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Photos Provided by Chris Howard

Christopher Howard is an assistant professor at Oberlin College as well as the faculty advisor for The Synapse board at Oberlin. He completed his undergraduate and graduate work at The Univisierty of Illinois. He then moved to La Jolla, California where he completed his post-doctoral fellowship at the Salk Institute. Since coming to Oberlin, Professor Howard has taught five different courses at Oberlin, including upper level Neursoceince Courses: Neurophysiology, Studies of Neural Functions, and the Addiction Capstone. Professor Howard's research at Oberlin focusses on dopamine signaling in the brain. We at The Synapse are excited to introduce you to this wonderful professor!

This interview has been edited for length and clarity.

When did you begin your interest in neuroscience?

Great question. So, I have two answers. The first is that I have had three grandparents in my life that were diagnosed with Alzheimer's Disease. So, that instilled in me a deep interest in how the brain works. My grandfather is of particular note, he was a musician. He was a composer and would play piano. Even deep stages into Alzheimer's disease he could flawlessly play the piano, which was phenomenal – it was incredible. It was clearly a conscious brain that was disrupted in Alzheimer's, and then there's this motor brain that totally intact even deep into this disease. So that's the first answer, right? That's what first gave me the interest. The second thing was, I sort of ended up in the field on accident.There was a fellowship, and I applied for it, and I got it.

Was this where you developed your interest in dopamine research?

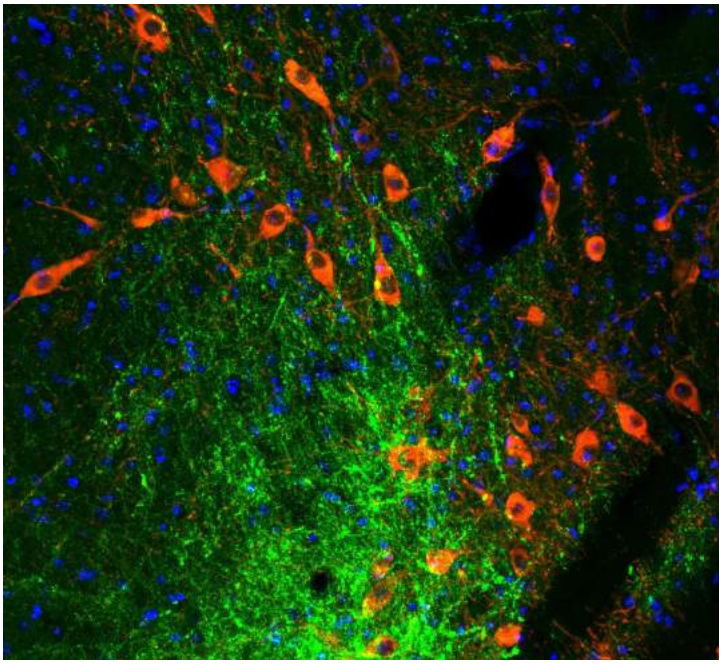
I began in my future graduate advisor's lab. So, I started in that lab. I liked the work they were doing, and I was kind of okay at it. So, he offered to give me a position. I figured, if I'm going be here, might as well get a Ph.D. and see what that is all about. And that's kind of what happened. [My lab at Oberlin] is still interested in dopamine, but we come from a physiological background than a behavioral background focus.

Could you discuss what you're currently researching?

We have currently three main projects in the lab. We're interested in how dopamine supports the formation of habits. We have two types of behaviors. There are goal-directed behaviors, for instance I pull a lever and I win some money. If I stop winning money, I no longer pull the lever. Or you have habitual behaviors, where you pull the lever and, regardless of the out come, you're going to continue to pull it. Habits have a bad connotation and clearly there I brought in a gambling analogy. Habit circuits underlie a lot of disease states including addiction, OCD – obsessive compulsive disorder, Tourette syndrome, and other non-drug related addictions.

So, we're interested in how dopamine facilitates or supports habit formation. What's known is that you need dopamine to form habits. If you take drugs of abuse, it exacerbates habit formation. We are now using optogenetics, which is the light activation of dopamine terminals, to see if we can facilitate habits to develop faster than they would typically form. So that's project one.

Project two, within the same area of brain where dopamine neurons project to, the striatum, there are these patchy areas of different receptors and different markers. The patches have been known about for 50 years. They are incredibly cool looking structures (*see photo below*). Most brain structures are bilaterally symmetrical, and they're the same more or less between individuals. Patches don't follow that arrangement. So, these patches are different between the left and right brain hemispheres and radically different between individuals, which I think is super cool. Despite the fact that patches are so salient and prominent, the role for patches has not been understood for about 50 years. They've been known about for 50 years, but no one knows what they really do. So, the field is ripe for investigation. We are now using the same sort of habit strategy to determine if we kill patches, can animals form habits? If we activate patches, do animals form habits faster or slower? So, that's what we're focused on.



Above is an image taken in Professor Howard's research lab at Oberlin College. This is an image of the substantia nigra in the midbrain of a mouse. The green indicates the dopamine receptor patches which project from the striatum to the substantia nigra. The orange are the dopamine neurons that are interacting with the dopamine receptors.

The third project involves dopamine neural transmission. This is me returning to my roots as a graduate student – it's all I ever did. We evoke dopamine responses and then we can apply drugs –

many different classes of drugs – to determine how that modulates dopamine neural transmission. So it's really pharmacology in its purest form. But we are specifically looking at melatonin, a neural hormone, to see if that changes dopamine signaling. And we're moving into – and I never thought I'd do this – we're moving into endocannabinoids too. So, I just got a small grant to study Cannabidiol (CDB), which is all the rage in the world right now.

Could you talk about the endocannabinoids and CBD?

This is probably common knowledge to most of the readers of *The Synapse*, but the industry is exploding right now with both recreational marijuana and this drug CBD or cannabidiol, has been added to a number of consumer products. Carl's Jr. now has a CBD burger. What is not known is what CBD actually does to the brain. We know that it binds to CB2 receptors, which are expressed in glial cells. They might also be expressed in some other neurological systems. It's likely that it is modifying brain activities. So, is it a good idea to distribute a drug that's not well known across the entire American population? Probably not.

You know what? Now that I've start talking about it, an interesting thing that I've found is that Carl's Jr., a fast food restaurant, can put CBD in its burger, but CBD is technically a Class 1 restricted substance. You know it doesn't get people high. So, me, as a neuroscience researcher, I have extremely restricted access to this chemical. There's some loophole, which I can't figure out. I am not allowed to order CBD from the NMH unless I apply for a schedule 1 license. Other schedule 1 licenses include THC, PCP. Methamphetamine is a schedule 2 substance – it's less tightly regulated than CBD. Explain that to me!

What impact does your research have on drug addiction?

Drug addiction is a multifaceted disorder. So there are sociological factors, for example. That's the only thing we don't talk about in my senior seminar course - although it is important. Habit is one of those factors. When people are returned to one of the cues for taking drugs they are more likely to fall back into those deeply ingrained habituated behaviors. So if you associate a drug with a place and you go back to that place, the craving for the drug will often present itself. How much habit plays a role in that is somewhat debated in the field, but it definitely is a factor. So, understand the neural mechanism of habit is a piece of the addiction story.

Turning the subject to your role here at Oberlin, how is research and teaching at Oberlin different than at other institutions.

I think research is the primary thing I can talk about here. When I was an undergraduate, I was at a school with graduate students and post-docs. 80-95 percent of the research that is done there is done by graduate students and post-docs. Undergraduate students can help, they can come along to see how things work, but they're not the main drivers of research. Obviously, that's not the case here at Oberlin. I would say 90 percent of the work that gets done in my lab gets done by students. So I think we interact in a really tight-knit way, that students may not get at a larger university. The opportunity is here for great research.

Do you think that relationship is also in the non-research aspects of the academics at Oberlin?

Yes. What I try to do, particularly in my teaching lab, is to give students to explore research techniques on their own terms. Students do their own projects in my teaching lab. In addition to that, I think we all expect a lot from the students because they are really getting these good experience here.

Do you have any advice for students who want to become involved in the physiological aspects of neuroscience?

Well, I think my advice would be general. Always work hard. Don't get over-involved. That's one of the things that both faculty and students fall into at Oberlin. It's great to have lots of opportunities, but it's better to excel in the opportunities you have. That's something I tell all of my advisees too, but I'll reiterate here. Another thing is, get into research. Get into research anyways you can - whether it's on campus, off-campus, or just during summer. Those kinds of experiences will inform you if this is the career you want or the career you don't want - which is sometimes better to find out.

Have their been recent discoveries in your field that have been particularly cool?

Yeah! Last week someone brought a pig brain back to life. Did you hear about that? There's a paper from last week. They took a brain that was dead for four hours and profused it with life-giving who-knows-what substance. They recorded neural activity in it. Now I'm not going to speak to the meaning of it, but I found that particularly interesting. Other big findings in the field? I think are really cool are the technical advances. There's an interesting debate about whether it's techniques that drive hypotheses or ideas that drive hypotheses. In the field, a lot of time the techniques advance first, and the hypotheses follow accordingly. There are a lot of great sensors that are being developed that we are hoping to use in my lab eventually. Thinking about other big findings - it seems like there's a big finding every week. Science is happening so rapidly. It's hard to keep up! • • •