

OCTOBER 2025



From  
One  
Brain  
To  
Another

## Student Research Reviews

Edited by: Allegra Favaretto, Hana Sopel-Mizrahi, Jana Alagha, and Nicole Pitkis

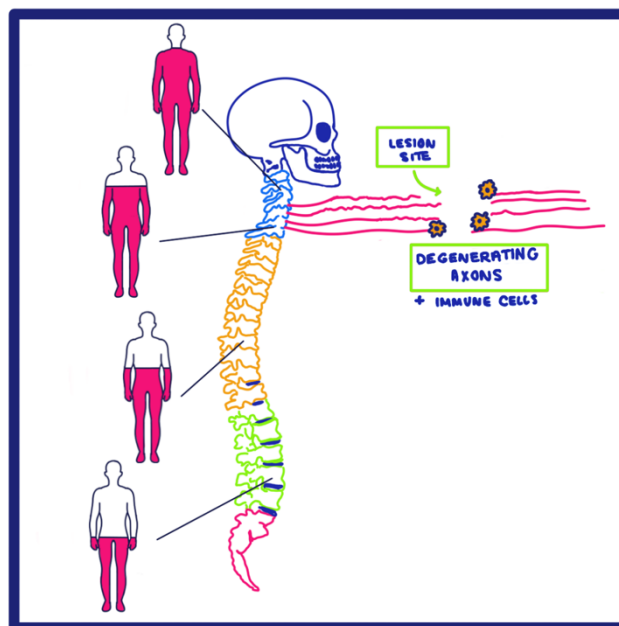
### Neuroplastic Changes in the Primary Somatosensory Cortex Following Spinal Cord Injury

By Allegra Favaretto

#### Introduction

Spinal cord injuries (SCIs) are a debilitating form of damage to the spinal cord. Primary damage will occur with “direct” damage to the spinal cord - the direct impact of a motor vehicle hit, for example. Secondary damage arises as a result of the primary damage, such as inflammation (Bennett et al., 2024). Both types of damage lead to the impairment or death of nerves at the site of injury, as well as in surrounding regions (National Institute of Neurological Disorders and Stroke, 2022).

As nerves once innervating a particular limb(s) become damaged, SCI's are seen to affect signal transmission between the central and peripheral nervous system, leading to common sensory symptoms such as numbness/tingling and loss of sensation in limbs. Such symptoms can affect the quality of life as patients adapt to the damage. Cortical regions, such as the primary somatosensory cortex (S1), exhibit significant anatomical and neuroplastic



changes in an attempt to support and mediate the injured state.

**Figure 1:** Diagram illustrating Spinal Cord Injury - Site of injury contains immune cells + other pro-inflammatory molecules, along with damaged axons. Illustrated by Allegra Favaretto (2025).

#### Anatomical Changes to the Primary

Usually, as one interacts with their environment, the primary somatosensory cortex (S1) and primary motor cortex (M1) form and utilize topographic maps: regions of

neurons in the brain organized according to what body part they represent or respond to stimulation of. These maps will experience changes and updates (neuroplasticity) according to sensory interactions, which are further used to influence movement production (Pazzaglia & Zantedeschi, 2016). With damage to peripheral nerves following SCI, sensory information from afferents (nerves that relay external and internal sensory stimuli to the brain) of affected limbs cannot enter ascending paths to reach S1. Consequently, S1 cannot send accurate body representative projections to M1 for topographically accurate movement generation. In a study by Freund et. al, it was revealed that SCI patients possess reduced grey matter (GM) volume and decreased cortical thickness in regions of M1 and S1 corresponding to the denervated leg region (regions of the leg now missing nerves for sensory and motor tasks due to damage) compared to healthy controls (Freund et al., 2012).

### **Neuroplastic Changes to the Primary Somatosensory Cortex**

Upon SCI, several types of plastic changes have been recorded in the primary somatosensory cortex (S1) in non-human primates and humans. When a particular limb becomes damaged following SCI, representations of denervated limbs within S1 may shrink or disappear over time during transneuronal atrophy (the loss of neurons following damage) (Jones, 1998, Leemhuis et al., 2019). Neighbouring regions within S1 representations may also overtake the deafferented limbs' previous representation.

For example, the case of a non-human primate with partial loss of afferents in the upper limbs: even with preserved hand afferents, nearby facial representations

within the topographic map were seen to overtake finger/digit representations within S1 (Pons et al., 1991, Leemhuis et al., 2019).

Such overtake has also been illustrated in paraplegic cases in which nearby representations overtook lower limb mappings upon loss of innervation to such limbs (Henderson et al., 2011). As discussed, area S1 illustrates decreased grey matter volume following SCI. When limb representation overtake occurs within S1, less shrinkage of volumetric GM has been observed in the same area. Accordingly, when experiencing SCI, neuroplastic overtake mechanisms may aim to preserve tissue structure and function of unaffected limbs. Thus, there will be increases in the representation and signalling capabilities of unaffected areas within S1, as they take over regions that were once corresponding to now affected limbs (Henderson et al., 2011).

### **Conclusion**

To conclude, Spinal cord injuries (SCIs) are a debilitating form of damage to the spinal cord affecting signal transmission between the central and peripheral nervous systems. Pivotal research has illustrated that, following SCI, various neuroplastic changes occur in essential regions for movement and sensory function such as S1. Understanding such plasticity may provide imperative prerequisites for understanding and researching treatment methods which work

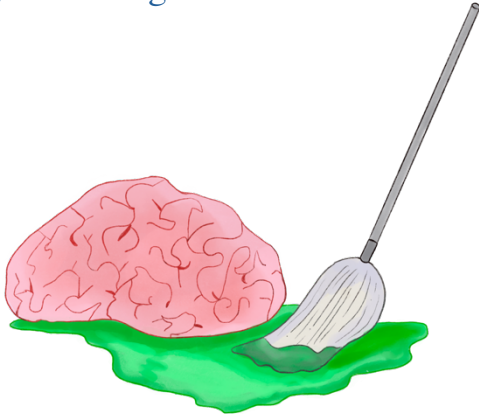
alongside the brain's natural rehabilitative methods.

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## The Brain's Cleaning Crew: The Glymphatic System

By Jana Alagha



Illustrated by Nicole Pitkis (2025).

Skipping sleep? That's not the brightest idea, considering this is the time when your brain can thoroughly clean out its trash. This is the job of the glymphatic system, the cleaning crew of the central nervous system (encompassing the brain and spinal cord).

Every night while you sleep, this system removes all toxins and waste products, a process that ensures the brain remains sharp and healthy (Gao et al., 2023). This illustrates the importance of sleep and that sleep disturbances can contribute to the onset of cognitive impairing disorders. Toxic substances in the brain can result from various sources, such as harmful lifestyle habits (e.g., smoking tobacco and drinking alcohol), prolonged exposure to pollution,

and disruptions in daily metabolic processes (Gazdzinski et al., 2006).

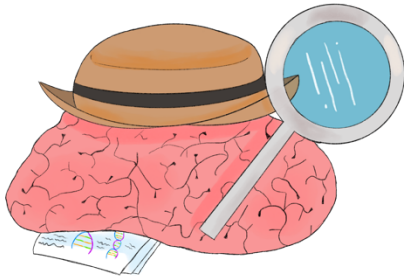
Now, you might be thinking, how does this work? Great question. Our bodies contain cerebrospinal fluid (CSF), which is a clear, water-based liquid surrounding the brain and spinal cord. It protects the brain and spinal cord from forceful impacts, provides the brain with essential nutrients, and removes waste; therefore, it plays a crucial role in the glymphatic system. CSF rinses out waste products by flowing into our brain tissue to wash away toxic substances and other waste. It's a cycle that connects to the blood-brain barrier, managing what enters and exits the brain to preserve its health and stability. Without this system, the waste would accumulate, contributing to neurological disorders, including Alzheimer's (Jessen et al., 2015). Without sleep, this process becomes slower, allowing harmful substances to remain in your brain for longer, which affects the brain's functionality and overall activity. Hence, make sure to get your fill of sleep, as your brain needs it to function properly!

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## The Importance of Memory Evolution in Research Studies

By Nicole Pitkis



Illustrated by Nicole Pitkis (2025).

Memory has a number of definitions; however, that found in humans is often described as the ability to store and retrieve information, something that makes one capable of recognizing and making connections. Our ancestors relied on their memory as a tool to survive, and, although many years have passed since then, we continue to rely on memory for our daily lives as it shapes our lifestyle choices and habits. Memory has changed its role from serving need to serving wants and aspirations, sparking yet another evolutionary advantage for us *Homo sapiens*.

Unfortunately, not much research has focused on the evolutionary component of memory, such as changes in the molecular pathways supporting memory development. By studying its evolution, researchers can uncover other mechanisms that were overlooked, in order to help: advance medical research and clinical practices, and shape our

understanding of neurophysiology in ourselves and other taxa.

**Reflection time:** In what ways (whether positive or negative) does memory influence our day-to-day lives?

One of the main reasons why perhaps memory evolution has little to no research is perhaps the lack of methods by which we could study biological processes from the past, and without the ability to compare other ancient taxa, we wouldn't be able to record all important physiological and neurological changes. In the modern day, this kind of data is useful when picking a model organism to study in medical drug trials and treatments, and predicting results from it. It would allow us to observe physiological and neurological changes in the organism without risking human life or harm, thereby obtaining an understanding of what responses a treatment may evoke in an organism.

Memory is fundamentally supported by neurons and the signals they communicate in the brain. The way by which we got to this point may have changed over time, and our foundations for memory could look different. Thoroughly researching how memory and its neurobiological mechanisms have evolved so as to sustain diverse species throughout time would be extremely valuable; this would

support the healthcare and lifestyle choices of many people around the world.

In a study done at King Abdullah University of Science and Technology, researchers explored how the hippocampus—which is the part of the brain responsible for learning and memory—functions in the formation of memories in avians, goldfish, and turtles (Anand & Dhikav, 2012). They deduced that there are similar brain structures among these organisms and in humans, leading to the discovery that human episodic memory functions similarly to ancestral, protoepisodic memory (Bajaffer et al., 2021). Protoepisodic memory is similar to episodic memory in the sense that they are both responsible for remembering specific details like who, when, or where the memory took place, and the prefix proto means “early” (Kunčická et al., 2024).

All together protoepisodic memory can be defined as early or primitive episodic memory. The article continues by discussing how using neurobiological evidence we share some similarities in the structure and shape of the hippocampus with other species (Bajaffer et al., 2021). They mention the parahippocampal region and prefrontal cortex of the human brain, which are regions of the brain dedicated for memory encoding and executive functions, have also been found in avians (Bajaffer et al., 2021). This highlights the importance of considering evolutionary change and history in memory, as these kinds of discoveries can lead to new model organisms to be examined and to develop better drugs for neurological conditions (Bajaffer et al., 2021).

We may get a more complete understanding of our bodies and predict future neurophysiological changes in the brain and memory through a comparative analysis with multiple species. Through the examination of the basic steps of memory: encoding, storing, and retrieval, we can also make assumptions and hypothesize about future evolutionary changes.

In a study published with Royal Society Publishing, researchers have studied a phenomenon called “active forgetting”, which is described as the process of actively forgetting memories stored in short term memory (STM), and how a gene called the “Rac” gene affects it (Watrobska & Leadbeater, 2025). The gene influences synaptic connectivity through changing the size or shape of the synaptic spines, which are little spikes that protrude from dendrites and are responsible for the compartmentalization of postsynaptic responses and input (Watrobska & Leadbeater, 2025; Hering & Shang, 2001).

Flies that lacked the gene were able to remember information stored in STM for a day longer than wild-type flies. Similar findings were also found for vertebrate species (Watrobska & Leadbeater, 2025).

This means that studying organisms with similar nervous systems and similar evolutionary changes in memory and brain function could lead to more research being conducted on humans, specifically examining different genes that may affect memory or brain function.

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## Undergraduate Research Endeavors

### Sadaf Yarmohammad, Third Year Neuroscience Student (Behavioural and Cognitive Specialty)

Interview: September 21<sup>st</sup>, 2025.

*Why did you choose neuroscience, and what do you like about it so far?*

“I chose neuroscience because it is a very interdisciplinary field, it combined lots of my interests into a single subject. For instance, I grew up really loving psychology, and I think neuroscience greatly integrates aspects of psychology with biology. I think as a result of its interdisciplinary nature, neuroscience can provide a nuanced lens and perspective of the world. We can understand individuals at a lot more of a molecular level. I think to really understand the world better, I think it’s really good to go into the most basic and reductionistic lens, which neuroscience supplies. Honestly, ***being able to challenge yourself every single day*** by learning hard concepts can be ***incredibly mentally stimulating***. It makes you not only increase your knowledge, but grow your brain, which is what Neuroscience is essentially all about.”

*Have you had any experience in a laboratory, and if so, with who, what type of research did you take part in, and what was your task in this role?*

“Over the summer, I worked full time in a biomotion laboratory. Essentially, what I did was focus on participant recruitment and manage data collection logistics. Our laboratory’s contribution to academic literature ***focuses on improving the way we understand the world by researching gaze perception***. When we interact with people, through, for instance, social media or through



calls, we’ll interact with them slightly differently than when we see them face-to-face. Our research study focused on creating a general model on this specific topic, so we collected data on gaze perception, and head mobility, and so forth. My role, as a student, was very much a learning opportunity for me – I focused on making posters that I put across the campus, I managed URPP, recruited participants externally, and executed data collection, so I was the primary person you would talk to, if you were a participant, during the study. This helped me gain lots of amazing experience and opportunities by, for instance, I ended up attending the June CVR (Centre for Vision Science) conference, where you can explore neuroscience, and see different professors

present their own research; *so being able to work at the lab was overall a very insightful and positive experience.*”

*How was the conference?*

“The conference was incredibly interesting, it was three days long, at the second student centre. I believe the co-chairs were both from the neuroscience department, and so when I attended the conference, I was fascinated by the intricate research concerning neuroscience. I learned a lot about neuroscience from lots of other professors, master’s students from different universities, professions and interests, who all came to the same place. Honestly, *it felt like an honour to see individuals with such a high level of expertise be able to explain their topics of interest.* It taught me that I could also be an individual on the same stage as them in the future and be able to present the things that they are able to present, so for me *it was a very motivating and positive experience!*”

*If you had any advice for students who wanted to gain a research opportunity in a lab, what would you tell them?*

“I would say that finding a volunteer opportunity might be a bit easier than finding a fully paid research position right off the bat. Because you may have less experience than the average person, and depending on when you want to start, for instance, if you wanted to start in second year, I would recommend cold-emailing professors, as many as you can, and networking with your professors by making connections with them, so that you may ask them for a position as a volunteer in their lab. Before I worked over the summer, I volunteered at a kinesiology lab. I just cold emailed a bunch of professors at first; and they typically require a transcript, so if you get really good grades, they might find that to be very helpful, and sometimes require CV’s and writing samples. Making sure you have all of those things would be incredibly

helpful, and then after you get basic levels of experience, you can apply by emailing your professors. *You can also get experience in so many ways outside of a laboratory.* For instance, if you are part of a writing club, you may have experience writing short stories, organizing literature submissions, which has highly transferable skills that can be applied in laboratory settings as well.

Focus on developing those soft skills, showcasing your ability to stay organized, manage deadlines, and write proficiently. You can apply these skills in your resume when you look for those research volunteer opportunities or paid research opportunities. Essentially, gain as much experience as you can. Start off by potentially working as a volunteer; you might not get as many tasks as you want, but you can start off small and validate that progress will be made over time; focus on taking things one step at a time. *There are lots of opportunities at York to apply for grants and funding to do research over the summer*, so you can look into those and connect with your professors, and hopefully they can help you work over the summer.”

*Is there anything else you would like to add for curious students?*

“I want to give some advice. I think lots of people, when they apply for research, sometimes they don’t land where they specifically want to be. For instance, maybe their interest lies in gaze perception, but then they end up working in a wet lab initially. *I think putting yourself out there, taking risks and chances will be very helpful regardless of where you end up*, and maybe the experience at the wet lab you worked at could help you later on at another lab you choose to go to. *Focus on exploring, taking on various opportunities, and not being shy*, because lots of students are in your position, and lots of them would love to do the things you want to do as well, so it’s not a lonely experience.”

## Graduate Research Work at York University

### Anton Machula (Masters in Neuroscience)



Interview: September 16<sup>th</sup>, 2025.

*What is your educational background?*

“I did a bachelor’s degree in kinesiology at York, it took me 5 years to finish. In the process, I worked full time for the government while trying to finish the degree, which was challenging. Then I finished the degree and turned it into a master’s degree.”

“When it came to how I got into this whole thing to begin with, I was taking a fourth-year neuroscience course with Dr. Lauren Sergio, and, at some point, it was in the peak of covid, I think, so most people were at home- no one would show up to office hours, which I find really surprising, because that’s what they’re for- and somehow we got into talking about my government situation, and the fact that I can program, specifically web apps, as well as iOS apps. A few weeks later, she sent me an email, along the lines of ‘would you be against programming?’ It turns out that her developer from the engineering department had to go home, so she offered me a 3-month contract that turned into a year and a half long contract to help her commercialize, originally, what we called a toolbox for physiotherapists and clinicians, that quantified your body pose and gait. She had a commercial partner who turned that into a digitized product that you could use your phone camera on, essentially, which was really neat. I came in for that, redeveloped it, and it brought me a lot of experience, after which I turned into making an augmented reality game.”

“At the time, we didn’t have much of a direction, outside of the fact that she had a magic leap system, we wanted to use it. They had a, almost like a circuit planned out- but it was relatively rudimentary. You walk around in a circle to increase vestibular loads- this was with concussion patients at the time- and the concept was, as you’re walking around, you’re picking things up from the floor, putting them into shelves. I think the concept came from the fact that a lot of people with persistent post-concussion symptoms can’t go to grocery stores without feeling nauseated. The first task that I was told to do was to invert control. I like making stuff, and I found that, at least

for me, my supervisor and I had a very good personality fit. She is a very big component of *'if you get the ball, you run with the ball, and then you shoot the score.'* I was given a very broad direction about the project, and at times I was confused about what I should be doing next- but very quickly, within the span of 6 months or so, as I continued to work as a research associate with her, I started to ideate and re-make the fundamental concept over and over again. *That transition was remarkably challenging, but I think it also gave me a fundamental insight* towards making things that people actually want to experience.”

“For the research, we made an original version with a lot of stuff, you essentially walked around in a circuit like originally, but there’d be 6 nests in 6 stations, and you’d walk around in a circle completing them, and every time you complete the circuit it gets slightly more challenging. It’s a time-based thing, so you start with basic picking up birds and putting them into nests, then that transitions into reversed controls, then the same thing with distractors. We presented that at a UHN conference within the first year, we collected 15 participants, I think, as a poster. I think the most surprising thing from it was the fact that *I was able to make an artificial intelligence basic classifier, where, based off of head movements, you could tell if someone was concussed or healthy.* After getting some feedback at a concussion network conference, what I came away with is the fact that you have to make something where there is fundamentally technically very little capacity for plateau- so that athletes and people could play it and their ranges of score would still be substantive. So, I took it from circuit into a game, where you have a big, central location to start, you see digits float. The digits disappear, and then after that, you go to the task stations accordingly with a high cognitive load, where, the more cognitive load you can tolerate, the better your score can be -in an exponential manner-paired with the idea that you have birds that you put into nests. The basic motor control paradigms, that are incredibly easy to replicate, paired with distractors- I found that to be the next logical direction. *I find the one thing that I’m pretty good at, is creating one paradigm that can translate into multiple possible outputs.* So, one of the things I thought about when I made this study, was the principles that, *not only do I want to make people feel better, but I want to collect as much data as I can in a multi-domain capacity.* My study was eight weeks, twice a week, of people coming in to play the game to see if they got better. Even out of that, we had the chance to get functional near-infrared spectroscopy out of it, brain scans before and after, and I went above and beyond a typical study for qualitative measures.”

“I think a big caveat for me, is I have a personal reason for doing neuroscience- my mom had brain cancer, so that kind of propelled me to be curious about the field in general- but I found out the why for me was to better understand the landscape, and better understand the language to advocate for her care. I find that the personal mission for me was important enough, that it made the work relatively easy. To give advice to people at an undergraduate level- the goal is, in high school, you have no idea what domain you want to go to, in undergrad, you want to understand the domain you want to enter, and in masters, you want to push the field fundamentally just a tiny bit farther, and *in a PhD you create a new, tiny, macro function of the field, so you literally are making novel advancements.* At an undergraduate level, I think you need to be honest with yourself about

what kind of autonomy you can tolerate. I find that the difference between getting the position you want and the capacity that you want, is your ability and knack for putting yourself out there, and taking on more responsibility than you think you can handle, and to become more proactive about the decision making that would lead to actual research taking place.”

“There’s a sweet spot between jumping into a lab, and giving yourself as free labor, let’s say, or paid labor, versus, *joining a lab with a point of view that you want to be explicit about following through on, and then developing that vision towards it actually happening*. Volunteering is great, for you and for the PI, but the reality of a lot of research, is, that more of it is spent on the computer than people ever give it credit for. And so, I think, one of the reasons I’ve gotten this far, to begin with, and the reason I think I’ve been valuable to my lab, has to do with my ability to program. I’ll be honest, my programming was not phenomenal at the beginning -and I’m fully self-taught- I went on YouTube as a kid and learned how to do everything from scratch; everything from game engine design, to web applications, to mobile applications, to even a little bit of hardware- *it was all me and a willingness to just do it*. If I’m being frank, if you had programming skills, and offered that to anyone from psychology, to neuroscience, wet labs or dry labs, it would be incredibly valuable to everybody. Even in the humanities, programming is a fundamental need: they do a lot of coding of interviews.

“It’s not necessarily just about saying ‘I’m happy to volunteer,’ that’ll get you somewhere, that might get you a ‘hello’ and the interview, but the fundamental problem you need to solve, is *how you could provide value to that lab in particular, and whether you want to provide that value*. I think a lot of research, and, actually, this is a fact- most people make research, or they start a graduate degree because they want a master’s or PhD, because they think it will help them with their work, but without any particular why. Why I think that’s important is research happens, and then no one commercializes it, and it dies. It kind of builds, builds, builds, but the problem is, people like my mum, or like you reading this now, let’s say, have no access to the research because no one took this from research to reality. That’s something I’m trying to do, I took my thesis concussion work, and I can tell you the entrepreneurial journey has been exciting so far. I hope that you have a chance to play “brain versus”, [brainversus.com](http://brainversus.com); it’s about your brain, and your brain power: specifically for our labs, we look at the way different parts talk, so, the highways, and how big the highways are. It’s the difference between you being awake and on your feet after a long day of work and being exhausted from a little bit of math. You can play for free, and it takes few minutes, and, it’s very addicting, so I’m sorry if you play it more than once, and it’s born out of research. So, if there’s one thing that I want you to do, is play the game. It’s out now!”

## Organizations, Opportunities, and Clubs at York University: CIAN, VISTA, the Neuroscience Society

CIAN – Centre for Integrative and Applied Neuroscience: A neuroscience research group at York University; its aim is to collaborate as a unit on subjects including, but not limited to health, education, and the industry. The organization hosts research seminars, conferences and events for scientists and interested members of all academic backgrounds and interests, including the general public.

### Upcoming October Seminars:

- **Friday, October 4<sup>th</sup>, 2025 @ 2:00pm-3:30pm** in Kaneff Tower, Room 519  
| Dr. Jonathan Cant's "*Unseen Influences: An Exploration of Ensemble Representations and their Cognitive Fingerprint*" seminar

CVR – Centre for Vision Research: York University's specialized vision research organization that comprises of leading scientists and professionals who aim to conduct ground-breaking research and further develop training in this field. Research seminars and events are also hosted for the benefit of interested members of all academic backgrounds and interests, including the general public.

### Upcoming October Seminars:

- **Friday, October 24<sup>th</sup>, 2025 @ 2:00pm-3:30pm** in Kaneff Tower, Room 519 | Dr. Eline Kupers' "*Towards a cross-modal computational approach for dynamic visual processing across human cortex*" seminar

The Neuroscience Society: For upcoming events, opportunities, and insights in neuroscience at York University, follow [neurosciencesocietyyork](#) on Instagram – a student club committed to promoting and connecting the neuroscience student body and faculty!

- <https://www.instagram.com/neurosciencesocietyyork/>

## A Grateful Thank You

This month's article, and the newsletter itself, would not have been made possible without the help of the following intelligent, talented, and passionate individuals who have dedicated time to present their original work and support the development of this month's issue. If you are interested in joining our team as we develop our issues for December 2025 and further, please click at the google form link attached below. Members of all disciplines and backgrounds are welcome to take part in this initiative.

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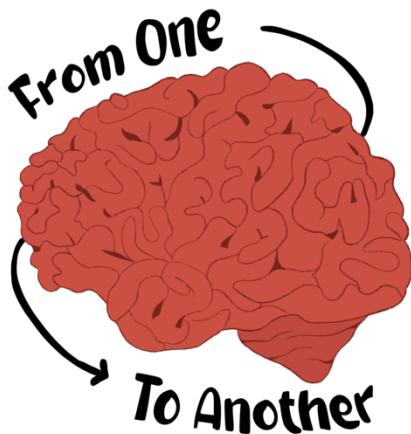
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[Google Form For Interested Volunteers](#)

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