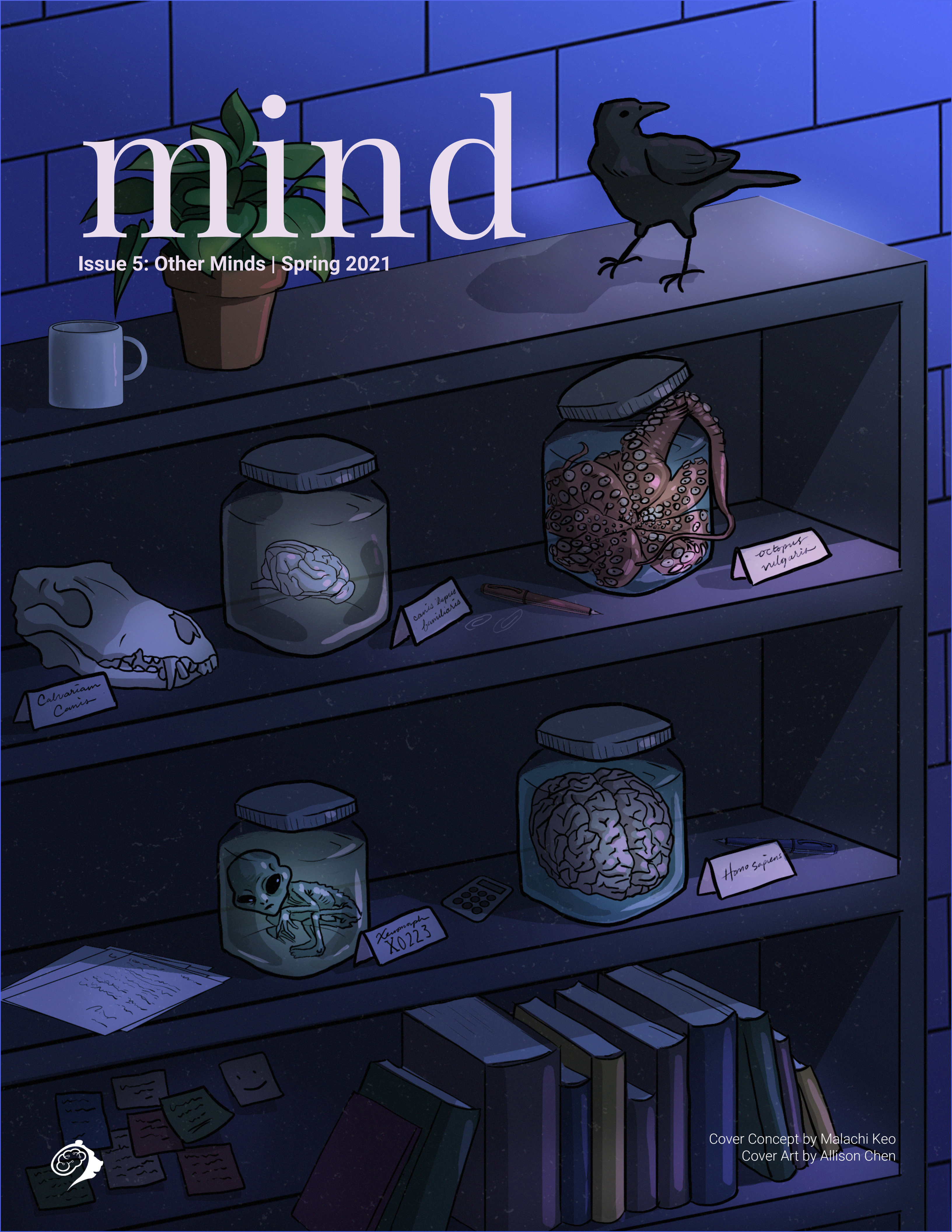
mind

Issue 5: Other Minds | Spring 2021



Cover Concept by Malachi Keo
Cover Art by Allison Chen

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Formatting by Amy Wang

Letter From the Editors

Dear Reader,

At the time of this publication, the world has been in a pandemic for over a year. We have encountered a wide array of challenges — from experiencing distressing levels of social isolation in remote learning environments to intensified political and societal tensions across the country. Yet, through it all, we found ourselves constantly adapting to unprecedented situations and learning more about the ideals, processes, and values that make us human.

In this 5th issue of MIND, we delve into the diverse embodiments of intelligence and cognitive structures through the lens of our theme: Other Minds. In 2016, the Australian philosopher Peter Godfrey-Smith wrote Other Minds: The Octopus, the Sea, and the Deep Origins of Consciousness which sought to probe the mystery of how subjective experience crept into being — how nature became aware of itself. Inspired by Godfrey-Smith's book, we aim to explore the vast topic of intelligence beyond our own minds — all the while seeking to uncover more of what it means to be conscious. In this sense, the theme Other Minds is a dynamic and open-ended topic that has been interpreted by our writers in many different ways.

Within this magazine, you will find well researched explorations of topics ranging from the brains of crows and orca whales to the importance of diverse perspectives in big tech. What unites all of our articles is a shared passion and curiosity for the intersections of neuroscience, cognition, and applications of technology.

Our writers have gone above and beyond to research, synthesize, and present some of the most exciting articles written on the topic of other minds. We are deeply grateful for the community of writers, editors, and designers who have dedicated countless hours to this magazine.

Now we present to you MIND, Issue 5: Other Minds. May the articles contained within these pages fill your mind with the wonders and mysteries of cognition - both human and otherwise.

Cheers,
Oliver Krentzman & Abraham Niu

Other Species

Art by Allison Chen

Orcas and Aliens

Pop culture vs actual cross-species communication

By Luc LaMontagne

Pop culture is obsessed with the idea of human-alien interaction. Countless movies, TV shows, comics, and even conspiracies tell tales of extraterrestrial-human entanglement, but very few broach the true nature of interspecies communication. One of my favorite movies is Arrival—an eerie film concerning a scientist and linguist's discovery of how to communicate with an alien species that arrives on Earth in mysterious pods. Despite attempts by the filmmakers to deanthropomorphize the aliens physically, certain qualities are inherently human, notably visually symbolic communication and gestures. Additionally there are aspects that are informed simply by our earthly experiences, such as sound and bodily speed. As much as I love these movies, I can't help but notice the similarities between our minds and even the most abstract fictional aliens. As humans we can't seem to imagine minds so fundamentally different from our own, indicating that if we did find extra terrestrial intelligence, we might not even recognize their alien minds as minds, let alone be able to communicate with them.

Graphic by Lilian Zhang

Regardless of their form, the issue is not whether or not aliens exist, but rather that our efforts to find them are wasteful and inevitably fruitless.

Alien contact requires two difficult steps: finding aliens— a task statistically near impossible— and then communicating with them— a task fundamentally near impossible. In order to find aliens, we have to use a range of tools to seek input from, literally, the rest of the universe, infinitely in every direction. Another similarly difficult way to contact aliens is to send the right kind of information in the right direction. Despite the intimidating vastness of space, humans have continued efforts to make contact. Even if humanity succeeded in making contact with aliens, we would need to be able to communicate.

First we must establish an understood means of communication, i.e. radio waves, light waves, sound, etc.— keep in mind that for all we know, aliens could be akin to crabs in an icy wasteland— and then we must have interpretable information to send. Without common ground, translation or other means of effective communication, especially removed from context, are nearly impossible. Humans tend to assume that basic communication skills are universal, but we would have nothing to go off of when communicating with aliens. Even on a basic level, people can communicate with animals via body language and interpreted motion: for example, baring teeth is a threat and gentle physical touch is affection. On an even more basic level, communication such as causing pain, which is considered antagonistic to any species on Earth, is an inherently Earthly quality. Humans tend to overestimate human-like qualities in extraterrestrial life, and even moreso, earthly qualities. This lack of shared experiences and physical limitations make alien communication practically impossible.

I also question the true value of accomplishing extraterrestrial communication. What is the point? Why is pop culture so obsessed with alien arrival? A few schools of thought seem heavily prevalent in response to these questions: Seeking alien contact is reminiscent of a Western desire to colonize; gold, glory and god all over again; We seem to think that they'll have the answer to all our problems, or that we will be inspired to unite and solve our own problems if contact is made; and lastly humans want to feel less lonely in this universe, and in turn to teach us about the uniqueness of humanity. However, humans can learn from and feel less lonely with other species on Earth. Interestingly, humans dismiss animal minds as less than, yet anticipate alien minds to be greater than human minds.

Nonhuman minds cannot be adequately described by simple comparison; it's apples and oranges, or rather humans and bats. Most humans believe that at least some other animals have minds, yet act as though these animals still do not qualify for some arbitrary threshold of intellectual worth. This perspective is largely Western but tends to dominate humanity's aggregate behavior towards animals. Despite our ignorance toward the matter, animals are unique and offer their own experiences and histories through which humanity has a chance to learn; this perspective is clear when considering animals that seem to share mental traits with humans. Primates, elephants, and cetaceans are tiny branches throughout evolutionary history to which humans admit intelligence. These creatures display complex behaviors, especially socially. Orcas, for example, use distinct communication patterns regionally, have been known to learn the communication of other dolphins, and hunt with extremely well coordinated and planned strategies[1]. Elephants mourn and have extremely good memories[2]. Gorillas use gestures to communicate, and can even learn sign language[3]. Despite their evident intelligence, animal minds are very hard to understand, just like human minds. Hilary Putnam, a prominent American philosopher of mind, once asked his friend if there were other minds to which he replied "not many". It is difficult to truly feel as though someone else has a mind without adequate language-based communication, so it makes sense that people generally underestimate the prominence of animal minds.

Nonhuman minds differ very distinctly based on the experience of each being. For example, dogs primarily understand their worlds through smell and sound, humans via sight and sound, and orcas via sound and sound; they differentiate between echolocation sounds and communicative sounds. An alien, in contrast, could experience the world through thorp and crong. Put simply, the evolutionary history shared by inhabitants of this planet inadvertently incline us towards intercommunication and empathetic understanding. We will surely be least capable of walking in the shoes of an extraterrestrial in contrast to even the most alien earthly creatures.

While there is little purpose in pursuing extraterrestrial communication, it would be wise for humanity to seek a means of communication with the other prominent members of our planet. For starters, orcas are humanity's oceanic equivalent. They inhabit all oceans around the world, they communicate, eat, look, and behave differently regionally, and they are benign, despite their misnomer "killer whales." Amongst all the potential candidates, orcas are an obvious species with which humanity should pursue enhanced communication.

Neurologically, orcas have even more evidence on their side: they have the second largest brain in the animal kingdom, they have the second most encephalized brain next to humans (encephalization is a metric used to compare brain size and intelligence based on average brain size compared to predicted average brain size[4]) and their cortical convolutions are extreme, harboring a thick cortex and extremely large subcortical regions. Orca brains are about 10x larger than human brains, and have comparable proportions. In humans, the parietal and temporal lobes are used for memory, imagination, language processing, visual processing, and sound processing, and our forebrains run our executive functions. While orcas have similarly exaggerated forebrains, they also have extremely developed posterior regions (the parietal and temporal lobes), indicating a approximately similar distribution of brain power. Cetaceans also generally have much larger neurons, and the speed of axon potential increases as the diameter of the cross section of an axon increases. This implies that certain networks in an orca brain process much more quickly than comparable networks in a human brain.

Clues in neurology and behavior have led scientists to argue that orcas understand the world with more emotion than humans. Additionally, the confluence of sound being used for

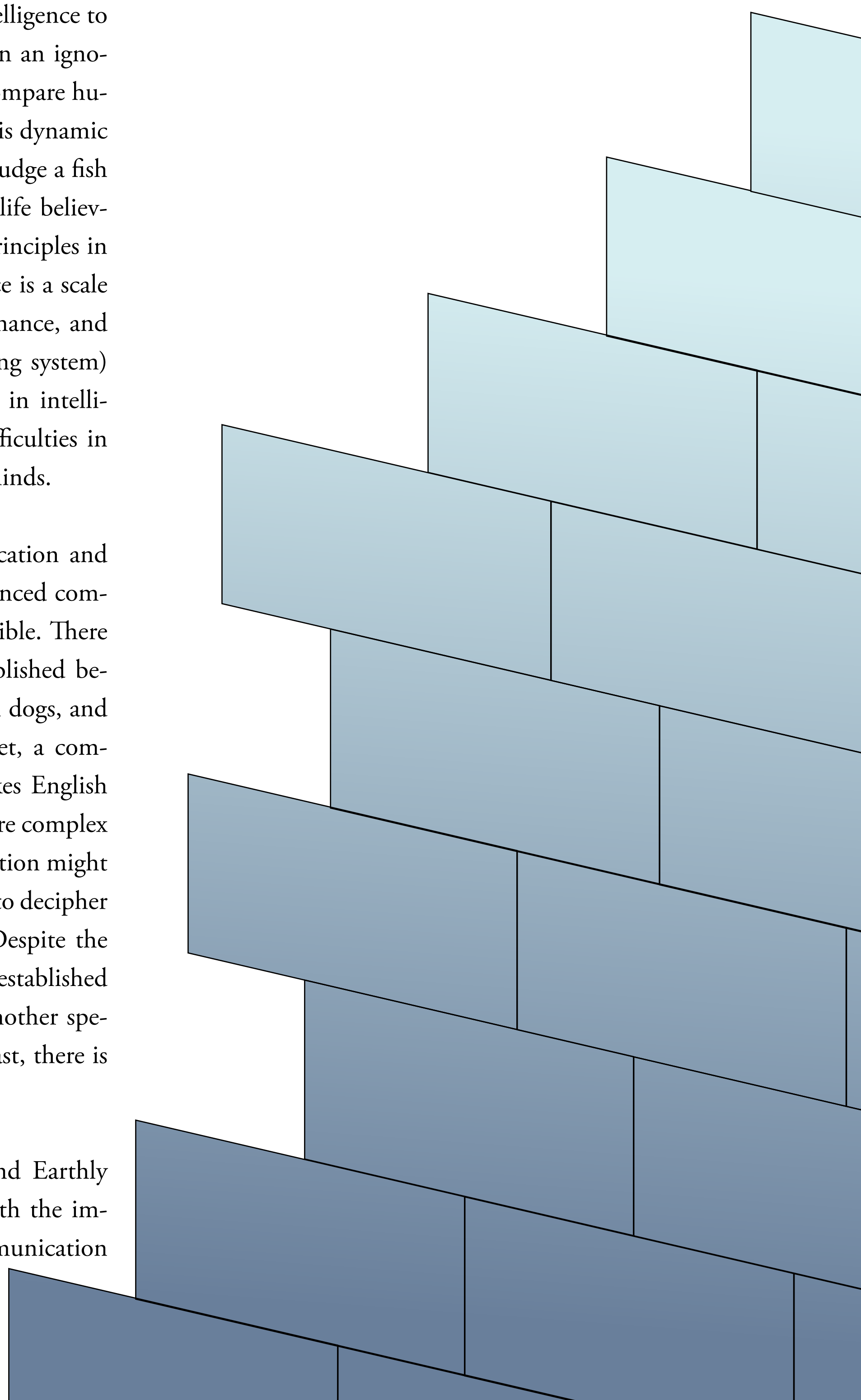
1 https://www.orcanation.org/2019/10/10/the-social-intelligence-of-orcas/#:~:text=orcas%20have%20the%20second%20largest,are%20very%20social%20and%20emotional.
2 https://www.scientificamerican.com/article/the-science-is-in-elephants-are-even-smarter-than-we-realized-video/
3 https://www.sciencedirect.com/science/article/pii/0093934X79900476
4 https://www.sciencedirect.com/topics/neuroscience/encephalization-quotient

both communication and spatial mapping could potentially lead to visually based morphemes— a language based unit of meaning, i.e. a short word in English. This would be comparable to a word being understood as an image, like talking using mental pictures. In short, orcas simply experience the world differently than humans, and despite popular beliefs that humans are “smarter than” them, we have much to learn from them. At a bare minimum, a member of any species on Earth, by virtue of its nature, has unique experiences from which humanity can learn.

People tend to place animals on a linear scale of intelligence to compare their cognition to ours. This is founded in an ignorant perception of intelligence— people wrongly compare human intelligences on a linear scale too. Intelligence is dynamic and embedded: “Everybody is a genius, but if you judge a fish by its ability to climb a tree, it will live its whole life believing that it is stupid.”[5] All minds run on different principles in different bodies with different purposes. Intelligence is a scale of performance of mind, but the intended performance, and physical capacity of a brain (or other mind deriving system) varies depending on the being. Extreme variation in intelligences and mental behavior inevitably leads to difficulties in communication between and even recognition of minds.

Skeptics may claim that pursuing alien communication and animal communication are both fruitless, but enhanced communication with other species is actually quite feasible. There is a degree of communication that is already established between species. Humans track whale songs and train dogs, and most animals understand body language. Cleverpet, a company famous on TikTok via Bunny the Dog, makes English speaking buttons to allow dogs to communicate more complex thoughts to owners. A similar means of communication might work with dolphins, or potentially people can learn to decipher the pops, whistles, and clicks of orcas using AI. Despite the means of enhancement, communication is already established by the simple interactions between humans and another species; we have a foundation to build from. In contrast, there is no starting point for alien communication.

The inherent lack of similarity between Aliens and Earthly creatures will inhibit communication. Coupled with the improbability of alien contact, alien contact and communication efforts would surely fail. If we truly want to know other minds, we should refocus our efforts towards interspecies communication on earth, orcas first and foremost. Through enhanced interspecies communication, knowledge about our oceans, information about climate change, histories, and cultural practices can potentially be exchanged. While it is natural for humanity to yearn for intelligence and interaction with another species, we can do so on our home planet. There is no point in continuing to pursue communication with extraterrestrials when there are plenty of alien minds on earth.



5 Albert Einstein

Murder(s of Crows)

By Iris Lu

In 2010, John Marzluff, a professor of wildlife science at the University of Washington, and his team were trapping and banding corvids for research when they ran into a slight inconvenience.

They were being ambushed by crows.

Angry scolding and cawing interrupted their research as mobs of crows flew overhead. But the crows weren't just attacking as a defense tactic -- even if the researchers had changed outfits or typical physical identifiers such as hats, armbands, or shoes, mobs of birds would still continue to enact their revenge once the team returned to the area.

The birds held a grudge, and it ran deep.

Graphic by Lilian Zhang

Facial Recognition

Plenty of animals, domestic and wild, are able to identify members of other species through a variety of visual, auditory, or olfactory cues. A dog might recognize its owner through sense of smell, while primates can easily distinguish humans simply through sight. Mockingbirds, for example, are able to distinguish human faces by associating them with past experiences.

In their quest for vengeance, crows employ a similar tactic. Upon their interaction or association with a human face, facial features are separated into one of two categories: "favorable" (caring), or "dangerous" (threatening). Faces that provide the birds with food or other resources are remembered as "favorable", while those that harm, or attempt to cage the birds are memorized as "dangerous", and kept in mind as a future possible threat.

As crows begin to memorize the human face, their memory retrieval begins at their target's eyes. Corvids, among other birds, are especially attentive to the human gaze due to the amount of spatial information received by tracking eye direction[1]. Following the gaze of other birds, predators, and even humans can provide crows with discerning evidence on if there is anything of significant importance in the location ahead (such as resources or obstacles), making the human gaze a vital source of information. While similar levels of focus are applied to the surroundings area of the face, little to no recognition is applied to similarly noticeable features such as body type, clothing, or movement -- making facial features the primary focus of facial recognition in corvids.

The bird then decides to store the specific features of the human face into its memory under one of the two earlier mentioned categories (favorable or dangerous). Upon having a threatening or dangerous interaction, crows immediately freeze, contributing to a significantly decreased blinking rate, and causing the activation of regions in the mesopallium and hippocampus -- all areas commonly associated with fear, and escape reactions. On the other hand, positive, favorable interactions lead to ac-

1 Bugnyar, Thomas, et al. "Ravens, Corvus Corax, Follow Gaze Direction of Humans around Obstacles." Proceedings of the Royal Society of London. Series B: Biological Sciences, vol. 271, no. 1546, 2004, pp. 1331–1336., doi:10.1098/rspb.2004.2738.

tivation of the hyperpallium and medial striatum, each related to associative learning and hunger motivation. Witnessing a human face associated with one of the categories causes the re-activation of each correlating neuronal circuit, contributing to the crows' ability to recognize human faces based on their automatic emotional response. And interestingly enough, this emotional response lasts a while.

Holding a Grudge

When a crow stores memories of a human face, they tend to be categorized as either positive or negative without consideration for the duration of the event. For example, long-term dangerous interactions (such as extended periods of capture and confinement) would be associated with a face just as equally to momentarily shooing a crow away from your porch. This connection is likely due to the presence of an enlarged rostral mesopallium in corvids, an area in the forebrain involved with accelerated multimodal learning[2]. Such a discrepancy contributes to the fixation corvids have on rewards and punishments, as well as positive and negative experiences in turn.

Not only does this mean that crows remember each person who has slighted them, but they can do so for years on end. Crows are able to remember and recognize specific faces for an average of 3 years, though special cases can extend that number to several years beyond[3]. And if that wasn't enough, they'll make sure to tell their friends as well.

This is what contributes to the mobbing and scolding behavior of a murder of crows. Crows learn most efficiently through associative and observational learning due to their fixation on rewards and punishments, so when one crow recognizes an unfavorable face and begins to scold them, other crows soon hear the sound and join in. This only causes more to participate, and the mob grows in number until every crow in the vicinity has recognized and remembered the face in question.

But these negative reactions don't happen too often -- in fact, for every person who may be deemed dangerous by these birds and doomed to years of scolding by their local murder, there are plenty of other people who experience the exact opposite.

How to Train Your Crows

Just as crows carry deep grudges, they can also hold others in high regard. In 2015, a Seattle girl who fed a local flock of crows found herself bombarded in trinkets as they showered her with gifts in return[4]. Meanwhile just 3 months ago, an Oregon citizen found himself at risk of a lawsuit when a crow he was feeding turned into an entire murder that would constantly attack any neighbors or guests that came over to visit, as a means of protecting their food source[5]. These are highly volatile creatures that have evolved over the years to make quick, spur-of-the-moment observations, clearly in their advantage. While such black-and-white reactions may seem bizarre, especially to humans that see crows as just another bird species among many, this facial recognition and associative learning has assisted them greatly in survival over the years.

These corvids are highly intelligent animals, smart enough to be operating on the same level as a seven-year old human child. While even children may have trouble understanding complex analogies or principles of cause and effect, crows are able to effectively innovate solutions for a problem at hand, and share it with others. Many 7-10 year olds struggle with the water-displacement test -- which involves water at a low height in a pitcher that must be filled with rocks to reach -- yet the experiment is no problem at all for crows, especially when food is involved[6].

Even the feeling of holding grudges, which is often seen as highly immature or downright unhealthy for humans, is used by crows to their advantage. Impressive memory retrieval regarding dangerous creatures helps a flock to stay alive, keeping them vigilant against any future threats. They have a knack for innovation and cognitive reasoning, but are also highly social creatures that learn from the habits of other birds and species around them.

Just hope you don't get on their bad side.

2 Marzluff, J. M., et al. "Brain Imaging Reveals Neuronal Circuitry Underlying the Crow's Perception of Human Faces." Proceedings of the National Academy of Sciences, vol. 109, no. 39, 2012, pp. 15912–15917., doi:10.1073/pnas.1206109109.

3 Cornell, Heather N., et al. "Social Learning Spreads Knowledge about Dangerous Humans among American Crows." Proceedings of the Royal Society B: Biological Sciences, vol. 279, no. 1728, 2011, pp. 499–508., doi:10.1098/rspb.2011.0957.

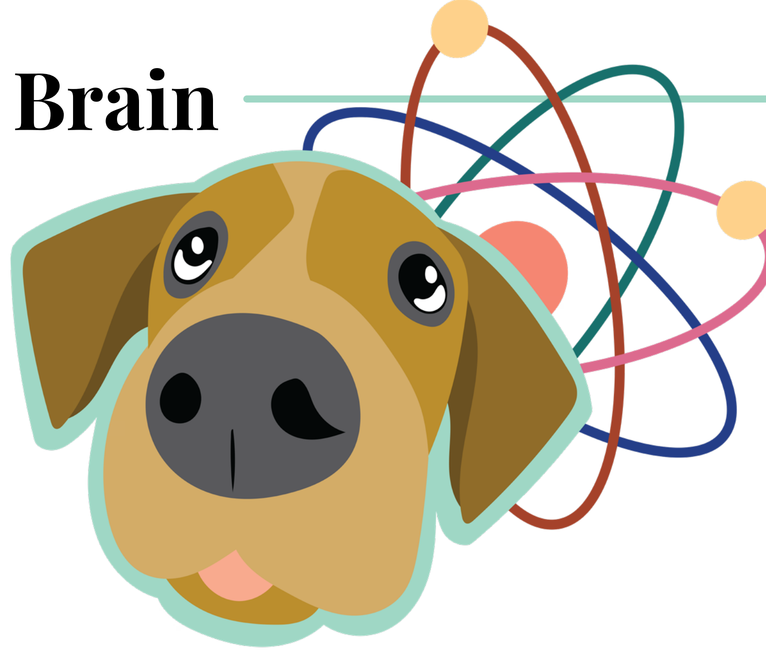
4 Nosowitz, Dan, and March 02. "Seattle Girl Befriends Generous Neighborhood Crows." Audubon, 14 July 2016, www.audubon.org/news/seattle-girl-befriends-neighborhood-crows-making-bird-lovers-everywhere-jealous.

5 "r/Legaladvice - [Oregon] I Accidentally Created an Army of Crow Body Guards. Am I Liable If My Murder Attempts Murder?" Reddit,

6 Logan, Corina J., et al. "Modifications to the Aesop's Fable Paradigm Change New Caledonian Crow Performances." PLoS ONE, vol. 9, no. 7, 2014, doi:10.1371/journal.pone.0103049.

~~Drugs~~ Dogs and the Brain

By Jacob Marks



One of the best classes I ever took in high school was Modern Philosophy during my senior year. While discussing the philosophy of language, my teacher, Mr. Fuentes, boldly pronounced, “Your dog doesn’t love you.” After the class finished arguing with him, giving all the reasons our dogs must love us, he went on to explain the philosophy of Ludwig Wittgenstein. According to Wittgenstein, language and thought are intertwined. As such, it is through language that we understand the world around us, realize abstract concepts, and even have a sense of self.

Dogs (and all non-human animals at that) do not have any internalized language. If you would have asked Wittgenstein, this means that they have no thoughts. But, how can this be true? Surely dogs are conscious of the world around them and seem to show their own emotions and personalities. This philosophy holds that, without language, dogs are incapable of processing and analyzing their experiences and emotions.

Dogs are unique in their close social and historical relationship to humans. They are certainly not like the chimpanzee, which is the species most closely related to humans, but they share a different type of bond. Dogs were the first animal to be domesticated by humans, possibly as early as 11 thousand years ago. Humans and dogs (most likely closer to wolves at the time) had a mutually beneficial relationship, with the humans offering the dogs food and the dogs providing humans some protection. This connection has fundamentally changed the way dogs have evolved, making them more “socially compatible” with us.

In the United States alone, nearly 40% of households have a dog and it is likely that someone in each household has at one point wondered what their pet is thinking. In my opinion, Wittgenstein’s philosophy does not provide a satisfying, complete answer to this question. While his ideas on language may be philosophically sound, I do not find them to be practical and their implications on how we treat animals should not be ignored. This is where neuroscience may come in to offer an alternative perspective.

To start off, humans have larger brains than dogs. This follows the trend that the larger a mammal is, the larger brain it has. Humans also have a much larger encephalization quotient (EQ) compared to dogs. EQ measures an animal’s brain mass relative to its body mass. An animal with an even brain and body size would have an EQ equal to one. Humans have a very large EQ of 7, while dogs have a relatively small EQ of 1.2. A larger EQ generally indicates that a species has greater intelligence, so it makes sense that humans have the highest EQ of any mammal, followed by dolphins, then chimpanzees.

Along with all other mammals, humans and dogs share the same core structures of the brain, with human brains being much more powerful and complex at a deeper level (as evidenced by the larger EQ). For instance, dogs and humans have a cerebrum (the largest, main part of the brain), cerebellum (motor center of the brain), hippocampus (memory center of the brain), amygdala (fear center of the brain), and four main lobes (frontal, parietal, temporal, occipital) among other important structures.

At the same time, major differences are found when comparing the size, and therefore complexity, of some of these important

Albuquerque N., et al. (2016). Dogs recognize dog and human emotions. Biol. Lett. http://doi.org/10.1098/rsbl.2015.0883
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structures. Dogs have a much larger olfactory system than humans do, which explains their enhanced sense of smell; however, their cerebrum in general is much smaller and smoother than humans, indicating the presence of fewer neurons. Most importantly, perhaps, is the difference between the size of the frontal lobe, which is the part of the brain responsible for emotional regulation, decision-making, and memory, among other executive functions. In humans, the frontal lobe takes up nearly one-third of our brain, while in dogs it only takes up about 10%. This difference may explain why humans have a much higher level of self-awareness and capabilities of social/moral reasoning. However, scientists are not yet certain if a frontal cortex contrast is the reason for the differing intelligence levels of species, since, for example, sea lions have larger frontal lobes than advanced primates like gibbons or baboons. Some researchers believe that a larger temporal lobe may explain greater human intelligence, but there is no affirming evidence yet.

The question remains of whether having a similar brain structure implies that dogs and humans experience and process the world in similar ways. There is not enough research (or any known methods) yet to definitively prove that dogs feel a full range of specific emotions, but scientists are able to use dogs' interactions with humans and other dogs, along with fMRI data, to make some conclusions.

In recent years, studies have used fMRI to scan dogs' brains and look at activity in response to certain stimuli. Scientists believe dogs (and humans) have gained basic emotions like happiness, anger, and fear evolutionarily. Dogs have similar brain structures as humans necessary for these emotions, which are primarily found in the limbic system, so it follows that they should have developed them too. A recent study showed that the nucleus accumbens, the reward center of the brain, lit up in participating dogs when they were presented with the scent of familiar humans. Whether this is actually 'happiness' or 'excitement' is a philosophical question, but it shows that dogs feel something associated with reward when presented with familiar stimuli.

Various studies using eye-tracking have found that dogs are able to recognize basic emotion (happiness, surprise, fear, anger, etc.) in both human and dog faces. It follows that dogs have an area of their brains specialized for face recognition, similar to the fusiform gyrus in humans. It is believed that dogs can distinguish between these positive and negative emotions and respond accordingly. According to Professor Miiamaaria V. Kujala, it "appears unquestionable that dogs can both produce and process emotions through facial expression." However, the question remains whether they are born with this ability and understanding, or if it is simply conditioned.

Whether or not dogs can feel or process complex, or "secondary," social emotions is not yet resolved. Examples of these types of emotions include shame, guilt, and contempt. To experience these emotions, dogs would need to have a much more heightened self-awareness. According to Professor Mark Leary, having a sense of self allows an animal to, "(1) evoke emotions in themselves by imaging self-relevant events, (2) react emotionally to abstract and symbolic images of themselves in their own minds, (3) consciously contemplate the cause of their emotions, (4) experience emotions by thinking about how they are perceived by other people, and (5) deliberately regulate their emotional experience." Though it is unknown how much of a sense of self dogs have, it is doubtful that it is akin to that of humans and more likely that they experience secondary emotions much differently than we do. Humans are able to experience and process secondary emotions because of intricate connections between the limbic system and the rest of the cerebral cortex. While dogs may have some of these connections too, humans' large EQ makes more connections and stronger connections at that. It is important to keep in mind that this does not stop them from having more basic emotions.

So, **does your dog love you?** While your response very much depends on how you define 'love,' I believe the answer is yes. Your dog may not fully understand 'love' or be able to conceptualize the abstract idea, but it does not mean that they lack feeling or do not see you as special among other humans. Dogs process the world differently than humans, which means that they must love differently, as well.

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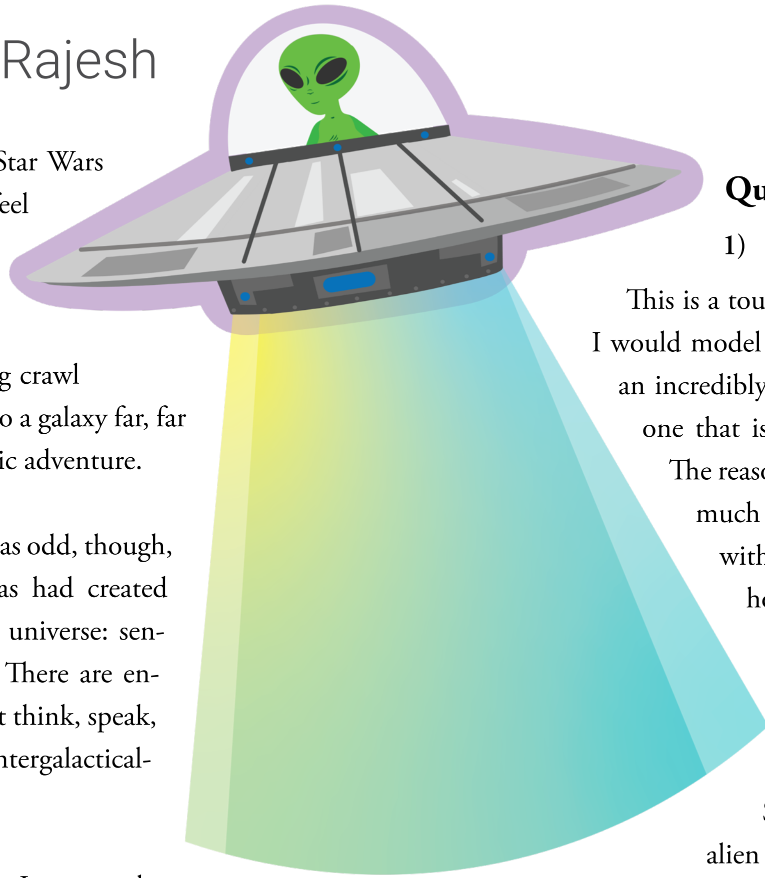
Little Green Men

By Sameer Rajesh



Growing up an avid Star Wars fan, to this day I still feel a rush of excitement as I hear the opening theme. Reading the slowly scrolling opening crawl and being transported to a galaxy far, far away is always a fantastic adventure.

What always struck me as odd, though, was what George Lucas had created within his little (huge) universe: sentient, non-human life. There are entire species of aliens that think, speak, engage in trade, travel intergalactically...and even wage war.

In childhood naivete, I assumed there must be such aliens out there. After all, how could there not be? It's miraculous we haven't been swept into some galactic civil war yet, the likes of which would have ravaged the galaxy as in the films.

As I got older, I was led to believe that maybe there were no aliens. We haven't seen any. Sure, there's always the crazy person who says the aliens we do find are stored cryogenically in Area 51. I'm not sure I believe those theories (but, you never know). What I will say, though, is we should not be so quick to dismiss the possibility of extraterrestrial life—nor, in the same spirit, should we dismiss the possibility of extraterrestrial intelligence.

I hope the rest of this article will lead you through a couple of questions that you might think about when considering the possibility of extraterrestrial existence. I'll then ask you to keep thinking about some of these questions as you move on past this article and think about how we, as humans, think about intelligence. I do not aim to provide any substantive answers—this is merely to spark your own curiosity.

Questions

1) How do aliens think?

This is a tough one. If I were designing an alien, I would model it after a human. This is, of course, an incredibly anthropocentric view—but I think one that is necessary to take in this instance. The reason I say this is because we don't know much about how thinking works to begin with. There is an age old question of how human thought and human consciousness arises in the first place, and it is one we have yet to answer satisfactorily.

So, let's suppose for the moment an alien thinks just like we do. They may not speak like us, or walk like us, or even talk like us—but fundamentally, their cognition looks like ours (whatever that really means). If such aliens existed, I imagine we might feel connected to them in some way. Another species, out from the farthest reaches of space, thinks the same way we do. What a small world we would live in.

2) Do aliens dream? If so, what do they dream about?

I imagine if aliens can think, and experience consciousness, like we do, then they should be able to dream like us as well. Perhaps they have happy dreams of visiting the nearby forest on their home planet, or scary dreams of an appointment at the alien dentist's office—or whatever their equivalent is. We can study dreaming in humans to a certain degree using functional MRI (fMRI) techniques but this works primarily because of the way our nervous systems are set up. If an alien's nervous system, its central processing units, are not designed the way ours are, I imagine studying alien dreams might be quite difficult.

We are only two questions in, and our answers have been resoundingly inconclusive. I hope you are prepared for more.

3) **Do aliens feel?**

This is perhaps the most difficult question of all. I cannot imagine that an alien that thinks like us and is conscious like us would be devoid of feelings—but it is entirely possible, of course, that evolution might have selected for unemotional creatures in a foreign environment. There is something strange about emotion, something that we can't quite put our finger on. There are some feelings, like fear and excitement, which we think have some clear benefit to us in survival, but in general emotion seems to have an ill-defined biological purpose. Still, I see no reason why, if in our grand thought experiment, our alien is able to think just like we do, that it cannot feel just as we do as well.

Perhaps I have asked these questions in a slightly anachronous way. By that I mean, what if the first point to consider is whether an alien feels, and only subsequently should we consider whether it thinks. Is feeling, and emotion, fundamental to conscious thought? Some might say no—a creature which cannot think, cannot feel. Others might say yes. Surely the myriad videos of smiling babies will convince you that infant can feel some emotion that resembles joy—but I dont know if I would go so far as to say an infant, at least in its first few days after birth, can think or behave consciously.

This is, of course, more philosophy than you might care to engage with. I'll let you decide on your own which comes first—feeling, or thought.

4) **Do aliens love, and can they hate?**

It is an interesting question as to whether emotions such as love and hate are merely anthropological. We know, of course, that our dogs get excited when we come home from work—maybe this is love outside of humans. I suspect we can't actually know, though. As to the question of whether extraterrestrial live can feel these emotions, I see no reason why they cannot. Especially given that love and hate, though complex and intricate, are universal amongst emotional beings like ourselves, I believe that if an alien did exist, with the cognitive properties above described, they could in fact feel love and hate.

This brings me to my last point. Anyone who has watched any of the Star Wars movies (if you haven't, that's your homework) knows that alien species are perfectly capable of waging war against each other.

5) **Is that fiction?**

Humans have a long history of conflict—it seems quite likely this is in part fueled by emotion. Whether love or hate, or some combination of both, war is a phenomenon that seems uniquely limited to species we consider "intelligent life" on Earth. The prospect of warlike alien species is disconcerting, I assume, so I reassure you that we are not being invaded by aliens anytime soon. The point stands, though, that a thinking, feeling, loving, hating alien race just might be out there, and it might be a lot more like us than you'd think.

These are but a few of the many different questions we can ask about alien intelligence, but we have skipped over the elephant in the room. Do intelligent aliens exist? I think the answer is very probably yes—it would be a rather lonely universe if there were no-one to share it with.

Of course, we are not limited to considering life forms away from Earth as aliens. Certainly, any mode of cognition very foreign to us is alien —a prime example of this is the octopus. While it is ridiculous to call an octopus an alien in the common sense of the word, their cognitive abilities remain a deep mystery. We do not understand their intelligence well. Octopuses, as invertebrates, are conventionally considered far less evolved than other vertebrates—how in the world could they possibly think the way they do? We hear stories of intelligence in monkeys and dolphins and other non-human creatures as well. Given the limitless ways in which matter can be organized using molecular circuits, there is no reason why forms of cognition absolutely beyond our imagination should not exist out in the vast expanses of space.

There is another intelligence that is rather "unintelligible"—that is, difficult to decode. AI (artificial intelligence) remains to us a rather large black box, a container into which we cannot yet see. There is no reason why we may not ask ourselves the same questions posed earlier regarding alien intelligence to AI. Can an AI feel? If it can, what are the ethics of shutting down an AI? What if a thinking, feeling AI does not want to be turned off—is hitting that off button akin to murder? Can an AI love, and can it hate? Can an AI one day decide to wage war against us?

Okay, now I'm rehashing the plot to The Matrix. Of course, I do not aim to be an AI naysayer with projections of only doom and gloom. But we should exercise caution in the ways we think about AI. Machines do not seem alien to us because we have coexisted with them for decades. Computers are ubiquitous and familiar. Because of this, the concept of AI does not feel as alien as I think it should. We do not know if an AI will be able to feel—does that change how we operate them? If an AI could feel, would it change our decision to shut it down, in the same way we might feel sad when a person has to be taken off of life support? How do we coexist in a world where machines have feelings, no matter how alien or human those feelings are?

We should, by all means, push forward with Artificial Intelligence. I believe furthering our understanding of cognition, computing, and neuroscience, can all be furthered—in addition, we will have created incredible thinking tools.[1] But the point stands that without understanding AI and asking these rudimentary, yet important questions, we may not be experimenting ethically. AI, though it may not be a biological life form, may one day be capable of complex thought just as a human might. It is a hypothetical, and a rather big one at that, but it is no more or less hypothetical than is the existence of extraterrestrial intelligence.

1 I use the term tools here in jest—obviously, should we create true general artificial intelligence which can think and feel just like we can, the use of the term "tools" would be ethically problematic.

Other Humans

Art by Allison Chen

How Urban Design Affects the Health of Kids

By Namrata Kantamneni

This semester's issue of MIND focuses on neurodiversity. Within this population includes brains that are still growing and developing, i.e. brains that are still being shaped.

And how exactly do we grow? We grow by exploring our surrounding environment. We learn how to socialize and interact by going off on secret adventures with our friends, to locations unbeknownst to our parents.

As a child, I was fortunate enough to live less than a mile away from my school. As a result, I walked to school throughout all of grade school. It was on those daily walks where I made many important memories. When I was younger, I'd walk to school with my mother and we'd walk through an unkept meadow. I'd inspect every plant and weed like a detective and my mother and I would race each other. I'd end up at school covered in sweat and mud, but with an endorphin rush that kept me in a state of alertness for the rest of the school day.

As I got older, I'd walk to school with friends. And on these walks with friends, we would go off the beaten path and try to find shortcuts. When we couldn't find any, we'd jump a neighbor's fence to make our own shortcut. Or we'd crawl through a gap in between the fencing and the ground. It was through these unexpected adventures that I learned how to jump and crawl. Sure, we'd arrive at school in a state of disarray (sometimes with cuts and scrapes from branches and trees and from falling off bicycles), but that was how we grew and developed in a way that no school could teach.

But today, few children walk to school. Few children are even allowed to be outside on their own. In fact, according to Ontario's transit agency the percentage of 11- to 13-year-old students walking to school within the Greater Toronto and Hamilton Area nearly halved between 1986 and 2016, while the number of kids being driven in cars nearly tripled[1]. In addition, in Canada as a whole, 58 percent of parents walked to school when they were children, while only 28 percent of their own kids were doing the same today[2]. And this isn't just when traveling to school or extracurricular activities: there has been a decreasing level of independence for children even when playing within a neighborhood. For example, a survey of almost 2,000 parents in the U.K. found that most of them won't let their kids play outside, unsupervised, until age 11[3]. The parents in the same study reported that when they were young, the accepted age for unsupervised play was 9 years old.

If we look back to the previous generation, the trend continues.. In 1979, the standard book for child development included a checklist of tasks a 6-year-old should be able to accomplish. And one of these tasks was: can he travel alone in the neighborhood (four to eight blocks) to store, school, play-

1 https://www.theglobeandmail.com/opinion/article-why-did-our-children-stop-walking-to-school/
2 https://www.cbc.ca/news/health/children-driven-around-too-much-canadian-report-suggests-1.1328982
3 https://www.theguardian.com/society/2021/apr/20/gradual-lockdown-of-uk-children-as-age-for-solo-outdoor-play-rises

ground, or to a friend's home[4]?

Imagine if kids were permitted to go to a playground or to school or to the store or to a friend's home by themselves. Parents would probably get called out by neighbors or even reported to child services, as was a mother who allowed her eight-year-old child to walk to school alone[5].

But forget about a 6-year-old child: at age 20, even I can't go to my school on my own anymore without access to a car and a driver's license. It is not possible to go to a friend's house, to a store, to a running trail, or even to my old high school. And the kids in my neighborhood today cannot walk to their grade school. In fact, in North America today, it is the norm to be cut-off from independent socialization, whether that is hanging out with friends or getting to school, until the age of 16, when teenagers can get their driver's licenses.

And what happens when we have to commute long distances to school, work, and grocery stores? What happens when children don't have independent mobility? We end up becoming lonelier and without normal socialization skills. In fact, a study of a group of 11–13-year-old Italian children found that lower independent mobility predicted more loneliness and a weaker sense of community because of less frequent interactions with friends[6].

So we've established that children should have a certain degree of independence, without being under the supervision of overprotective parents.

But are these fears justified on part of the parents, or is there any rational basis in them?

As it turns out, there is.

When looking at what fears parents have when letting their children out to play, several reasons are present. One reason, which is unfounded, is a fear of strangers, even though few empirical studies have confirmed this[7]. But some fears aren't unfounded. Particularly, the fear of being in an accident is not unfounded: statistic after statistic tells us that pedestrian deaths are increasing, particularly as people are choosing larger vehicles and choose to drive places instead of walking or bicycling, thus adding more cars to the road overall.

Here are some of those statistics:

- Between 2008 and 2019, pedestrian fatalities in the U.S. increased 41 percent[8].
- In the first half of 2020, U.S. pedestrian deaths per mile spiked 20%[9].
- In 2019, pedestrian deaths in the U.S. were the highest in 30 years[10].
- In 2019, Montreal's pedestrian deaths were at the highest levels in 6 years[11].
- From 2010 to 2016, pedestrian fatalities increased by 39.2% in the U.S.A., one of only seven countries with an increase in fatalities in that time period[12].

And one of the reasons for the increase in pedestrian fatalities is the rise in popularity of the SUV and other large vehicles. The Federal Highway Administration says that pedestrians struck by large SUVS are twice as likely to die as those struck by a car[10]. And between 2009 and 2018, percent of sales of new vehicles that were light trucks (including SUVs) rose from 48% to 69%[10]. But this only impacted fatalities for pedestrians: the number of all other traffic deaths rose only 2% between 2009 and 2018[10]. In fact, the number of passenger-vehicle occupants dying in 2018 was 25% lower than 1975[10].

And this problem won't stop anytime soon. SUVs became the best-selling cars in 2014[13], and have continued to be popular since light truck sales in March 2021 soared to an all-time high, topping 13.8 million units[14]. And since bigger vehicles are directly resulting in more pedestrian deaths, there is no

4 https://reason.com/2021/04/23/survey-we-keep-raising-the-age-that-children-are-allowed-to-play-outside/
5 https://www.macleans.ca/society/how-did-good-parenting-become-a-crime/
6 https://www.tandfonline.com/doi/abs/10.1080/14733285.2013.812277
7 https://www.sciencedirect.com/science/article/abs/pii/S1353829213001561
8 https://www.cnbc.com/2019/02/28/pedestrian-deaths-hit-a-28-year-high-and-big-vehicles-and-smartphones-are-to-blame.html
9 https://www.usnews.com/news/health-news/articles/2021-03-23/us-pedestrian-deaths-rose-in-2020-even-though-driving-declined
10 https://www.caranddriver.com/news/a31136893/pedestrian-deaths-increase-2019/
11 https://globalnews.ca/news/5382380/montreal-pedestrians-deaths-2018-high/
12 https://financialpost.com/transportation/canada-among-only-seven-countries-to-see-rise-in-pedestrian-deaths-oecd-study-finds
13 https://www.freep.com/story/money/cars/2018/06/28/suvs-killing-americas-pedestrians/646139002/
14 https://usa.streetsblog.org/2021/04/21/suv-and-pickup-purchases-soar-but-whos-buying/?fbclid=IwAR1TSN_ekne7ci-uimMOtjKXyggYp-FORL_VtgboOUwZXoL85TyLcBPTZ3o

question that by driving bigger vehicles, we have created a hostile environment for children[15].

What all this shows is that we have directly created a hostile environment for children where they cannot walk to school or to the grocery store for a popsicle.

So what do we do?

Perhaps we can take a page from the Dutch, who have mastered the art of city planning by purposefully designing a bicycler's paradise, where children can freely flutter from place to place like butterflies. In fact, Dutch children often top the list of happiest children in the world[16]. And a big reason for this is the emphasis on independence in Dutch society: Dutch kids often walk or ride their bicycle to school or extracurriculars by themselves, thus allowing for kids to grow and develop naturally and eliminating the need for the stressed-out minivan mom shuffling kids from point A to point B[17].

In fact, the Dutch Road Safety Organization recently asked parents to NOT drive their kids to school [18]. And Thomas Stuiver from the organization Safe Traffic Netherlands recently stated: "My advice to parents: bring children by bike or by foot (to school) as much as possible"[18].

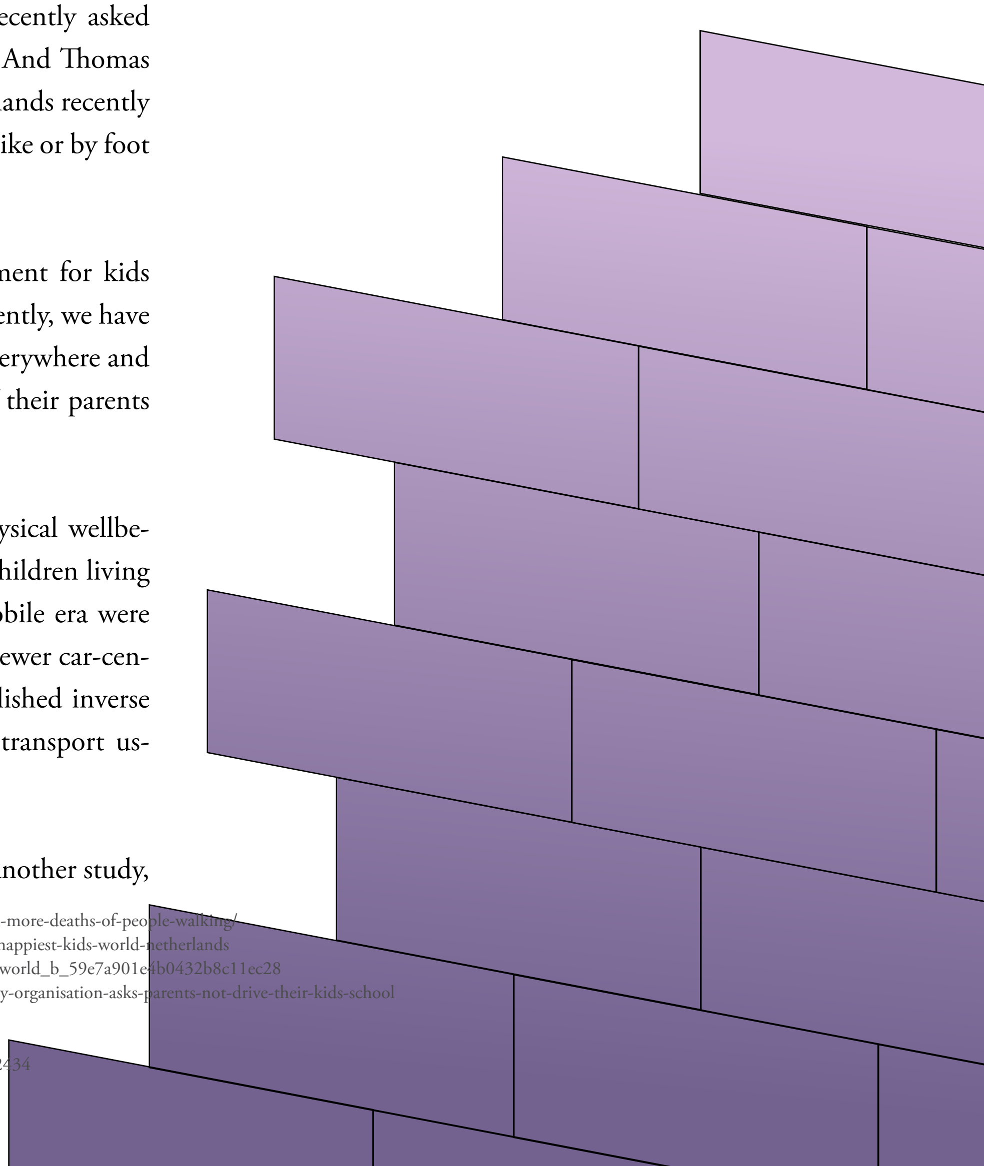
And that's what we need to create an environment for kids where they can play and grow normally. But currently, we have an urban environment where kids are shuttled everywhere and as a result are always under the watchful eyes of their parents 24/7.

But we need to fix this, for the mental and physical wellbeing of kids in today's car-centric world. In fact, children living in older neighborhoods built before the automobile era were found to be more physically active than kids in newer car-centric areas[19]. In addition, there has been an established inverse association between obesity and cycling/public transport usage[20].

In addition, there are mental benefits as well: in another study, children going to school on their own achieved the best performances in both making a sketch map of the itinerary and in drawing their movements on a blank map[21]. So it's not just physical benefits, there are mental benefits too. By allowing children independence, they are able to explore their surrounding environment and develop in spatial awareness, a form of intelligence which is often not tested in any IQ test or school exam.

These are just some of the many intangible benefits children have when they grow up in a walkable, kid-friendly environment. But right now, we don't have that kid-friendly walkable environment; instead, we have a car-centric environment filled with SUVs where driving is the primary mode of transport and it is too dangerous for children to walk or ride a bicycle to school, lest they get into an accident in the blind spot of a large vehicle.

So let's fix that.

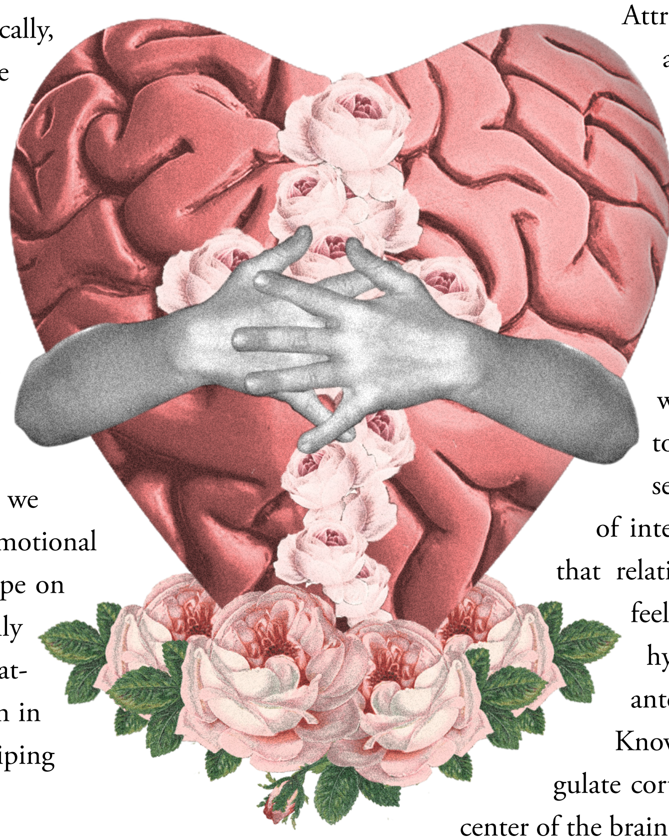


15 https://smartgrowthamerica.org/bigger-vehicles-are-directly-resulting-in-more-deaths-of-people-walking/
16 https://mom.com/momlife/272681-countries-where-kids-are-happiest/happiest-kids-world-netherlands
17 https://www.huffpost.com/entry/how-to-raise-the-happiest-kids-in-the-world_b_59e7a901e4b0432b8c11ec28
18 https://www.iamexpat.nl/expat-info/dutch-expat-news/dutch-road-safety-organisation-asks-parents-not-drive-their-kids-school
19 https://pubmed.ncbi.nlm.nih.gov/16829327/
20 https://core.ac.uk/download/pdf/11541568.pdf
21 https://www.sciencedirect.com/science/article/abs/pii/S0272494402902434

Can We Find True Love on Tinder?

By Emma Clark

When you think about the question "What is love?" The first answer that may come to mind is "baby don't hurt me… no more." Despite being the opening phrase of Haddaway's hit 1990s anthem, this age-old question is one that neuroscientists, psychologists, and philosophers alike continue to grapple with. Love is a human experience of such great interest due to its inherently complicated nature. Some academics consider it an emotion, but neurologically, the processes that occur when one experiences love are much more complicated than neural processes that occur during other emotions, suggesting that it may be more of a cocktail of emotions that work together to create an incredibly unique neural state. As if understanding and finding love isn't complicated enough, what happens when we try to foster this complex socioemotional interaction through a simple swipe on our phone? Can those swipes really help catalyze love? How are we attracted to people we've never seen in person on Tinder, and why is swiping for hours so easy to do?



A Crash Course on the Neurobiology of Love

As mentioned earlier, the human experience of love is a multi-layer neurological process composed of chemical, cortical, and subcortical interactions. The key neurotransmitters that facilitate love connections are oxytocin, vasopressin, norepinephrine, dopamine, and phenylethylamine. Norepinephrine, dopamine, and phenylethylamine are the primary chemicals that facilitate romantic feelings, while oxytocin and vasopressin facilitate more long-term pair bonding. These chemicals release in many neural processes besides love, but let's have a look at the distinct role they play in facilitating the feelings we associate with love.

Attraction is the first step to developing a passionate love for someone, and happens when different brain regions come together to produce a rush of dopamine, norepinephrine (adrenaline), and oxytocin. Norepinephrine and dopamine cause us to feel giddy to the point of nervousness when we see someone we are attracted to, while oxytocin fosters a unique sense of connectedness to the person of interest, regardless of how established that relationship actually is. This flood of feel-good chemicals originates in the hypothalamus, hippocampus, and anterior cingulate cortex (The Clinical Knowledge Network). The anterior cingulate cortex is often regarded as the reward center of the brain, which is why these feelings persist and motivate us to further pursue people we are attracted to.

The neural footprint of passionate love is different from that of other emotions in that it is both cortical and subcortical, meaning that networks of neurons in multiple layers of the brain are working together to form a complex, multi-dimensional neural circuit. Cortical networks involved with social cognition, self presentation, and memory in the fusiform re-

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Cupid's chemical addictionn- the science of love. The Clinical Knowledge Network. https://www.ckn.org.au/content/cupid%E2%80%99s-chemical-addiction-%E2%80%93-science-love

Fisher, H. (2006). The Drive to Love: The Neural Mechanism for Mate Selection. In R. J. Steinberg & K. Weis (Eds.), The new psychology of love (2nd ed., pp. 87–115). Yale University Press. http://www.helenfisher.com/downloads/articles/15npolve.pdf

gion, angular gyrus, dorsolateral middle frontal gyrus, superior temporal gyrus, occipital cortex, and precentral gyrus activate in concert with subcortical structures including the thalamus, anterior cingulate cortex, caudate nucleus, and ventral tegmental areas which produce dopaminergic effects, leading to feelings of reward, euphoria, and motivation (Cacciopo et al 2012). A similar network of structures are highly active when someone is experiencing a high from drugs such as cocaine or opiates. The distinct feeling that this "bliss circuit" creates is likely why people often describe being deeply and passionately in love like being on a drug.

The blissed out feeling resulting from the subcortical circuit coupled with social awareness and self-presentation – impulses that compel us to put our best foot forward to impress our love interest – creates a feedback loop. This motivates us to be our best selves and the brain produces a reward response when positively interacting with another person. The present motivation-reward relationship explains why when we are in love, we often feel higher self-confidence. Although it may feel like the other person is making us present and that's why we perceive ourselves more favorably, in reality, the dopamine reward we experience from interacting with the other person motivates us to continue to independently have higher social awareness and, consequently, self esteem. So, if passionate romantic love creates such an ideal state of mind, can you just fall in love with the first person you match with on Tinder? Unfortunately, probably not.

Love via Tinder?

Tinder and other dating apps have attempted to aggregate and digitize the experience of first seeing someone whom we are attracted to. Instead of occasionally being flooded with feel-good chemicals when seeing someone attractive on the street, Tinder creates a space to foster instant attraction with no more than a swipe right on your phone screen. This constant stream of stimuli activating our reward centers simply makes us want more of it. Enter, doom-swiping. When you combine the feelings that result from initial bursts of attraction with the feel-good effects we get from immediate gratification on our devices, like matching with someone on Tinder, we essentially create a "dopamine vacuum" in which we have a constant space to initiate these feelings, so we continue to use it, even if those swipes fail to result in an actual love connection. Here begs the question of whether Tinder can really be a catalyst for love, or if many users are just hooked on the quick, short-term satisfaction that matching with someone you find attractive provides.

Because humans are inherently social creatures, we are relatively adept at perceiving social cues. Between interpersonal awareness and Theory of Mind, the human ability to think about what other people may be thinking, we can usually form an idea of whether our attraction to someone is reciprocated or not relatively quickly. However, online dating apps like Tinder remove the space for interpersonal cues that in the real world that help us decipher this. This phenomenon is a double-edged sword; matching with someone feels more exciting because you had no way to form an expectation about if they would be attracted to you, but also makes it all the more disappointing when you don't match with someone you were really hoping to, because there was no real way to determine that they might not be attracted to you and change our expectations for the possibility of a relationship with the person.

The discrepancy in expectations of a relationship that may exist as a result of meeting on Tinder along with the gratification of instant attraction may imply that a swipe right is not realistically all that likely to lead you to your life partner. In fact, a 2017 study found that among a sample of Tinder users, the highest motivator for using Tinder was "the thrill of the excitement," and "finding a stable relationship" was ranked as one of the least important factors for using the app (Sumter et al 2017). Further, a later study found that Tinder users were more likely to engage in risk-taking behaviors than non-users (Sevi 2019). Norepinephrine is the primary neurotransmitter that releases when we engage in risky behaviors or seek thrills and also releases in the reward circuit that activates while swiping. This presents the possibility that since this small thrill is so readily available to Tinder users, other activities provide relatively less thrill than they would without the constant excitement of Tinder. As a result, this may motivate them to engage in more risky behaviors to achieve the same thrill that less risky behaviors used to give them.

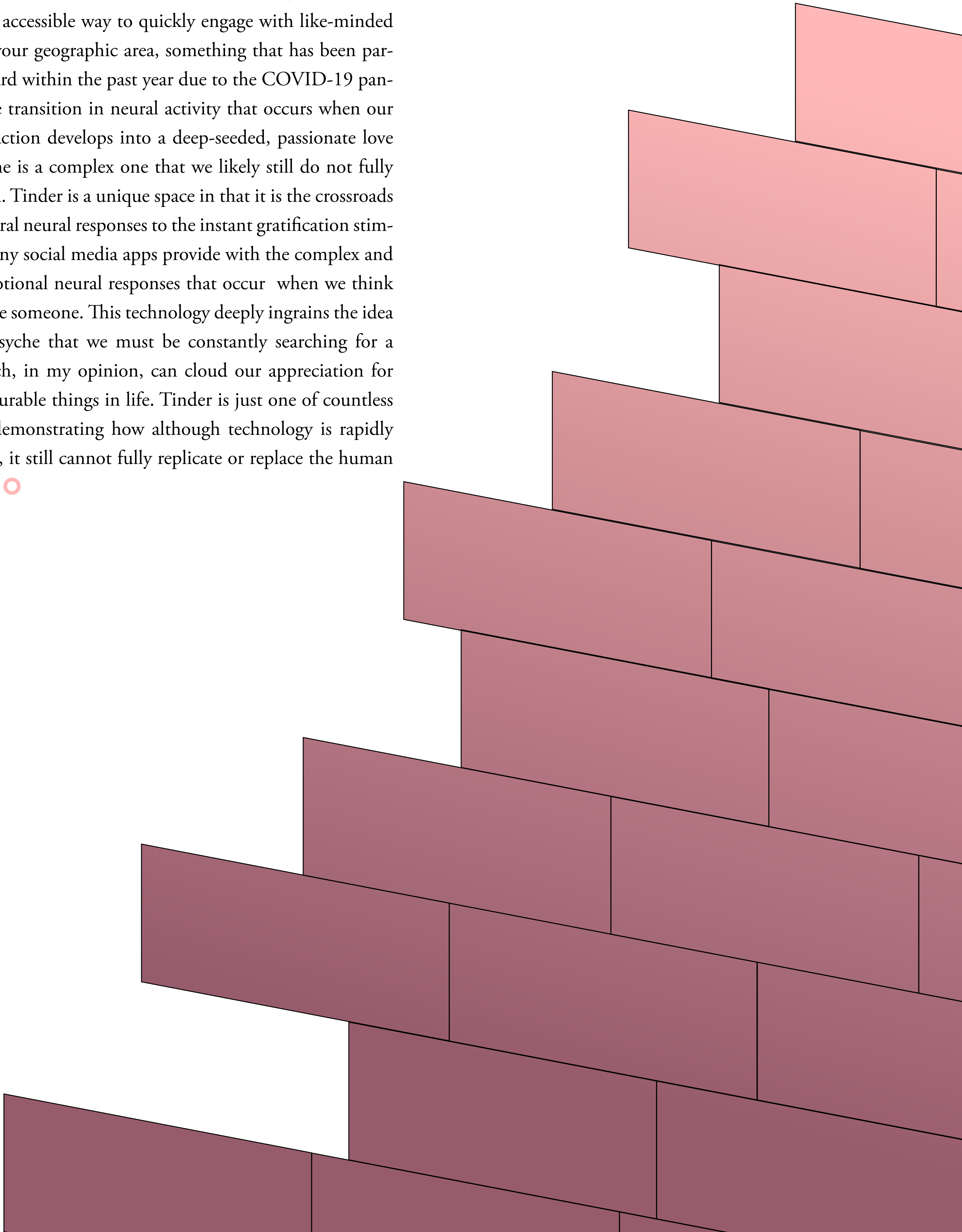
Nicholson, J. (2019, September 29). Tinder Dating: Can You Find Love, or Just Lust? The Attraction Doctor. https://www.psychologytoday.com/us/blog/the-attraction-doctor/201909/tinder-dating-can-you-find-love-or-just-lust

Sevi, B. (2019). Brief Report: Tinder Users Are Risk Takers and Have Low Sexual Disgust Sensitivity. Evolutionary Psychological Science, 5(1), 104–108. https://doi.org/10.1007/s40806-018-0170-8

Sumter, S. R., Vandenbosch, L., & Ligtenberg, L. (2017). Love me Tinder: Untangling emerging adults' motivations for using the dating application Tinder. Telematics and Informatics, 34(1), 67–78. https://doi.org/10.1016/j.tele.2016.04.009

To Swipe, or Not to Swipe

Overall, as great as it feels to get a match on Tinder, it, sadly, will oftentimes not result in the love of your life, or a romantic relationship of much substance at all. That said, Tinder does provide an accessible way to quickly engage with like-minded people in your geographic area, something that has been particularly hard within the past year due to the COVID-19 pandemic. The transition in neural activity that occurs when our initial attraction develops into a deep-seeded, passionate love for someone is a complex one that we likely still do not fully understand. Tinder is a unique space in that it is the crossroads of our natural neural responses to the instant gratification stimuli that many social media apps provide with the complex and deeply emotional neural responses that occur when we think we may love someone. This technology deeply ingrains the idea into our psyche that we must be constantly searching for a mate, which, in my opinion, can cloud our appreciation for other pleasurable things in life. Tinder is just one of countless examples demonstrating how although technology is rapidly developing, it still cannot fully replicate or replace the human experience.



The Other Minds Within Oneself

By Milan Filo

When thinking about other minds, we naturally think about those that exist beyond our own. From turtles and mice to whales and perhaps even extraterrestrial beings, the other mind is considered to exist outside of us. The question remains, how can we know that other entities with emotions, feelings, and other mental characteristics exist beyond ourselves? The word solipsism comes from the Latin root solus that translates to "alone" and ipse meaning self. It is a metaphysical notion whereby only one's own consciousness is certain to exist. In other words, it is a philosophical position that states that awareness of something except one's own mind is uncertain and anything outside of one's own mind cannot be understood. Based on this concept, if we are unsure about what exists outside our own minds, how can we be sure that what exists within our own is certain? This article seeks to launch an investigation that looks deeper into our own mental landscape and explores the other minds within the mind that we consider our own.

Knowing the Self

When examining the first-person perspective, the Self can be thought of as the individual of one's own consciousness. Prior to development, infants already possess a primitive-instinctual form of Self before developing reflexive self-consciousness. There is no denying that as humans we have developed a multilayered neural-evolutive architecture of the Self. Carl Jung, a psychotherapist and psychiatrist, who helped to establish the discipline of analytical psychology in the early 20th century, proposed that archetypes were centrally important and universally distributed with regards to our mind's architecture.

Neuroscientific research confirms that a primitive type of subjectivity exists at the first layer of the brain hierarchy (the reptilian-paleomammalian instinctual brain). This subjectivity is broadly distributed across mammals and possibly other vertebrates, meaning that the concept of the Self and its recognition is not entirely unique to humans. Self-awareness has been tested in animals via the mirror self-recognition test. Although not all species are able to recognize that their reflection is their own, this should not eliminate the possibility that animals are self-aware as they are able to distinguish between their own and others' scents for example.

The Duality of Human Nature

Yet, the question remains, can our mind possess multiple levels of subjectivity that are entirely distinct from one another? For example, one might look at The Strange Case of Dr Jekyll and Mr Hyde written in 1886 by Scottish author Robert Louis Stevenson, around the same time that the idea of psychoanalysis started to receive attention. The Gothic novella explores psychological archetypes and the idea that two existing identities might inhabit one single body - a duality of consciousness and unconsciousness that motivate the behaviour and identity of one another. Through this literary example, we are prompted to reflect on the other components that make up our psyche when the individual perceives existences outside of its own conscious field. As Carl Jung carefully explains, 'the Self embraces ego-consciousness, shadow, anima, and collective unconscious in indeterminable extension' (Jung, 2020).

American Psychiatric Association. 2013. Diagnostic and statistical manual of mental disorders: DSM-5. Arlington, VA: American Psychiatric Association.
Jung, Carl Gustav. Psychology of the Transference:(From Vol. 16 Collected Works). Princeton University Press, 2020.
"Jung'S Model Of The Psyche!". 2021. Psychology: The Exploration Of The Mind. https://psychmajors.tumblr.com/post/41040080174.

Jungian Theory

The human psyche, according to Jung, is made up of a variety of distinct yet interconnected structures, whereby the ego represents the conscious mind as it contains the feelings, memories, and emotions that an individual is aware of at any given moment. Identity thoughts are primarily the responsibility of the ego.

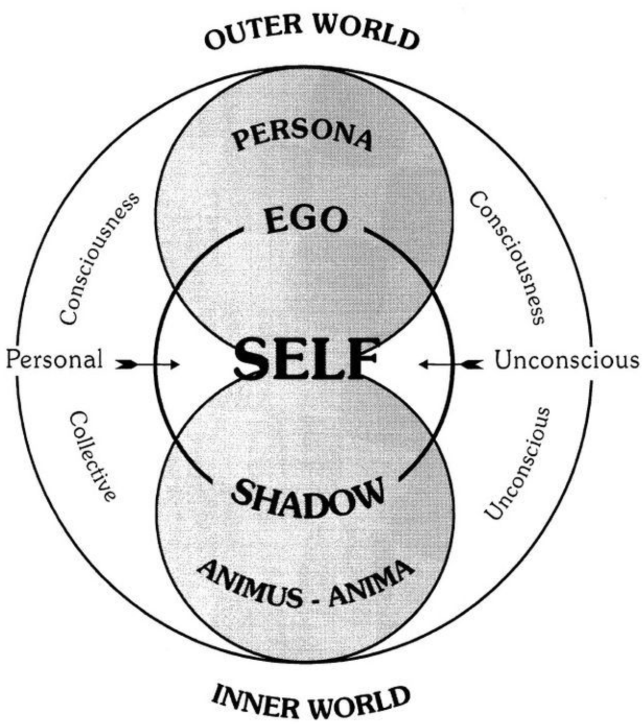


Figure 5: Jung's Model of the Psyche.

On a social level, according to Jungian theory, people may adopt multiple personas that they use in different contexts in order to appear more desirable, thought of as a mask that one would wear in front of others, ultimately concealing one's true identity (ego). Jung also argues against overusing personas out of fear of losing one's own personality. What's more interesting is someone's ability to develop multiple personas. If each persona has a different personality, are they all fragments of one whole or completely different segments of one's psyche? As described above, these ideas are purely psychological in nature. From the perspective of clinical neuroscience, what compelling evidence is out there that suggests that the human psyche can give rise to multiple centers of consciousness?

DID: Separate Centers of Consciousness and Identity

Dissociative identity disorder (DID) is a complex and highly contentious diagnosis that lacks a precisely empirical definition and has undergone many revisions since its recognition by the Diagnostic and Statistical Manual of Mental Disorders (DSM). DID has shown empirically that consciousness can generate numerous distinct centers of experiences working in parallel, with each center having its own sense of identity and personality. Symptoms of DID recognized by the DSM include a lack of identity as compared to distinct personality states, as well as loss of time, sense of self, and consciousness. In DID, alters is the term given to these distinct identities/ dissociated personalities.

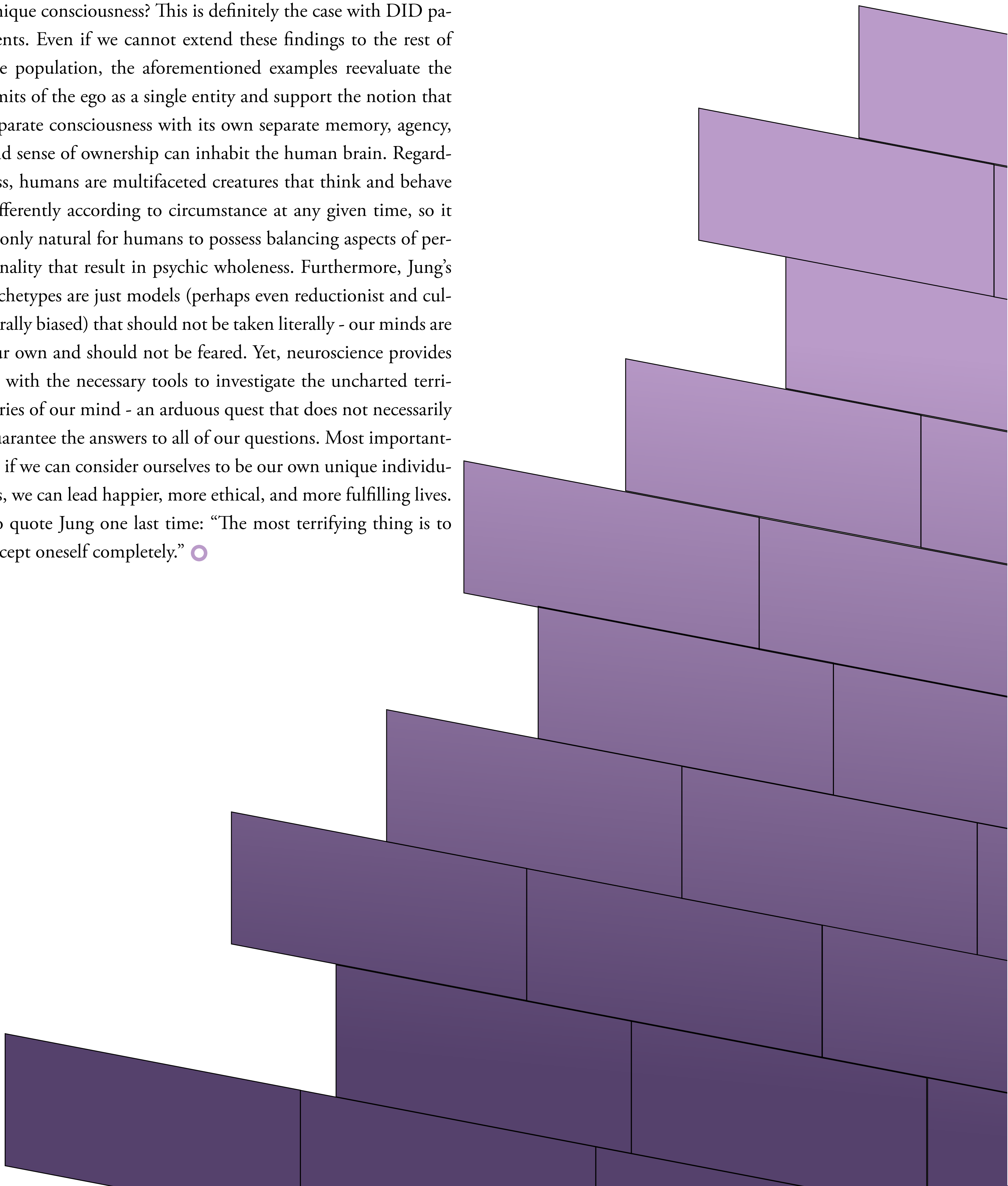
With the aid of magnetic resonance imaging (MRI), doctors conducted functional brain scans on both DID patients and healthy controls. The scans of the patients differed significantly from those of the controls, indicating that dissociation has a distinct neural activation pattern and a strong basis in the brain's structure (areas including the amygdala, the hippocampus, and the orbitofrontal cortex). This provides empirical evidence that this state of separateness produced by altering identities has a neurobiological basis and that the human psyche is continuously engaged in producing personal units of behavior.

Waldvogel et al. present the case of a woman that exhibited DID, with a variety of alters that claimed to be blind, indicating that a majority of her personality states had lost vision, whereas others had normal vision. After 15 years of misdiagnosing her cortical blindness, using electroencephalograms (EEGs), doctors found out that during periods when a blind alter was in charge of the woman's body, brain activity normally associated with sight was almost nonexistent. When an alter that claimed to see took over, regular brain function was present. This is another fascinating example of how each distinct dissociation had its own separate center of consciousness.

Neuroscience News. "Computers Can Spot the Difference Between Healthy Brains and Those with Dissociative Identity Disorder." Neuroscience News (blog), December 7, 2018. https://neurosciencenews.com/ai-did-brain-10312/.
Waldvogel et al. "Sight and blindness in the same person: Gating in the visual system." PsyCh Journal 4, no. 4 (2015): 178-185.

Conclusion

If such alters are considered to be concurrently conscious and identify themselves as distinct identities separate from the executive ego, can our mind be inhabited by more than one unique consciousness? This is definitely the case with DID patients. Even if we cannot extend these findings to the rest of the population, the aforementioned examples reevaluate the limits of the ego as a single entity and support the notion that separate consciousness with its own separate memory, agency, and sense of ownership can inhabit the human brain. Regardless, humans are multifaceted creatures that think and behave differently according to circumstance at any given time, so it is only natural for humans to possess balancing aspects of personality that result in psychic wholeness. Furthermore, Jung's archetypes are just models (perhaps even reductionist and culturally biased) that should not be taken literally - our minds are our own and should not be feared. Yet, neuroscience provides us with the necessary tools to investigate the uncharted territories of our mind - an arduous quest that does not necessarily guarantee the answers to all of our questions. Most importantly, if we can consider ourselves to be our own unique individuals, we can lead happier, more ethical, and more fulfilling lives. To quote Jung one last time: "The most terrifying thing is to accept oneself completely."



The Sanctity of Neuroscience

By Aakarsh Kankaria

The horizon shatters.

Ever so slightly at first, the night breaking into a thousand pieces of fractured heaven, flung outward and high across a blanket of green, the velvet glow melted by the shining morning star.

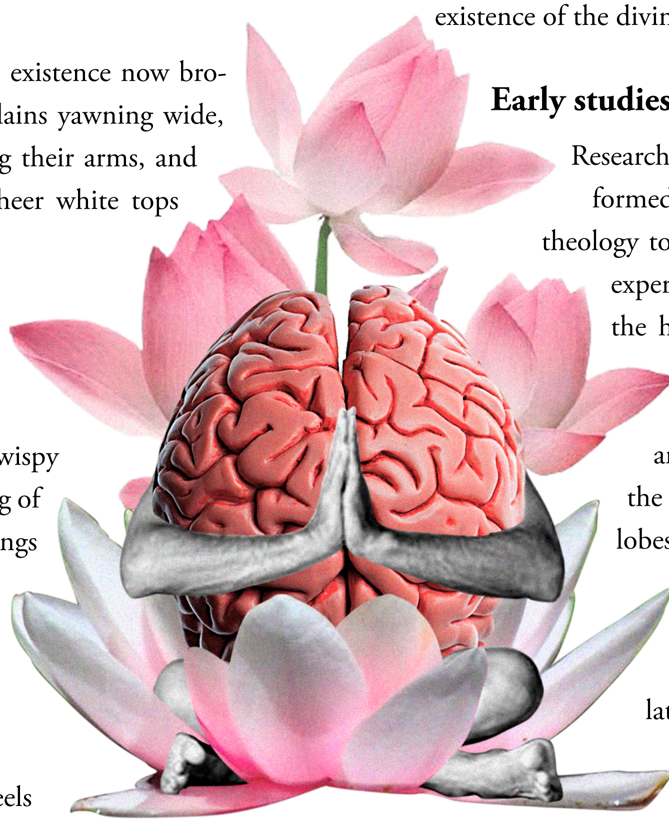
Life gleams.

With the dreary shell of human existence now broken, you see the green of the plains yawning wide, the conifers stirring and opening their arms, and the hills quivering in playful cheer white tops basking in merry.

Mirth abounds.

And peace calls out your name, long drawn and stretched on wispy white clouds, and into this feeling of serenity you enter, the heartstrings of your soul shaking awake that midnight lull.

You coalesce.



Is that what transcendence feels like? And if so, what are the neurological underpinnings of the religious experience? With advancing imaging technology and brain research, the ability to quantify and test how our minds respond to the divine presence of an *other* is becoming clearer. However, before launching into neurotheology, or the neuroscience of religion, the ethical implications of ongoing research must be addressed. Rapid development of neuroimaging techniques have reignited the age old debate between science and religion. Neuroscience is increasingly being used for speculative arguments that religious experiences are simply illusions of the cognitive activities of the brain. Current research has only investigated changes in the mind of ascetics, nuns, and devotees in the practice of God. As such, neuroscience cannot answer if God exists or not. Andrew Newberg, the director of the Marcus Research Institute of Integrative Health, puts it perfectly that "if we take a brain image of a person when she is looking at a picture, we will see various parts of the brain being activated. But the brain image cannot tell us whether or not there actually is a picture out there or whether the person is creating the picture in her own mind." Hence, this article will discuss relevant research in neurotheology without attempts to prove nor undermine the existence of the divine.

Early studies of Neurotheology

Researchers d'Aquili and Newberg performed the first experiments of neurotheology to test their hypothesis that religious experiences during meditation occur via the hyperactivation of the structures of the limbic system, specifically the amygdala and the hypothalamus. This hyperactivation results in the blockage of input into the parietal lobes of the brain[1]. Since parietal lobes are concerned with spatial perception and separation of the self from others, a blockage would cause isolation and an assumed experience of a higher power. To test their theory, they used functional magnetic resonance imaging (fMRI) to scan the brains of Tibentian monks and Catholic nuns during intense meditation and found increased activity in the frontal lobes, concerned with the ability to make decisions and foreseeing the future, and decreased activity in the parietal lobes. However, in another study which looked into the brains of those in Islamic prayer, found contradictory results. The frontal lobes showed lower activity than the parietal lobes. These findings suggest that religions differ widely in their schools of thought and the theory that spiritual experiences could be distilled into underlying common neural mechanisms still remains unclear. Even though such studies contain controversial

1 D'aquili and Newberg, "The Mystical Mind."

claims, the d'Aquili and Newberg project opened the field of neurotheology and provides the opportunity to bridge the gaps of cognition, philosophy, and anthropology.

Transcendence

How do brains respond to the evocative metaphysical experience of being one with God, of feeling the Holy spirit? Dr. Jeff Anderson from the University of Utah has published a study that seeks to answer this very question[2]. His team of researchers examined the brains of 19 Mormons during profound religious experiences of oneness. Michael Ferguson, the co-author of the study said, "when our study participants were instructed to think about a savior, about being with their families for eternity, about their heavenly rewards, their brains and bodies physically responded." Indeed, fMRI scans showed increased activity in the nucleus accumbens, frontal attentional and ventromedial cortical loci. These structures are regarded as the reward and pleasure systems of the brain, all of which are activated during sex, love, and drugs, and are meant to reinfornce positive feelings and warmth. The study raises the undeniable question: if we stimulate areas of the brain, is it possible to recreate the other's presence? The "God-Helmet" answers this question.

The Fallacious "God-Helmet"

Dr Michael Persinger, of the Laurentian University in Canada, hypothesized that the presence of the other can be felt by stimulating electrical activity in specific areas of the brain[3]. He claims that since the sensation of the self lies in the right hemisphere, magnetically stimulating the temporal lobe in the left hemisphere causes transient electric impulses that induce the subjective experience of feeling the other. To support this theory, he devised a "God-Helmet" that uses Transcranial Magnetic Stimulation (TMS) to stimulate the other in the brain. Participants did not know whether the Helmet was active and were asked to press a button if they felt the presence of a higher power. The study results showed that 80% of the study participants tested reported the presence of some kind, but claimed it wasn't the divine. This study received vast media attention, however, it contains several controversial claims and demonstrated scientific and methodological flaws. First, a study is only considered scientifically valid if its results can be duplicated in a similar experiment. In a double blind experiment, Granqvst and his team of researchers conducted a similar TMS study and found no statistically significant results[4]. They concluded that Persinger's results were flawed due to high suggestibility of experiencing the mystical. Second, traditional TMS research uses magnets on the order of one or two teslas. However, Persinger used magnets of the magnitude of microtesla to stimulate electrical impulses. Hence, it remains unclear whether low magnetisation can stimulate significant firing of neurons.

Future of Neurotheology

Some critics of neurotheology argue that, due to the experimental and design flaws of neurotheology research, religion is too complex and nuanced to be studied by simply taking a scan of the brain. Evan Thompson, a philosophy professor of the University of British Columbia, says that "when we study the brain, we're interested in how it enables human cognition generally. And if we want to understand religion, we need something like anthropology.[5]" However, in unraveling human behavior, neuroscience remains paramount in understanding why we do certain things the way we do. Uffe Schjoedt, of the department of the study of religion in the University of Aarhus, provides insights into how the field of neurotheology can hold scientific validity, "it will be necessary for future studies to use well-established theories of brain function for interpretation rather than developing new controversial hypotheses on mechanisms supposedly unique to religious experience." and "experimental neuroscience must take the diversity of religious thought and behaviour into account in order to understand the complexity of religion and to give a realistic account of distinct religious practices and experiences.[4]"

What is the *other*? The word itself is filled with ambiguity and dread. It might seem something foreign, alien, something unattainable, something you ought to be afraid of. Neurotheology is not meant to widen the gap between science and religion but in studying this *other*, or the unknown, and infusing it with the mind through understanding, we unravel questions. Questions that will propel us to the highest star, to the deepest sea, and to the very precipice of human knowledge, so that one day the *other* is not so scary anymore. Hence, my dear readers, stay curious.

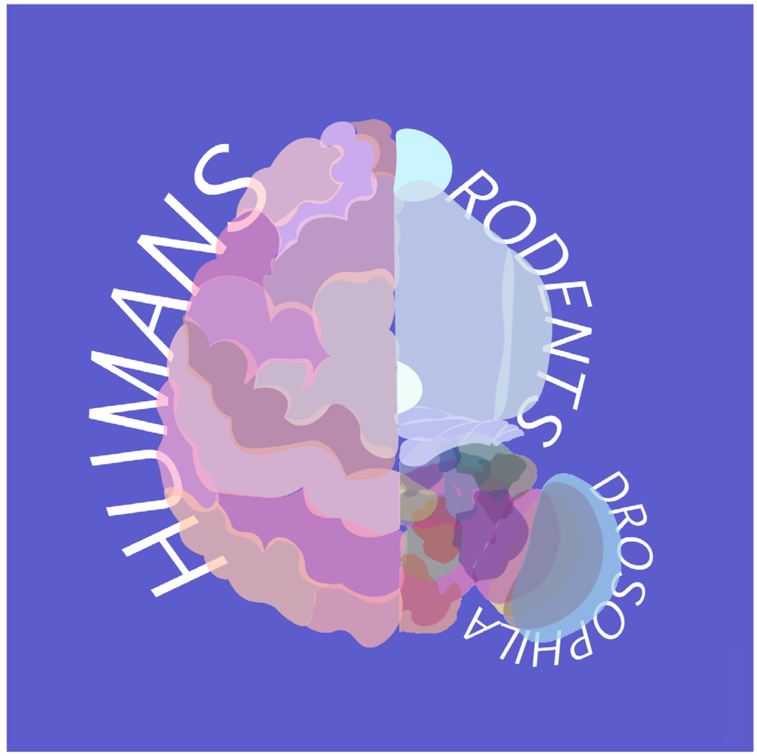
2 Ferguson et al., "Reward, Salience, and Attentional Networks Are Activated by Religious Experience in Devout Mormons."
3 "Introduction to the God Helmet. | Spirituality and The Brain."
4 Schjoedt, "The Religious Brain."
5 "The Neuroscience Argument That Religion Shaped the Very Structure of Our Brains."

How We Sleep

Exploring Sleep Among Common Animal Models

By Lilian Zhang

While its exact function and role remains unknown, the importance of restful sleep is incontestable. Lack of sleep leads to impaired cognitive function, an increased drive to sleep, and can have long-lasting impacts on health. It has been implicated in a variety of roles including waste clearance, metabolic health, brain recovery, and macromolecule synthesis.



Graphic by Lilian Zhang

It is therefore essential to gain a nuanced understanding of the kind of sleep experienced by the animals we research. This general overview of sleep states in key animal models is essential to understanding current research regarding differences in sleep in each species.

Rodents

Perhaps the most prevalent animal model for sleep are rodents. Rats and mice are the most commonly used, with two distinct stages of sleep: non-Rapid eye movement (nREM) sleep, and rapid eye movement (REM) sleep. Defined predominantly through electroencephalographic (EEG) and electromyographic (EMG) studies, nREM is classified as a stage of sleep associated with slow sleep wave oscillation in the neocortex, sharp wave-ripples (SWRs) in the hippocampus, and a decrease in cerebral blood flow in humans.[1] REM sleep, however, is characterized by EEG and EMG activity resembling alert waking behavior — reduction in sleep wave amplitudes, loss in muscle tone, and random rapid eye movements. Often called "dream sleep," human subjects aroused from the REM-stage have reported having experienced vivid dreams.[2]

Humans cycle through periods of nREM and REM stages throughout the course of their 6-8 hour sleep; similarly, rodents cycle through the same pattern, but in a prolonged sleep duration of up to 14 hours. Studies done in the neocortical and hippocampal regions of the rat's brain show that rodents do exhibit similar SWRs and slow oscillations during nREM sleep. As in humans[3], rodent REM sleep is also homeostatically regulated, and proposed to be coupled to the amount of nREM sleep experienced, with the total percentage of nREM sleep and power of slow-wave activity (SWA) in REM sleep increasing during periods of REM sleep deprivation.[4]

These similarities in rodent and human models of sleep make mice and rats ideal candidates for the study of sleep disorders including insomnia and narcolepsy. Genetic engineering of mice has enabled researchers to breed mouse strains that exhibit characteristic phenotypes of such disorders. For instance, the inbred mouse strain DBA/2J may be a promising mod-

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2 Cirelli, Chaira, and Daniel Bushey. "Sleep and Wakefulness in Drosophila Melanogaster." Annals of the New York Academy of Sciences 1129, no. 1 (June 28, 2008): 323–29. https://doi.org/10.1196/annals.1417.017.

3 Dang-Vu, T.T., M. Desseilles, P. Peigneux, S. Laureys, and P. Maquet. "Sleep and Sleep States: Pet Activation Patterns." Encyclopedia of Neuroscience, 2009, 945–51. https://doi.org/10.1016/b978-008045046-9.00056-5.

4 De la Herrán-Arita, Alberto K., Magdalena Guerra-Crespo, and René Drucker-Colín. "Narcolepsy and Orexins: An Example of Progress in Sleep Research." Frontiers in Neurology 2 (April 18, 2011): 2–26. https://doi.org/10.3389/fneur.2011.00026.

el for insomnia, as it exhibits fragmented sleep and a greater overall time awake during a 24-hour period.[5] Mice models for narcolepsy have been genetically engineered to lack orexin, a neuropeptide crucial for control of appetite, sleep-wakefulness, and neuroendocrine homeostasis.[6,7] Consequently, these mice show fragmented nREM periods, greater amounts of REM sleep, and decreased latency to REM sleep in active phases of their sleep-wake cycle.

However, while these strains serve as invaluable tools to study human sleep disorders, there are differences between human and rodent sleep. Aging alters the body's sleep pattern, with older human subjects experiencing a decreased drive to sleep.[8] In mouse models, the opposite is true, with older mice having an increased number of longer nREM sleep durations. Analysis of EEG data indicate that sleep waveforms in older mice resemble the effects of sleep-deprivation, suggesting mice experience less restful sleep as they age, leading to the inability to reduce sleep pressure and consequent increase in sleep.

These differences may suggest changes in fundamental sleep architecture with age along different pathways for humans to rodents. However, this does not discredit the effectiveness of mice as a model for sleep disorders as these differences could be attributed to differences in circadian rhythms of the two organisms or the size of neuronal populations recorded.[8]

Flies

Sleep in Drosophila is a different matter. Their relatively smaller genome and short life cycle make flies ideal for genetic studies and mutagenesis screens, allowing researchers to investigate effects of single genes on sleep. However, while fly sleep appears to differ initially from mammalian sleep, both can be characterized by three main criteria: behavioral quiescence, homeostatic drive, and circadian regulation of sleep.[9]

Behavioral quiescence defines a period of reduced responsiveness to external stimuli. This quiescent period must be reversible to distinguish sleep from coma, while the threshold to arousal must be high to distinguish sleep from quiet wakefulness. In motoring fly behavior with visual observation, ultrasound, and an automated infrared system, it was found that flies show sustained periods of immobility with reduced responsiveness to stimuli over the course of the night. Interestingly, these sleep periods in flies differ from humans in duration — rather than a single sustained period of sleep over the course of the night, sleep in flies is defined in short periods of behavioral quiescence lasting at least 5 minutes.[10]

Like humans, flies experience a period of increased drive to sleep (sleep rebound) following sleep deprivation, reflecting a homeostatic drive to sleep. As in mammalian sleep, flies experience an increase in arousal threshold above baseline levels following sleep deprivation, indicating deeper sleep periods. Recovery sleep following sleep deprivation is also associated with fewer brief awakenings and impaired memory in certain mutants.[9]

Flies also have a circadian rhythm, sleeping mainly at night. In flies that have had circadian genes (Cycle, Per, Clock) mutated, sleep is increased to the entire 24-hour period.[10] This can be distinguished from homeostatic sleep, as the same sleep rebound occurs following sleep deprivation in these mutant flies as well.

There are, however, key differences between mammalian and Drosophila sleep. While nREM and REM sleep stages are not defined in flies, proboscis extension sleep has been proposed to be a deep sleep stage instrumental in waste clearance. The proboscis, the fly's feeding organ used for taste and digestion, extends spontaneously during active waking periods. In sleep, however, it has been observed that flies demonstrate a proboscis extension followed immediately by retraction even in the absence of gustatory stimuli.[11] During periods with bursts of proboscis extensions, flies show increased arousal thresholds and

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9 Moosavi, Maryam, and Gholam Reza Hatam. "The Sleep in Caenorhabditis Elegans: What We Know Until Now." Molecular Neurobiology 55, no. 1 (January 11, 2017): 879–89. https://doi.org/10.1007/s12035-016-0362-9.

10 Nath, Ravi D., Claire N. Bedbrook, Michael J. Abrams, Ty Basinger, Justin S. Bois, David A. Prober, Paul W. Sternberg, Viviana Gradinaru, and Lea Goentoro. "The Jellyfish Cassiopea Exhibits a Sleep-like State." Current Biology 27, no. 19 (September 21, 2017). https://doi.org/10.1016/j.cub.2017.08.014.

11 Nichols, Annika L., Tomáš Eichler, Richard Latham, and Manuel Zimmer. "A Global Brain State Underlies C. Elegans Sleep Behavior." Science 356, no. 6344 (June 23, 2017). https://doi.

decreased local field potential power in electrical recordings of neurons, suggesting a discrete deep sleep stage. In experiments where flies were fed luciferin, a light-emitting molecule, and then subsequently were prevented from extending their proboscis, the flies were slower to clear the injected dye and were more likely to die following high-impact trauma assays. This suggests that this distinct sleep stage and the proboscis extensions in it are crucial for the role of sleep in waste clearance.

C. Elegans

C. elegans, famously the subject of the connectomics project to map and model the worm's entire nervous system, offers the ideal organism for investigating the neuronal circuitry of sleep. Sleep in nematodes is well defined as two states: developmentally-timed sleep (lethargus), and stress-induced sleep (SIS).[12] Lethargus, a developmental stage that occurs before larval molts, is associated with behavioral quiescence, characteristic relaxed body posture, and reduced neuronal activity. During lethargus, worms stop feeding and maintain increased arousal thresholds.[13] In lethargus, the worm experiences alternating bouts of locomotion and quiescence, ranging from 2-100s.[12] Lethargus is homeostatically regulated, with deprivation of developmentally-timed sleep potentially lethal to the worm.

However, normal bouts of sleep in lethargus is not essential to survival. Studies have shown that deprivation of developmentally-timed sleep alone does not lead to death. Coupling sleep deprivation along with mechanical perturbation instead induces death, with sleep deprivation contributing to inability to overcome environmental stress.[14]

SIS occurs following stimuli causing cellular damage and stress. Conditions including excessive heat, mechanical perturbation, chemical toxins, infection, and starvation can induce SIS in worms. Like lethargus, SIS is associated with increased arousal thresholds, termination of feeding, behavioral quiescence, and reduced neuronal activity. However, while lethargus occurs at specific developmental stages of the worm's life cycle, SIS can be induced any time in response to environmental stressors.[12] C. elegans therefore offer researchers a great degree of control over its waking or sleep states, with experiments inducing sleep through mechanical stimulation,[15] microfluidic chambers,[16] oxygen levels,[17] and chemical treatments.[18] This manipulation allows for research into neuronal control of wake or sleep, investigating the connections leading to this "switch" of the global brain state.

While sleep can generally be characterized as a period of behavioral quiescence regulated by homeostatic control, sleep across the animal kingdom is widely differentiated. While this article provides an overview only on mammalian and invertebrate models of sleep, further research currently being done on fish,[19] avian,[20] and Cnidarian[21] models of sleep may offer new perspectives to our current understanding of sleep. Together, these models join to shed light on the complexity of a fundamental and essential, yet diverse physiological state.

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13 Panagiotou, Maria, Vladyslav V. Vyazovskiy, Johanna H. Meijer, and Tom Deboer. "Differences in Electroencephalographic Non-Rapid-Eye Movement Sleep Slow-Wave Characteristics between Young and Old Mice." Scientific Reports 7, no. 1 (March 3, 2017). https://doi.org/10.1038/srep43656.

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15 Peever, John, and Patrick M. Fuller. "Neuroscience: A Distributed Neural Network Controls REM Sleep." Current Biology 26, no. 1 (January 11, 2016). https://doi.org/10.1016/j.cub.2015.11.011.

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19 Toth, Linda A, and Pavan Bhargava. "Animal Models of Sleep Disorder." Comparative Medicine, April 2013, 91–104.

20 van Alphen, Bart, Evan R. Semenza, Melvyn Yap, Bruno van Swinderen, and Ravi Allada. "A Deep Sleep Stage in Drosophila with a Functional Role in Waste Clearance." Science Advances 7, no. 4 (January 20, 2021). https://doi.org/10.1126/sciadv.abc2999.

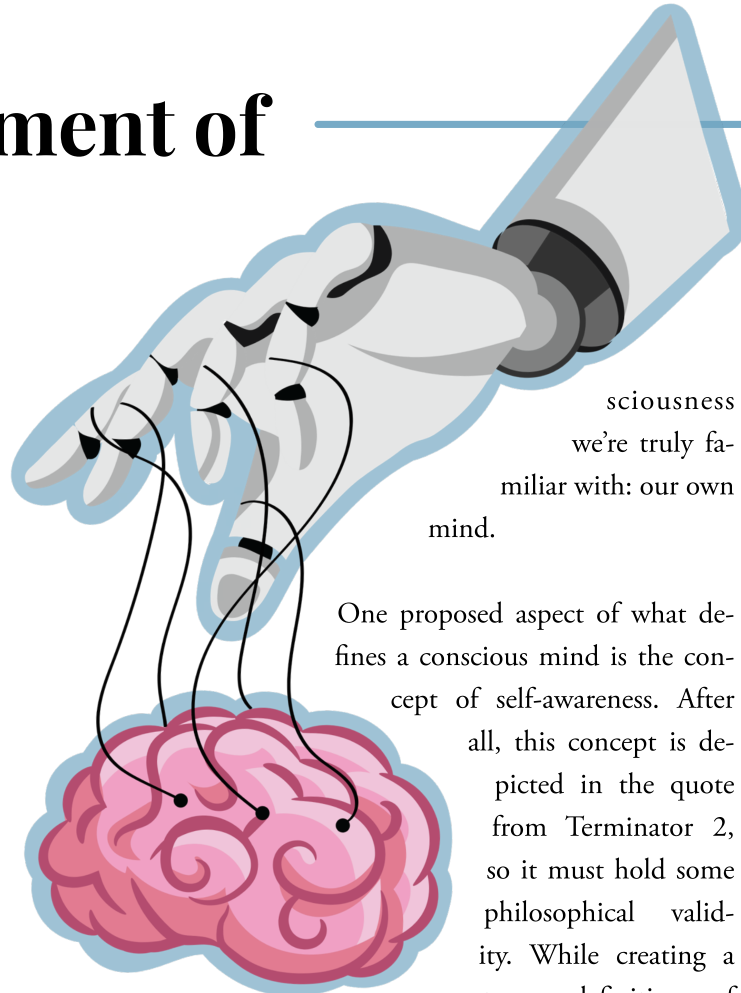
21 van der Meij, Jacqueline, Dolores Martinez-Gonzalez, Gabriël J. Beckers, and Niels C. Rattenborg. "Neurophysiology of Avian Sleep: Comparing Natural Sleep and Isoflurane Anesthesia." Frontiers in Neuroscience 13 (March 28, 2019). https://doi.org/10.3389/fnins.2019.00262.

Other Technology

Art by Allison Chen

AI and the Development of the Artificial Mind

By Alex Soliz



“The Skynet Funding Bill is passed. The system goes online August 4th, 1997. Human decisions are removed from strategic defense. Skynet begins to learn at a geometric rate. It becomes self-aware at 2:14 a.m eastern time, August 29th. In a panic, they tried to pull the plug.”[1]

– The Terminator, Terminator 2: Judgement Day

The concept of a machine capable of thought has been an idea floated around by philosophers for centuries. While the original concepts seemed to differ from the conceptual pieces we’re familiar with in today’s science fiction, these machines have been in development for nearly a century since the birth of computers. However, modern AI implementations still stand far from what one could call sentient, so much so that we won’t need to worry about the first terminator for quite some time. Despite the ethical concerns (a topic that would struggle to fit in its own book), the theoretical idea of a conscious computer is an extraordinarily complex topic, which requires us to understand what it even means to be conscious.

Understanding What Defines a Conscious Entity

Defining the term “conscious” is something that philosophers and cognitive scientists have struggled with for quite some time. For something that stands as possibly the most integral feature of human life, it’s almost comical how elusive it remains to us. The reason it poses such a challenge to define originates from the fact that the only experience or true understanding of what constitutes a mind is through our own perceptual experience of being conscious (often referred to as a “phenomenal” experience). This produces an interesting problem: given a possibly sentient being (that isn’t human), how can we truly identify if it holds consciousness, or instead creates an illusion of consciousness? In order to better understand how to answer this question, the best approach is to look at the only example of consciousness we’re truly familiar with: our own mind.

One proposed aspect of what defines a conscious mind is the concept of self-awareness. After all, this concept is depicted in the quote from Terminator 2, so it must hold some philosophical validity. While creating a strong definition of self-awareness can be almost as difficult as defining consciousness, it can be summarized as an explicit knowledge of the self and the knowledge of what an entity knows.[2] With this, an entity would know what it knows, which would enable it to categorize a given problem with its known capabilities, transforming a learned behavior into an applicable skill.[2] This seems to greatly fall in line with human consciousness, which in turn, can be used as a template definition of consciousness.

With these concepts in mind, an even more significant question is raised: how can these processes be constructed? Recalling that one of the main problems of consciousness is that it’s a phenomenal experience, the only feasible method is reconstructing our own methods of consciousness. There are many approaches to this problem, one of them originates from the concept of symbolic representation. Symbolic representation states that the mind holds information through symbols, and thought is the mental manipulation of these symbols.[3] What this means in terms of human consciousness and cognition is that objects and ideas are stored in mental representations rather than definitive mental images.[3] These symbols, or tokens,

1 https://www.imdb.com/title/tt0103064/characters/nm0000157
2 https://www.frontiersin.org/articles/10.3389/frobt.2018.00088/full
3 https://www.sciencedirect.com/science/article/pii/0167278990900876

have characteristics and features that guide how they interact with one another, and in turn, relate to how their physical counterparts interact. With this theory, an entity can create a symbol representing itself and associate it with other symbols that relate or define its own knowledge, solving the self-awareness problem.

While a seemingly solid theory, symbolic representation stood as one of the leading theories in cognitive science until philosopher John Searle opposed it with the Chinese Room Argument.[4] This argument creates a hypothetical room, where Chinese characters are given as an input, and an entity must consult a collection of rules to figure out what the correct output is. In this context, the Chinese characters are (just as in any language) symbols for a deeper meaning. However, in this hypothetical situation the entity has no knowledge of what the symbols represent, only access to information on what to output when given a specific input. This thought experiment highlights a significant issue with symbol processing: an entity is capable of successfully representing its inputs symbolically yet lacks any understanding of what it actually means. This is often referred to as the symbol-grounding problem and has pushed some cognitive scientists towards other theories of information processing.

A significant rival to symbolic representation known as connectionism has recently reemerged, which follows a much more neurological approach and has inspired some of the most recent developments in artificial intelligence. Connectionism explains these functions of the brain through one of the most fundamental and atomic brain structures: neural networks.[2] A connectionist system consists of a large number of simple yet highly connected "units", or neurons.[5] These individual units receive valued activity (either excitatory or inhibitory) input from their connections, sum this activity, and change their state as a function of this sum (usually depicted as a threshold, these neurons fire when the threshold is surpassed).[5] Each individual unit is able to modify how it reacts to a given input through two properties called weights and biases.[5] These weights and biases are the key to how neural networks function, as it allows specific connections to strengthen or weaken depending entirely on its error and the basis of new inputs (this is the founding idea of backpropagation).[3] This creates a system capable of recognizing patterns, solving problems, and even learning.[3]

While connectionism holds great merit (especially considering its fundamental intrinsic relationship with neurological function), it still has its fair share of criticism. While this model seems to accurately mirror how a brain functions, it makes an assumption of high interconnectedness (a significant part of connectionism).[6] This assumption isn't always the case, as other information processing models argue that the mind contains relative modularity.[6] There also have been arguments that connectionism itself is a symbol model, which brings its own associated problems along with it.[3] For instance, the connectionist model doesn't seem to address the symbol-grounding problem, as a neural network can backpropagate appropriately without fully understanding the context of why its change is important or what it actually means. While this model seems to be imperfect in certain aspects, connectionism still stands as a plausible and proven effective method of processing information.

Current AI

With a basic understanding of how human information processing functions, a clear look at how current artificial intelligence methodology can be understood in the context of consciousness. One of the more recently prominent methods in the field of artificial intelligence is the method of deep learning, which utilizes a simulated connectionist model. Utilizing a created neural network, a deep learning model contains a network of nodes, each with their own connections to other nodes.[7] These connections can then be strengthened or weakened depending on the values and biases a node has, which can be changed through backpropagation.[8] Collectively, this method creates an extremely powerful method of handling a specific task; in most cases, these tasks are handled more effectively and significantly faster than human capabilities.

However, while deep learning stands as an effective tool, it remains as just that: a tool. This distinction between the ability to handle a single problem and generalizing its knowledge in order to apply it to a new problem is known as the distinc-

4 https://plato.stanford.edu/entries/chinese-room/
5 https://www.sciencedirect.com/science/article/pii/0010027788900315
6 https://www.sciencedirect.com/science/article/pii/0749596X88900745
7 https://towardsdatascience.com/classical-neural-network-what-really-are-nodes-and-layers-ec51c6122e09
8 http://neuralnetworksanddeeplearning.com/chap2.html

tion between weak AI and strong AI.[9] Deep learning models can handle a specific task with remarkable speed and accuracy, yet still lack any concept of self-awareness or a solution to the symbol-grounding problem. To elaborate, these models are incapable of understanding the context between its given inputs and outputs, and even more so, any understanding of itself and its skills in a way that can be applied to new problems. Because of these two points, deep learning models still hold substantial distance from consciousness, even if they mimic human neural interaction.

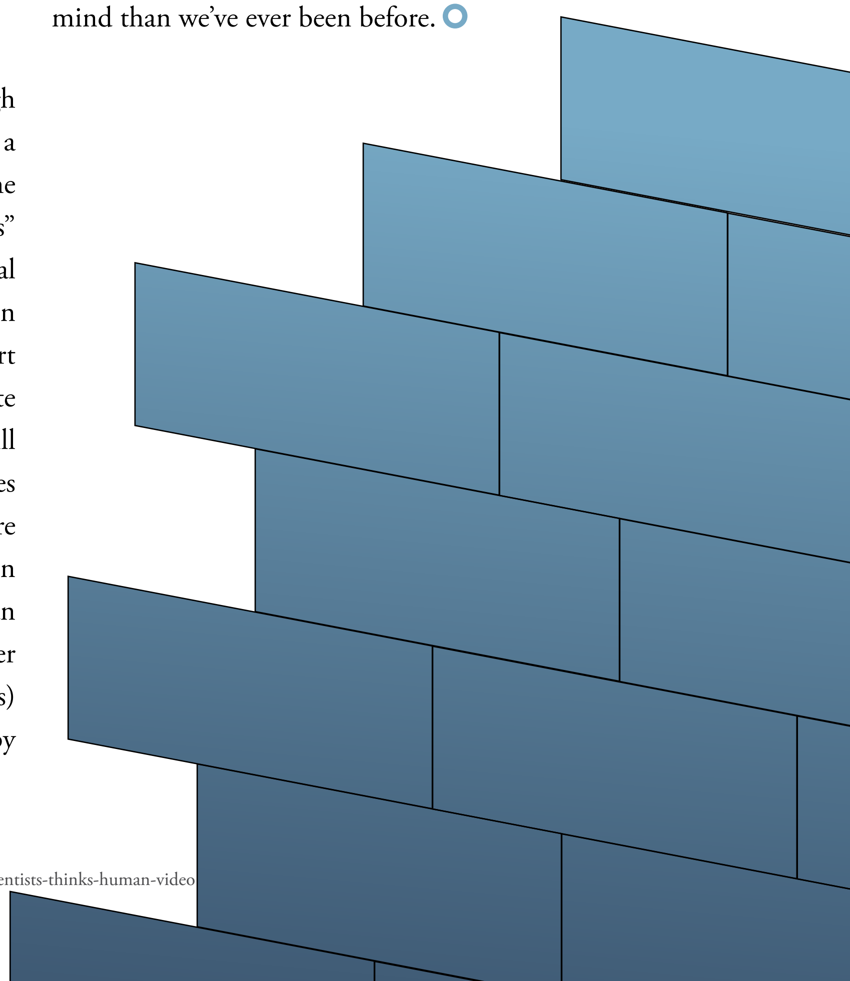
Future AI Development and Consciousness

While deep learning models lack certain key functions of consciousness, there do seem to be extraordinary correlations between these models and the modularity of the human brain. More specifically, there is evidence that a convolutional deep learning model for vision has remarkable similarities in patterns it creates in its network and patterns in voxels in the visual cortex, even while the deep learning model lacks context on the images.[10] This particular finding could possibly demonstrate the modularity of the mind and be a key factor to not only further our understanding of cognition, but possibly propose that deep learning may stand as a weak AI, but could potentially be a significant piece of a functional strong AI.

An interesting application of this approach can be seen through Spaun, a model containing 2.5 million simulated neurons, a simulated eye, and a virtual arm.[11] This creation utilizes the concept of modularity in the brain, with separate "regions" dedicated to specific tasks (specifically a simulated prefrontal cortex, basal ganglia, and thalamus).[11] With these tools, Spaun is capable of reading numerical input, performing some sort of learned calculation, and then controlling the arm to write the solution. [11] While this demonstration of modularity still lacks the key components of consciousness, it demonstrates a proof of concept in the plausibility of simulating an entire human brain. However, the key point to denote is that Spaun contains only 2.5 million simulated neurons, while the human brain contains 6.5 billion. This shows that the great limiter in a simulated brain is (as in most computational problems) a matter of computational power and the limitations set by modern technology.

Concluding Thoughts

As seen above, the concept of a conscious machine is a much more convoluted topic than one would likely expect. While current deep learning methodology mirrors neural activity, it lacks the key components of self-awareness and informational context, which creates the distinction between weak AI and strong AI. However, creating a theoretical strong AI seems to look much like an exceptionally complex game of telephone; our concept of consciousness originates from our personal understanding of consciousness, an elusive concept which comes with much distortion and imperfection. This is then passed to our understanding of how the brain represents information, a still widely debated topic in cognitive theory which holds its own errors and problems along with it. This is then finally passed to a computational reconstruction of that representation, which is not only limited in the accuracy of its implementation, but by computational power as well. With each step in the process, more and more error is introduced, which by the end leaves us with something far from where we started (much like the game of telephone). Nevertheless, the recent progress seen in deep learning shows that these distortions are minimizing, and when considering how far AI research has progressed in recent years, we are significantly closer to a true artificial mind than we've ever been before.



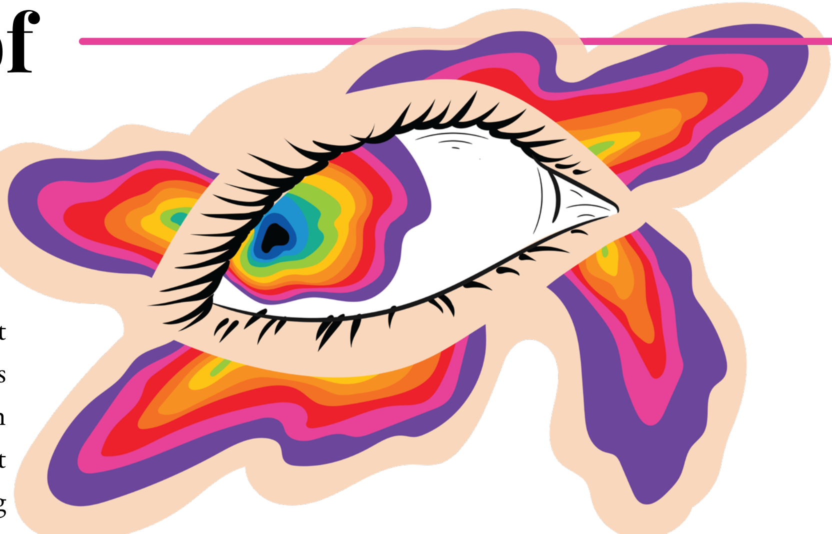
9 https://www.ibm.com/cloud/learn/strong-ai

10 https://www.sciencedirect.com/science/article/pii/S0010027720301840

11 https://www.pri.org/stories/2012-11-30/spaun-simulated-human-brain-built-canadian-scientists-thinks-human-video

The Embodiment of Color Perception

By Nehchal Kaur



Hermann von Helmholtz, a German physicist claimed that we do not have direct access to the world and its constituents (Patton, 2018). We can only access the events they lead to in our brains. For example, looking at the sky and realising that there is a full moon most notably involves processes of sensing the visual stimulus, perceiving the image so formed on our retina, recalling and recognizing it as a full moon, among others. Each of these processes, albeit related to an external object, are occuring inside our brains. Thus, 'encapsulated by our body', there is no way for us to escape and interact with the world outside of these bounds. Although, there has been quite a lot of debate around this perspective, specifically with the idea of an encapsulated brain, it inadvertently seems to support certain philosophical and psychological propositions of how humans experience life that ascribe a certain romance to the idea. To begin with, qualia is a term used to define a conscious experience that is by nature subjective and specific to each individual. Considering that we are in fact inside our skulls instead of the other way round, 'we' are the brain. It could then be argued that qualia result from the fact that we are only able to sense effects instead of external objects themselves. Further, this approach brings to mind the efficacy of the realisation that extends the experience of qualia to the fact that the uniqueness of our own human experience is reflected in everyone else's; the realisation that 'everyone has a story as vivid as our own', as captured by the word Sonder. However, perhaps the most important implication it may hold is that the body and the senses that come with it define bounds for the brain in a way that conclusively affects cognition.

Deriving from old philosophical debates of the mind-body duality, the concept of embodied cognition implies that the body is not a peripheral or secondary attribute, nor is it separate from what the brain can achieve (Leiten & Chaffey, 2014). The perceptual and the motor systems, the environment in which they develop, and how they eventually come together to contribute to the structure of the organism, all are understood to affect cognition, in much the same way that cognition is expected to affect all these in turn. As Aristotle said, "The whole is greater than the sum of its parts." Cognition – in equal parts – arises from both the body and the brain. Not least because of being a sub-process of the cognitive operation, but also due to having direct links with the physical senses that act as windows to the outside world, perception is then also straightforwardly embodied.

Understanding that our perception is likely to be influenced by the body that is doing it, provides us with a method through which we are better able to explore the complex cognitive architectures displayed by the diversity of the animal kingdom. It has, for instance led to our appreciation of the superiority of color perception that is seen in a wide variety of animals as a result of their remarkable bodies. An exemplar of such existences is the mantis shrimp. The mantis shrimp is a carnivorous animal with a deadly sting and has a lifespan of about 3-6 years. The characteristic that sets it apart from other arthropods and in fact, from any other living species, is its eyes. It has two compound eyes on stalks that can move independently, each of which have 12-16 types of photoreceptor cells as compared to the 3 that the majority of humans display. This leads to the development of one of the most complex visual systems known to man. Their visual system can perceive light ranging from deep ultraviolet (UVB) to far red (300 to 720 nm). Although they cannot discriminate between wavelengths as well as humans

Graydon, O. (2009). An eye for inspiration. Nature Photonics, 3(11), 668–668. https://doi.org/10.1038/nphoton.2009.211
Leitan, N., & Chaffey, L. (2014). Embodied Cognition and its applications: A brief review. Sensoria: A Journal of Mind, Brain & Culture, 10, 3–10. https://doi.org/10.7790/sa.v10i1.384
Criado, L. (2017, January 12). NEIL HARBISSON, viewing colour through a spectrum of sound waves | CLOT Magazine. https://www.clotmag.com/body-sculptures/neil-harbisson
OSA | Bio-inspired color-polarization imager for real-time in situ imaging. (n.d.). Retrieved May 9, 2021, from https://www.osapublishing.org/optica/fulltext.cfm?uri=optica-4-10-1263&id=375131

do, i.e. they might not be able to tell many hues apart, they are able to detect polarised light. Briefly, non-polarised incident light like sunlight travels through electromagnetic vibrations that occur in all directions perpendicular to its propagation. When light gets polarised due to polarizers, like being reflected off of fish scales, in contrast, it displays vibrations in a single plane. The special feature of being able to detect flat as well as circular polarised light holds survival value for the mantis shrimp inside water where they are able to see organisms better against the backdrop of non polarised light. The system thus leads to a vivid perception of the world that is unimaginable to us, yet (Thoen et al., 2014).

Evidently, how the mantis shrimp will perceive color is embedded in its bodily structure. While matter that makes up an object is inherent to it, color as a property is embedded in the method that is used to examine it. It is not intrinsically originating from the 'truth' of the object. Furthermore, it has been securely established to be influenced by cultural backdrops and differences in language by previous research (Roberson et al., 2005; Regier & Kay, 2009). However, it is safe to attribute much of the flux secured to the act of its perception to the body committing it. Perception with regards to color is so fluid in fact that it has been exemplified to be derivable from features besides the visual, going beyond an object's interaction with light.

Along a similar trend, Neil Harbisson is a Spanish native who identifies himself as a Cyborg and is the first person in the world to be officially recognised as one by a government. Born with achromatic vision, he built an antenna that has permanently been implanted into his occipital bone which allows him to 'see' and 'feel' colors through audible vibrations. He thus cannot understand the visual aspect of color but he is able to hear and form associations between sounds and the light frequencies they are mapped to. His perception of color, or rather the association with the perception is, as a result, widely different from the cultural ideas we would have. For example; the color that soothes him the most because of it's low frequency, would be red, as opposed to the traditional blue (that people associate with skies and seas). It influences not just the way he sees and paints the world but also how he thinks and consequently has an impact on his mental environment; mood, emotions and so on (Criado, 2017).

Color perception is suggestible, prone to framing effects, known to display metamer mismatching (colors appearing same in one light and different in another) and sometimes arises as a perceptible feature of things otherwise not associated with specific colors (as in synesthetes). These attributes already question its constancy and also how inherent it is to the psychological features of an object. Adding to such dynamism of color perception, the act also stands as a testament to how intelligence is not limited to human superiority in the food chain. Take the mantis shrimp from our previous discussion. Since they can detect as well as broadcast circular polarised light, this not only forms a channel of private communication unique to their species but may also help detect cancer at earlier stages. Recent research shows that unhealthy tissue in the human body reflects polarised light differently from healthy tissue and this sign occurs before other symptoms do (Garcia et al., 2017). Their special mechanism has also inspired camera lenses and smart vision devices (Graydon, 2009). So, besides spectacular medical advancements, this also begs the discourse of whether our advancements in robotics and neurotechnology are able to strive for and finally achieve such intelligence? If we do, would it genuinely change the novelty of the experiences we come across in our lives as supplemented by color?

Mary's room is a philosophical thought experiment that provides an interesting context to such questions. It describes a scientist, Mary who resides in a black and white world but has complete access to the physical descriptions of color. Although she has had no actual experience of perceiving color, she 'knows' all there is to know about the experience. The question is, would she gain new knowledge when she finally experiences color? Extending this setting, consider a virtual reality experience of color in the black and white room. Does this add in any way to her knowledge and/or change what your answer was to the last question?

Patton, L. (2018). Helmholtz's physiological psychology 1. In S. Lapointe (Ed.), Philosophy of Mind in the Nineteenth Century (1st ed., pp. 96–116). Routledge. https://doi.org/10.4324/9780429508134-6

Regier, T., & Kay, P. (2009). Language, thought, and color: Whorf was half right. Trends in Cognitive Sciences, 13(10), 439–446. https://doi.org/10.1016/j.tics.2009.07.001

Roberson, D., Davidoff, J., Davies, I. R. L., & Shapiro, L. R. (2005). Color categories: Evidence for the cultural relativity hypothesis. Cognitive Psychology, 50(4), 378–411. https://doi.org/10.1016/j.cogpsych.2004.10.001

Thoen, H. H., How, M. J., Chiou, T.-H., & Marshall, J. (2014). A different form of color vision in mantis shrimp. Science (New York, N.Y.), 343(6169), 411–413. https://doi.org/10.1126/science.1245824

Talking Minds

Can Minds Talk to Other Minds?

By Czarinah Micah Rodriguez

The development of language is arguably one of the most important innovations in human history. It has allowed us to communicate with one another in ways never thought possible—to communicate information so very precisely—and it has such a great linguistic diversity, with over 7000 different languages spoken around the world. Yet, language is still an imperfect means of communication: there is invariable some information lost when we transfer our thoughts to words and sometimes context can be hard to parse. We have had to deal with the limitations of language for the past ten thousand years, but with the emergence of even-improving neurotechnology, is it possible that we can eliminate this intermediate representation and facilitate direct mind-to-mind communication?

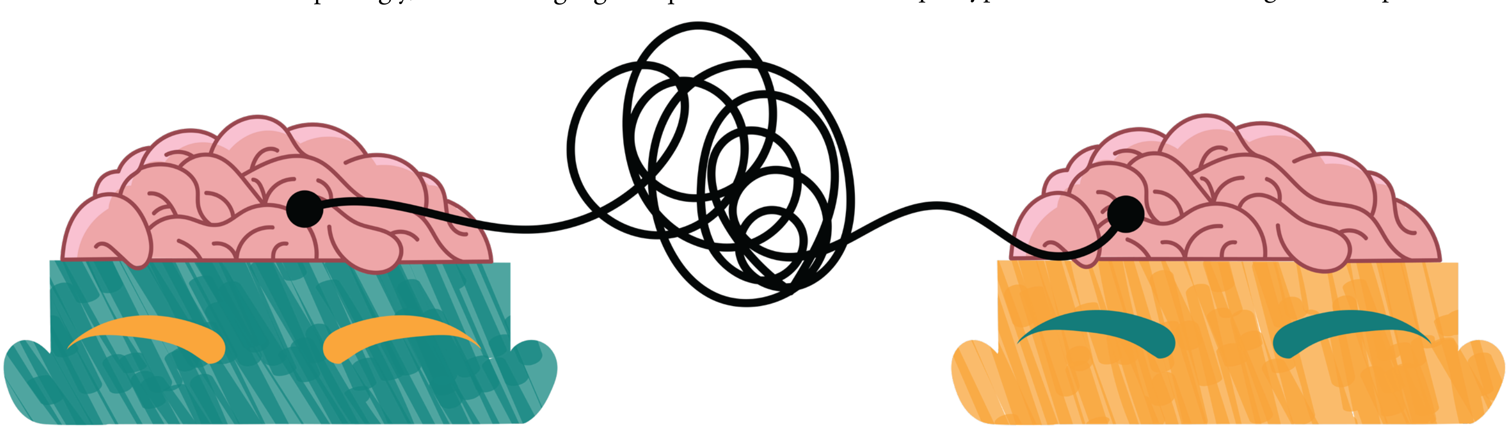
The human sensorimotor system provides a natural means for communication between individuals. Of course, the languages used to process and communicate this system's information originates from the talking minds inside our brains. Little minds (or sets of neurons) talk to each other inside a person's brain to accomplish all sorts of things, whether that be physical movement or internal thoughts.

The neural processes underlying the sensorimotor system are actually better understood than those of conceptual and abstract information. Unsurprisingly, human languages require both sensorimotor and abstract processes. Thus, developing a neurotechnology that enables brain-to-brain communication with respect to human language would not be an easy task, considering how much work still needs to be done in order to understand the neural mechanisms underlying human language. Nevertheless, even by just simple means, brains can still communicate with other brains using current technology via brain-to-brain interfaces.

What are Brain-to-Brain Interfaces?

A brain-to-brain interface (BBI) is a communication pathway that directly sends information from one brain to another. It's basically a combination of brain-computer interfaces (BCI) and computer-brain interfaces (CBI) into one interface!

BBIs have been used to link mice brains with electrodes in order to improve the performance of untrained mice and to help a team of mice collaboratively accomplish a task together.[1] In another different study, a group of scientists formed a network of animal brains that allowed cooperation and exchange of information in real-time via direct brain-to-brain interfaces. This network named Brainet is used to interconnect four rat brains. The scientists proposed that this network could be the main core for a unique type of device called an organic computer.[2]



1 Brain–brain interface. (2020). In Wikipedia. https://en.wikipedia.org/w/index.php?title=Brain%E2%80%93brain_interface&oldid=950143027

2 Pais-Vieira, M., Chiuffa, G., Lebedev, M., Yadav, A., & Nicolelis, M. A. L. (2015). Erratum: Corrigendum: Building an organic computing device with multiple interconnected brains. Scientific Reports, 5(1), 14937. https://doi.org/10.1038/srep14937

Brainets performed the same or higher levels than single rats in numerous tasks such as solving computational problems like discrete classification, image processing, and memory storage/retrieval. Teamwork really does make the dream work.

Non-invasive means were utilized in multiple BBI research studies with human subjects. In a simple experiment, two subjects were playing a game and one person has to imagine clicking a button at a specific time. The participants' brain signals were recorded using Electroencephalography (EEG). A computer translated their motor imagery signals into a TMS signal that stimulated the motor cortex of a different participant. In this way, binary information was quickly transmitted from one brain to another using only brain signals![3]

Neuroscientist Greg Gage introduced a different form of BBI in a TED talk where one person can control another person's hand movement using electrodes placed on their arms.[4] Whenever the female volunteer (the sender) moves and squeezes her hand, the free will of the male volunteer (receiver) is briefly taken away as he immediately does the same action almost like a reflexive response. What does this have anything to do with talking minds if the electrodes are only placed on the arms? If the researcher takes the sender's hand and tries to move it without the sender's control, the receiver does not respond to the sender's hand movement. Why? Because the sender's brain has to be able to control these signals. The interface only reads signals from the brain. In this case, the interface picks up signals that go down from the motor cortex in the cerebrum, and down into the spinal cord to the lower motor neurons that control the hand muscles. Therefore, the sender's mind has to be communicating with the electrodes in order for the receiver to initiate the same hand movement.

A different group of scientists presented the first multi-person BBI for collaborative problem solving known as BrainNet.[5] This is similar to the Brainet used with mice except the interface non-invasively combines EEG and TMS to record and deliver information, respectively. This interface allows human subjects' brains to talk to one another to collaborate and accomplish a task together such as a Tetris-like game. Two out of three subjects are assigned as "Senders" whose EEG signals are extracted from. The interface extracts each Sender's decision about whether to rotate a Tetris block or keeping it in the same orientation. Their decisions are transmitted online to the third subject, the "Receiver", who cannot observe the game screen. The Receiver makes a decision after receiving the TMS signal which essentially integrates information received from the two Senders. A second round allows for Senders to evaluate the Receiver's decision and to provide feedback through the interface. The Receiver can then correct a mistake they made in the first round. Artificial noise is also injected into one of the Sender's signals to check how the Receiver will respond to noisy signals. With the help of the BrainNet, the Receivers are able to learn to trust the reliable Sender more. Interestingly, the results of this multi-person BBI collaboration shows that the average accuracy across all five groups is 81.25%. Indeed, the BrainNet allowed for effective direct collaboration using a collection of human minds. How cool is that? Imagine the other possibilities with this type of teamwork!

The Future of Talking Minds

Our species evolved a unique repertoire of communication that includes gestures, sophisticated languages, and pressing buttons on a keyboard. We are always striving to create evermore immersive methods to communicate ideas and experiences. Over time, we created technologies that utilize sense after sense, incorporating certain human behaviors along with them. We created books (vision), radios (hearing), telephones (hearing and speaking), moving pictures (vision and hearing), computers (vision, hearing, speaking, typing), and virtual reality! What comes next?

Each new form of communication technology provides a new dimension of immersion through increasing amounts of spatial information. The possibilities are limitless! Imagine a virtual reality technology that incorporates a brain-to-brain interface. VR was a fringe technology that was later adopted to mainstream use. Brain-to-brain interface is a primitive technology that is already being applied to simple games in research stud-

3 Rao, R. P. N., Stocco, A., Bryan, M., Sarma, D., Youngquist, T. M., Wu, J., & Prat, C. S. (2014). A direct brain-to-brain interface in humans. PLoS ONE, 9(11), e111332. https://doi.org/10.1371/journal.pone.0111332

4 Gage, G. (n.d.). How to control someone else's arm with your brain. Retrieved April 18, 2021, from https://www.ted.com/talks/greg_gage_how_to_control_someone_else_s_arm_with_your_brain

5 Jiang, L., Stocco, A., Losey, D. M., Abernethy, J. A., Prat, C. S., & Rao, R. P. N. (2019). Brainnet: A multi-person brain-to-brain interface for direct collaboration between brains. Scientific Reports, 9(1), 6115. https://doi.org/10.1038/s41598-019-41895-7

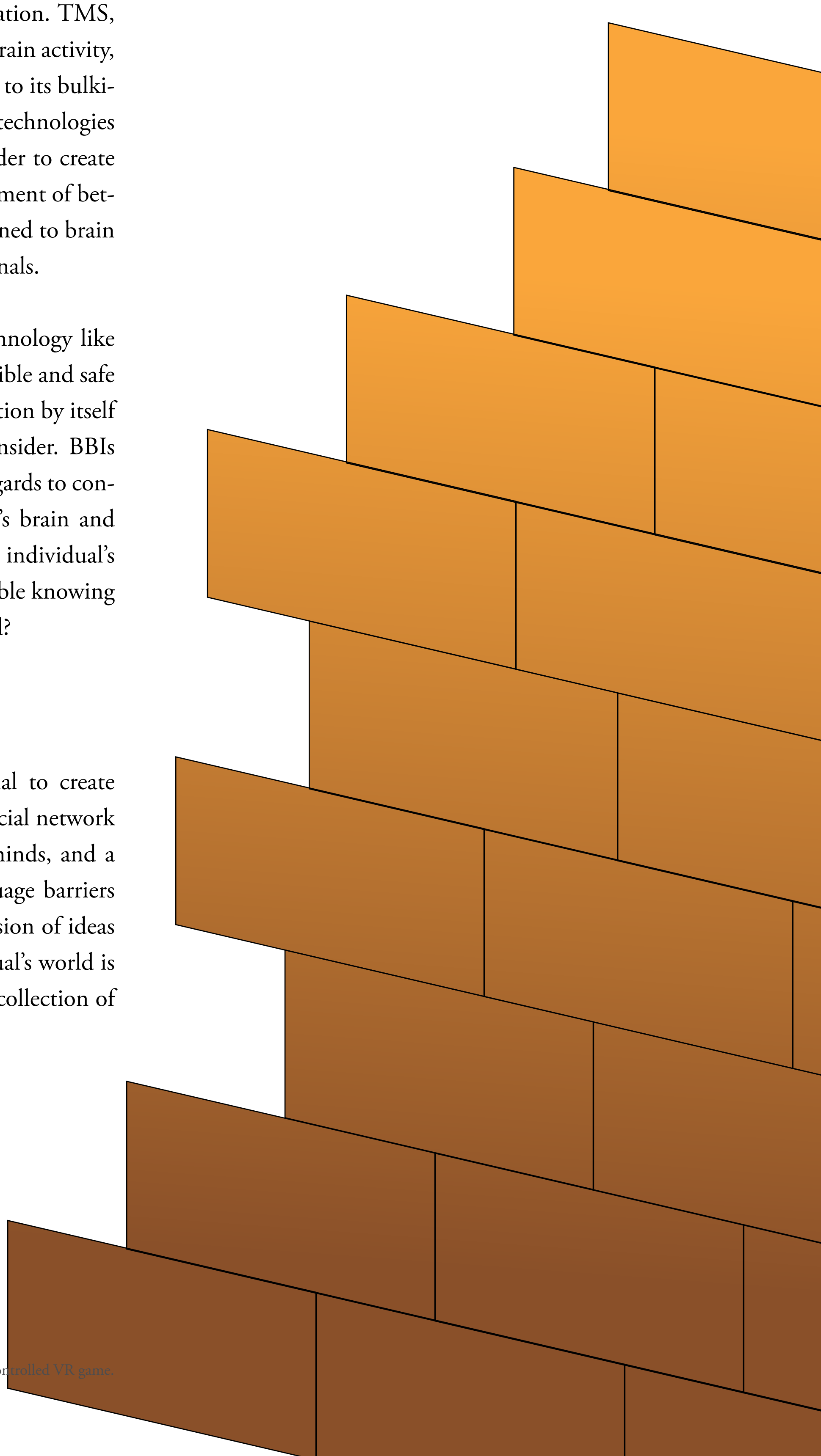
ies. Its practical use is yet to be realized. If we already have mind-controlled VR games through BCIs,[6] then adding a CBI component to it would add a whole new dimension to communication. Imagine a VR game that allows cooperative problem solving using a more complex BrainNet.

Of course, our CBI technology still needs to improve before we can develop such immersive forms of communication. TMS, one of the most common ways to modify human brain activity, would not be feasible to use for such purposes due to its bulkiness. Asides from CBI technology, there are other technologies and techniques that still need improvement in order to create an immersive BBI technology, such as the development of better and more efficient machine learning models tuned to brain signals to allow for real-time decoding of these signals.

It also remains unclear just how current CBI technology like TMS works and whether or not it would be reversible and safe to use. In addition, the concept of brain manipulation by itself already brings up important ethical issues to consider. BBIs raise even more ethical concerns, particularly in regards to controlling or extracting information from a person's brain and whether or not these efforts would compromise an individual's privacy and sense of self. Would you feel comfortable knowing that there's a different mind inside your own mind?

A Whole New Mind

Brain-to-brain interfaces could have the potential to create multiple types of talking minds: a dual mind, a social network of connected brains, an AI of multiple human minds, and a lot more. Such technology could overcome language barriers and allow for more immersive sharing and expression of ideas and experiences. Additionally, since every individual's world is fascinatingly different, a whole new mind from a collection of human minds is like a whole new world.



6 Neurable is a BCI neurotechnology company that created the first mind-controlled VR game.

Why We Need "Other Minds" in the Tech Industry

Diversity in Demographics and Specialties

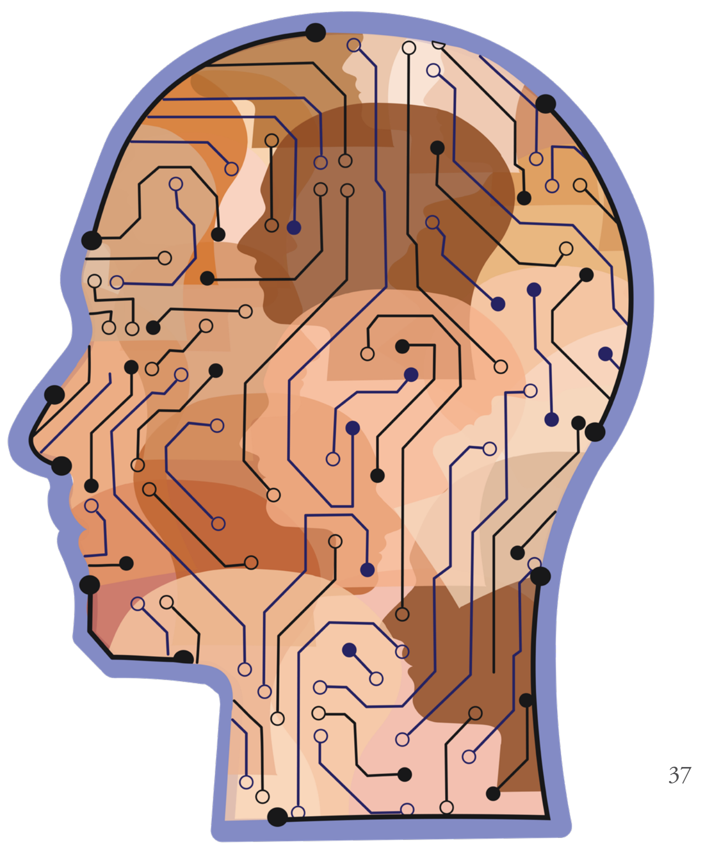
By Annabel Davis

People are becoming increasingly aware that since 2014, major tech companies such as Apple and Google have released diversity reports of their company demographics, which - to our shock but also in line with prior expectations - were not at all diverse. These reports from major companies showed a huge display of primarily White or Asian, cis-male engineers. This began to reveal more evidently the unfortunately expected lack of ethnic and gender diversity that we would hope for in companies that are creating products that shape our everyday lives. Since 2014, we would hope to see drastic changes to this, but there have been minimal changes to their hiring demographics since. From this, we see that not only is it a more systemic, societal issue, but tech companies are also struggling with "culture-wars" and lawsuits because of demographic biases at shareholder meetings and with public representation.

Silicon Valley generally has been plagued with systemic lack of diversity in their workforce and unconscious bias in their hiring and product testing. Part if this has been pegged to the fact that as Harvard Business Review stated, "Startups don't have time for diversity." When hiring or trying to put a product together as they attempt to "beat the clock" before the market moves on, startups typically go with those who are not only convenient and at direct disposal to them, but also who they believe have the "highest qualifications" to make the product. There is a huge snowball effect that occurs when small companies that are just starting off slowly make their way into being more so tech giants. They become seemingly more and more homogenous when diversity is not valued from the beginning, similar to the whole slippery slope phenomenon that we are all warned against as kids.

But this is the exact opposite of what needs to be done to not only help the company in the long run, but to also alleviate this issue of hiring bias. We know the stats for how diverse companies actually have better marketing for their product like how "companies in the top quartile for gender diversity on executive teams were 25 percent more likely to have above-average profitability than companies in the fourth quartile"; but also we know that "47% of millennials want to work at diverse companies" and that percentage goes even higher for younger generations.

In this kind of snowball effect, it's also not just the fact that companies have this, but when a small company of 3 white men slowly become a homogeneous group of 45 and then hundreds of men, women or people of color no longer feel comfortable interacting with those kinds of spaces. This kind of issue starts at the beginning and perpetuates itself even in the hiring process with gender and racially skewed language in the job descriptions and the different types of signalling that occur in company work advertisements.



https://hbr.org/2014/01/the-signals-that-make-tech-startups-so-homogeneous
https://launchpadrecruits.com/insight-articles/silicon-valley-diversity-market-emerges
https://www.teamblind.com/post/Cultural-homogeneity-in-tech-companies-CaK0gEMD

How Homogeneity is “Harming Our Data” And How Lack of Diversity Affects Products

Even beyond “outdated and biased hiring practices”, there are so many intersecting factors that need to be addressed in order to approach these discrepancies in tech and industry appropriately. For example, the field ignores not only societal demographics but also specialty demographics such as linguistics, ethinc studies, gender and women’s studies, psychology, and so on - and instead focuses all intention on engineers and computer/data scientists. This discrepancy in and of itself perpetuates the lack of diversity of knowledge and allows for a higher chance of ignorance in this field.

Beyond this, however, this lack of diversity in both specialty and societal demographics are causing latent harm to the data that these companies deal with in order to create their products. We saw issues such as the one back near 2019 where Apple’s credit card actually had a lower limit to women than to men - Goldman Sachs claimed that this was due to determining “creditworthiness”. AI services from Google and Amazon were both less likely to recognize the pronouns “hers” versus “his” and typically don’t recognize female-centered language when analyzing text. AI is trained/created through human interaction and therefore also human bias, and this continues to dictate how algorithms manage and prioritize data. Associate Professor in Law and AI Ethics at Oxford University, Sandra Wachter, talks about this in more detail in her practice and explains that AI and data offer a huge reflection to where our society lacks equality. Algorithms based on this kind of biased data reflect who gets shown ads for certain jobs/opportunities or even certain products and differing product prices.

How this “Harm” Manifests in Big Ways

A prime example of how data can be harmed due to bias is actually evident in our healthcare systems. Back in October 2019, data researchers investigated an algorithm using +200 million patients in the United States which found that white patients were highly favored in extra medical care over black patients, reflecting on discriminatory health care cost. We also see this extreme bias in AI with Correctional Officer Management Profiling algorithms that are used in US justice systems to predict likelihood of repeat offenses of a defendant - which “predicted twice as many false positives for recidivism for black offenders (45%) than white offenders (23%).

Even in the actual data algorithms for hiring, back in 2015 we saw that Amazon’s Machine Learning used for employment was biased against hiring women due to the fact that it was trained with more male submitted resumes than female submissions.

Certain projects that are working with more ambiguous or obscure data such as facial recognition and tracking, for example, require a more interdisciplinary approach that goes beyond just engineering and Computer Science. The need for interdisciplinary roles in tech end up not being as obvious in some areas such as bio-tech as compared to others like marketing and system set up, but it is more than just critical for tech industries to realize these roles and take responsibility for the data being utilized in all areas of functionality. This negligence in hiring and consulting habits need to change in order to address these intersectional and interdisciplinary issues as we move forward in the role of technology in our society.

Data needs to be analyzed and influenced by a more diverse group of people in order to diminish the prevalence of these biases . Even if there are more influences of one demographic over the other due to societal constraints, there needs to be higher influence in ensuring that the data represents “what should be” and not “what is”.

Historical Failure of Diversity

Diversity in the tech industry has always been problematic, and although it is rooted in many issues outside of the tech industry, that does not mean that data-driven industries do not perpetuate these issues as our society grows and develops around technology. The reason we see so many of the same types of people (cis-white men) in tech is because these are typically the people that are both encouraged and systematically have more access to technology to begin with. On top

https://medium.com/@melindaozel/big-techs-homogeneous-hiring-habits-are-harming-our-data-9739ead740d4
https://www.forbes.com/sites/paologaudiano/2019/02/25/the-dawn-of-the-inclusive-enterprise/?sh=400dc11769bd
https://www.educative.io/blog/diversity-inclusion-tech-industry
https://www.cnbc.com/2018/06/20/silicon-valleys-diversity-problem-is-its-achilles-heel.html

of that, almost all positions of power in tech (leaders, “herps”, and role models) are white men that were born wealthy and made wealthy through their access to technology such as computers and CS education. Access and education are a huge part in allowing students, specifically students in low income areas, to get entrance into computer science type fields. Kids who get much more exposure to technology in the first place are those who end up having more developed skills within the field as they get older. The people who get this access tend to be in the same realm of homogeneity that we see reflected in the tech industry today as mentioned previously.

The narratives that we build around the tech industries and all its inspirations are constructed primarily off of these men - excluding so many possible experiences and innovators who are not legitimately included in the “face of tech” as it currently stands. The actual stories of minorities in tech also become the exception to industry norms rather than an integral part of the industry’s growth - causing minorities to feel more isolated from tech-related opportunities. Womxn and people of color have, in a large part, shaped the tech industry, but still become the “other” or the “exception” in many cases nonetheless, especially when it comes to how society frames the industry. Imposter syndrome and its effect on confidence in entering the field is why the pay gap still remains large in these spaces between the homogeneous groups and womxn/people of color, but also is a resulting effect of societal implications and why so many minority groups also do not feel welcome in the field, regardless of their education and ability.

The issue, along with these historical and systemic issues, is that there is long term perpetuation of this homogenous groupthink due to misrepresentation of diversity in tech industries. Tokenism in tech is a particularly huge problem when it comes to addressing homogeneity in these spaces. Women, people of color, and disabled people are all used in advertising and speaking on behalf of the company, but when we think about the actual numbers - the legitimate representations look very different from the display. The deception, in this case, allows for consumer ignorance on the company’s message and present virtue signalling to present as fair and diverse - instead of real change. Tech industries need to show actual growth and real efforts toward diversity and inclusion in the workplace instead of just offering “lip-services” to the public to make it seem as though they are changing their status.

How Can We Fix The Industry?

As we see now, there are unsurprisingly but also unfortunately many intersecting influences going against minority entrances into the tech industry - but what can be done to fx this? First, there needs to be more investigation in how Diversity actually offers commercial benefit to a company’s success. Studies on company economics have shown that diverse workgroups actually have higher overall profits. As well as the fact that companies that hold a core value of diversity and inclusion actually have a higher retention rate of employees - resulting in a happier and more sustainable company community. Company leaders that have this as a core value see benefits of this in the company’s overall innovation, adaptability, retention rating, diverse skill sets, and generally leads to a better reputation. Diversity in the workplace also allows companies to break self-reinforcing behaviors and gives many more insights and data points to the innovation of the company. This kind of influence also allows for the company to mirror a broader population and have a greater understanding of the people that they are attempting to serve.

Well known companies that have actually excelled in higher success due to enforcement of diversity and inclusion policies now includes Cisco, Microsoft, and Facebook at the top three for diversity and inclusion out of the top 10 tech companies in the industry. As people move on to realize that diversity and inclusion is a huge importance in the community of the workplace and also in the production of work, we hope to see that tech industries see this as well. The trend of workplace values is moving to resemble the fact that “54% of women and 45% of men research a company’s diversity and inclusion policies before accepting an employment offer” and is only estimated for that percentage to get higher when considering job acceptance. It has also been found that “employees who think their organisation is committed to improving and supporting diversity, increases their ability to innovate by 83%”.

The future of diversity and inclusion in the workplace is imperative for the whole industry to move forward in a way that

https://sdtimes.com/softwaredev/theres-a-diversity-problem-in-the-tech-industry-and-its-not-getting-any-better/
https://www.wired.com/story/five-years-tech-diversity-reports-little-progress/
https://www.score.org/blog/10-business-benefits-diversity-workplace

is beneficial and innovative for the whole world instead of a select few. It may seem that the larger tech companies are too far gone to fix diversity issues within it sooner rather than later, but there is so much hope for developing startups. A nonprofit organization called Project Include acts as “a resource for people to implement change around diversity and inclusion in the tech industry” - and has made massive improvements in showing startups this exact argument - and it’s working! The tech industry is slowly making its way to be more diverse whether it wants to or not because diversity is moving to be less of an option and more of a necessity, and a valuable one at that.

For the future of diversity and inclusion in the Tech Industry there needs to be distinct diversity representation and inclusion goals, a holistic and comprehensive approach to these goals, investment in people of color and female leadership, organization and advocacy by the workers about diversity, and broadened executive collaboration on this topic. Embracing diversity is no longer an option for company growth nor should it ever have been, and now we are seeing all of the benefits from inclusion as what they are instead of “what they should be”.

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https://linkhumans.com/diversity-inclusion-tech-companies/
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Contributors

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Aakarsh Kankaria is a freshman at UC Berkeley intending to major in Molecular and Cell Biology with a minor in Data Science. He is incredibly passionate about the intersection of therapeutics, technology, and neuro oncology. He is fascinated by the philosophy of the mind and the role of consciousness. Outside of work, he loves travelling and can be found snuggling with a good book in a library.

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Abraham Niu is a junior at UC Berkeley studying Cognitive Science and Data Science. He is extremely interested in the intersections between healthcare and technology and is often pondering over the potential applications of extended reality in everyday life and the reconciliation of religion and science. In his spare time, he enjoys snowboarding, meddling with music, watching anime, and playing basketball.

Alex Soliz | Author

Alex Soliz is a senior at UC Santa Cruz majoring in cognitive science and minoring in computer science. His research interests lie in the convergence of cognitive processes and computer science, specifically in neurotechnology and artificial intelligence. Alex enjoys cooking, hiking, catching up on Netflix, and spending time with friends and family. After graduation, he plans on pursuing a master's degree in computer science.

Allison Chen | Design

Allison Chen is a junior studying psychology and art practice. As a dedicated Visual Artist and graphic designer, she hopes to utilize her art skills to enhance design projects and achieve visual innovation and beauty. Her current interests are UI/UX, magic, and playing games.

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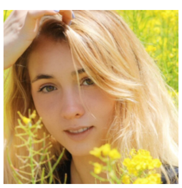
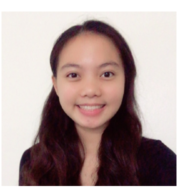
Amy is a third year studying Neurobiology and Data Science. In addition to the design team, she is also part of the Education division in NT@B. Her academic interests range from magnetogenetic neuromodulation to machine learning, and when she's not frantically putting together MIND at the end of every semester, she loves watching Netflix, exploring coffee shops, baking, and figure skating.



Annabel Davis | Author

Annabel Davis is a Junior at UC Berkeley majoring in Cognitive Science and a list of minors in Global Health, Linguistics, and Disabilities Studies. She loves investigating the intersectionality of Neuroscience and Society and how current innovation plays a role in modern development. Outside of her work and studies you can find her at a random coffee shop at any given time, boxing, cooking, or surfing the waves on the West Coast. Annabel hopes to work in Global Health in any capacity and possibly in the realm of Psychiatric Social Work.



Czarinah Micah Rodriguez | Author

Micah is a senior at UC Berkeley majoring in MCB neurobiology, cognitive science, and psychology and minoring in computer science and data science. She's highly interested in the brain and loves studying any topic that intersects with neuroscience. She plans to pursue a PhD in clinical neuropsychology, focusing on the neurosurgical and pediatric subfields. She loves competing in ballroom and figure skating, reading, traveling, executing ballet variations, K-pop dancing, swimming & diving, coding, singing & playing the guitar, drawing, learning languages, practicing martial arts, and spending time with friends and family.

Emma Clark | Author

Emma is a junior at UC Berkeley studying cognitive science and data science. She is incredibly passionate about the intersections of public health, technology, and neuroscience and exploring innovative approaches to understanding interactions among these fields. In her free time, Emma is an avid hiker and camper and loves cooking and baking for her friends and family. Eventually, she hopes to work in community public health investigating social determinants of physical and mental health.

Iris Lu | Author

Iris Lu is a sophomore studying Human Biology at UC Berkeley. She loves researching the connection between the eyes and the brain, and is currently studying the effect of brain trauma on vision. Her hobbies include painting, hiking, and delving into the rabbit hole that is internet subcultures.

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Jacob Marks is a sophomore at UC Berkeley studying Cognitive Science and Data Science. He loves studying the brain and is specifically interested in language, memory, and the intersection between cognitive and computer science. While not in class, Jacob enjoys playing for the Cal Club Golf Team, rooting for his hometown Los Angeles Dodgers, and spending time with his dog.

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Jandy Le is a junior at UC Berkeley studying Human Biology and Public Health. Although she is pursuing a pre-health career track, she loves learning about the applications of data science and technology in healthcare. Her hobbies include crocheting, trying new recipes, and exploring the Bay!

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Lilian Zhang is a junior at UC Berkeley studying Chemical Biology. While also interested in physical chemistry, Lilian is fascinated with neuroscience and memory consolidation, and currently is researching the neurobiology of sleep in jellyfish. After graduation, she hopes to pursue a PhD in chemistry.

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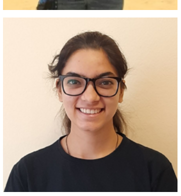
Lillian Shallow is in her third year at UC Berkeley studying Microbial Biology, Public Health, and Spanish. She loves to read short stories and volunteer in her community. Lillian plans to pursue a career in microbiology and public health focusing on the Global South.

Luc LaMontagne | Author
Luc LaMontagne is a junior at UC Berkeley studying Cognitive Science and minoring in BioEngineering. He is fascinated by the mind, and thinks the best means for understanding it is through neuroscience and technology. He hopes to pursue a career in the neurotech industry in order to facilitate a greater understanding of the mind, and to increase the bandwidth between the brain and computers. He has an affinity for maps, and is usually dancing to his own (not so great) singing. He can be found by the ocean, reading on the beach, surfing, or sailing with the Cal Sailing Team.

Malachi Keo | Design
Malachi Keo is a junior at UC Berkeley studying Psychology and Neurobiology. His research interests are in understanding developmental and molecular processes related to experience-dependent change, like stress. This spring, he's found himself being a consumer of entrepreneurial business and city takeout—just maybe not at the same time.

Milan Filo | Author
Milan Filo is a senior at UC Berkeley majoring in Neurobiology and minoring in Data Science and French. Milan enjoys studying the intersectionality of neuroscience and connecting the human brain with fields such as design. Current interests include: computer graphics, UX, fencing, learning Italian, and getting better at Western horseback riding. After taking a gap year, Milan plans to pursue a master's degree in computer and game technology.

Namrata Kantamneni | Author
Namrata Kantamneni is a junior at UC Berkeley studying computer science and neurobiology. She loves whistling to music and can be found coding neural nets or running in the woods. She has been on a slow downward spiral since peaking in 4th grade after winning the spelling bee.



Nehchal Kaur | Author
Nehchal Kaur has completed her M.Sc. in Cognitive Systems at Ulm University, Germany and is deeply passionate about neurotechnology and its potential. Her two dreams are to develop music based neuromodulatory rehabilitation techniques and to realise the BCI equivalent of the Babel fish as described by Douglas Adams.

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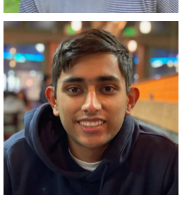
Oliver Krentzman is a senior studying Cognitive Science at UC Berkeley. With a passion for understanding the brain and its processes, Oliver's main interests are within the fields of cognitive neuroscience, psychopharmacology, ethnobotany, and biochemistry. Outside of academics, Oliver enjoys spending time in nature, reading self development books and lifting weights. After undergrad, Oliver plans to pursue a PhD in Neuroscience focusing on developing the scientific understanding of consciousness.



Sameer Rajesh | Author
Sameer Rajesh is a sophomore at UC Berkeley majoring in Molecular and Cell Biology. He thinks brains are pretty cool (obviously) and hopes to continue studying them and working with neurological disorders as a physician. Sameer can often be found watching Netflix, hanging out with friends, and most recently, hopelessly trying to learn how to cook for himself.