviews of a rejected submission to the ACM Multimedia call for grand challenges, a revised version of which is available as (Craig and Taswell 2024c) from *Brainiacs Journal*, and two published peer reviews of a recently published neuroscience article (G. Lu et al. 2024). In the current work, we apply these same FAIR Metrics to evaluate examples of published peer reviews of works related to brain informatics. This analysis allows us to identify key areas where editors and readers can maintain standards to support reproducibility of peer review and, thereby, a more well-curated scientific record of published literature.

Methods

Literature search

We searched the websites of six publishers advertised as practicing open peer review. On each site, we searched with the two queries "brain informatics", "brain imaging data management" without quotes and selected the first four articles that appeared to be about brain informatics based on their abstracts and that had at least two published peer reviews. We considered only reviews of initial submissions, as reviews of revised versions rarely had new critiques and instead merely acknowledged that the authors had made the recommended changes. The reviews we evaluated are of the following 14 articles, grouped by publisher and journal:

- 2 from eLife Sciences Publications, both in *eLife*: Scheffer et al. (2020); Markiewicz et al. (2021);
- 4 from F1000Research, all in *F1000Research*: Attendees (2016); Crusio et al. (2017); Navale et al. (2020); Guiet et al. (2021);
- 2 from Open Research Europe (also part of the F1000 publishing group), both in *Open Research Europe*: Tarnanas et al. (2021); Ilias et al. (2023);
- 1 from IOS Press, in *Semantic Web Journal* Sy et al. (2023);
- 3 from Nature Research: 1 in *Nature* Oh et al. (2014), 1 in *Nature Communications* Collins et al. (2024), and 1 in *Nature Human Behavior* Li et al. (2024);
- 2 from Oxford University Press, both in *GigaScience*: Craddock et al. (2015); O'Connor et al. (2017).

We assessed two reviews per article for a total of 28 reviews.

FAIR Metrics calculations

For each peer review, we calculated FAIR Metrics according to the process described in Craig and Taswell (2024b). We can summarize this process in five steps: 1) Read the review, and identify the key factual claims that the reviewer used to support their recommendation. 2) Classify each claim as pertaining primarily to either the work under review (the Target work), the conference, journal, or book publisher to which the authors submitted their work for publication (the publishing Venue), or information relevant to the scientific problem domain of the target work for the chosen venue (the Domain knowledge). 3) Classify each claim as correctly attributed to a source or misattributed. A correctly attributed claim has a cited source and accurately reflects the meaning of one or more statements in that source. A misattributed claim either has no cited source or misrepresents the content of that source. 4) Tabulate six counts of classified claims: A_T and M_T for correctly Attributed and Misattributed statements about the Target, A_V and M_V for correctly Attributed and Misattributed statements about the Venue, and A_D and M_D for correctly Attributed and Misattributed statements about the Domain. 5) Use these counts to calculate four ratio FAIR Metrics of peer review quality for the Target, Venue, Domain and combined Justification ratios:

$$F_T = (A_T - M_T)/(A_T + M_T) \quad (1)$$

$$F_V = (A_V - M_V)/(A_V + M_V) \quad (2)$$

$$F_D = (A_D - M_D)/(A_D + M_D) \quad (3)$$

$$F_J = \frac{A_T + A_V + A_D - M_T - M_V - M_D}{A_T + A_V + A_D + M_T + M_V + M_D} \quad (4)$$

Semantic records of FAIR Metrics analyses

As described in Craig and Taswell (2024b), we have extended the PDP-DREAM Ontology FAIR Metrics module with classes and properties

Table 1: Classes of the FAIR module of the PDP-DREAM Ontology for assessment of peer reviews; "new" indicates introduced here.

Name	New	Parent	Explanation
PdpDreamFairEntity	No	owl:Thing	Equivalent to owl:Thing root class for the module
Document	No	PdpDreamFairEntity	Resource containing text and possibly other media
Review	Yes	Document	a document that reviews another resource
Statement	No	PdpDreamFairEntity	Statement in some language
AttributedStatement	No	Statement	Statement correctly attributed to and cited from another resource, previously termed "Quoted" instead of "Attributed"
MisattributedStatement	No	Statement	Statement incorrectly referenced from another resource, previously termed "Misquoted" instead of "Misattributed"
AttributedTargetStatement	Yes	AttributedStatement	Statement correctly attributed to the report under peer review
MisattributedTargetStatement	Yes	MisattributedStatement	Statement incorrectly attributed to the report under peer review
AttributedVenueStatement	Yes	AttributedStatement	Statement correctly attributed to an editorial policies document of the publication venue
MisattributedVenueStatement	Yes	MisattributedStatement	Statement incorrectly attributed to an editorial policies document of the a publication venue
AttributedDomainStatement	Yes	AttributedStatement	Statement correctly attributed to other prior work in the domain
MisattributedDomainStatement	Yes	MisattributedStatement	Statement incorrectly attributed to other prior work in the domain

Table 2: Object properties of the FAIR module of the PDP-DREAM Ontology for assessment of peer reviews; "new" indicates introduced here.

Name	New	Parent	Explanation
hasPdpDreamFairObjectProperty	No	owl:ObjectProperty	Root object property for the module
isReviewOf	Yes	hasPdpDreamFairObjectProperty	Subject resource reviews the object resource
hasStatement	No	hasPdpDreamFairObjectProperty	Subject resource includes object statement
hasAttribution	No	hasPdpDreamFairObjectProperty	Subject statement has attribution (whether correct or not) to object resource
hasEquivalentStatement	No	hasPdpDreamFairObjectProperty	Subject and object statements are semantically equivalent
hasContradictingtStatement	Yes	hasPdpDreamFairObjectProperty	Subject and object statements contradict each other

Table 3: Data properties of the FAIR module of the PDP-DREAM Ontology for assessment of peer reviews; "new" indicates introduced here.

Name	New	Parent	Explanation
hasPdpDreamFairDataProperty	No	owl:DatatypeProperty	Root data property for the module
hasName	No	hasPdpDreamFairDataProperty	Text value is name for subject
hasText	No	hasPdpDreamFairDataProperty	Text value is summary phrase for subject
hasFairMetricValue	No	hasPdpDreamFairDataProperty	Root for data properties with FAIR Metric values
hasFairMetricCount	No	hasFairMetricValue	Root for data properties with FAIR Metric counts
hasFairATCount	Yes	hasFairMetricCount	Numeric value is A_T count for subject
hasFairMTCount	Yes	hasFairMetricCount	Numeric value is M_T count for subject
hasFairAVCount	Yes	hasFairMetricCount	Numeric value is A_V count for subject
hasFairMVCount	Yes	hasFairMetricCount	Numeric value is M_V count for subject
hasFairADCount	Yes	hasFairMetricCount	Numeric value is A_D count for subject
hasFairMDCount	Yes	hasFairMetricCount	Numeric value is M_D count for subject
hasFairMetricRatio	No	hasFairMetricValue	Root for data properties with FAIR Metric ratios
hasFairFTRatio	Yes	hasFairMetricRatio	Numeric value is F_T ratio for subject
hasFairFVRatio	Yes	hasFairMetricRatio	Numeric value is F_V ratio for subject
hasFairFDRatio	Yes	hasFairMetricRatio	Numeric value is F_D ratio for subject
hasFairFJRatio	Yes	hasFairMetricRatio	Numeric value is F_J ratio for subject

Table 4: Example FAIR Metrics scores from analysis of open peer reviews.

Report	Review	A_T	M_T	A_V	M_V	A_D	M_D	F_T	F_V	F_D	F_J
Crusio et al. 2017	1	13	0	0	0	0	0	1.00	0.00	0.00	1.00
Crusio et al. 2017	2	8	0	0	0	0	1	1.00	0.00	-1.00	0.78
Guiet et al. 2021	1	9	0	0	0	2	0	1.00	0.00	1.00	1.00
Guiet et al. 2021	2	0	3	0	0	1	0	-1.00	0.00	1.00	-0.50
Markiewicz et al. 2021	1	1	0	0	0	1	2	1.00	0.00	-0.33	0.00
Markiewicz et al. 2021	2	2	0	0	0	0	1	1.00	0.00	-1.00	0.33
Navale et al. 2020	1	4	1	0	1	0	1	0.60	-1.00	-1.00	0.14
Navale et al. 2020	2	11	0	0	0	2	2	1.00	0.00	0.00	0.73
Scheffer et al. 2020	1	4	0	0	0	1	1	1.00	0.00	0.00	0.33
Scheffer et al. 2020	2	6	0	0	0	0	0	1.00	0.00	0.00	1.00

that we use to make Resource Description Framework (RDF) documents recording FAIR Metrics analyses of peer reviews, which we have listed in Tables 1, 2, and 3. A well-documented FAIR Metrics analysis of a peer review lists a unique URI to identify the work under review, all key claims of the review, each assigned the correct class corresponding to one of the six categories, the cited source of each claim if any, the six counts, and the four FAIR Metrics ratios F_T, F_V, F_D, F_J.

Results

We present specific FAIR Metrics results for 10 example cases from the neuroimaging literature in Table 4. In this small data set, we did not find explicit misrepresentations of reports as making claims that they did not. However, we did find examples of misrepresentations of omission in which reviewers falsely claimed that a work was missing information. Most claims used to justify a recommendation were about the report itself with very few explicitly invoking requirements of the publication venue or knowledge from previously published literature. When invoking outside domain knowledge, reviewers typically made broad generalizations instead of explicitly citing reference sources. Indeed, for the small-size sample studied in our analysis, in order to demonstrate examples of non-zero A_D counts, it was necessary to loosen the requirements for identifying and referencing a specific project, software tool, or dataset with a website where an analyst of the review (the peer reviewer of the peer review) could find and verify a specific claim. Nevertheless, this result raises concerns about the the validity of peer review claims when not cited and reference with the source evidence.

Discussion

Holding peer review to a higher standard

While the infrequent references to venue requirements may reflect an implicit mutual understanding that a submission meets basic requirements of relevance and proper presentation unless otherwise noted, the near-absence of discussion of how the reports under review fit into the larger context of prior research in brain informatics indicates that the reviewers have not adequately assessed the novelty or importance of the research. At a minimum, a reviewer should agree or disagree with the authors' assertion that the work fills some gap in knowledge, solves some unsolved problem, or otherwise serves as a reproducibility, verification, and/or validation study. If they agree, then they can refer to the same sources the authors used to justify the claim. If they disagree, then they can reference other published literature that present results answering the same question or providing an existing solution.

The comparatively higher incidence of misattributions of omission suggests a different problem, but the origin of this trend is not yet clear and will require much evaluation of a much larger sampling of open peer reviews. It may simply be due to a lack of attention to detail from reviewers when reading reports, but that does not explain why they then assume that the information they insist is important to include is absent. One possible explanation is miscommunication between reviewers and authors due to differences in their understanding of the terminology of the field. Another is that reviewers simply use inappropriately false accusations of omission as pretext with stock criticisms by which to extend the length of the review. To identify the root of the problem, we will need to do further research that will involve actively engaging with peer reviewers, presenting them with the passages that provide the information they demanded and recording their responses regarding whether they suffice and, if not, how they should provide more detail.

Easing adoption of FAIR Metrics

FAIR Metrics evaluation, whether of scholarly research submitted for publication or of peer reviews, requires systematic assessment not only of the text itself but also of multiple related publications in the literature. Tools for automating various steps in the FAIR Metrics evaluation process will make their use more practical. In support of this goal, Brain Health Alliance will open the first Multimedia FAIR Metrics Grand Challenge to submissions in 2025. This contest will award a cash prize to the team that develops the best software automating some or all of the steps of FAIR Metrics evaluation (Craig and Taswell 2024c):

- Extract text and image data from different file formats.
- Separate text into discrete statements.
- Convert information in figures and tables into discrete statements.
- Distinguish substantive claims from other statements.
- Retrieve cited sources of claims.
- Search prior work for potential uncited sources of claims.
- Distinguish whether two claims are equivalent in meaning.

Conclusion

We performed FAIR Metrics analyses of published open peer reviews of scholarly articles in the scientific field of brain informatics. Based

on these analyses, we recommend that the brain informatics community hold peer review, and especially open transparent peer review, to a higher standard of reliability and reproducibility. We strongly recommend that reviewers make clear explicitly the sources on which they base their claims by citing the relevant references when making arguments for or against these claims. We will then better support meta-research for meta-science and the development of algorithms for meta-analyses of the historical record of published literature.

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Reproducibility, Validity, and Integrity in Scholarly Research: Questions Seeking Answers

Carl Taswell

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Reproducibility, Validity, and Integrity in Scholarly Research: Questions Seeking Answers*

Carl Taswell†

Commentary

Our Guardians Conferences continue to address the general theme of *reproducibility, validity, and integrity* when conducting and communicating research while avoiding common fallacies and pitfalls in the relevant field of experimental science. Invited speakers at Guardians 2024, Maggie Mulqueen (2024), Philip Koch (2024), Natalie Burke (2024), Joshua Rubin (2024), and Olivia Sagan (2024), addressed the 2024 focus theme of *people talking to people with civility, courtesy, tolerance, and respect*. We honored Peter Ash, as our 2024 Guardian of Truth and Integrity in recognition of his extraordinary role model example of leadership and advocacy for people talking to people in order to promote healthy communities saving the lives of children with albinism.

Next year at Guardians 2025, we will continue the conversation on people talking to people, but refocused on *scholars talking to scholars* with an emphasis on rebuilding commitments to peer review of peer review. Here are the questions seeking answers that we will continue to address at the Guardians Conferences:

- What accountability for willful disregard (Taswell 2023) of reproducibility, validity, and integrity in scholarly research?
- How should we heal and cure the worsening 4G problem in academia of *Grooming, Gleaning, Gaslighting, and Ghosting* by promoting the alternative of citational justice (Taswell 2022) and other forms of epistemic justice?
- What new nosology and new metrics (Taswell 2024) should we develop to evaluate and measure collective, community, social, and public health?
- What can we do to promote collegiality with peer review of peer review (Craig et al. 2022) supported by *scholars talking to scholars with civility, courtesy, tolerance, and respect*?
- What must we do to end the information wars (Athreya et al. 2023) threatening to destroy democracy in countries around the world?

Profiles in courage and leadership in support of democracy as represented by the work and words of American Presidents can be found from many sources including the 2024 President's Day list compiled by Caldwell (2024). Example quotes from the Greatest Generation impacted by the Great Depression, World War II and the Korean War in the 20th Century highlight the importance for all of us to do our part and fulfill our individual duty contributing to our collective responsibility to defend democracy against those who would destroy it.

- F. D. Roosevelt: "The only thing we have to fear is fear itself.", "We must be the great arsenal of democracy.", "The test of our progress is not whether we add more to the abundance of those who have much; it is whether we provide enough for those who have too little.", FDR Presidential Library.
- H. S. Truman: "The buck stops here.", "I never did give anybody hell. I just told the truth and they thought it was hell.", "Whether discrimination is based on race, or creed, or color, or land of origin, it is utterly contrary to American ideals of democracy.", HST Presidential Library.
- J. F. Kennedy: "Ask not what your country can do for you — ask what you can do for your country.", "Mankind must put an end to war before war puts an end to mankind.", "If we cannot now end our differences, at least we can help make the world safe for diversity.", JFK Presidential Library.

Democracy can be best served by people talking to people, scholars talking to scholars, and especially, by politicians talking to politicians with exemplary civility, courtesy, tolerance, and respect as role model examples for all citizenry. Instead of making accusations and fomenting fear, hatred, and division, politicians should be asking questions and promoting understanding, trust, and collaboration to solve problems for a better world for all of us. This communication and interaction style of asking questions to solve problems with a collaborative rather than divisive approach has been discussed in recent books on leadership (Maxwell 2016; Stanier 2016; Wise and Littlefield 2017; Gordon and Leavell 2021; L. Ashley-Timms and D. Ashley-Timms 2022; Marquardt and Tiede 2023; Gaddis 2024). At Guardians 2025, we will continue to pose and discuss questions seeking answers in support of democracy and collaboration to solve problems and to promote truth in science and integrity in research.

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Who are the Guardians of Truth and Integrity for 2024?

Adam Craig, Carl Taswell

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Who are the Guardians of Truth and Integrity for 2024?*

Adam Craig and Carl Taswell†

Abstract

On October 9th, Brain Health Alliance (BHA, a 501c3 nonprofit organization) hosted Guardians 2024, our third annual conference entitled "Who are the Guardians of Truth and Integrity?" Open to the public, the conference provided a conversation about current challenges in maintaining the integrity of the scientific record and fostering ethical standards in various domains. The presentations highlighted the critical role of collaboration, transparency, reproducibility, and accountability in scientific research and societal practices. With the focus theme for 2024 devoted to *people talking to people with civility, courtesy, tolerance, and respect*, invited speakers emphasized the importance of collective action and individual commitment to fostering meaningful human connections, promoting research integrity, and advancing medical, scientific, and societal progress.

Keyphrases

Research integrity, citational justice, publishing ethics, scientific truth, academic ghosting, FAIR Metrics.

Contents

*Presented at Guardians 2024 with slides and video.
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Guardians 2024 Program

Guardians Conferences ask the question "*Who are the Guardians of Truth and Integrity?*" and discuss the use of mis-information, dis-information, anti-information, caco-information, and mal-information (S. K. Taswell, Athreya, et al. 2021) in science, engineering, and medicine. Guardians 2024 was held on October 9th as an online event with 5 invited speakers:

- Natalie Burke, Common Health Action, Washington DC
- Philip Koch, Colorado School of Mines, Golden CO
- Maggie Mulqueen, Brookline MA
- Joshua Rubin, University of Michigan, Ann Arbor MI
- Olivia Sagan, Queen Margaret University, Edinburgh UK

who discussed this year's focus theme of *people talking to people with civility, courtesy, tolerance, and respect*. The workshop began with recognition of Mr. Peter Ash as our 2024 Guardian of Truth and Integrity.

Guardians 2024 Opening Session

- 09:00 Julie Neidich, Honoring our BHAVI 2024 Guardian: Peter Ash (2024 Guardian slides and video)
- 09:15 Peter Ash, Under the Same Sun: Changing Hearts and Minds about Albinism (Learn More about UTSS and 10 years of UTSS)

Invited Talks

- 10:00 Maggie Mulqueen, What Does Care Look Like in 2024? Caring for Others in Times of Dissent and Distress (video, edoc)
- 11:00 Philip Koch, Holding Their Feet to Our Fires: Rural Emergency Services and the Struggle to Serve in the Face of Ignorance and Corruption (slides, video, edoc)
- 12:00 Natalie Burke, The Journey Towards Health Equity: Taking Uncomfortable Steps to Change Hearts and Minds (slides, video, edoc)

- 13:00 Joshua Rubin, Musical Chairs for Darvomanics: How Anti-Learning Systems Enable Systemic Abuses of Power in Academia and What We Can Do Together to Help Them Learn (slides, video, edoc)
- 14:00 Olivia Sagan, Loneliness, Social Cohesion and the Role of Art Making (slides, video, edoc)

Technical Talks

- 15:00 Micha Burkhardt, UOL Germany, Quantifying Similarities between fMRI Processing Pipelines for Efficient Multiverse Analysis (slides, video, edoc)
- 15:20 Pan-Jun Kim, HKBU Hong Kong, Long-Term Innovative Potential of Genetic Research and its Suppression (slides, video)
- 15:40 Adam Craig, BHAVI USA, From Open Review to Reproducible Review: FAIR Metrics Analysis of Peer Reviews for Brain Informatics Literature (slides, video, edoc)

Guardians 2024 Closing Session

- 16:00 Carl Taswell, BHAVI USA, Reproducibility, Validity, and Integrity in Scholarly Research: Questions Seeking Answers (slides, video, edoc)

All slides and recordings of the talks are also available at Guardians 2024 Program. Background references on reproducibility, validity, and integrity for the Guardians Conferences include Craig, Ambati, et al. (2019); Athreya, S. K. Taswell, et al. (2020); S. K. Taswell, Triggle, et al. (2020); S. K. Taswell, Athreya, et al. (2021); Craig, Lee, et al. (2022); C. Taswell (2022); Athreya, Craig, et al. (2023); C. Taswell (2023).

2024 Guardian: Peter Ash

Brain Health Alliance recognized and honored Peter Ash as the BHAVI 2024 Guardian of Truth and Integrity.

Julie Neidich offered a tribute to Peter Ash honoring him as the BHAVI 2024 Guardian for his tireless advocacy on behalf of individuals with albinism. Ash, the founder of Under the Same Sun, has dedicated his life to protecting and empowering people with albinism, particularly in African nations where superstition and discrimination are rampant. Neidich highlighted the severe challenges faced by individuals with albinism, including social ostracism, physical attacks, and even murder for their body parts, which are believed to possess magical properties (United Nations, 2013). Ash's organization, Under the Same Sun, has been instrumental in creating safe spaces, providing education, and advocating for policy changes to protect the rights of people with albinism.

Following Neidich's tribute, Peter Ash participated in a Q&A session where he addressed the misconceptions and superstitions surrounding albinism, particularly in African countries. Ash discussed the negative portrayal of individuals with albinism in media, the critical issue of skin cancer among people with albinism, and the personal risks he faced during his advocacy work. He emphasized the importance of accurate representation, grassroots education, and international advocacy in improving the lives of individuals with albinism.

Maggie Mulqueen

Mulqueen (2024), "What Does Care Look Like in 2024? Caring for Others in Times of Dissent and Distress", emphasized the profound importance of human connection in fostering both mental and physical well-being. Central to this connection is the critical role of listening and ability to listen effectively, which enables individuals to feel heard and understood. In a society increasingly dominated by disinformation and contentious dialogue that prioritizes talking over others rather than listening and hearing, improving the skill of listening and understanding remains crucial to building and maintaining meaningful relationships. As Frank Bruni (2024) explains in *The Age of Grievance*, the tendency to filter information through echo chambers and the rise of cancel culture have further complicated the landscape of communication, making authentic listening all the more challenging.

Mulqueen outlined several essential components of effective listening, including genuine interest, trustworthiness, and setting boundaries. Mulqueen posits that the act of listening, often overshadowed by the cultural emphasis on speaking and winning arguments, is a powerful component of care. Deborah Tannen (1999) work on psycholinguistics highlights how varied speech patterns and norms can either facilitate or hinder effective communication. Mulqueen stresses the importance of setting boundaries and maintaining confidentiality to foster an environment conducive to open dialogue. This approach not only ensures that the listener is trustworthy but also that the speaker feels safe and respected.

In the context of professional and personal interactions, Mulqueen emphasizes the distinction between listening and problem-solving. She argues that offering comfort through attentive listening can be more impactful than attempting to solve problems, which can inadvertently create a power imbalance. This perspective aligns with the findings of Tavris and Aronson (2020) in *Mistakes Were Made (but Not By Me)*, which illustrate how individuals often double down on their beliefs rather than remain open to new information. By genuinely listening without the expectation of agreement, one can foster deeper connections and a better understanding of differing viewpoints.

She also explored the complexities of listening in the digital age and stressed the importance of listening to oneself as a form of self-care. Mulqueen also addresses the complexities of communication in the digital age, where the absence of body language and tone can lead to misunderstandings and heightened tensions. She advocates for setting clear expectations and boundaries in digital communications to mitigate these issues. Furthermore, Mulqueen calls for a balanced approach to self-care and caring for others, emphasizing that listening to oneself is essential for sustaining the ability to listen to others effectively. This holistic view of care, which integrates self-awareness and empathy, is crucial in navigating the challenges of contemporary communication and fostering meaningful human connections.

Philip Koch

Koch (2024), "Holding Their Feet to Our Fires: Rural Emergency Services and the Struggle to Serve in the Face of Ignorance and Corruption", provided an insightful overview of the challenges faced by rural emergency services, particularly volunteer firefighters in Colorado. Koch highlighted the systemic issues that impede effective emergency response, including the politicization of board elections and the lack of knowledge among elected officials. He recounted the failed attempt to consolidate three fire protection districts due to misinformation and unethical tactics by opponents. Koch emphasized the need for informed and ethical governance in emergency services to ensure public safety.

At the Guardians 2024 Conference, Philip Koch, a professor at the Colorado School of Mines and a volunteer firefighter, delivered a com-

pelling presentation on the critical yet often overlooked challenges faced by rural emergency services. Koch highlighted that military personnel receive more recognition than do emergency service workers, even though both frequently encounter dangerous situations. He illustrated the perilous nature of their work by describing Colorado firefighters' struggle to contain the Quarry Fire near Denver and went on to emphasize that organizational failures unnecessarily exacerbate these risks (Wertz et al., 2024).

Koch's dual roles as a scholar and firefighter provided a unique perspective on the financial and operational challenges faced by rural fire departments. He noted the high costs of essential equipment and the necessity for regular replacements to meet safety standards. Most fire departments in Colorado, organized as fire protection districts (FPDs), rely on property taxes for funding, which requires community approval (Colorado Legislature, 2023). Koch criticized the politicized nature of FPD board elections, which often lead to mismanagement due to the lack of expertise among board members.

The presentation also addressed the detrimental effects of political corruption within FPDs. Koch distinguished between financial and moral corruption, with the latter going beyond inappropriate acceptance of financial or political gains to obstruction of those working selflessly to protect public safety. He provided specific examples of how corrupt board members promote personal agendas at the expense of addressing critical issues such as increasing fire incidents and rising costs. Koch, who serves on both the Elk Creek and Hartsel FPDs, advocated for Consolidation of the two districts, which would combine them to reduce overhead, improve mutual aid, and enhance operational efficiency (Elk Creek FPD, 2024b). However, this proposal faced resistance from politically motivated opponents. He and his colleagues countered this by proposing Unification, a similar process to Consolidation that does not require changes to property taxes or voter approval and has garnered preliminary support from the respective Boards (Elk Creek FPD, 2024c). Koch's advocacy for Unification aims to improve public safety and support the dedicated emergency service workers who brave life-threatening blazes to serve their communities.

Koch concluded by emphasizing the importance of informed and proactive citizen involvement in addressing these structural challenges. His presentation underscored the need for fact-based governance and the prioritization of public safety over political agendas.

Natalie Burke

Burke (2024), "The Journey Towards Health Equity: Taking Uncomfortable Steps to Change Hearts and Minds", focused on the persistent inequities in healthcare and the broader implications of social identity, bias, and systemic racism for health outcomes. Burke highlighted the stark disparities in care practices, such as the lack of vaginal births after cesarean sections (VBACs) for African-American women. She emphasized the importance of addressing these inequities by embracing discomfort and understanding the impact of social identity on health equity. Burke provided actionable steps to achieve health equity, including disrupting bias and racism, re-examining racially biased algorithms, and teaching the history of systemic inequities.

At the Guardians 2024 conference, Natalie Burke made a powerful case for the need to confront uncomfortable truths to achieve substantial change. Burke, a renowned advocate for health equity, highlighted systemic inequities in healthcare, particularly those affecting African-American women and infants. She illustrated these disparities through a study revealing that, over a twelve-month period, African-American women did not experience a single successful vaginal birth after cesarean section (VBAC) at a hospital where women of other racial groups did. This discrepancy underscored the urgent need for systemic transformation.

Burke's approach to addressing health inequities is rooted in Jack Mezirow's theory of perspective transformation, which posits that changes in knowledge, thinking, and beliefs compel individuals to act differently (Mezirow, 1978). She argued that fostering perspective transformation requires a combination of logic, data, and compelling arguments grounded in fairness and justice. Burke shared her personal background as the child of Jamaican immigrants, which shaped her understanding of health equity, and recounted how her grandparents faced significant healthcare barriers upon moving to Georgia, sparking her interest in health outcomes and motivating her advocacy work.

Central to Burke's argument is the concept of social identity and its impact on health outcomes. She explained that social identity, defined by group affiliations, plays a crucial role in shaping experiences of privilege and oppression. Burke highlighted historical examples of public policies rooted in social identity, such as the state-sanctioned extermination of Native Americans and the Chinese Exclusion Act, demonstrating their long-lasting impacts on marginalized communities. She emphasized the distinction between health disparities, mere differences in outcomes, and health inequities, meaning disparities resulting from systemic, preventable, and unjust policies and practices.

Burke concluded by outlining steps to achieve health equity, advocating for embracing the complexity of social identity, fostering meaningful relationships across different identities, and equipping individuals with the tools to address bias and racism. She called for a re-examination of race-based algorithms and education on the history of systemic inequities. Ultimately, Burke's message was one of hope and action, urging the audience to commit to creating a more equitable healthcare system by addressing uncomfortable truths and fostering transformative change.

Joshua Rubin

Rubin (2024), "Musical Chairs for Darvomanics: How Anti-Learning Systems Enable Systemic Abuses of Power in Academia and What We Can Do Together to Help Them Learn", addressed systemic abuses of power within academic institutions, focusing on issues of sexual predation, racism, and the stifling of free speech. Rubin highlighted the importance of transparency, accountability, and the role of individuals in fostering institutional change. He recounted the systemic sexual abuse perpetrated by Dr. Robert Anderson at the University of Michigan and the critical role of survivors and allies in demanding accountability and justice. Rubin emphasized the need for learning health systems to prevent future abuses and promote institutional integrity.

At the Guardians 2024 conference, Joshua Rubin presented a critical analysis of the systemic issues plaguing academic healthcare systems, which hinder the realization of Learning Health Systems (LHSs). Rubin highlighted that despite the aspiration to become LHSs, these systems are often entrenched in anti-learning cultures due to ingrained structures and incentives that perpetuate abuses of power (Bravo-Moreno, 2022). He identified various manifestations of these systemic problems, including sexual predation, racism, antisemitism, plagiarism, and the suppression of free speech, which persist despite significant efforts to address them (Svrluga, 2022).

Rubin emphasized that these pervasive problems are interconnected, representing different facets of the same underlying issue: systemic

abuses of power. He introduced the concept of 'darvomanics,' individuals who exploit power through tactics like Deny, Attack, Reverse Victim and Offender roles (DARVO), which obstruct organizational learning and perpetuate harmful dynamics (Freyd, 1997; Harsey & Freyd, 2020). Rubin argued that fostering moral courage within these systems is essential to counteract these abuses and promote a culture of continuous improvement and accountability.

In his professional capacity, Rubin has worked extensively to advance LHSs, which aim to use data from experiences to generate actionable knowledge and empower decision-makers (Friedman et al., 2015). He described the challenges of transforming non-learning systems into learning systems, particularly in environments where anti-learning cultures prevail. Rubin's advocacy for systemic change includes promoting transparency, supporting survivors of abuses, and leveraging his expertise to catalyze a novel academic discipline that addresses these systemic issues (Rubin & Ocepek, 2024).

Rubin concluded by advocating for three key actions to combat systemic abuses of power: speaking out when witnessing wrongdoing, supporting those affected by these abuses, and using one's skills to drive change. He underscored the importance of moral courage and collective action in creating environments that prioritize learning and improvement. By addressing these systemic challenges, Rubin envisions a future where academic healthcare systems can truly fulfill the promise of Learning Health Systems (Gladwell, 2015).

Olivia Sagan

Sagan (2024), "Loneliness, Social Cohesion and the Role of Art Making", explored how art can mitigate loneliness and enhance social cohesion. Sagan emphasized her phenomenological approach and the importance of understanding the cultural context and heterogeneity of loneliness experiences. She discussed the positive impact of community art making on well-being and social cohesion, citing studies that support the role of the arts in fostering human connection and alleviating loneliness. Sagan advocated for accessible, equitable, and inclusive community art programs to enhance social cohesion and well-being.

At the Guardians 2024 Conference, Olivia Sagan, a psychology professor at Queen Margaret University in Edinburgh, provided a compelling presentation on the interplay between loneliness, social cohesion, and the therapeutic potential of art making. Utilizing a phenomenological approach, Sagan explored how engaging in art can mitigate loneliness and enhance social cohesion within communities, thereby addressing significant public health concerns.

Sagan began by contextualizing the increasing academic and societal focus on loneliness, highlighting its detrimental effects on well-being and its complex relationship with social cohesion (Sagan, 2023). She cited the work of Hannah Arendt to frame her argument, demonstrating how art making facilitates the processes of being seen and showing oneself, which are crucial for alleviating loneliness and enhancing individual agency and social cohesion (Arendt, 1973; Arendt, 2018). Sagan emphasized that loneliness, often termed a "global health crisis" and a "behavioral epidemic," is intertwined with broader socio-economic factors and requires holistic, integrated approaches to be effectively addressed (Hayden-Nygren, 2019; Jeste et al., 2020).

Central to Sagan's discussion was the critique of the current literature on loneliness, which she argued often depoliticizes and medicalizes the issue, thus overlooking its socio-economic dimensions (McLennan and Ulijaszek, 2018). She pointed out the limitations of viewing loneliness as a personal failure and stressed the need for a broader understanding that includes cultural context and social contagion (Van Staden and Coetzee, 2010). Additionally, Sagan called attention to the lack of research on loneliness among minoritized communities and individuals with severe mental illness or those living in poverty (Leigh-Hunt et al., 2017).

Sagan concluded by advocating for the integration of art making into community-building initiatives. She argued that participatory community arts projects can foster social cohesion by building social capital through bridging and bonding connections (Putnam, 2000; Putnam, 2020). Sagan's reanalysis of data from community arts activities demonstrated that art making facilitates connections on multiple levels, leading to a sense of validation, agency, and belonging. Drawing on Arendt's concept of agency, Sagan posited that art making allows individuals to appear as unique selves in the world, counteracting isolation and vulnerability, and promoting democratic participation and social cohesion (Arendt, 1973; Lucas, 2019).

Micha Burkhardt

Burkhardt et al. (2024), "Quantifying Similarities Between fMRI Processing Pipelines for Efficient Multiverse Analysis", focused on developing methods to improve the robustness and reproducibility of fMRI data analysis. Burkhardt highlighted the challenges associated with the inherent noise and complexity of fMRI data and the need for multiverse analysis to address the many choices researchers face when selecting a processing pipeline. He discussed the limitations of current approaches and proposed a novel method based on a graph convolutional neural network to assess the similarity between pipelines. Burkhardt emphasized the potential of this method to improve data analysis efficiency and reproducibility.

Pan-Jun Kim

Pan-Jun Kim's presentation, "Long-Term Innovative Potential of Genetic Research and its Suppression", focused on the impact of commercial pressures on scientific research, using genetic research as a case study. Kim discussed how industry-supported research often favors short-term gains and risk aversion, which can stifle long-term innovation. He analyzed data from papers and patents to examine the influence of commercial pressures on genetic research and highlighted the importance of new combinations of genes in fostering innovation. Kim emphasized the need for a balanced approach to research funding and direction to sustain long-term progress.

Adam Craig

Craig and C. Taswell (2024), "From Open Review to Reproducible Review: FAIR Metrics Analysis of Peer Reviews for Brain Informatics Literature", addressed the importance of developing the Fair Attribution to Indexed Reports (FAIR) Metrics to evaluate the quality of open peer reviews. Craig highlighted the challenges associated with assessing peer review quality and the need for metrics that encourage proper attribution and rigorous referencing practices. He discussed the design principles for FAIR Metrics and their application to peer reviews. Craig emphasized the potential of these metrics to improve the transparency, reproducibility, and overall quality of peer reviews.

Carl Taswell

C. Taswell (2024) delivered the closing remarks on "reproducibility, validity, and integrity" with "questions seeking answers", emphasizing the importance of ongoing inquiry and reflection in the scientific community. He reiterated the need to address the persistent issue of willful disregard for reproducibility and integrity in scholarly research and the need for better accountability. Taswell termed the common pattern of abusive behavior by those in positions of power "grooming, gaslighting, ghosting, and gleaning" (4G) and encouraged the development of new metrics to measure collective, community, social, and public health. He called for societal action to promote civility, courtesy, tolerance, and respect in public discourse and concluded by urging attendees to contribute positively to their communities through volunteerism and acts of kindness.

In his closing remarks at the Guardians 2024 conference, Carl Taswell addressed the conference's core themes of reproducibility, validity, and integrity in experimental science research. He emphasized the importance of maintaining rigorous standards and avoiding common fallacies and pitfalls to ensure the credibility and reliability of scientific findings. Taswell highlighted the 2024 focus on fostering civility, courtesy, tolerance, and respect in scholarly communication, as exemplified by the contributions of the invited speakers: Maggie Mulqueen, Philip Koch, Natalie Burke, Joshua Rubin, and Olivia Sagan.

Taswell discussed the persistent challenges in academia, particularly the "4G problem" of Grooming, Gleaning, Gaslighting, and Ghosting. He advocated for promoting citational justice and other forms of epistemic justice to counter these issues (Taswell, 2022). He also called for the development of new nosology and metrics to evaluate collective, community, social, and public health, emphasizing the need for accountability in scholarly research (Taswell, 2024). Taswell underscored the significance of peer review and collegiality among scholars to uphold the integrity of research and foster a collaborative academic environment (Craig et al., 2022).

In his presentation, Taswell referenced historical quotes from American Presidents to illustrate the importance of democracy and collective responsibility. He highlighted the role of effective communication and leadership in promoting understanding, trust, and collaboration to solve societal problems. Taswell's advocacy for "people talking to people", including "scholars talking to scholars", with respect and civility aims to create a more inclusive and productive academic community (Maxwell, 2016; Stanier, 2016).

Looking ahead to the Guardians 2025 conference, Taswell emphasized the continuation of these discussions, with a specific focus on rebuilding commitments to peer review and addressing the information wars threatening global democracy (Athreya et al., 2023). He called for scholars to engage in meaningful dialogue and collaborative problem-solving to promote truth in science and integrity in research, ultimately contributing to a better world for all.

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