Science AMA Series: Hi Reddit, I'm David Linden, a neuroscientist working on brain plasticity and the editor of a new book of essays: "Think Tank: 40 Neuroscientists Explore the Biological Roots of Human Experience." AMA!

HopkinsMedicine$_{A}MA^{1}andr/ScienceAMAs^{1}$

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April 17, 2023

Abstract

Hello Reddit, my name is David Linden and I'm a professor of neuroscience at the Johns Hopkins University School of Medicine. In my lab, I study neural plasticity- the ability of the brain to be modified by experience- whether from learning, hibernation, hormonal fluctuations or injury. I have a long-standing interest in scientific communication and have served for years as the chief editor of The Journal of Neurophysiology. I've also written several books about neural function for a general audience including The Accidental Mind (2007), The Compass of Pleasure (2011) and Touch (2015). I find that scientists are trained to be meticulous when they speak about their work. That's why I like getting my neuroscience colleagues tipsy. For years, after plying them with spirits, I've been asking brain researchers the same simple question: "What idea about brain function would you most like to explain to the world?" I've been delighted with their responses. They don't delve into the minutiae of their latest experiments or lapse into nerd speak. They sit up a little straighter, open their eyes a little wider, and give clear, insightful, and often unpredictable or counterintuitive answers. A new book I've edited, called "Think Tank: 40 Neuroscientists Explore the Biological Roots of Human Experience" (Yale Press, 2018) is the result of those conversations. I've invited a group of the world's leading neuroscientists, my dream team of thoughtful, erudite, and clear-thinking researchers, to answer that key question in the form of a short essay. I have encouraged each author to choose her or his own topic to tell the scientific story that she or he is burning to share in clear and compelling language. Lets' talk brains, behavior and scientific communication. I look forward to having you #AskMeAnything on April 30th, 1 PM ET.

the WINNOWER

REDDIT

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HOPKINSMEDICINE_AMA R/SCIENCE

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How far off are we from incorporating technology into our brains which directly interface with neurons, in order to produce some sort of beneficial effect such as supplementing damaged areas of the brain, or even incorporating artificial intelligence to raise our own human intelligence?

Alpaca64

Great question. We already have crude technologies to activate electrical activity though electrodes implanted in the brain or spinal cord. They can be used to relieve chronic pain, temporarily reduce the movement initiation problems in Parkinson's disease and relieve otherwise intractable depression. There are other technologies that pass currents or magnetic fields into the brain from outside the skull, but they are even more nonspecific.

Present technologies like electrodes will active all types of neurons and nerve fibers near the electrode

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tip, so their effects are not subtle. Now, with optogenetics- a technique that combines infection of particular types of neurons with a harmless virus followed by activation of those neurons by light delivered with a fiberoptic device implanted in the brain or spinal cord- we have the ability to activate specific groups of neurons. Say, just dopamine-using neurons of the ventral tegmental area or just GABA-using neurons in the cerebellum. This technique, which is now in clinical trials, will hopefully allow for much more useful and targeted therapies.

That said, while neural interfaces are progressing, don't look for an intelligence-boosting implant any time soon. We simply don't have the knowledge at present to know which neurons to target to improve memory or problem-solving or insight or creativity, much less the technical ability to target them specifically.

What is your answer to the question you asked the neuroscientists? What idea about brain function do you most want to explain to the world?

reallybigleg

Thanks for asking. It turns out that I did write an essay in the THINK TANK collection and it's called "Human sexual orientation is strongly influenced by biological factors." It explains the evidence from twin and adopted twin studies indicating that about 40% of the variation in male sexual orientation can be accounted for by inherited factors (it's about 20-25% in women). It cites the literature that, remarkably, there is no clear evidence to establish that any practices of child-rearing influence adult sexual orientation. If child-rearing has little or no effect on sexual orientation and genes have only a partial effect, then why are some people straight while others are bi or gay? At present, the most promising insights come from biological effects that that are independent of genes, most notably exposure to sex hormones (and possibly signaling molecules of the immune system) in utero and in early postnatal life.

As a neuroscientist, what method do you think is the best to discover more about the brain?

Venax19

That's a wonderful question for the present moment. I don't think that there's any single best method for understanding brain function. Rigorous behavioral analysis, recordings of electrical signals in neurons, detailed neuroanatomy, gene expression profiling, etc. They are all useful and they all contribute different aspects to our understanding. Right now, there's a lot of effort being put into large scale projects in neuroscience. For example, creating a map of all of the connections between neurons in the mouse brain or defining all of the different functional types of neuron through analysis of gene expression. These are fine things but in the end they are tools for understanding. They do not constitute understanding themselves. By comparison with a previous large-scale biology project, when the final bases of the human genome were first read there was an expectation that somehow some great organizing principle of life would be revealed. It wasn't. The human genome and the other genomes that have followed it are great tools that biologists use every day but alone they did not produce fundamental understanding. That insight has come, almost entirely, from small science in individual labs. The brain connectome and the atlas of neuron types will be similar- wonderful, essential tools but they are unlikely to be truly revelatory by themselves.

About the future of humanity - hundred, and thousand years ahead? - given the gap between biology and evolution on the one hand (slow change) and technology on the other (fast change): is the brain malleable enough to balance out inherent aggression and other animal traits with the increasing power

available through technology, and will the change be fast enough to avoid a looming catastrophe from the imbalance? Asked in another way: Can the evolutionary old brain be updated to deal with the technology we're developing faster and faster? Is brain therapy a solution? Will laws be enough to contain the dangers?

nnoename

It's easy to imagine that evolution can only move slowly and gradually- and often it does- but we also know that evolutionary change can happen much more quickly in certain circumstances. A great example of this is the development of lactose tolerance in humans that accompanied cattle domestication and dairy farming [After you've read THINK TANK, see Marlene Zuk's fine book Paleofantasy for more on this :)]. And, as you correctly point out, learning gives us rapid flexibility to change that beats the most rapid evolutionary processes. We may be doomed from climate change but I don't think we're doomed because our brains can't evolve to handle technology.

Hi David, thanks for the AMA! Can you share with us any surprising (counterintuitive) lab results on learning and memory that you've encountered in your lab over the years?

Editress

We and others have found that the number of synapses- connections between neurons- in many brain regions varied by about 30% over the ovarian cycle in mice, rats, monkeys and presumably human females. If, as most neuroscientists believe, memory is stored in the connection pattern and strength of these synapses then how come memory is not overwritten in females over a few cycles? In mice, these cycles occur every 5 days! We are working on this puzzle now...

Why do you think people believe in the supernatural? Are our brains adapting to a belief even if an entity isn't there?

dem0n0cracy

That's a fine question. The belief in the supernatural is so widespread- from origin and life-after-death stories to ideas about unproven medical practices. Even scientists when asked "What do you believe that you cannot prove?" will usually have an answer. I suggest that the left cortex's always-on narrative constructing function promotes the acquisition of religious thought through both subconscious and conscious means. Religious ideas involve non-naturalistic explanation. Whether religious ideas are regarded by their practitioners as "faith" or merely "given knowledge" they share the property that they violate everyday perceptual and cognitive structures and categories. The left cortex predisposes us to create narratives from fragments of perception and memory. Religious ideas are similarly formed by transforming everyday perceptions, by building coherent narratives that bridge otherwise disparate concepts and entities.

Has any progress has been made in attempting to understand the question of how the 5 senses are blended together to create a unified experience?

psioni

That is one of the great outstanding questions of neuroscience and much remains mysterious. To start, it's picky but I have to take issue with the notion that there are only 5 senses- taste small vision, touch hearing. There's also proprioception (sensing where your limbs are in space even with your eyes closed), vestibular sense (knowing the tilt of your head relative to gravity), the sens eof how full your

stomach and bladder are, etc. Not all of the senses are pointed outwards at the world. Some are pointed inwards at your own bodies.

One of the things we now know is that even areas of the cortex that we once thought of as being devoted to a certain sense, like vision, also receive other sensory, motor, emotional, and reward information. This blending of information streams is a part of creating an overall gestalt sense of the world and our place in it. Check out Ed Connor's essay on vision in Think Tank as a way to get started on this topic.

Would it be possible to link neurons to something like a prosthetic arm to give ambutees some semblance of a limb.

The_impericalist

Yes, this work has been underway for some years now although there still is a long way to go. Some researchers implant sensors in movement-controlling areas of the brain and then use those signals to drive a prosthetic limb. Others use sensors in the roots of the motor nerve or even in the remaining stump muscle if there is any. This is an endeavor that will really benefit from newly developed high density electrodes with many recording sites along their shafts to provide rich information. Much progress to come.

What are some of the newer, less known, exciting facts we are learning about mental health, and how might this impact future treatment?

Yamster80

The brain is chock full of receptors for signaling molecules of the immune system- cytokines and others. These have been very poorly understood. in the future, look for new neuropsychiatric therapies that target immune signaling in the brain.