

Transcript

Speaker 1: [inaudible]

Speaker 2: [inaudible]

Speaker 1: hello and welcome to the graduate, uh, radio show dedicated to graduate in research here at birth. My name is Stephanie Kurtzman. I'm a graduate student myself and I'll be your host [00:00:30] for the show here on k a l l Berkeley. So today I'm talking to Hania covert a Ph d student in neuroscience. So welcome. Hania. Thank you. Uh, we're going to be talking about her research on the neural basis of perception. So just to start out, can you give us a brief introduction to your work?

Speaker 3: Okay. So basically I'm in the neuroscience department and what we're really interested in is understanding how perception works. [00:01:00] And so basically what that means, we take it for granted that as we walk around we can see objects and we can hear music and we can feel things. But actually how this actually happens, how we perceive all these things around us and are able to make sense of the really complicated streams of data that are coming in from outside is one of the biggest unsolved mysteries.

Speaker 1: Neuroscience. Well. Okay, we'll just to give some background, can you talk a little bit about how we understand perception?

Speaker 3: [00:01:30] Okay. So I think the first person who really started trying to understand what perception was, I'm trying to get a clue about, you know, how the brain gives rise to perception was an English neurologist who lived in the 19th century called John Jackson. And what, he had several patients that had epileptic seizures in various parts of their brain. And he found that whenever these patients had a seizure, they would perceive things that weren't there. So they would be like, oh my goodness, my hand is tingling or a wow. I can see like really bright colors [00:02:00] and it would just take a couple of minutes. And once the seizure was over, they would no longer perceive it. And so he was the first person to actually say, well, you know, when something goes wrong in the activity as neurons, when they start firing in situations where they shouldn't be firing, people perceive things.

Speaker 3: Therefore the firing of neurons must be what brings about perception. And sort of later in the 1950s there was an American neurologist who sort of pioneered this technique of brain stimulation. So he would stick electrodes in his [00:02:30] patient's brains. And this was, you know, way back when, when you, when you could do this kind of stuff. And he would stimulate different areas. And we found that depending on where he stimulated, the patients would tell him that they felt different things. So they would be like, wow, like I can see my childhood home or I can, you know, I can, I can recall this really complex

memory of when I was in, you know, on vacation in Africa or something. Or I can hear music and all kinds of really complicated things. And so he also said, wow, you know, different parts of the brain lead to different kinds of sensations and sort of started [00:03:00] mapping the brain and finding that different areas of the brain, like the activity of neurons in different areas of the brain give rise to different kinds of perception.

Speaker 3: And so what we know nowadays is that visual perception takes place mainly in the visual Cortex, which is at the back of the brain. We know that, you know, auditory perception takes place in the auditory Cortex, which is sort of on the side of the brain or factory perception. So the perception of smell takes place at the front of the brain and the olfactory cortex. So we know where these [00:03:30] neurons are that are giving rise to perception, different areas. But what we really don't understand is how they give rise to perception, right? So you know, neurons firing visual cortex and we, we see a tree, but how does that work? What exactly are those neurons doing? Who is, who is decoding the activity of these neurons? So there's this whole problem of like, you know, is there a souls sitting back there that reading out the activity of neurons or you know, presumably that's not the case and the neurons themselves are generating this percept.

Speaker 3: And that's really what we're [00:04:00] trying to understand with our research is the mechanisms of perception rather than where it's happening or you know, we already know that it's the result of neurons firing. That's sort of the premise and we trying to understand specifically how the firing of neurons gives rise to perception. But when you pose the question as how, what, what kind of answer are you expecting and how so neurons fire [00:04:30] and then we see a tree and what, what, what are you looking for in between those two things happening? Are you looking for, I don't even know it. I mean that's a very good question. We really don't know what we're looking for ourselves. Right? Neurons firing to your tree, you know, how to, how does that work? We don't know. But a woman behind the curtain [inaudible] ugly. Like it's really a control, you know, sort of the way people think of this, like for example, visual perception.

Speaker 3: People think that, well, you know, our neurons must be just representing [00:05:00] the world and there's like a movie of the world playing inside and someone's sitting there watching that movie. The problem is, is that that person's sitting there watching that movie has to have a person sitting in their head watching that movie. And so you really run into like a philosophical problem about how, you know, how perception works. But the approach we take is we try to sort of look at situations in which perception is altered and perception is often altered because we actually don't perceive the world at all as it is depending on experience and depending on what we're expecting we see or hear or [00:05:30] feel things that aren't actually there. But there are sort of in line with what we want to see or hear or feel. And so we can look at situations where perception is different in different conditions.

Speaker 3: And then we can look at the activity of neurons and try to understand what's different about the activity of neurons in each case. And that sort of the approach we take to understanding how neurons are giving rise to assumption. Basically we let experience change, um, neural coding [inaudible] and then we look at [00:06:00] how we look at the neural coding by looking at the changes in area. Um, in the brain basically that are representing certain things. We work with auditory cortex. So we look at the area in the brain, which represents certain sounds and then we test behavior to see whether we can sort of see a correlation between the changes in behavior or perception and changes in neural coding. So, okay. So in your research outline, you say that when neural coding is trying to interpret some [00:06:30] kind of a stimulus, um, it resorts to prior experience less when the stimulus is more certain.

Speaker 3: And of course, oddly it would resort to prior experience more if the stimulus is less certain. So first just what does it mean for a stimulus to be certain or uncertain? So basically the idea there is that when we receive sensory inputs from the outside world, that they're often incomplete and we couldn't actually like know what [00:07:00] was going on just from the information we're getting. So in many cases, like if we see if we see an object somewhere on the horizon, you know somewhere in front of us say a ball, that ball could be a really large ball that's really close to us or a really small ball ball that's, or sorry the other way around, I'll give you a small ball close to eyes or a large ball really far away. And the visual information we're getting about the ball is actually definitely not enough to know what is going on in the situation.

Speaker 3: And so that's an example of sensory information [00:07:30] that's uncertain and it's been shown that as the sensor information that is coming into a [inaudible] to the brain basically becomes more uncertain. The brain sort of relies more on prior experience. So it's been shown that if you blur visual stimuli, for example, the brain sort of the perception of that stimulus is more like things that the person has seen before than what it actually is. Certain or uncertain depends also on your prior [00:08:00] experience. Well it's not, it's not like stimuli themselves are certain or uncertain. There are certain or uncertain depending on like I guess some stimuli that can be interpreted different ways like the one that you just said. But it also depends on your prior experience, whether your brain and the view using prior experience in order to interpret whatever. Exactly. If you're in a novel situation, if you've never experienced anything like this before, you have nothing.

Speaker 3: You have no prior information to incorporate into your perceptible, [00:08:30] you're going to have to work with what you have. But it's been shown that basically, you know, if you have visual information and touch information and sound information and sort of integrate all those together and then you add in prior experience and that's, that's what happens. Every time we perceive something, it's not something, it's something that happens subconsciously even before we realize what we're seeing. Um, and you know, if you, if you blindfold and don't let them use their hands and they only have to use their

ears, they're going to incorporate prior information a lot [00:09:00] more than if they had all the other information as well.

Speaker 1: So the reason I ask is because I'm still trying to imagine what an answer to this, how perception works question would look like or what kinds of predictions you would be able to make based on your results. And I guess an example would be, um, prior experience changes perception more when the stimulus is less certain. I mean that's [00:09:30] an example of a prediction that I can imagine. But can you talk about what kinds of predictions you're making are, are they based on the certainty of the stimuli are on completely different variables?

Speaker 3: Um, that the prediction you just mentioned is definitely one of the predictions that people have made before. So what a lot of people do is they sort of vary the certainty of a stimulus and then try to look at exactly how the percept or the perception is formed. And so a lot of [00:10:00] work has been done on that actually in the last five years or so. And people are increasingly finding that the brain is sort of statistically optimal. Like it integrates everything in this perfect way. And so what we're trying to understand more is how it does this. So we know that the brain does this and we want to understand if we look at the activity of neurons, can we tease apart which neurons are representing prior experience, which neurons are representing information coming from various modalities and how are they sort of putting all the information together. So the, [00:10:30] a lot of [inaudible]

Speaker 1: really interesting implications of this work. And in describing your research you write that in essence we don't perceive the world at all as it really is think optical illusions. But that is precisely what makes us so incredibly intelligent. So I know you referred to this a bit in the beginning of the conversation, but can you talk a little bit about the implications of your work for how we understand intelligence?

Speaker 3: Right? [00:11:00] Yeah, definitely. So I think sort of in the 70s when the whole artificial intelligence thing started going, everybody got really excited because they were like, all we need to do to, you know, do human intelligence is make computers that can like take in a lot of data from outside world and make like a one-to-one mapping so that like we have it in the inside world. And then, you know, based on that intelligence is just the next next step. But actually we're finding out that intelligence is really inextricably, inextricably linked to perception. The ways in which we [00:11:30] as humans perceive the outside world is already the way in which we are acting intelligently. So we can for example, recognize an object no matter what orientation that object is, is shown to us. So, and we, and our perception of that object immediately is grouping it into something meaningful.

Speaker 3: And that's something that, for example, computers can do. They can't even do simple things like object recognition. Um, and it looks like the problem is that they're not sort of perceiving [00:12:00] the world intelligently, which is what we're so good at. And so, and

understanding how it is that we incorporate so much information in order to just understand what's going on around us, um, we might be able to understand what it is that makes humans so intelligent. Well, it sounds like intelligence moves from being something that just resides in our brains to something that's more of an interaction. It's a relationship between us and the world. That's just [00:12:30] continuously, definitely, definitely. That's like a dance intelligence is just Bam thing with the world. Can you sell? So with the world. Um, okay. So how about the implications of your work for the nature nurture debate? So I think the, the reading, that's a difficult question is because nature and nurture in this case are really inextricably, it's not like neural coding is nature.

Speaker 3: Neural coding is, [00:13:00] is the result of nature and nurture right at the same time. So that's the whole point that neural coding changes very, very dramatically and visibly in response to experience nurture. And so you can't, you can't really tease them apart. And we're trying to understand how neural coding is dependent on nature, how it is dependent on nurture and how that then causes the behavior that basically incorporates both of those. And so we're really trying to look at the mechanisms [00:13:30] of how that works. But then what am I referring to your work as the neural basis of perception? It seems like it's the, the um, well, like complex interaction between experience, perception and neural as, as I guess as mediated through neural coding. I mean, I mean the thing is, I think you're completely right in the sense that it is all very circular, right?

Speaker 3: We start with neuro code coding and then experience changes that which changes [00:14:00] our interaction with the world, which changes our experience, which changes neuro coding. And so you have this loop that sort of goes on forever. And so it's really hard to say, well I'm studying this, so we're studying how experience affects neural coding and how this then leads to experience dependent changes and perception. Okay. And then I find I interviewed, I'll say it that way if you can remind me what it was. So for those of you who are just joining us, you're listening to the graduates on Calex [00:14:30] today I'm talking to honey, a cobra about the complex interaction between perception and experience as mediated through neural coding. So can you talk a little bit about your methodology? The way we do this, as we look at the activities of neurons in the brain and we just basically look at neurons, receptive fields, and what that means is what neurons like best.

Speaker 3: Okay. So we, [00:15:00] we find neuron a and neuron a starts firing a lot, a lot, a lot. When it sees a picture of Stephanie in and sees a picture of me, it doesn't fire it all. So we conclude that that neuron, like Stephanie is receptive field is Stephanie. All right, we look at a different neuron and it also has a receptive field for Stephanie. And another neuron also has a receptive field for Stephanie. So basically the neural coding of Stephanie in this brain is very, very pronounced. We were like 70 better definitely. And so flattered. [00:15:30] Basically looking at neuro coding just refers to looking at the activity of neurons in the brain and trying to understand what they like or what they code for and then trying to understand how that leads to perception in different ways. [inaudible] so can you talk a little bit about some of your results?

Speaker 3: Yeah. Okay. So specifically, um, what will you work on? As I said, is auditory perception. And so last year we had a paper that came out where [00:16:00] basically what we showed is that you, if you get an increase in the area in your brain that is representing a certain sound, that you actually become worse at discriminating between sounds that are sort of around near to that sound. And the idea basically is that because you've experienced one sound a lot, it becomes overrepresented in your brain and subsequently you sort of perceive everything that is close to that sound as being meant sound. And we think that that this is one of the mechanisms [00:16:30] that leads to categorical perception of speech sounds, which is the font phenomenon where, you know, whether you say an ae or someone else's name with a low voice or someone else says a with a really high voice, I always hear it in a, and I, I don't really discriminate the differences between that. Have you ever

Speaker 1: of the theory of morphic resonance? No. Okay. So this is a theory, some confederate, uh, pseudo theory but interesting, nevertheless [00:17:00] developed by um, a biologist named Rupert Sheldrake who studied the way that plants grow. And basically the first time an event happens, it has to tunnel its way through the gelatinous substance of space time. Right. And then, and it creates a tunnel for itself so that the next time it's going to happen, that tunnel is already there waiting for it. And it, it's easier for [00:17:30] that same event to happen. Um, and the more and more that the event happens, it kind of just fits itself into that tunnel because it already fits there and the tunnel can turn into a habit, can turn into a ret, can turn into an addiction. Right. Cause all of a sudden anything that's at all similar to the event kind of has

Speaker 3: his gravitational, he pulled through that tunnel. And that sounds kind of similar to the way that you're describing perception, it seems [00:18:00] like. Yeah. And I think that's a really good analogy. So the idea is that when you form these, what we call perceptual magnets, they sort of act as attractors to attract any sort of other things into this perceptual sort of black hole, I guess in a way. And that's really, really useful in many ways. Right? It's useful because it allows us to group things together. One of the best examples of this is in language where we perceive speech sounds that are kind of, you know, like different utterance of the world word [00:18:30] la for example, for English speakers all sounds sort of the same. And then raw sounds different, although there's all kinds of utterances, but they all sound like one thing. Whereas Japanese speakers who haven't had the chance to sort of form these perceptual magnets and those locations can't hear the differences between La. And so that's an example of how forming these perceptual magnets is really, really useful.

Speaker 3: But like you said, you know, if you're, if you start perceiving everything as the same thing, that's obviously a bad thing. And there's definitely evidence that the more sort of diversity [00:19:00] of sort of things you were exposed to at a very young age, the more you're able to subsequently perceive things properly or also form new kinds of perceptual magnets in different situations. So children who are bilingual and trilingual

can definitely learn languages better later on. And that may be because they just don't have these very, very strong perceptual magnets in a few locations. Instead, they have many more perceptual magnets, which all are, don't have as much attractive power [00:19:30] and therefore they're able to sort of deal with new situations and new stimuli better. It's a good thing we have iPods that store tons of music because it means we'll have lots and lots of magnets.

Speaker 3: Yes. Um, so definitely, you know, this is just another piece of evidence that the more experience you have, the better you become at interpreting the world. Right? So the premise here is that by gathering a whole bunch of information, [00:20:00] a whole bunch of clues from over a long period of time, you are much, much better at dealing with every new situation. Um, and so, you know, it's been shown in other experiments that, you know, if you like young, if you have young babies that are in very rich environments, that they're just able to learn better and to, to be more intelligent later in life. Um, and there's also an idea that the more sort of diversity you're exposed to at a very young age, the more sort of inferences you will be [00:20:30] able to draw later in life on all sorts of, in all sorts of different domains.

Speaker 3: And so there's lots of evidence that like bilingual and trilingual children are much, much more able to learn languages later in life. And part of the idea there is that they don't have these like very, very strong perceptual anchors that are sort of pulling anything that is similar to tones in, in whatever language they know towards that tone that they're sort of more able to, um, sort of articulate the differences between. Exactly. [00:21:00] Yeah, exactly. I mean, I think with neuroscience, a lot of, a lot of the time you find that, you know, you come up with this theory and you're like, well, people have known that for thousands of years. Of course, you know, education is important and people have known for a very long time that you need to expose young children to a diverse environment, um, later on in life. But it's just nice when you start understanding why that is actually happening and what's what's going on in the brain and these different situations.

Speaker 3: But, okay, actually I'm gonna, I'm gonna push you on that cause he [00:21:30] said why it's happening. So are you assuming that what's going on in the brain? Is the cause of this happening or, well, I mean definitely we think that, you know, what we see in terms of the activity of neurons is causal of what we see in terms of behavior and perception on all of these things. Um, but sometimes, you know, people are like, well that's great. Now you know, what's going on in neurobiological level. But I already knew that diversity was important for my children. But I think that, um, what this research [00:22:00] you know, is really good for like, it can be applied to medical disorders. For example, there, there are certain conditions, for example, dyslexia that people now think are associated with a problem in perceptual processing. So there's some people who think that dyslexia comes about when children are unable to form these perceptual anchors that non dyslexic children can.

Speaker 3: So they, they basically can't really use their experience to guide their perception of new incoming information. And so [00:22:30] understanding how that works definitely, um, you know, helps us develop therapies for these kids. There's a, there's a company in San Francisco, there's neuroscientists that started it, um, but actually has a training program for dyslexic children, which is based on sort of rewiring the brain in ways that will help them form these perceptual anchors. Another application of the research is, for example, schizophrenia, which is a condition characterized by perceiving things that aren't actually out there in the world. And so by understanding [00:23:00] how perception works, we might be able to gain insight into what is going wrong in these patients who, who start perceiving things that have nothing to do with reality. Okay. So we will be right.

Speaker 4: Yeah. Our next week's show, I'll be talking to Larissa Mann, a phd student at Boalt law school about creativity and copyright laws. So please join me for the graduates every Monday from 12 to 1230 on Cadillac's [00:23:30] and the graduates has swiftly moved into 2008 from aol.com to Facebook. So please visit our very new Facebook page. Search for the graduates calyx on facebook.com a you can become a fan right on the wall. Check the guests of future shows or suggest yourself as a guest. So don't be shy. That's the graduates. K A I. X. You [00:24:00] can search for that in quotation marks on Facebook.

Speaker 1: Welcome back. Today I'm talking to honey, a covert about about the interaction between perception, experience and neural coding. I'm curious, can you situate your, the work that you're doing within the field of neuroscience in general, do you, is this approach that you're taking where [00:24:30] you're really looking at this as a, as a dynamic interaction, is that kind of a novel thing? Is that where neuro science is headed? Is that your work specifically

Speaker 3: me? So I think it's definitely part of the, the sort of very recent trend in neuroscience. Originally what neuroscientists used to do is they sort of tried to find the neural code in the brain. So they were like, here's the outside world, which neuron is coding for this feature? Which neuron is coding for this feature? And sort of trying to understand this one, two, one code [00:25:00] that people thought were going on. But more recently people have realized that there's a lot more going on than just a one to one mapping of the outside world and the inside world and that we have an internal world that influences the external world and vice versa. And it's a very complex interaction between these two things. Exactly. It's just like a dance. Um, and so definitely the field of neuroscience is starting to move in a direction where it's trying to understand how experience, shapes perception, how, you know, [00:25:30] the world shapes perception, um, to try and sort of tease apart the neural code because the other method just wasn't really taking us where we wanted to go. So, um, how has your work influenced your own perception? No, I'm just kidding.

Speaker 3: So actually I have to say it made me a lot more aware of perception. I think I definitely took for granted that, you know, I could see everything around me and hear everything around me and you know, thinking [00:26:00] about it a lot has made me just realize how amazing it is that we can navigate through the world and understand it.

Speaker 1: [inaudible] so I feel like no discussion about this, at least within the context of academia would be complete without the, um, but doesn't your perception affect your perception of perception? I bet you get that a lot. So what's your loss?

Speaker 3: So what's your response to that? [00:26:30] Um, definitely. I mean, I definitely agree that of course I'm limited by my perception, um, in terms of understanding perception. But I think that we have sufficient sort of methods to feel confident that we're measuring things that are actually real. So we're not only, I'm not only looking at the brain and relying on my visual signals of what is going on. We have technology that can record things and we have computers which do have the great advantages that [00:27:00] they actually do represent the world at it as it is. You know, that's what makes them stupid. But that's what makes them reliable. So you should just tell the philosophy is that our brains are the, the, the neural coding is actually statistically optimized to understand perception. That's true. Yeah. That's a good argument. Okay. So I know that everybody's thinking mind control, right?

Speaker 3: So you can go in there and mess around with someone's neural coding [00:27:30] and change the way that they experience the world. So, um, either, I mean, either for beneficial purposes or for not so beneficial purposes. Is there work being done on this? So it's really a question. Um, I know that there is some sort of therapy that's being tried on people with post traumatic stress disorder, sort of, you know, after they've veterans coming back from war and things like that where I think they're using certain sort of antidepressants that have certain sort of [00:28:00] kind of plasticity reducing effects to try and get rid of basically of the effects of experience on neural coding. Right? Because what's happening in these patients is they have these horrible, horrible memories that are sort of interfering with their lives in very, very horrible ways. And so if we could just get, erase those from neuro coding essentially, maybe we could help these patients.

Speaker 3: And I know people are looking into that, but I don't know if they have any viable therapies. Can I some them? When did you get to eternal sunshine? [00:28:30] Yeah, so it turned out that into exactly that idea where, you know, if we, if we could only find out where our memories were stored, we could, you know, erase them and then we wouldn't ever have to remember things we didn't want to. Um, that's definitely a science fiction movie. But you know, you know, maybe we understand perception to the point where we can pinpoint the specific mechanisms that are leading to perception. We could presumably do things like that one day. All right. Well to end on that [00:29:00] ominous note, it was a pleasure talking to you honey. Yeah. Thank you very much.

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Speaker 4: So you've been listening to the graduates or radio show dedicated to graduate student research on k a l ex Berkeley. My name is Stephanie Griffin. Please visit our Facebook page, search for the graduate Hallux on facebook.com and join me next Monday from 12 to 1230

Speaker 2: [00:29:30] [inaudible].