

Science AMA Series: I'm King-Wai Yau, a neuroscientist at Johns Hopkins Medicine studying sight and smell. My lab has just affirmed that mouse pupils respond to light without their brains. AMA!

HopkinsMedicineAMA¹and r/ScienceAMAs¹

¹Affiliation not available

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Abstract

Hi Reddit, my name is King-Wai Yau, and I'm a neuroscientist at the Johns Hopkins University School of Medicine studying sight and smell! I started out in medical school at the University of Hong Kong but soon switched back to basic science and came to study in the U.S I have been studying vision for over 40 years, focusing on its first step, in which light interacts with the rod and cone receptor cells of the retina, initiating a complex biochemical/biophysical process which your brain eventually interprets as vision. However, we now know that additional photoreceptor cells beyond the rods and cones you learn in school actually exist in the retina. These newly found cells mediate eye functions unrelated to creating images, like constricting your pupil in response to changes in light. These non-rod/non-cone photoreceptors are important for helping us appreciate the progress of the day and, for example, in enabling us to get over jet-lag when traveling across time zones. Recently, my research has focused on understanding how light-induced pupillary constriction in mouse eyes can occur without the brain. Unlike in humans, mice's pupils can constrict without an obligatory connection to the brain because light-detecting pigment, present in the iris' sphincter muscle, responds directly to light. These findings shed light on the evolutionary path of the pupillary light reflex in vertebrates, which is essential for regulating light entry into the eye especially under bright conditions. Outside of the lab, although I hardly watch any commercial television, I would compulsively put aside work in the evening to watch Nature and Nova programs when they come up on Public Television. Any knowledge about biology, physics and chemistry is fair game to me! Check out my latest research here I'll be back at 1pm ET today to answer your questions.

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Series: I'm King-Wai Yau, a
neuroscientist at Johns

What are we trying to determine when shining a flashlight into an unconscious person if it isn't brain function? How did you think the pupil reflex was connected to brain activity in the first place?

[proficy](#)

The dogma has been that the pupil light reflex invariably involves the brain. This is still true for humans, but turns out to not be true for many animals. When you shine a beam of light into the eyes of someone who is unconscious, if the pupil constricts, it tells us that at least part of the brain that is responsible for the light reflex is still working. It's possible that other parts are not working, but for general comatose patients it is a good place to start.

I'm not sure if this is relevant because much of what you address is concerning sight, but in regards to smell, I know a few people that cannot smell but still have a sense of taste (albeit they like their food to

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be very strong tasting, salty/spicy etc). How is this possible? I always thought the sense of smell and taste went hand in hand (when I have a cold and am stuffy I can't taste a thing). So how is it that those who have no sense of smell can still taste?

[Ofthesee](#)

The senses of taste and smell are distinct. They have different receptors and the signals go to different places in the brain. However, there is some connection between taste and smell, possible because some of the stimuli that do to the nose also go into the mouth because the two cavities are interconnected. Presumably, some of the stimuli from food still activate the sensors in the oral cavity allowing them to taste without smell. The sensations go hand in hand, but one is not dependent on the other.

Dr. Yau, is the mechanism behind the photic sneeze response fully understood? If so, please enlighten. If not, where do its remaining mysteries lay?

[EntropicHeatDeath](#)

It's interesting! There are all kinds of funny things like this. Some people sneeze, some people get intense headaches or migraines. Once the light goes into the brain, this information goes to many different parts. Sneezing isn't common, but it isn't the only unusual reaction I've heard. There are others, but it hasn't happened to me. There are so many complex reactions from the brain that make everyone unique. There may be some uncommon pathways coming from the eye to the brain that cause you to sneeze. The mystery still remains to what these pathways are. I'm more concerned with understanding how light may cause migraines than causing sneezes.

In your discovery, did you manage to discern the underlying mechanism for triggering iris sphincter muscles response ? I mean what does the light sensitive pigment do to stimulate iris muscles response without the brain?

[ascendingorbit](#)

The light triggers a series of biochemical and biophysical reactions that cause the cells to react. Very similar reactions happen in the rods and cones that give us vision, but the final outcome is different. In one case the signal goes to the brain, in another it causes the muscle to contract.

What effects does invisible light have on our retina? I am aware invisible light can blind you, but how? If the tissue doesn't react, how can invisible light hurt you?

Why is it, if I'm in a room with one color light, my brain tried to add color?

As a child watching Black and White television, I found myself always adding the colors back...

[BenRandomNameHere](#)

One good example of invisible light is UV. You don't see it because the photosensitive cells in your retina don't specifically absorb it very well, but UV light has very high energy and, even if nonspecifically absorbed by the retina, it can cause severe damage - Just like a sunburn. Infrared light is also invisible, but because it is of low energy, it is less damaging than UV light. However, with very intense infrared light, and therefore more energy, it can still be harmful.

To the second part of your question, I am not an expert in perception, but it sounds like you are a very

imaginative person! In fact, I sometimes wonder why some of my dreams are in color and others in black and white.

Why can't we recall tastes and smells like visual memories?

[the-real-apelord](#)

We can. However, as humans, we rely a lot more on and are also dominated by our vision and hearing, and not so much on the senses of smell and taste. If you are deprived of these more dominant senses, either through blindness or blindfolding, the other senses will take on more prominence. Have you seen the James Bond movie where a woman was captured and blindfolded by villains and recognizes her captor by the scent of his aftershave? I don't remember the name of the film right now...

It's been said that you can't know other people see the same colors as you.

What are your thoughts on that statement?

[the-real-apelord](#)

Most of us actually do see similar colors, but there is a significant percentage of the population that doesn't see the same colors because there are mutations in the pigments in the rods and cones that give us image vision. These mutations affect the colors we see, so what you perceive may not be what I perceive depending on our pigments. Furthermore, people with fewer pigments because of genetics are considered colorblind. Because we have only 3 cone pigments, there are many color mixtures we cannot tell between. In a way, color blindness is a relative thing. If someone has fewer pigments than we do, we would consider them colorblind. But, compare us to a turtle, and humans are relatively colorblind.

Do blind people constrict and dilate their pupils?

[ninja542](#)

Interesting! It depends on the cause of blindness. If the blindness comes from the loss of rods and cones in the part of the eye that gives us image vision (i.e. recognizing faces) it will lead to blindness, but will not necessarily affect the dilation and constriction of the pupil because the signals from non-rod/non-cone photoreceptors are still intact. If the cause of blindness is located in the brain, you could have no perception of vision and still have a pupillary reaction if that part of the brain is still functional because the pupillary reflex and vision are controlled by different areas of the brain.

Do human pupils respond to light without our brains?

[NokiaSnakeWorldChamp](#)

No. Nor do non-primates that are active in the daytime. In many nocturnal non-primates, like moles, the pupil will respond to light without the brain.