WEBVTT

NOTE duration:"01:08:45.3140000"

NOTE language:en-us

NOTE Confidence: 0.912937879562378

00:00:01.180 --> 00:00:13.780 Alright Good morning. Everyone let's make a start. It is a huge honor and a pleasure for me to introduce Lisa Feldman Barrett. Lisa is a University distinguished professor of Psychology Northeastern University.

NOTE Confidence: 0.887657105922699

00:00:14.300 --> 00:00:29.540 With appointments at Harvard Medical School and Mass General Hospital in psychiatry and radiology. She's a 2019 Guggenheim Fellow. She has a NH directores Pioneer Award for her groundbreaking work on emotion in the brain.

NOTE Confidence: 0.911328971385956

00:00:30.080 --> 00:00:59.450 She's an elected Member of the American Academy of Arts and Sciences and the Royal Society of Canada. She's president of the Association for psychological science, where somehow she also finds time to write blogs, most recently on the publication arms race an topically with Halloween around the corner on zombie ideas. These ideas that have been so thoroughly refuted empirically. And yet they refuse to die like the idea that vaccines cause autism and I'm sure some of you think predictive coding 2.

NOTE Confidence: 0.907097995281219

00:01:00.050 --> 00:01:30.260 So she's authored over 200 peer reviewed publications in various high profile journals nature neuroscience nature reviews neuroscience in motion psychological science ticks and 10s. But for me. It's her most recent book how emotions are made The Secret Life of the brain that I'm most excited about. I think I've gifted it to my friends and family more than any other book, particularly ones you don't really understand what it is that I do. They now do having read her book? Which I'm a little bit jealous about?

NOTE Confidence: 0.92484724521637

00:01:30.260 --> 00:01:35.090 It's a really incisive and broad, ranging synthesis of emotion in the brain.

NOTE Confidence: 0.87418133020401

00:01:35.970 --> 00:02:06.800 Through the lens of predicted processing, which is a really powerful account and through its lens. I think she's been able to Unite sort of apparently desperate accounts of how emotions come about from people like William James and Walter Cannon. I always like to ask people I introduced for a fun fact about themselves and least it tells me that she's unable

to walk and talk about exciting ideas at the same time, so this morning. I think she's probably going to be rooted to the spot and delighted to host her an really looking forward to her tool. Thank you for coming.

NOTE Confidence: 0.921979248523712

00:02:13.690 --> 00:02:44.500 Good morning, everybody. Thank you to fill for the invitation and also for the very, very lovely introduction, so today. I'm not going to be talking to you about emotion per say. Although I'm happy to use some evidence about the study of emotion to make the point that I want to make today. I want to talk to you more broadly about predicted processing as a paradigm for understanding.

NOTE Confidence: 0.922428369522095

00:02:44.500 --> 00:03:01.460 How a brain in a body surrounded by other brains and bodies creates a human mind and what might go wrong with the mental features of life that we experience in life based on how brains and bodies work.

NOTE Confidence: 0.925424158573151

00:03:03.040 --> 00:03:34.070 Anne for audiences like this in my experience. It's usually good to try to pitch. The talk kind of out of general level instead of dictating a deep dive into the computational details of the data so that's what I'm going to do today. But if you have specific questions about the details. Feel free to ask because I have a bunch of data slides that I'll be talking that I can talk around as well, but but mostly what I want to do today is just give you a feel for.

NOTE Confidence: 0.881632328033447

00:03:34.070 --> 00:03:43.170 The potency and also the big questions of this framework and so to start a sof I'm going to.

NOTE Confidence: 0.936057686805725

00:03:43.960 --> 00:03:49.750 Cover the history of psychological science in one slide.

NOTE Confidence: 0.916465640068054

00:03:52.320 --> 00:04:03.700 So I think this is relevant for psychiatry audience because we study the mind and as psychologists and psychiatrists and also his neurologists and so on.

NOTE Confidence: 0.905509829521179

00:04:04.370 --> 00:04:34.890 And all of us pretty much since the time of play dough have been using a set of what philosophers call folk. Psychology categories or common sense categories. These are these make up the typology of mental faculties that organize how we understand what a mind is to think, to feel to perceive and since the 19th century.

NOTE Confidence: 0.936943590641022

00:04:34.890 --> 00:04:57.440 When psychology became a science by taking mental philosophy. The categories of mental philosophy, thinking feeling perceiving and so on, and attempting to find the brain basis of those mental categories, using the scientific tools available at the time, which was 19th century, Physiology, and neurology.

NOTE Confidence: 0.932870328426361

00:04:58.020 --> 00:05:15.550 And so basically since the birth of psychology neurologist physiologists and then later psychologists began to search for the physical basis of these categories using a paradigm from 19th century, Physiology, which is where you apply a stimulus and then you observe a response.

NOTE Confidence: 0.946518778800964

00:05:16.140 --> 00:05:24.500 And for decades in psychology, and elsewhere. Scientists were unable to find the physical basis of these mental categories for emotion, and cognition and so on.

NOTE Confidence: 0.948751032352448

00:05:25.010 --> 00:05:30.030 And so they decided to take another experimental approach.

NOTE Confidence: 0.902572691440582

00:05:31.500 --> 00:05:42.590 And that is the approach of functionalism where science of understanding what a mind is and how a mind works and from there, it was a very quick jump.

NOTE Confidence: 0.880107223987579

00:05:43.270 --> 00:05:52.870 To behaviorism and infamous phase of psychology, where the mine disappeared as a topic of inquiry at all.

NOTE Confidence: 0.9249347448349

00:05:54.610 --> 00:06:16.650 Now behaviorism was not a total loss, even though it was a very infamous period in psychology. It launched decades of careful research on brain circuitry. Some of which we still use today. But scientists after a couple of decades became profoundly dissatisfied with behaviorism because.

NOTE Confidence: 0.932546138763428

00:06:17.150 --> 00:06:21.140 It ignores the basic fact that every single person in this room knows.

NOTE Confidence: 0.883056163787842

00:06:22.240 --> 00:06:25.460 And that is that you have a mind.

NOTE Confidence: 0.942090749740601

00:06:26.600 --> 00:06:34.250 And in every waking moment of your life your mind is moving from one mental state to another.

NOTE Confidence: 0.941752314567566

00:06:34.830 --> 00:06:51.820 And mental states have to be explained in scientific terms. If we're ever going to be able to treat and even prevent mental illness. So, in the 1960s, the cognitive revolution in psychology reinstated the topic of the mind for scientific inquiry.

NOTE Confidence: 0.906784772872925

00:06:52.570 --> 00:07:08.200 And this revolution gave birth to cognitive neuroscience and all of the neuroscience is that UM sort of evolved out of that affect of neuroscience and social neuroscience and pick a topic and there's a neuroscience for it.

NOTE Confidence: 0.91580057144165

00:07:09.160 --> 00:07:15.850 Using brain imaging, which as you know peers into the brains of awake experiencing humans and attempts to measure neural activity.

NOTE Confidence: 0.922489523887634

00:07:17.380 --> 00:07:41.430 But it was faculty psychology, all over again basically for decades, human neuroscience was organized around. These mental faculties. That's why we have a cognitive neuroscience and a social neuroscience and affective neuroscience people speak about the emotional brain and they speak about the cognitive brain and the attention brain and the social brain, but you don't have forebrains you have one brain.

NOTE Confidence: 0.925520241260529

00:07:42.720 --> 00:08:13.050 And this has been I think a bit of an epiphany at least in the brain imaging world because the shiny new toys that we developed with brain imaging. It's not that they failed to teach us something at all. It's that they taught taught us something we didn't expect and that is that we don't have different parts of the brain that are dedicated to thinking and feeling your brain is not a battleground between cognition and emotion.

NOTE Confidence: 0.925382792949677

00:08:13.050 --> 00:08:44.280 You know in the struggle for your behavior that's a narative that we've had since Plato. It's a cherished narrative that appears in law and it appears in economics, but it actually is not respected by the brain by the anatomy of the brain are by the functioning of the brain and so this has led number of scientists, including myself. To actually question whether there isn't a better way to really have a unified approach to understanding brain function that will help explain?

NOTE Confidence: 0.917499899864197

00:08:44.280 --> 00:08:52.110 How we experience the mental features we experience in life and also that controls our behavior and so in my lab?

NOTE Confidence: 0.921349704265594

00:08:52.880 --> 00:09:20.680 Instead of starting with the categories and then asking well. Where are these categories in the brain or how is the brain creating? Where in the brain? Does it process emotion or cognition? We actually start with the brain structural and functional properties and then we ask OK well given our best understanding of how a brain is structured and how it works in a human body surrounded by other brains and bodies.

NOTE Confidence: 0.917982339859009

00:09:21.270 --> 00:09:24.380 Exactly what kind of minds can this brain produce.

NOTE Confidence: 0.938717007637024

00:09:25.520 --> 00:09:26.730 In different cultures.

NOTE Confidence: 0.916177093982697

00:09:27.360 --> 00:09:58.070 And what are the computational properties that can be used to understand mental life and so today. I want to introduce to you or talk to you just sketch for you, I guess the approach that we take which is a predictive processing approach, which I stumbled upon in 2010 because I was asked to review what what became a Seminole paper in the field, which was a fantastic paper in behavior and brain Sciences by.

NOTE Confidence: 0.862326979637146

00:09:58.070 --> 00:10:01.160 Andy Clark and the philosopher Andy Clark.

NOTE Confidence: 0.918279767036438

00:10:01.930 --> 00:10:31.940 This was my introduction to predictive coding an in order to review that paper. I had to go and read like 20 other papers because I had never actually heard of it. Before I mean in psychology. We've really even before in philosophy right there's a number of philosophers who talk about how prior experience is a lens through which we control action and construct experience can't said this.

NOTE Confidence: 0.926852762699127

00:10:31.940 --> 00:10:43.530 In psychology him hold said. This There are many times throughout the history of psychology where this idea has come about, but I was really impressed by the fact that.

NOTE Confidence: 0.903993844985962

00:10:44.070 --> 00:10:52.100 When I was reading neuroscience, neuroimaging work when I was reading work in anatomy and.

NOTE Confidence: 0.915484070777893

00:10:52.760 --> 00:11:23.450 Track tracing work in neuroanatomy when I was reading work in electrical engineering that Bears on the electrical functioning of the brain and in Physiology. These various different literatures were all pointing to the same insights. Even though they didn't weren't talking to each other, which I I just don't know another time in my scientific career over 25 years where that's ever happened. And so I'm going to talk to you about a couple of these insights today.

NOTE Confidence: 0.893538355827332

00:11:23.450 --> 00:11:28.490 And use some of the research from my lab to discuss these insights.

NOTE Confidence: 0.763328790664673

00:11:29.730 --> 00:11:31.340 And so.

NOTE Confidence: 0.922788202762604

00:11:32.480 --> 00:11:37.090 The first insight that comes from a predicted processing approach.

NOTE Confidence: 0.912103950977325

00:11:38.520 --> 00:11:54.570 Is that your brain actually is continually constructing concepts all the time and these concepts are? What control your actions and construct your experience.

NOTE Confidence: 0.911018967628479

00:11:55.430 --> 00:12:08.300 And so to explain how this works. I'm going to start from the brain's perspective, so I want us to take the brains perspective for a moment and so that we can understand really the brains Maine.

NOTE Confidence: 0.922289311885834

00:12:08.840 --> 00:12:14.140 You know puzzle that it has to solve is something that we can describe as a reverse inference problem.

NOTE Confidence: 0.894905686378479

00:12:15.000 --> 00:12:18.610 Or an inverse inference problem in the following sense.

NOTE Confidence: 0.927713394165039

00:12:19.130 --> 00:12:24.370 For your entire life, your brain is stuck in a dark silent box.

NOTE Confidence: 0.829492509365082

00:12:25.510 --> 00:12:26.570 Called your skull.

NOTE Confidence: 0.942549645900726

00:12:28.140 --> 00:12:38.100 And it learns what is going on in the world only by receiving scraps of information from the sensory channels of the body?

NOTE Confidence: 0.867385029792786

00:12:39.460 --> 00:12:41.910 Like the retina the Coclea and so on.

NOTE Confidence: 0.92780601978302

00:12:42.430 --> 00:12:48.040 These sensory changes that the brain receives are the effects.

NOTE Confidence: 0.931358158588409

00:12:49.600 --> 00:12:51.710 Of some causes in the world.

NOTE Confidence: 0.929547846317291

00:12:52.220 --> 00:12:56.530 But your brain doesn't know the cause, it only receives the effects.

NOTE Confidence: 0.938076674938202

00:12:57.230 --> 00:13:07.200 So it has to figure out what caused these sensory inputs, the sense data to know what to do about them, so that it can keep you alive and well.

NOTE Confidence: 0.738240003585815

00:13:07.780 --> 00:13:08.350 And.

NOTE Confidence: 0.951008796691895

00:13:08.860 --> 00:13:16.730 If we were evolutionary biologists, we would say to keep you alive and well so that you can do the most important thing.

NOTE Confidence: 0.904824674129486

00:13:18.510 --> 00:13:20.230 Which is eat chocolate?

NOTE Confidence: 0.913165748119354

00:13:22.080 --> 00:13:24.590 And also pass your jeans on to the next generation.

NOTE Confidence: 0.924583971500397

00:13:25.320 --> 00:13:27.860 It's hard to know sometimes which of those is more important?

NOTE Confidence: 0.918961524963379

00:13:30.020 --> 00:13:36.580 So any given sensory input, a flash of Light, a sound can have many, many, many different causes.

NOTE Confidence: 0.967252790927887

00:13:38.510 --> 00:13:39.980 At the same time.

NOTE Confidence: 0.890288889408112

00:13:40.520 --> 00:13:44.340 Your brain is also receiving sense input from your body.

NOTE Confidence: 0.90471088886261

00:13:44.850 --> 00:14:16.040 So from your brains perspective your body is another environment that it has to guess at the causes of the effects that it's receiving we call those effects into receptive inputs from the body, so an ache in your gut could be hunger. If you're sitting at the table dinner table at dinner time it could be waiting in the doctors office for test results so it could be anxiety. The same ache in your gut if you're a judge in a court room.

NOTE Confidence: 0.897159278392792

00:14:16.040 --> 00:14:29.970 Might be a feeling that the defendant can't be trusted. So, your brain us to determine the causes of these sense data, which are the effects so this is the classic kind of inverse or reverse inference problem.

NOTE Confidence: 0.934531211853027

00:14:30.540 --> 00:14:38.470 And So what does it do? How does it solve this problem it's trying to solve this problem from the moment that you're born until the moment that you die, So what is it using?

NOTE Confidence: 0.934901058673859

00:14:39.260 --> 00:14:47.690 And the answer is it has one other source of information and that is the past experiences that it has encoded.

NOTE Confidence: 0.690512895584106

00:14:48.210 --> 00:14:50.090 In the

NOTE Confidence: 0.960654377937317

00:14:50.650 --> 00:14:52.290 Connections between neurons.

NOTE Confidence: 0.92083603143692

00:14:53.670 --> 00:15:08.230 So, your brain has to remember past experiences that are similar to the present in some way in order to make a guess at what to do next to keep you alive and well.

NOTE Confidence: 0.918664574623108

00:15:09.620 --> 00:15:38.610 And I think the important thing here is that the brain when your brain receives sound or change in wavelengths of light and so on. It's not asking What is this is asking? What is this similar to? What is this similar to in my past experiences when the physical changes in the world and my body were similar to the present that is the sense data or similar to the present? What did I do next.

NOTE Confidence: 0.931971669197083

00:15:40.060 --> 00:15:49.820 Well, in psychology things that are similar to one another in their function is a category and a mental representation of a category is a concept.

NOTE Confidence: 0.912549734115601

00:15:50.770 --> 00:16:04.840 So you could say that what your brain is doing is it's constructing ad hoc concepts on the fly in order to make sense of sense data so that it can control your actions.

NOTE Confidence: 0.937525629997253

00:16:06.090 --> 00:16:12.570 So we all know that a category is a group of things that are similar in some way for example, a category of cats.

NOTE Confidence: 0.93743371963501

00:16:13.420 --> 00:16:15.460 Cats are similar in various ways.

NOTE Confidence: 0.833353996276855

00:16:16.030 --> 00:16:23.360 They have fur most of them that some they have 2 eyes. They have a nose, they've whiskers they?

NOTE Confidence: 0.825592935085297

00:16:24.250 --> 00:16:30.260 You know like to catch mice, most of the time.

NOTE Confidence: 0.930437505245209

00:16:32.880 --> 00:16:58.970 Now, what I just did I just give you a list of features that list of features is the mental representation of a cat that's called a concept, and in fact when psychologists study concepts. They ask people to give them a list of features that define the concept so for example, if I asked you to tell me what the prototype, the concept is for a bird? What would you say?

NOTE Confidence: 0.775766015052795

00:17:01.930 --> 00:17:02.560 Sorry.

NOTE Confidence: 0.918385624885559

00:17:04.090 --> 00:17:08.160 Right so, give me an example of a bird that has those features.

NOTE Confidence: 0.888816356658936

00:17:09.850 --> 00:17:19.930 A blue Jay a Crow OK now imagine that you were in pet store and I asked you to tell me what the prototype of a bird is what would you say?

NOTE Confidence: 0.91264933347702

00:17:21.880 --> 00:17:29.530 Sure, that's a feature but tell me give me give me the some of the features in an example, so what's the prototypical bird if your goal is to have a pet?

NOTE Confidence: 0.873970627784729

00:17:30.640 --> 00:17:34.560 Parakeet and what about if you're at the dinner table.

NOTE Confidence: 0.907950937747955

00:17:40.400 --> 00:17:49.600 The chick in an if it's Thanksgiving. It's a Turkey and if you live in South America. You wouldn't have said a Crow or a blue Jay you would have said a Peacock.

NOTE Confidence: 0.937120616436005

00:17:51.080 --> 00:18:07.410 So what's happening here, which what we just did is we just replicated an experiment from the 1980s. In cognitive science, where scientists discovered that the prototypes. The concepts that go with categories are highly variable there is variable as your blood pressure basic.

NOTE Confidence: 0.926716208457947

00:18:08.120 --> 00:18:27.810 Because what people are doing you don't have one concept stored in your head. One prototype your brain is making a prototype every single time in every context. For whatever function that category is serving right so we just talked about the category of eating a bird. The category of having a bird as a pet and we could talk about others as well.

NOTE Confidence: 0.902564108371735

00:18:29.290 --> 00:19:00.100 So we can do this with cats. If I asked you to list. The features of a cat and give me an example of a prototype of a cat you know you might say a tabby cat, but then if I said, well what about a cat who's good at catching mice well. What about a cat who is a good pet well. What about a cat who lives in a zoo and so on, So what your brain is doing is it's Taylor making concepts as you need them, which would actually dictate your action towards.

NOTE Confidence: 0.897007882595062

00:19:00.100 --> 00:19:20.530 The The The instance of the category in question right you wouldn't eat. A Parakeet and you wouldn't get well. Some people do keep chickens as pets. So I can actually use that as an example anymore. But maybe a Turkey. I can tell you turkeys are really annoying so you wouldn't keep we have wild turkeys where we live and they're very, very, very annoying. I mean, not as pets, but they just wander the street and terrorized people.

NOTE Confidence: 0.946193158626556

00:19:22.770 --> 00:19:30.890 So what I want to suggest you today is that this is the operating principle of the brain. So when I show you something like this.

NOTE Confidence: 0.915009140968323

00:19:31.790 --> 00:19:45.180 Your brain is just made a concept for cats and so when you see this you see it. You're more likely to see it as a cat because I just showed you a bunch of cats and so your brain is primed essentially to make an ad hoc.

NOTE Confidence: 0.893405735492706

00:19:45.720 --> 00:19:54.460 Category I ad hoc concept for cat so you see this as a cat as opposed to an Apple, which you might see it if we had just talked about fruit.

NOTE Confidence: 0.945050239562988

00:19:55.020 --> 00:20:02.860 And So what you experience in the moment is a combination of sensory information from the image an from the concept in your head.

NOTE Confidence: 0.928633034229279

00:20:03.660 --> 00:20:09.640 This is why Andy Clark likes to refer to conscious experience as a controlled hallucination.

NOTE Confidence: 0.933848917484283

00:20:11.470 --> 00:20:21.710 Now there are a couple of things about the way that our brains make concepts that set us up nicely to talk about predictive processing and here's one of them.

NOTE Confidence: 0.944176495075226

00:20:24.200 --> 00:20:25.710 So what is this?

NOTE Confidence: 0.928466439247131

00:20:26.470 --> 00:20:27.360 What do you see?

NOTE Confidence: 0.90629631280899

00:20:28.960 --> 00:20:32.710 You see something is playing a jump jump rope game, what's playing jump rope.

NOTE Confidence: 0.917604386806488

00:20:34.010 --> 00:20:38.570 Yeah, transformer? How many of you have ever seen an electrical tower in your life play jump rope.

NOTE Confidence: 0.915469110012054

00:20:40.260 --> 00:20:41.080 Well, I never.

NOTE Confidence: 0.905433833599091

00:20:42.370 --> 00:20:44.750 So right away but you're not recognized.

NOTE Confidence: 0.911767542362213

00:20:45.300 --> 00:21:04.460 Speaking so how did your brain do that? Well, this demonstrates one of the cognitive scientist called the most powerful capacity of a mind? Which is to do conceptual combination your brain takes bits and pieces of the past and combine them in new ways, so that you can make a concept, and understand burgers is.

NOTE Confidence: 0.933348655700684

00:21:06.250 --> 00:21:08.120 Now let's just look at it for a minute.

NOTE Confidence: 0.711755692958832

00:21:11.340 --> 00:21:12.240 Many of you.

NOTE Confidence: 0.877724409103394

00:21:15.080 --> 00:21:19.590 And feel the pounding of the the transformer tower when it lands.

NOTE Confidence: 0.916064620018005

00:21:23.620 --> 00:21:27.040 I'm not sure it works in this space, but how many you can hear it jumping.

NOTE Confidence: 0.937415182590485

00:21:28.550 --> 00:21:33.230 Yeah, I seen this probably 500 times and it never goes away.

NOTE Confidence: 0.96230137348175

00:21:33.780 --> 00:21:37.620 And this is the other really important thing about concepts.

NOTE Confidence: 0.881567001342773

00:21:38.400 --> 00:21:46.700 Concepts are not these abstract a modal propositional things they are in body.

NOTE Confidence: 0.933494687080383

00:21:47.510 --> 00:21:49.640 When your brain is making a concept.

NOTE Confidence: 0.946211099624634

00:21:50.360 --> 00:21:51.600 It's actually.

NOTE Confidence: 0.93079286813736

00:21:52.380 --> 00:21:57.150 Doing something really remarkable it's changing the firing of its own sensory neurons.

NOTE Confidence: 0.905701458454132

00:21:57.650 --> 00:22:08.690 Based on what you see your brain is changing the firing up your own sensory neurons, so that you feel. Some somatosensory impact and you also.

NOTE Confidence: 0.875849306583405

00:22:09.200 --> 00:22:19.050 I hear some people come here actually the jumping of the tower. How many of you have ever had a song going through your head that you can't get rid of.

NOTE Confidence: 0.911868453025818

00:22:24.820 --> 00:22:27.410 Here's just one study from my lab.

NOTE Confidence: 0.906468689441681

00:22:28.180 --> 00:22:59.370 Where we verified this effect, so here what you're looking at are 2 brains one in the medial view one in the lateral view. Just sliced in a bit so you can see the insular lobe. I'm assuming everyone here knows how to find their way around a brain so I'm not going to Orient. You and what subjects were doing here is that they were lying still in this. I'm so they were asked to basically create a set of concepts. And here's what we see despite the fact that subjects are lying completely still in the scanner.

NOTE Confidence: 0.92493212223053

00:22:59.370 --> 00:23:11.720 We see massive activities in Motor Cortex Somatosensory Cortex Premotor Cortex and Supplementary Motor Cortex. Despite the fact that their eyes are closed. We see massive changes in activity in V1.

NOTE Confidence: 0.885187745094299

00:23:12.380 --> 00:23:14.180 An early Visual Cortex.

NOTE Confidence: 0.921014964580536

00:23:16.140 --> 00:23:49.150 This is the mid posterior insula, which is considered primary interoceptive cortex or visceral. Visceral sensory cortex, so despite the fact that subjects were not moving the regions that represent changes in the interior of the body, the internal milieu from changes in heart, beating an in lungs expanding basically anything to do with the autonomic nervous system changes in metabolism changes in immune function and so on.

NOTE Confidence: 0.905330896377563

00:23:49.150 --> 00:24:18.900 We see changes in the representation of sensory inputs to the body and most interesting. Lee even though subjects are completely. Still, you see increases in activity in the hypothalamus all the way down through the NTS, which are the regions which are the matrix of nuclei, which control the internal Millia. The systems of the internal milieu. Autonomic nervous system and so on, and so forth and that's just from lying and listening to words.

NOTE Confidence: 0.720543742179871

00:24:23.500 --> 00:24:24.140 Now.

NOTE Confidence: 0.914796113967896

00:24:24.900 --> 00:24:26.960 When your brain can't make a concept.

NOTE Confidence: 0.929376602172852

00:24:28.030 --> 00:24:31.660 That's right for the situation you are experientially blind.

NOTE Confidence: 0.940675795078278

00:24:33.650 --> 00:24:35.200 Presumably, like right now.

NOTE Confidence: 0.929200232028961

00:24:35.800 --> 00:24:52.210 Unless you've seen me give this talk before and you've seen this image. What's probably happening for you right now is that you know your billions of your neurons are attempting to make sense of this black and White Blobby image so that you see something other than black and white blobs.

NOTE Confidence: 0.931239902973175

00:24:52.860 --> 00:25:04.030 And your brain is basically searching through your lifetime of past experience asking the question. What is this similar to What is this similar to my past experience?

NOTE Confidence: 0.887809574604034

00:25:04.660 --> 00:25:20.190 Figuratively, speaking right the last time that my time that my body was in this situation and in this state in this room or in a room like this, or at a talk like this? What visual visual sense data mean?

NOTE Confidence: 0.916286885738373

00:25:21.580 --> 00:25:22.990 And then what do I do next?

NOTE Confidence: 0.942340195178986

00:25:24.590 --> 00:25:27.420 So how many of you actually see an object here.

NOTE Confidence: 0.897089719772339

00:25:29.430 --> 00:25:30.470 Yeah, what do you see?

NOTE Confidence: 0.729636013507843

00:25:35.830 --> 00:25:37.090 A Monster.

NOTE Confidence: 0.831448376178741

00:25:39.600 --> 00:25:41.960 Nice anybody else.

NOTE Confidence: 0.860260188579559

00:25:42.980 --> 00:26:01.320 Western Western Europe are you now I'm going to so for you, your your brains are attempting to deal with this experiential blindness. So now I'm going to cure you of your experiential blindness actually

when I when I'm in medical audiences. I usually like to kind of get up in front and go.

NOTE Confidence: 0.767856359481812

00:26:01.920 --> 00:26:02.430 I'm going to.

NOTE Confidence: 0.825080215930939

00:26:04.380 --> 00:26:07.540 Are you ready to be cured?

NOTE Confidence: 0.707906246185303

00:26:13.160 --> 00:26:19.500 Much better now can we have that Amen.

NOTE Confidence: 0.762608349323273

00:26:24.740 --> 00:26:25.140 Right.

NOTE Confidence: 0.877897560596466

00:26:29.160 --> 00:26:31.110 OK, now how many of you CAB.

NOTE Confidence: 0.86707478761673

00:26:31.850 --> 00:26:33.390 Or at least part of the be yeah.

NOTE Confidence: 0.942908406257629

00:26:35.220 --> 00:26:41.490 Because now when your brain is searching through past experience. There is new information there from that color photograph.

NOTE Confidence: 0.921133577823639

00:26:42.090 --> 00:26:53.770 And this knowledge changes how you experience these blobs. So, your brain is actually constructing an image of a B, even though there is no image of be present, hence the idea of a controlled hallucination.

NOTE Confidence: 0.912790238857269

00:26:54.480 --> 00:27:18.790 An and of course, there are people here, including Phil, who study actual clinical hallucinations, but things kind of work the same way so this hallucination is what I am calling a concept, and in a moment I will show you that this is actually what neuroscientists call a prediction, which is business as usual for your brain.

NOTE Confidence: 0.932977020740509

00:27:19.480 --> 00:27:22.860 Because these this input from your brain.

NOTE Confidence: 0.940698027610779

00:27:23.370 --> 00:27:31.070 The is necessary for you to have anything other than experiential blindness.

NOTE Confidence: 0.918785572052002

00:27:31.580 --> 00:27:50.410 It's what's required for you to hear the words coming out of my mouth and have them make sense to you right if you were not a native speaker of English or someone who was exposed to English and he would learn the language what you would be hearing is a bunch of noise. I mean, some of you may still feel like you're doing a bunch of noise, but

NOTE Confidence: 0.780040800571442

00:27:51.210 --> 00:27:56.840 That was a funny joke.

NOTE Confidence: 0.919573187828064

00:27:59.820 --> 00:28:04.990 Have to have a concept to be able to hear heavy metal as music.

NOTE Confidence: 0.868636965751648

00:28:05.860 --> 00:28:06.850 I had to learn that.

NOTE Confidence: 0.926332116127014

00:28:07.680 --> 00:28:09.420 My daughter is a heavy metal drummer.

NOTE Confidence: 0.896262764930725

00:28:11.780 --> 00:28:25.450 And so on, and so forth, but in order for the sense data to make contact with your guide your actions your brain has to be able to make make meaning make a concept of what those sense data mean?

NOTE Confidence: 0.903798639774323

00:28:26.220 --> 00:28:29.750 So the inside here is that?

NOTE Confidence: 0.92039942741394

00:28:30.310 --> 00:29:00.320 Psychological phenomena like what you would find in the table of contents in a intro. Psych book and the kinds of phenomena that you deal with with your patients are made with concepts. You are your concepts. So I'm not saying that your brain deliberately makes concepts, although sometimes it does, I'm saying, You are the concepts that your brain makes your mind is the concepts that your brain makes your concepts become your actions and the contents of your experience.

NOTE Confidence: 0.902750134468079

00:29:00.320 --> 00:29:07.220 And that sets us up nicely for the second insight, which is that this whole production happens productively.

NOTE Confidence: 0.96299421787262

00:29:09.050 --> 00:29:10.370 In psychology.

NOTE Confidence: 0.941706418991089

00:29:11.320 --> 00:29:18.660 We have a model of the mind really that comes to us from Physiology experiments of the 19 century.

NOTE Confidence: 0.902869164943695

00:29:19.880 --> 00:29:33.980 That the mind is the mind or the brain is dormant that it's stimulated by stuff in the world and then we react. We might do some cognition. Or maybe some emotion, they might battle with each other for control of behavior and then we make a response.

NOTE Confidence: 0.917465806007385

00:29:35.150 --> 00:29:45.870 That's not a straw man that is really the dominant paradigm still actually in psychology, and actually that is the basis of a lot of the treatments that we use.

NOTE Confidence: 0.895358085632324

00:29:46.370 --> 00:29:53.750 But your brain is not wired to react your brain is actually anatomically wired to predict.

NOTE Confidence: 0.933721899986267

00:29:54.590 --> 00:30:22.860 You are walking around with a brain that is loaded with bits and pieces of your past and your brain is using that to predict your immediate future, including what is going on in your own body with ad hoc concepts? Which ultimately become the experience and actions of the present this is what scientists call running an internal model of the world. Actually, your brain is running a model of your own body in the world.

NOTE Confidence: 0.900722324848175

00:30:23.850 --> 00:30:29.180 And these ad hoc concepts predict incoming sensory inputs, and motor changes.

NOTE Confidence: 0.926907896995544

00:30:29.830 --> 00:30:53.740 They represent the causal relationships between the events in the world and the body as they are right now and the sensory and motor consequences in a moment from now and again the best available evidence now from thousands of studies across more than 5 research domains is that this is the best guess about how your brain navigates the world and constructs your experience.

NOTE Confidence: 0.902753949165344

00:30:54.360 --> 00:30:58.060 So again here is an intuition here's an example to give you an intuition.

NOTE Confidence: 0.915721118450165

00:30:58.890 --> 00:31:00.180 Let's all do it together.

NOTE Confidence: 0.642587065696716

00:31:01.930 --> 00:31:03.120 Once apona.

NOTE Confidence: 0.960550963878632

00:31:06.630 --> 00:31:09.240 In a magical Kingdom.

NOTE Confidence: 0.853790462017059

00:31:10.080 --> 00:31:13.000 Far far.

NOTE Confidence: 0.956870079040527

00:31:14.480 --> 00:31:16.760 There lived a beautiful.

NOTE Confidence: 0.906025350093842

00:31:28.350 --> 00:31:30.830 That's a drag Queen superhero by the way.

NOTE Confidence: 0.649866819381714

00:31:32.200 --> 00:31:32.770 OK.

NOTE Confidence: 0.910498380661011

00:31:33.910 --> 00:31:51.000 This is a really nice example of prediction right. The fact that we've all been exposed to in this room to most of us to fairy tales and they all pretty much begin in the same way. And so our brains are able to predict exactly.

NOTE Confidence: 0.920085966587067

00:31:51.860 --> 00:32:11.150 What will come next just like right now you're listening to words come out of my mouth and to you it seems like you're just reacting to the words, I say, but actually your brain is making predictions about every single sound that escapes my.

NOTE Confidence: 0.925916194915771

00:32:12.890 --> 00:32:44.510 Mouth right lips, yeah, and it would be really funny. If I had mentioned some other part of my body that you were not expecting. That's what we would call prediction error. Now there are well over at this point, I would say, well over 500 papers closer to 1000 papers that we've been able to identify across multiple domains of research which actually support predictive coding and none of you most of you don't know me very well so you don't.

NOTE Confidence: 0.756622314453125

00:32:44.510 --> 00:32:47.080 Except one person alley.

NOTE Confidence: 0.873259842395782

00:32:47.770 --> 00:32:53.160 Ellie you can attest to the fact that I'm very critical person right. Yes, how are you I just believe what I read?

NOTE Confidence: 0.825961112976074

00:32:54.220 --> 00:33:24.980 So I guess my problem. Thank you point is that whatever about to tell you is not of course. Everything is still a hypothesis but

but I was really surprised by the I am still continually surprised by the extent to which the data tend to support this view normally.

NOTE Confidence: 0.93580549955368

00:33:24.980 --> 00:33:37.990 What I do now is I just show you a cacophony of examples of these papers just to make the point that this is like an avalanche of research across many different research domains, but I'm just going to sort of show you the most important ones.

NOTE Confidence: 0.856775224208832

00:33:38.570 --> 00:33:45.780 Whoops I really wanted to show you I just pulled these from fills I think it's going to there, we go.

NOTE Confidence: 0.809613406658173

00:33:46.300 --> 00:33:46.740 Yeah.

NOTE Confidence: 0.919449627399445

00:33:48.750 --> 00:34:19.840 Yeah, so I should I should say I'm not just showing you feels papers. Uh because he's the one who invited me. I actually fills papers are a staple in my lab because it's some of the most really impressive work. Of course, probably in psychiatry. People are interested in this because of the topic, but from our perspective we are interested in this because this work constitutes really some of the best empirical evidence for predictive coding.

NOTE Confidence: 0.919368803501129

00:34:19.840 --> 00:34:20.750 In the brain.

NOTE Confidence: 0.923524618148804

00:34:21.610 --> 00:34:41.170 And when you take this work along with the work in electrical engineering and the work in Physiology and the work in track tracing studies of Anatomy and in brain imaging and so on what you get is a coherent. Neurobiologically inspired research program for understanding the human mind and human behavior.

NOTE Confidence: 0.8328657746315

00:34:41.980 --> 00:34:43.580 Which Unites?

NOTE Confidence: 0.919321358203888

00:34:44.100 --> 00:34:50.730 All of the social brain and the emotional brain and the cognitive brain and so on into a single brain.

NOTE Confidence: 0.907182514667511

00:34:52.340 --> 00:34:54.220 Now this single brain.

NOTE Confidence: 0.938437879085541

00:34:55.270 --> 00:34:56.380 Is expensive?

NOTE Confidence: 0.934086859226227

00:34:57.060 --> 00:35:05.250 You may have thought you that you were a frugal person, but you have a very expensive brain your brain cost 20% of your metabolic budget.

NOTE Confidence: 0.912377655506134

00:35:06.960 --> 00:35:17.940 Unlike say a chimp it when you compare chimpanzee for example, whose brain costs about 99 or 10% and 70% of this metabolic budget.

NOTE Confidence: 0.920890271663666

00:35:18.850 --> 00:35:34.590 Is is dedicated to Watt neuroscientists call intrinsic activity? Which means activity in neurons that is not due to being prompted by a stimulus from the outside world.

NOTE Confidence: 0.909602284431458

00:35:36.590 --> 00:36:06.620 So largely this activity is about predictions, which means 14% of your metabolic budget 14% of the oxygen used 14% of the glucose used goes to maintaining your internal model of the world, which are these predictions for what we would call them. Concepts ad hoc concepts. And so generic just really sort of simple simple here is like a simplified explanation.

NOTE Confidence: 0.915688335895538

00:36:06.620 --> 00:36:10.060 Just going to show you in cartoons 1st and then I'm going to show you on the brain.

NOTE Confidence: 0.939841389656067

00:36:12.000 --> 00:36:16.650 This is how this is the hypothesis the general hypothesis for predictive coding.

NOTE Confidence: 0.921475112438202

00:36:18.280 --> 00:36:21.010 That you have a brain that's largely talking to itself.

NOTE Confidence: 0.944133996963501

00:36:22.190 --> 00:36:31.430 Your brain starts with initial conditions as they internal model of the representation of what's going on in the world and what's going on inside your own body.

NOTE Confidence: 0.906408607959747

00:36:33.030 --> 00:36:43.470 And then IT projects itself forward in time, creating ad hoc concepts based on functional similarity or you could say creating a prediction about what the body has to do next.

NOTE Confidence: 0.908384382724762

00:36:44.370 --> 00:36:51.500 So these would be the motor actions and the visceral motor actions, which have to support those motor actions.

NOTE Confidence: 0.923066556453705

00:36:53.630 --> 00:37:10.740 And these commands also create the predicted sensory consequences of those actions, so in effect. The brain is asking itself well. The last time I was in this situation and I prepared to make this action? What did I see what did I hear? What did I feel, and so on.

NOTE Confidence: 0.922859668731689

00:37:11.350 --> 00:37:24.690 In those predictions actually change the firing of sensory systems, so that we have this these simulations that we experienced earlier with the examples.

NOTE Confidence: 0.907186627388

00:37:25.590 --> 00:37:26.410 And then

NOTE Confidence: 0.893240213394165

00:37:29.000 --> 00:37:31.750 Sense data comes from the world.

NOTE Confidence: 0.930038213729858

00:37:32.950 --> 00:37:35.160 And there are comparisons.

NOTE Confidence: 0.930403053760529

00:37:36.260 --> 00:37:41.220 And if the comparisons indicate that there is a pretty good match.

NOTE Confidence: 0.923501789569855

00:37:41.790 --> 00:37:43.490 They confirm the predictions.

NOTE Confidence: 0.896686196327209

00:37:44.000 --> 00:37:54.600 Then that means the sensory inputs were made meaningful to guide your actions and create your experience and we call this categorization.

NOTE Confidence: 0.896988689899445

00:37:55.530 --> 00:37:59.430 So predictions are like Anticipo Tori.

NOTE Confidence: 0.918049156665802

00:38:00.030 --> 00:38:18.760 Guesses or anticipo Tori opportunities for categorization that are then confirmed by the sense data in the world and the really interesting thing is that if it's the case that your prediction largely is confirmed by the sense data from your body and from the world then.

NOTE Confidence: 0.913211345672607

00:38:19.740 --> 00:38:34.630 The there's not that much change in information from the world doesn't make it very far into your brain after that because basically the neurons are already firing in a way to capture the sense data from the world.

NOTE Confidence: 0.800605475902557

00:38:36.540 --> 00:38:39.990 Oops. Sorry I hit the wrong slide.

NOTE Confidence: 0.943244695663452

00:38:41.570 --> 00:38:42.590 However.

NOTE Confidence: 0.923437297344208

00:38:43.270 --> 00:38:51.480 It might also happen that there is information that we in the sense data that we didn't anticipate.

NOTE Confidence: 0.901544094085693

00:38:51.980 --> 00:39:17.330 We call that prediction error and so this is what happens is the brain than has the opportunity to modify its internal model that is, we have a fancy name for this in psychology. We call it learning so the brain can learn information learn new sense data so that it can predict better next time.

NOTE Confidence: 0.91289085149765

00:39:19.270 --> 00:39:36.670 And this is general this is the generic idea of how light becomes vision and chemicals in the world becomes smells and how the interceptive sensations in your body become affective feelings that we used to build emotions.

NOTE Confidence: 0.892680704593658

00:39:37.330 --> 00:39:44.190 So this is how an ache in your chest. The exact same ache in your chest might be loneliness.

NOTE Confidence: 0.914172351360321

00:39:45.070 --> 00:39:47.380 It might be anxiety.

NOTE Confidence: 0.933791220188141

00:39:48.270 --> 00:39:50.540 Or it might be the beginnings of a heart attack.

NOTE Confidence: 0.882156491279602

00:39:52.840 --> 00:39:54.510 Not a joke that's actually not a joke.

NOTE Confidence: 0.920304417610168

00:39:56.220 --> 00:39:57.630 Which I can talk about later?

NOTE Confidence: 0.564290106296539

00:39:58.130 --> 00:39:58.890 So.

NOTE Confidence: 0.939378559589386

00:39:59.620 --> 00:40:01.680 If we're going to put this on the brain.

NOTE Confidence: 0.900538623332977

00:40:02.310 --> 00:40:04.510 And you know what I'm showing you here again is sort of.

NOTE Confidence: 0.852228105068207

00:40:07.220 --> 00:40:08.490 Backed up by.

NOTE Confidence: 0.666008830070496

00:40:08.990 --> 00:40:10.150 About.

NOTE Confidence: 0.870361149311066

00:40:12.660 --> 00:40:18.710 As well as a couple of examples. I'm going to show you in a minute. So here what I've done is I've just.

NOTE Confidence: 0.264731019735336

00:40:19.700 --> 00:40:21.180 Put.

NOTE Confidence: 0.638519108295441

00:40:21.770 --> 00:40:23.890 I've taken

NOTE Confidence: 0.877388417720795

00:40:26.750 --> 00:40:56.760 Anna colored some regions to make a point, which is the regions that are evidence. Strong evidence that they initiate the cascade of predictions that will become your ad hoc concepts are colored in blue. The Red Strip is your motor strip and yellow are colored 3 primary sensory regions just for Illustration V1.

NOTE Confidence: 0.91062468290329

00:40:56.760 --> 00:41:19.790 S1 so primary Visual Cortex Primary Somatosensory Cortex and primary interoceptive cortex. And so the idea is that when your brain projects itself into the future what it's doing is it's making a first, a set of visceral motor predictions to control your autonomic nervous system your immune system your endocrine system and so on.

NOTE Confidence: 0.891880035400391

00:41:21.050 --> 00:41:21.860 And then

NOTE Confidence: 0.897622883319855

00:41:25.080 --> 00:41:39.660 Those regions make a prediction to Motor Cortex, an motor cortex also sends a actually the motor system sends a set of predictions to your skeletal motor system and those are the motor predictions that which come first.

NOTE Confidence: 0.927596628665924

00:41:40.190 --> 00:41:44.740 And I'll show you why we believe this in the next couple of minutes.

NOTE Confidence: 0.902195870876312

00:41:47.380 --> 00:41:55.110 And then copies of those motor predictions and bitter motor predictions are then sent to the primary sensory regions.

NOTE Confidence: 0.931784272193909

00:41:57.220 --> 00:42:01.000 So it's this constant cascade of prediction.

NOTE Confidence: 0.905318140983582

00:42:03.810 --> 00:42:15.490 And then a constant cascade of sense data, which comes from the body an from the world to constrain those predictions to confirm them or 2.

NOTE Confidence: 0.861046195030212

00:42:16.690 --> 00:42:17.820 To change them.

NOTE Confidence: 0.921720921993256

00:42:18.860 --> 00:42:21.530 So traditional experiments.

NOTE Confidence: 0.883865177631378

00:42:22.290 --> 00:42:55.020 An traditional treatments to some extent, which are are pretty much designed on a model of the brain, which goes like this we have, we stimulate the subject in some way then something goes on inside their head like they make evaluations, which we could describe as cognitive or emotional and then there's a response and actually what we do is we give sets of trials in experiments where we presented stimulus.

NOTE Confidence: 0.901711344718933

00:42:55.020 --> 00:43:24.160 And then we measure, the response presented stimulus measure. The response to trials are randomized, so that we can aggregate them in statistical analysis. And so basically the brain's predictions are going to be wrong. Almost all the time because we've set the experiment up that way. And so basically what we're doing is forcing the brain into a mode where it favors encoding and processing of prediction error, which are driven by the stimuli that we present.

NOTE Confidence: 0.90781182050705

00:43:25.000 --> 00:43:45.160 When in the real world, the real world dynamics of the brain probably work more in a temporally continuous way where the brain is a system. An it's dynamically moving from one state. One part of its state space to another or for today. Will say one state to another.

NOTE Confidence: 0.236592888832092

00:43:46.690 --> 00:43:48.000 Ann.

NOTE Confidence: 0.894823491573334

00:43:48.880 --> 00:44:16.950 Actually and then is constrained by by sense data from the world and from the body and psychopathology can be understood a range of different psychopathologies different diagnostic categories, which are kind of like the folk psychology categories. Psychology are diagnostic categories are also folk psychology categories are full categories to some extent, there ways that we categorize symptoms.

NOTE Confidence: 0.909747779369354

00:44:17.710 --> 00:44:40.510 But it's possible to have a framework where we can understand particular types of symptoms as problems with the internal model problems with processing of prediction error, either with the the ability to encode the prediction error, the ability to the precision or reliability of that error and so on, and so forth.

NOTE Confidence: 0.885880768299103

00:44:44.750 --> 00:45:11.710 And so here's an example of just one kind of study and I've picked a study which sort of supports the idea of predict if this predictive coding model that we've come up with and I should say I should have said this before that, the schematic that I just showed you is based on mostly actually on track. Tracing evidence from Helen Barvis is where we'll go over again in a minute.

NOTE Confidence: 0.860717058181763

00:45:12.270 --> 00:45:13.520 But there's

NOTE Confidence: 0.926259279251099

00:45:14.250 --> 00:45:44.900 You know there are lots and lots of different predictive coding models. The one that we use is kind of a whole brain model. We also have worked in the cerebellum and also the hippocampus which I'm happy to talk about. But in an hour long talk. You can't cover everything so I'm just going to focus on the Cortex and here's one really nice example of a study that supports this view, which comes from the animal literature that has nothing to do with prediction, meaning this is these are not. People who set out to study prediction instead.

NOTE Confidence: 0.915636777877808

00:45:44.900 --> 00:45:47.250 What they were studying was vision?

NOTE Confidence: 0.607979297637939

00:45:47.880 --> 00:45:49.260 And.

NOTE Confidence: 0.794363260269165

00:45:49.860 --> 00:45:55.720 They trained rodents to run on a wheel.

NOTE Confidence: 0.92571222782135

00:45:56.410 --> 00:46:17.640 And while that wrote it was running on a wheel. They recorded from single cells single neurons in various parts of the brain, including V1, so the animals running on the wheel. You record from V1, you get the pattern of activity. That represents the animals visual sensations, while it's running on the wheel.

NOTE Confidence: 0.847234427928925

00:46:18.710 --> 00:46:19.520 Then.

NOTE Confidence: 0.776720285415649

00:46:20.830 --> 00:46:24.240 You a blade the retinas of the animals so you blind them.

NOTE Confidence: 0.865924596786499

00:46:26.640 --> 00:46:32.600 And then you measure their neural activity for 48 hours.

NOTE Confidence: 0.910731256008148

00:46:33.490 --> 00:46:40.830 And what you find is that V1 neurons quieten down initially 'cause they're not receiving any sense data from the periphery.

NOTE Confidence: 0.940474033355713

00:46:41.360 --> 00:46:46.100 And then they very quickly over 48 hours ramp up back to normal firing rates.

NOTE Confidence: 0.848353981971741

00:46:48.320 --> 00:46:52.270 And then you stick the rap the rats back on the wheel.

NOTE Confidence: 0.858368754386902

00:46:53.470 --> 00:46:57.360 And you measure their neural firing in V1 and you find.

NOTE Confidence: 0.955103158950806

00:46:58.120 --> 00:47:01.370 It's pretty much identical to what it was before.

NOTE Confidence: 0.859716653823853

00:47:01.880 --> 00:47:03.310 When they were cited.

NOTE Confidence: 0.931623458862305

00:47:04.910 --> 00:47:21.740 But you're also measuring from other neurons in other parts of the brain so you can figure out what is driving those V1 neurons now that there is no visual input from the retina to the thalamus 2V one. So where is this activity coming from?

NOTE Confidence: 0.940689206123352

00:47:23.930 --> 00:47:25.120 And the answer.

NOTE Confidence: 0.447998970746994

00:47:26.420 --> 00:47:27.080 Is?

NOTE Confidence: 0.802800476551056

00:47:27.920 --> 00:47:29.300 This singulate cortex.

NOTE Confidence: 0.813594698905945

00:47:32.500 --> 00:47:33.910 The Singulate Cortex.

NOTE Confidence: 0.87847113609314

00:47:36.500 --> 00:47:38.510 Is driving V1 neurons?

NOTE Confidence: 0.889297008514404

00:47:40.880 --> 00:47:46.270 When the rat is blind in order to create visual representations BC.

NOTE Confidence: 0.244229003787041

00:47:47.140 --> 00:47:47.580 Hum.

NOTE Confidence: 0.909127950668335

00:47:48.100 --> 00:47:50.680 This is what we I just called a prediction.

NOTE Confidence: 0.822911322116852

00:47:56.830 --> 00:47:57.750 Now the singular.

NOTE Confidence: 0.806898176670074

00:47:58.920 --> 00:48:05.680 In this study, the single it was described this, this sort of.

NOTE Confidence: 0.814491927623749

00:48:07.070 --> 00:48:15.890 But sometimes called the doors are serious cigarette or the anterior move was described as a A Mover Association area in which it is the Motor Association.

NOTE Confidence: 0.803392827510834

00:48:16.880 --> 00:48:17.990 It's also.

NOTE Confidence: 0.882980763912201

00:48:18.720 --> 00:48:37.290 A primary control region for regulating your autonomic nervous system and your immune system annuar entropy system. It's a primary regulator. The hypothalamus and all the nuclei all the way down into the spinal cord.

NOTE Confidence: 0.926381826400757

00:48:39.350 --> 00:48:41.930 And that's a really important insight.

NOTE Confidence: 0.928285539150238

00:48:42.460 --> 00:48:54.560 Because as I'm going to show you because it turns out that these regions are are really important for issuing predictions along with the hippocampus.

NOTE Confidence: 0.903542995452881

00:48:55.330 --> 00:49:01.930 So that's just one study from from a mountain of studies, which suggest.

NOTE Confidence: 0.852586328983307

00:49:02.820 --> 00:49:07.460 That the brain is working predictably and.

NOTE Confidence: 0.923878788948059

00:49:08.720 --> 00:49:35.940 Basically, what this means is that we have to really kind of change our understanding of what is stimulus and a response are right? A stimulus is merely perturbing a bunch of intrinsic activity that's going on in your brain right now, so right now. This stimulus is are my words and my actions and that is not causing things to happen in your brain. It's actually just perturbing the trajectory of activity that's already there.

NOTE Confidence: 0.931504428386688

00:49:36.590 --> 00:49:46.400 So if you came to this talk full of caffeine and presumably dopamine and you had a really good breakfast and he slept really well last night, you're probably thinking.

NOTE Confidence: 0.926399230957031

00:49:50.170 --> 00:49:51.810 And if you skip breakfast.

NOTE Confidence: 0.904509782791138

00:49:52.880 --> 00:49:55.530 Are you didn't sleep well last night you're probably.

NOTE Confidence: 0.954904615879059

00:50:02.180 --> 00:50:03.970 But it also suggests.

NOTE Confidence: 0.875747203826904

00:50:05.460 --> 00:50:08.600 As I've shown you just giving you a hint of arte stuff.

NOTE Confidence: 0.70462703704834

00:50:09.130 --> 00:50:10.200 Yeah, that.

NOTE Confidence: 0.438551127910614

00:50:11.710 --> 00:50:12.240 At this end.

NOTE Confidence: 0.596104681491852

00:50:14.200 --> 00:50:14.830 Body is

NOTE Confidence: 0.522805452346802

00:50:16.030 --> 00:50:16.780 Ability to

NOTE Confidence: 0.89072847366333

00:50:17.280 --> 00:50:22.760 What the hell does that mean well here is really what it means if you?

NOTE Confidence: 0.91515976190567

00:50:24.120 --> 00:50:53.090 And this, I would say probably is the big take-away from this talk if there's one thing that you remember, hopefully it's this your brain did not evolve for you to think and feel and see your brain evolved. This is work on developmental an evolutionary neuroscience your brain involved involved for rationality. It didn't involve for accurate perception your brain evolved to control your body efficiently.

NOTE Confidence: 0.927722632884979

00:50:54.180 --> 00:51:03.600 That's why brains evolved sensation and perception an experience in at are all in the service of action there in the service of regulating the body.

NOTE Confidence: 0.80741685628891

00:51:05.890 --> 00:51:08.220 This is

NOTE Confidence: 0.882694065570831

00:51:09.510 --> 00:51:19.210 In evolutionary and developmental neuroscience pretty much a given and it's backed up by a lot of.

NOTE Confidence: 0.892293691635132

00:51:19.900 --> 00:51:38.030 Research, including research from this fantastic book called the principles of neural design. We are I took this quote the core task of all brains is to regulate and organisms. Internal milu by anticipating the needs of the body and preparing to meet those needs before they arise.

NOTE Confidence: 0.880901753902435

00:51:39.370 --> 00:51:42.060 Physiologist in many neuroscientists already know this.

NOTE Confidence: 0.901880919933319

00:51:42.790 --> 00:52:15.660 You can think about your brain as running a budget for your body. It's not budgeting money. It's budgeting glucose and water and oxygen and so on. We give this the fancy name of Allostasis because

it's not doing this reactively. It's doing it. Predictably, it's just metabolically more efficient to have a predicting brain if you don't predict very well it's much more metabolically inefficient.

NOTE Confidence: 0.898531854152679

00:52:15.660 --> 00:52:47.370 And for example, autism is seen as a problem with with prediction an interception, which are this is the sense data arising from this body budgeting from Alice thesis is what we call interoception and so some of the findings. I'm going to show you today. Next will show you will suggest that metabolism and energy regulation and the sensory consequences of those are at the core of all mental activity, not just emotion. But every waking moment of your life.

NOTE Confidence: 0.904824614524841

00:52:47.370 --> 00:52:50.320 When you're thinking when you're perceiving when you're deciding and so on.

NOTE Confidence: 0.942091166973114

00:52:52.770 --> 00:53:00.650 Representations of what you do ultimately give rise to what you See and what you hear and what you feel, and even your sense of self.

NOTE Confidence: 0.905453264713287

00:53:01.160 --> 00:53:18.500 So here's what I've done is I've just taken the Broadman areas on the lateral surface. The medial surface and the insula and what I've done is I've colored them, according to you. About 30 years of tracked raising research so this is research where you place a referee.

NOTE Confidence: 0.828992307186127

00:53:19.780 --> 00:53:27.850 Freezer in one part of the brain, then you watch it spread and what I've done is like you know if you take the cortical sheet.

NOTE Confidence: 0.697332918643951

00:53:28.500 --> 00:53:32.710 Oh, I'm sorry if you.

NOTE Confidence: 0.841729342937469

00:53:33.590 --> 00:53:36.330 What did I say about I can't talk and yet?

NOTE Confidence: 0.847866475582123

00:53:37.600 --> 00:53:42.090 Is that it OK if you take the cortical sheet off?

NOTE Confidence: 0.899864435195923

00:53:43.450 --> 00:53:51.500 The rest of the brain and you stretch it out like a napkin. You will see that the neurons are arrayed in layers. That's what it makes that's what makes it a cortex.

NOTE Confidence: 0.894012928009033

00:53:52.060 --> 00:54:22.950 And some layers have 4 layer some parts of the record except for layers. Some have 5. Some have 6. Basically, the parts that have 4 are the parts that originate with along with the hippocampus originate predictions. In the brain that make that initial volley of predictions and those are colored in light to medium. Gray here and so this is based on you know, mostly work in macaques, but also in other.

NOTE Confidence: 0.892158985137939

00:54:22.950 --> 00:54:24.290 Mammals as well.

NOTE Confidence: 0.852398097515106

00:54:24.900 --> 00:54:39.190 Predictions go from light Gray to black regions. That's how they propagate out and prediction error goes from black to the light Gray along the Cortex along that cortical gradient.

NOTE Confidence: 0.883407115936279

00:54:40.270 --> 00:54:49.650 So these regions we refer to them as a granular ordis granular cortex, but they have another name does anyone know the name.

NOTE Confidence: 0.810169637203217

00:54:50.380 --> 00:54:51.700 What is the mid singulate?

NOTE Confidence: 0.598242878913879

00:54:54.370 --> 00:54:56.070 Limbic their limbic.

NOTE Confidence: 0.921612143516541

00:54:58.030 --> 00:55:05.920 Are you shocked you should be shocked because limbic regions? Are the most powerful predicting regions in the brain?

NOTE Confidence: 0.911020576953888

00:55:09.930 --> 00:55:27.250 Along with the hippocampus which was included in the so-called mythical limbic system. This suggests hypothesis that that concepts and predictions originate concepts, as predictions originate in the parts of the brain that for.

NOTE Confidence: 0.931296765804291

00:55:27.760 --> 00:55:46.900 Centuries was considered to be the most reactive part of the brain. The home of motion. People still write about this. These regions as if they are emotional regions. They're not emotional regions. Their regions of the brain that controls the body and as a consequence, they are at the Top of the anatomical hierarchy prediction hierarchy in the brain.

NOTE Confidence: 0.913901150226593

00:55:48.020 --> 00:55:59.600 So they're supposed to be the home of your inner beast, which is most reactive to things in the world. But in fact, and in need of control. But in fact, these regions are driving perception and action throughout the brain.

NOTE Confidence: 0.887681722640991

00:56:00.690 --> 00:56:30.920 An actually if you seed those if you do something called a resting state study where you have subjects just lying in the scanner with their eyes open or closed and they're not they're asked to keep their mind clear and you seed. The limbic regions and you look for places where there connected and So what we did is we?

NOTE Confidence: 0.890429854393005

00:56:30.920 --> 00:56:41.100 We actually verified anatomical connections between these regions and then we did this resting state analysis with.

NOTE Confidence: 0.843197703361511

00:56:41.810 --> 00:57:16.820 Actually, over 700 subjects so we split this sample in half and we used half as a discovery sample half is a test sample attest. Yeah, test sample and then we look to see for each limbic each part of limbic cortex. Watt were the areas that gave us that what were the areas that had voxels or parts of the brain that whose time course correlated the signals correlated with those seed regions the.

NOTE Confidence: 0.869751036167145

00:57:16.820 --> 00:57:46.020 The limbic regions that we seated and if we had more time I go over the findings. More with you. But we basically seated all along the single it and we see did the anterior insula, which is a granular and what we recovered were one. Discovery map of like all the voxels in the brain, which are coral whose time courses correlated stay with the anterior insula and we had this for every single region, we seated. We had a discovery map and then we did.

NOTE Confidence: 0.912484526634216

00:57:46.710 --> 00:58:17.720 A cluster analysis and we found 2 networks that overlap in a set of rich club hubs very, very connected hubs in the brain and here they are, and actually some of you will be familiar with these networks. This is the default mode network and the salience network, which are considered to be resting state or intrinsic networks that reflect the large scale wiring in the brain and they actually overlap in a set of rich club hubs that have been identified in connectomics research all of the limbic tissue in your brain.

NOTE Confidence: 0.916741371154785

00:58:17.720 --> 00:58:19.270 Is in those 2 networks?

NOTE Confidence: 0.886554718017578

00:58:20.890 --> 00:58:35.750 The other thing which was interesting was that we found that the posterior insula mid posterior insula is also a hub that connects these networks this is.

NOTE Confidence: 0.907803654670715

00:58:36.610 --> 00:58:44.780 The region that is representing sense data from the internal milieu of your body.

NOTE Confidence: 0.904583394527435

00:58:46.270 --> 00:59:21.280 Now, for most of you well, I see it this way interception intercept if information is always with you all the time it's part of every representation your brain makes whether your emotional not whether you're aware of it or not, and most of the time you're not aware of it. Most of the time we don't experience in teh receptive sensations, as physical sensations were not really wired to experience the world. That way ourselves in the world that way. If we were we would never pay attention to anything outside our own skin ever again. 'cause there's a lot of drama going on right now, you guys are sitting there really quietly but.

NOTE Confidence: 0.897705078125

00:59:21.280 --> 00:59:24.320 The whole orchestra of things happening inside your own body that you're unaware of.

NOTE Confidence: 0.917096793651581

00:59:25.700 --> 00:59:28.550 Instead we experience.

NOTE Confidence: 0.857698798179626

00:59:29.190 --> 00:59:35.540 We access affect we access into receptive information as affect.

NOTE Confidence: 0.916008591651917

00:59:36.040 --> 01:00:00.060 As feeling pleasant or feeling unpleasant as feeling worked up or feeling calm. These experiences of of affect our features of consciousness like lightness and darkness and so on, there, not emotions. They are properties of consciousness that are always with you whether you are in an event that we would call a perception or a thought.

NOTE Confidence: 0.877492666244507

01:00:02.680 --> 01:00:08.560 So they're kind of like barometers for how Alice statically how your body is doing.

NOTE Confidence: 0.876725494861603

01:00:11.250 --> 01:00:17.030 And the brain system that seeds predictions also.

NOTE Confidence: 0.907843172550201

01:00:18.210 --> 01:00:48.840 As I just want to show you also regulates the body, so these again. The blobs are connectivity. Here, not activity. So there connect they reflect connections between regions and hear what we've done is we've taken the default mode network and the salience network just the limbic portions of those networks and projected them into the volume of this image. Ng study with 700 plus subjects and what you can see is that?

NOTE Confidence: 0.894740164279938

01:00:48.840 --> 01:01:06.600 These cortical regions actually have projections connectivity that we verified with Amtrak, tracing projections in macaques. All the way down through this matrix of Regions in the brain stem, which control your body that maintain allostasis.

NOTE Confidence: 0.538717210292816

01:01:08.640 --> 01:01:09.270 So.

NOTE Confidence: 0.915688753128052

01:01:10.860 --> 01:01:21.800 This is what your brain is always doing regardless of whether you experience yourself as having a thought or or perception or an emotion your brain is always controlling your body?

NOTE Confidence: 0.870464563369751

01:01:22.600 --> 01:01:39.790 Here's just a sampling of studies that these are mainly activation studies that look at for default mode that have shown activity in default mode during tasks an not just during rest, but also during tasks.

NOTE Confidence: 0.935194849967957

01:01:40.290 --> 01:01:48.320 So when you're affiliating socially when you're experiencing chronic pain when you're doing a reward based task and so on, and so forth.

NOTE Confidence: 0.921100437641144

01:01:49.160 --> 01:02:02.240 When you're making decisions when you're creating perceptions basically whenever you see this activity your brain is regulating your body even though you yourself may not be experiencing it.

NOTE Confidence: 0.921489596366882

01:02:02.950 --> 01:02:15.600 An our hypothesis is that default mode activity is really about is really concerned with the predictions that creating the predictions that become your experience.

NOTE Confidence: 0.934641242027283

01:02:16.800 --> 01:02:18.690 These regions also.

NOTE Confidence: 0.858798742294312

01:02:19.370 --> 01:02:24.980 Control the bed nuclei of the.

NOTE Confidence: 0.874937534332275

01:02:25.650 --> 01:02:45.500 That give rise to the neuromodulators, which we think of as attentional so regions that are part of the default mode that our limbic actually and also part of salience so this is more salience.

NOTE Confidence: 0.861223876476288

01:02:46.090 --> 01:02:48.750 And this is more default mode.

NOTE Confidence: 0.899658441543579

01:02:49.320 --> 01:02:59.960 This is more default mode, these limbic regions also control the bed nuclei for Norepinephrine Serotonin and dopamine.

NOTE Confidence: 0.925999581813812

01:03:00.960 --> 01:03:31.780 And to me what's really interesting about this so that means that these are the neuromodulators that are considered to be important for regulating attention. The attention of matrix in the brain so that suggests that these regions are not just important for generating predictions. They also should be important for determining which prediction errors. You will pay attention to and which ones you won't and was really interesting to me is that we have this reading groups. You guys might know this because your physicians. Many of you but we didn't know this.

NOTE Confidence: 0.958795368671417

01:03:32.280 --> 01:03:34.080 Dopamine and Serotonin.

NOTE Confidence: 0.930217981338501

01:03:34.640 --> 01:03:41.960 Actually, there's whole literatures on these neuromodulators and they're important for regulating metabolism.

NOTE Confidence: 0.926088929176331

01:03:43.390 --> 01:04:08.500 Serotonin for example, is a neurotransmitter that allows the brain to spend its resource is when there is no there's no immediate reward insight. It's basically allowing a brain to forage or explore to learn prediction errors right? What are the 2 most expensive things your brain can do it can move your body?

NOTE Confidence: 0.937557280063629

01:04:09.530 --> 01:04:11.050 And it can learn something new.

NOTE Confidence: 0.926015913486481

01:04:13.700 --> 01:04:16.370 And you need serotonin to be able to do those things.

NOTE Confidence: 0.911603987216949

01:04:18.370 --> 01:04:25.620 And so you can start thinking about for example, what SSR eyes might be doing to a patient who has who's depressed.

NOTE Confidence: 0.884417414665222

01:04:26.180 --> 01:04:42.260 And how it might help initially but how it might stop helping at a certain point, and might even contribute to the ongoing to an ongoing symptom picture if depression is at its base is a metabolic disorder.

NOTE Confidence: 0.913875162601471

01:04:44.060 --> 01:05:09.530 Similarly, dopamine is not a reward neurotransmitter. There is a massive amounts of evidence at this point that dopamine is really important for effort for any kind of effort. Anytime you're going to spend basically any kind of cognitive effort any kind of any kind of processing effort. Any kind of physical effort. Dopamine is involved and over mean there's a whole literature on it's important in regulating metabolism.

NOTE Confidence: 0.934884965419769

01:05:13.450 --> 01:05:17.840 So, in a very real sense your body is part of your mind.

NOTE Confidence: 0.917985677719116

01:05:20.010 --> 01:05:39.650 You have a mind because you have a body your brain is always maintaining allostasis and therefore it's always doing in representing the state of the body doing interception and it's always attempting to create concepts to make sense of your body in relation to what is going on around you?

NOTE Confidence: 0.842528641223907

01:05:40.440 --> 01:05:42.830 And in this way.

NOTE Confidence: 0.886330187320709

01:05:44.610 --> 01:05:50.830 A body bodies function is always important to mental events, even when.

NOTE Confidence: 0.907301425933838

01:05:51.920 --> 01:05:57.030 Even when we're not aware of it, even during cold cognitive so called cold cognitive states.

NOTE Confidence: 0.860934853553772

01:05:57.590 --> 01:06:00.750 So I'm just going to wrap up now and say.

NOTE Confidence: 0.895043671131134

01:06:01.590 --> 01:06:05.990 From from my perspective.

NOTE Confidence: 0.649635493755341

01:06:06.590 --> 01:06:07.090 It's

NOTE Confidence: 0.915055632591248

01:06:07.590 --> 01:06:38.400 Useful to think about the combination of prediction and prediction error as a framework for understanding mental life and also understanding what goes wrong with mental life and to some extent, you know in our lab. We're now thinking about depression and anxiety. You know along with the construction of emotion, and other phenomena in this way. And if I had more time I was going to prepare to talk to you, a little bit about the metabolic SUV.

NOTE Confidence: 0.891420066356659

01:06:38.400 --> 01:06:57.540 Brain function because that's where our work is going looking at the ways in which encoding prediction error. That is learning something new. That isn't in your in already in your internal model learning to make new concepts as it were is a metabolically costly.

NOTE Confidence: 0.904734790325165

01:06:58.240 --> 01:07:01.770 Activity that not every brain can do.

NOTE Confidence: 0.880344271659851

01:07:02.660 --> 01:07:05.320 But the I will just leave you with this.

NOTE Confidence: 0.91222208738327

01:07:06.140 --> 01:07:16.330 This idea at the end, which is that this predictive coding approach really dissolves the false boundary between the body and the mind.

NOTE Confidence: 0.909778714179993

01:07:17.410 --> 01:07:44.580 Between the mental and the physical not in some ghazi mystical way. But in a really concrete scientific way, and that means that many of the illnesses that we think of as mental like depression may have a basic may have basic biological similarities to other phenomena that we think of as mainly physical diseases like diabetes.

NOTE Confidence: 0.767818570137024

01:07:45.320 --> 01:07:45.750 Right.

NOTE Confidence: 0.908344805240631

01:07:46.330 --> 01:08:01.770 So what I'm not suggesting here is a diabetes causes depression or the depression causes diabetes. But I'm I'm suggesting that there's a common metabolic there. A common set of metabolic concerns that the brain has and when those metabolic concerns are disrupted.

NOTE Confidence: 0.916090726852417

01:08:02.390 --> 01:08:25.280 That leaves patients that leaves us vulnerable to lots of diseases that are highly comorbid in ways that we don't understand. But

actually if we took this kind of an approach it might shed some light on the ways in which why there comorbid. It's not because one is causing the other. It's because they actually have a common set of underlying causes and with that I will.

NOTE Confidence: 0.969799339771271

01:08:25.820 --> 01:08:28.860 Thank you for your attention.

NOTE Confidence: 0.900992214679718

01:08:29.440 --> 01:08:41.160 And also thank my fantastic lab who will show up in a minute who actually do all the heavy lifting in my in my lab. Thank you very much.