WEBVTT

00:00:00.180 --> 00:00:30.370 It is my pleasure to introduce our speaker. Today, who's doctor George Strigoi and George is someone who did his MD and trained in both Medison as well as doing some clinical work in psychiatry in his early days in Romania and then he decided that he really wanted to go much more deeply into neuroscience and into what was happening in the brains of his patients and in general of.

00:00:30.370 --> 00:01:01.100 Of mammals and so he came to the United States and he trained with Boo Jackie at Rutgers and started to do really beautiful. Both Physiology and then also computational work to make sense of the recordings that he was doing. He went on, then to do a PhD postdoctoral fellowship with Suzumoto Nagawa at MIT and there, he had the rare distinction of having a 2 author paper where he was first.

00:01:01.100 --> 00:01:32.590 And his mentor was 2nd and we all know that mentors don't do that much, so really a beautiful paper showing an absolutely fundamental phenomenon in the hippocampus that had not been discovered before and that was that there were ensembles of neurons within the hippocampus. I'm not going to tease him too much 'cause you will tell you more, but they were already ready to encode trajectory's in space so that then when an animal moved through space. These pre played ensembles of activity.

00:01:32.590 --> 00:02:07.600 Predicted the later sequences of neuronal activity when an animal learned a new environment. Now his work here in dependently has extended that hippocampal work in that ensemble work. But what's really exciting about the work is although it's very fundamental about how all of us actually use our hippocampus? How we encode our movement through space. It's also important for understanding how the hippocampus participates in internal representations and when we think about patients with schizophrenia for example, those internal representation.

00:02:07.600 --> 00:02:32.070 It's become independent of the external world and so some of his work now in the Department in particularly in collaborate collaboration with folks who are doing human work is extending this fundamental neurobiology too? How do we understand processes that may go wrong? In

psychiatric illness so without any further ado, I'd like to introduce George and welcome him to the podium.

NOTE Confidence: 0.913028180599213

00:02:41.080 --> 00:02:48.700 Thank you very much for the kind introduction and thank you. All for coming to the to my presentation. I'm really.

NOTE Confidence: 0.880356669425964

00:02:49.210 --> 00:02:52.680 Happy to be in the Department of psychiatry.

NOTE Confidence: 0.828952312469482

00:02:53.210 --> 00:03:12.880 I have a journey that started a while ago night are not the volume so a journey psychiatry who started quite awhile ago in medical school when I attended all five of My 6 Summers into the partner psychiatry was particularly.

NOTE Confidence: 0.890004575252533

00:03:13.390 --> 00:03:17.590 Female side causes unit and I've learned a lot from from that experience.

NOTE Confidence: 0.924722492694855

00:03:18.120 --> 00:03:22.060 Later on, I came to the US to do a PhD in neuroscience.

NOTE Confidence: 0.943455696105957

00:03:22.900 --> 00:03:26.080 And much, much later about 5 years ago.

NOTE Confidence: 0.899601995944977

00:03:26.590 --> 00:03:50.710 I give another set of presentations to the problem psychiatry, and made a few promises there in a in a 5 year plan that I hope today. Those people who are there also will appreciate some progress so I hope you're not going to be intimidated by the title or the contents of the work. I'll try to connect as much as possible and feel free to ask questions during the Clarifier.

NOTE Confidence: 0.795916736125946

00:03:51.340 --> 00:03:58.100 It's just so the title is neuron ensemble in underlying internal generated representations.

NOTE Confidence: 0.89942991733551

00:03:58.710 --> 00:04:17.940 And what I mean by internally generated representations of what everybody else should mean his mental representation of physical objects or events that not currently present so there. Several forms 4 of which are listed below. Some have to do with our path such as the case of memory. We can retrieve memories of events and physical objects that mattress currently present.

NOTE Confidence: 0.894681036472321

00:04:18.450 --> 00:04:48.180 Some have to do with our future such as the case of imagining and planning. Probably the most genuine form of these internal gender. Representation occurs during sleep when the brain is fairly disconnected from the external world and we have vivid representations about the world and finally not because we're in Department psychiatry, but this is always been there. Some of these internal generator representation. Take out normal form such as the case of hallucinations and delusions where subjects perceive.

NOTE Confidence: 0.884024620056152

00:04:49.990 --> 00:04:52.570 Objects that no one else can see.

NOTE Confidence: 0.890520691871643

00:04:53.100 --> 00:05:06.300 So where in the brain should we look for neuronal ensemble in neural patterns that may underlie and make lead us to understand better how the brain generates internal internal representation so.

NOTE Confidence: 0.893171608448029

00:05:07.170 --> 00:05:20.640 Sorry it turns out that the brain area called hippocampus that I had been working on mostly to understand the encoding of spatial information has been intimately related to all those 4 aspects.

NOTE Confidence: 0.854295074939728

00:05:21.170 --> 00:05:35.260 Primarily starting with the 1957 case of very famous patient now HM who lost the ability for a new memories after bilateral removal of is with people campus school was the surgeon.

NOTE Confidence: 0.871202528476715

00:05:35.760 --> 00:05:44.650 And Brenda Miller or investigated his ability to form new memories for many years after and this was done to alleviate an intractable epilepsy.

NOTE Confidence: 0.897507548332214

00:05:45.500 --> 00:05:51.620 Took about 50 more years to realize that the same brain area and actually in the same patients.

NOTE Confidence: 0.9062340259552

00:05:52.270 --> 00:05:59.890 Does play a critical role in imagining and planning particularly in those representations have something to do with whoever spatial content?

NOTE Confidence: 0.906799852848053

00:06:01.960 --> 00:06:10.540 As I mentioned we dream about things and we have representation during dreaming and this is now moving to the rodent type of studies.

NOTE Confidence: 0.825637400150299

00:06:11.080 --> 00:06:20.370 Back in 2001, Matt Wilson was next door. They might take while I was in some alternate was lab and we discuss interactive quite deeply.

NOTE Confidence: 0.885666489601135

00:06:20.950 --> 00:06:30.340 His lab has shown that temporal structure replay overweight people complain sample activity can happen during rapid eye movement sleep, which is primarily associated with dreaming.

NOTE Confidence: 0.813534677028656

00:06:31.160 --> 00:06:32.800 And finally.

NOTE Confidence: 0.86605441570282

00:06:34.130 --> 00:06:59.940 And finally there's a number of studies and as an increasing number of studies their associate's psychosis with Aper campus and it turns out that Scovel knew very well how to do that surgery because he was already operating on people with suffering from schizophrenia and by bipolar disorder and bilateral dissection of a program was actually attenuated quite significantly there.

NOTE Confidence: 0.867870509624481

00:07:00.450 --> 00:07:10.420 Generation of a delusion alusa nation, so we know we know this brain area is involved in it, and there's something that links all these all these factors with the Hippocampus.

NOTE Confidence: 0.916691899299622

00:07:11.230 --> 00:07:16.880 So a few words about the hippocampus in the human is this C shaped structure located in the middle, temporal lobe.

NOTE Confidence: 0.819089114665985

00:07:17.470 --> 00:07:37.570 In a rodent it's also assists abstract shaped structure, an if we perform a cut around this level, we can reveal the intrinsic circuitry, which functionally goes by the try synaptic excitatory Circuitry International Cortext Adenta Gyros since information about.

NOTE Confidence: 0.80847555398941

00:07:38.070 --> 00:07:46.780 Pretty much all the sounds they walk into dental gyrus, then then projects heavy excited very projections, to see a 3.

NOTE Confidence: 0.907411694526672

00:07:47.310 --> 00:07:58.660 Where there's a lot of other sensitive fibers that sort of connect neurons and most likely form sequential activity that we see later in a CA one which is the final stage.

NOTE Confidence: 0.861379325389862

00:07:59.180 --> 00:08:12.680 And it's mainly the output of the foreground was towards the rest of them primarily to internal cortex and then we also be Cologne like really, really broadcasting for the rest of the brain so all of the experiments that I'm going to talk about today.

NOTE Confidence: 0.799577236175537

00:08:13.270 --> 00:08:23.180 Revolve around recordings in freely moving through behaving rodents rats and mice that from which the activity was recorded from dorsal say, 1 area.

NOTE Confidence: 0.813054382801056

00:08:24.480 --> 00:08:27.630 So this is the anatomy, but they?

NOTE Confidence: 0.828127264976501

00:08:28.250 --> 00:08:35.900 Neuronal ensemble, but the age or LFP type there. There's a very prominent 2 stage model memory formation.

NOTE Confidence: 0.873251020908356

00:08:36.440 --> 00:08:54.790 First argued by my PhD advisor project in 1989 in which he associated the two stages. The well known stages are memory formation. Encoding and consolidation with two very distinct electrophysiological patterns that occur.

NOTE Confidence: 0.852692902088165

00:08:55.560 --> 00:09:05.020 Primarily Napa campus at the time it was thought to be exclusively for campus an that is during encoding when animals explore and most likely.

NOTE Confidence: 0.843038499355316

00:09:05.580 --> 00:09:08.610 Encounter novel information there is a.

NOTE Confidence: 0.870260775089264

00:09:09.270 --> 00:09:39.340 Stater 12 Hertz oscillation called data in River campus with when the animals go into non rapid eye movement sleep and this by the way will be this little Camera for my talk from now on. I'm not going to mention that on rampart or even resting very different pattern seems to dominate the activity of the G level and that is the ripple oscillation about two hundred 250 to 200. Hertz and then at the same time is the so-called sharp wave which represents really.

NOTE Confidence: 0.832980453968048

00:09:39.340 --> 00:09:42.470 Very strong synchronous input from the seat rear end to the C1.

NOTE Confidence: 0.873277723789215

00:09:43.200 --> 00:09:48.690 This brings together a lot of neurons an looking into the content of that a lot of.

NOTE Confidence: 0.635283768177032

00:09:49.640 --> 00:09:51.720 For not going to describe later.

NOTE Confidence: 0.889231145381927

00:09:52.890 --> 00:10:03.340 So this is uh the ensemble level, but not at the individual level. But the individual neurone level. Similar discovery by the AC even those graphically work in 1971.

NOTE Confidence: 0.838963329792023

00:10:05.530 --> 00:10:19.820 Cold or named the individual place of individual neurons principle neurons in the in the CL. One area placers and that the same is true for CA 3 and allowed to logics, then today gyros so all 3 subregions of vapor campus.

NOTE Confidence: 0.896399796009064

00:10:20.460 --> 00:10:29.810 Are able to at the individual level be active in a certain area and the environment? Despite the animal traveling throughout this would be a square box in from above.

NOTE Confidence: 0.889897286891937

00:10:30.410 --> 00:10:48.070 And you can see the spatial reference that individual cell if we would record for multiple cell at the same time, it will see other sales mapping neighboring areas, sometimes overlapping area in in a way that the ensemble tessellates in Maps. The entire environment of the that that the animal travel through.

NOTE Confidence: 0.910593748092651

00:10:48.600 --> 00:10:56.730 So this is also time to say that individual cells are very interesting and exciting to study but it is the ensemble that really gives us?

NOTE Confidence: 0.88069099187851

00:10:57.400 --> 00:11:02.830 The full picture of how the brain encodes a map or even experience in space.

NOTE Confidence: 0.87784743309021

00:11:03.440 --> 00:11:09.960 The same phenomenon of glacial activity seems to be occurring in humans here is.

NOTE Confidence: 0.848263740539551

00:11:10.460 --> 00:11:13.010 Epileptic patients with intracranial.

NOTE Confidence: 0.897290289402008

00:11:13.540 --> 00:11:21.330 Electrodes and recordings being performed through that as the human performs virtual reality navigation task and here.

NOTE Confidence: 0.880142390727997

00:11:21.890 --> 00:11:30.380 This should be firing rate this will be the activity of of a neuron. There is maximal in this area just like it happens in the road and but not so much around.

NOTE Confidence: 0.889003932476044

00:11:31.080 --> 00:11:45.870 And for all this work and more Nobel Prize in medicine, or Physiology has been given in 2014 to John O'Keefe and to maybe it mother and Edward Moser, who did Seminole discoveries on other aspects of a spatial and memory encoding.

NOTE Confidence: 0.895926177501678

00:11:47.700 --> 00:12:02.640 So I already alluded to the fact that the ensemble seems to bring additional information into the picture compared to single cells. And here I'm I'm showing a cartoon and animated cartoon of an animal moving on what you can imagine being a linear track.

NOTE Confidence: 0.866293787956238

00:12:03.650 --> 00:12:30.490 And then place cells will be activated at sequential locations along the trajectory of the animal. I already mentioned they they like to fire with the spatial tuning and certain parts of the environment. So here I hate sales that form a sequence. This activity was believed and still is believed to be experienced driven because the animal is moving is awake and then a lot of sensor Inputs. This doing local activate the neurons as the animal moves when the animal goes to sleep.

NOTE Confidence: 0.894191682338715

00:12:31.260 --> 00:12:39.810 In a significant number of cases, the same neurons can fire in a much compressed manner. There's no time scale here, but about 20 times compressed in time.

NOTE Confidence: 0.856492042541504

00:12:40.350 --> 00:12:56.650 In the same order they had fired during the run, so because this occurred during slow wave sleep at this compressed manner. It was believed there internally driven and they were called replay because they followed the activity that just occured on the linear track.

NOTE Confidence: 0.874072551727295

00:12:57.520 --> 00:13:17.320 It was believed also that there is some critical processing that happens during sleep by which the sequences are being compressed, and then likely rehearsed autonomously during the sleep such that the network now learns about the experience damages had the other function of this would be to connect hippocampus with other brain areas and then.

NOTE Confidence: 0.745824337005615

00:13:18.140 --> 00:13:21.690 But he becomes will teach other braid hairs in.

NOTE Confidence: 0.892324864864349

00:13:22.470 --> 00:13:27.260 Understanding this type of information for long term storage is super canvas is known not to be.

NOTE Confidence: 0.797688126564026

00:13:27.960 --> 00:13:32.400 Diligently becomes I've known not to affect the very late the very early memories.

NOTE Confidence: 0.842813491821289

00:13:33.800 --> 00:13:37.130 Find a little bit of a technical aspect.

NOTE Confidence: 0.933121979236603

00:13:38.050 --> 00:13:40.060 We are greatly helped by the fact that.

NOTE Confidence: 0.868707478046417

00:13:40.830 --> 00:14:02.480 Neural ensemble neuron assembles in Depot campus like to fight in synchrony and then like to rest in synchrony too. So we have this up and down states within the campus during slow wave sleep, which allow us to establish boundaries to synchronous activity where the there. We can look for content and we call this frames of activity in this term will kind of.

NOTE Confidence: 0.767343044281006

00:14:03.250 --> 00:14:06.080 Recur problem the meaning of my talk.

NOTE Confidence: 0.813857138156891

00:14:06.590 --> 00:14:10.840 Later on, just about 4 years later.

NOTE Confidence: 0.900030851364136

00:14:12.230 --> 00:14:24.810 We realized that in fact, these type of compressed, temporal sequence activity is not specific to sleep. But in fact, is occurring as the animal is exploring in our case, there was a familiar linear track.

NOTE Confidence: 0.854864358901978

00:14:25.430 --> 00:14:31.080 So here there's a cartoon description of potato isolation and then.

NOTE Confidence: 0.872675478458405

00:14:31.650 --> 00:15:02.770 Squared linear mazes more onto that little solution and this will be around 125 millisecond and you can see here depicted in color. The the same cells that fires in a compressed manner in asleep after they had fired already during the run, so with that. I'd like to propose and we propose at the time that an animal model of internal representation of the external spaces.

This compressed, temporal sequence of neuronal firing laser activity in the road in program was that can occur during awake.

NOTE Confidence: 0.8558748960495

00:15:02.770 --> 00:15:04.900 Explorer 30 States and also during sleep.

NOTE Confidence: 0.883544027805328

00:15:05.900 --> 00:15:10.040 So how did they emerge? Where does it start?

NOTE Confidence: 0.894518852233887

00:15:10.750 --> 00:15:19.130 Is it all created during the run for the very first time and then as people have argued replay during internal generated states in the campus.

NOTE Confidence: 0.88800722360611

00:15:19.780 --> 00:15:33.950 It turned out that if we take naive animals and let them run for the very first time and Marina loaded already did this finding on a linear track. We express' we analyze the data and then can order the place cells based on the location of the big firing.

NOTE Confidence: 0.859548389911652

00:15:34.510 --> 00:15:55.150 And can we expresa relatively long sequences about Harry cells here and then we if we look. This is a naive animal. If you look in the slowest it before the animal has ever run on this, or any linear track and then we use more sophisticated procedure rather than displaying the spikes. We decode the activity from the ensemble of neurons. We call it by isn't decoding.

NOTE Confidence: 0.883993923664093

00:15:55.890 --> 00:16:12.040 We observed trajectory like sweeps during the sleep through something that looks like the environment that will the animal run next so the position decoded position will be on the Y axis and then.

NOTE Confidence: 0.81677383184433

00:16:12.670 --> 00:16:17.820 The decoded time or the time it happens in a compressed manner.

NOTE Confidence: 0.594647645950317

00:16:18.360 --> 00:16:19.180 In the

NOTE Confidence: 0.89856618642807

00:16:19.720 --> 00:16:49.920 Just about 102 Seven 800 millisecond long on the X axis so these are the heat map descript. The decoded position virtual position of the animal on the linear track and you see they look like projectors, so this was done in a 2011 now in my lab. We've reproduced these effects it. In fact, on a

new data set and this is actually a data set recorded in the particular completely independently and published as partly replication of the phenomenon in 2016.

NOTE Confidence: 0.889402329921722

00:16:49.920 --> 00:17:05.280 We re analyze their data and found the same thing to happen in a different data set different set of animals an quite interesting. Lee across to environment so the sleep was in one environment and then the run was in a different environment, so this speaks to the network reconfiguration.

NOTE Confidence: 0.913158059120178

00:17:05.890 --> 00:17:12.880 And sort of argues that the cognitive mapping is driven by external environment is probably secondary to.

NOTE Confidence: 0.881710708141327

00:17:13.480 --> 00:17:29.880 To the network reconfiguration, so we propose granite through the development of ideas in this field, we propose that the hippocampal network generates preconfigured patterns or configuration of patterns that are later being selected, and used to encode Noble information.

NOTE Confidence: 0.495715588331223

00:17:32.690 --> 00:17:33.360 So.

NOTE Confidence: 0.884500324726105

00:17:33.900 --> 00:17:54.780 This is a cartoonish description of what I just said. This is the dominant it was the dogma in the field prior to 2011 by which externally driven inputs, extended driven activity occurs in Naper campus is the animal runs on a linear track and if one looks in the sleep following that experience.

NOTE Confidence: 0.882152140140533

00:17:55.380 --> 00:18:05.800 Sees that the sequence of play. Selectavision is now replayed as the major remaining the only thing that happens in that network without much any other sequence occurring.

NOTE Confidence: 0.883438646793365

00:18:06.300 --> 00:18:18.590 If one would look as people did being asleep before when will not find such patterns of activity so this was dubbed a blank slate or a double as a type of network in which everything is created.

NOTE Confidence: 0.861999213695526

00:18:19.160 --> 00:18:28.490 The novel during an experience and then replay it for a few hours and then the board is or erase again ready for a new type of information to being called the next day or next experience.

NOTE Confidence: 0.872617661952972

00:18:29.120 --> 00:18:36.280 So that was a pretty powerful model in quite intuitive for a lot of people and.

NOTE Confidence: 0.883958876132965

00:18:37.910 --> 00:18:42.650 We have to somehow change that that vision be given our data.

NOTE Confidence: 0.906351864337921

00:18:43.240 --> 00:19:02.270 So what we're proposing and we propose back in 2011 and a few years later is that indeed the place cells? Do fire in a sequence is the animal runs and we do see this replay of activity, matching the way the neurons head fire during the experience. But there are other sequences, there occur in the network that are not significantly correlated with this sequence.

NOTE Confidence: 0.884938776493073

00:19:03.180 --> 00:19:18.160 And even more importantly, the same neuron had fired in the same order in asleep before the experience so the network is pretty confident ever has those patterns on going all the time and it's it's providing this patterns and then associating that type of neural activity with.

NOTE Confidence: 0.920804083347321

00:19:18.710 --> 00:19:22.770 With the external environment stimuli from the external environment and then becomes.

NOTE Confidence: 0.900390446186066

00:19:23.350 --> 00:19:30.910 An index for retrieving that type of information later on is like if you like a cell Phone number that here may not have a lot of meaning.

NOTE Confidence: 0.899731874465942

00:19:31.530 --> 00:19:38.490 But once it becomes yours, then it means a lot of different things. But the Phone number was there before you was not created necessarily for you.

NOTE Confidence: 0.900778532028198

00:19:40.640 --> 00:19:55.450 A few remaining questions were still on the table at the time the argument here was that everything here is 100% replay of that activity and it's simply our inability to detect the significant correlation of all the other patterns.

NOTE Confidence: 0.909105062484741

00:19:56.000 --> 00:20:12.570 But they they they are all 100% replay so we couldn't really address that here because we had the animals exposed a single linear track. So we did a different experiment in which we let the animals run on 3 different tracks and they lead to 3 different types of activation of of neurons.

NOTE Confidence: 0.864385068416595

00:20:13.190 --> 00:20:18.900 And then we found a replay here in red for track one in yellow.

NOTE Confidence: 0.809597551822662

00:20:21.290 --> 00:20:27.190 For Track 2 and then in blue for tractor E and then we found pre playful for that, like so we

NOTE Confidence: 0.884319722652435

00:20:28.370 --> 00:20:33.500 Proposed in the study that in fact, the sequences exist.

NOTE Confidence: 0.859467387199402

00:20:34.010 --> 00:20:42.740 Prior to the very first experience on a linear track and they're selected online and associated with stimuli from this very environment to encode that information and they're later replayed.

NOTE Confidence: 0.88189971446991

00:20:43.380 --> 00:20:46.820 A few questions actually a lot of questions have been.

NOTE Confidence: 0.852159321308136

00:20:47.420 --> 00:20:54.360 Raised by this type of a model some of which I've brought into the lab here at Yale and in the?

NOTE Confidence: 0.900838971138

00:20:54.960 --> 00:20:57.590 Next part of the presentation I will show 2.

NOTE Confidence: 0.887915551662445

00:20:58.130 --> 00:21:24.730 Completed studies that that will address and explain and hopefully solve those issues, so one is what is the capacity of the hippocampal network to pre play or preconfigured future patterns of activity? Is there a limit given that we can detect those significant events. Is there a limit to the capacity after which may be confusion occurs in the may be repeated experience needs to this to be performed.

NOTE Confidence: 0.884203553199768

00:21:26.200 --> 00:21:45.170 So network reconfiguration network capacity is one aspect and the other one is given. This a pipe patterns occurring before can, we move from the core relative domain. Can we move to the predict if a man can, we look at those patterns that recur during sleep an?

NOTE Confidence: 0.910329818725586

00:21:45.940 --> 00:21:51.630 For the time being, ignoring anything else that happened in the environment predict some part of the of the way.

NOTE Confidence: 0.900157749652863

00:21:52.270 --> 00:21:55.830 How the neurons will fire in pretty much any next environment?

NOTE Confidence: 0.814713597297668

00:21:56.730 --> 00:21:58.560 So this is a?

NOTE Confidence: 0.887939035892487

00:21:59.420 --> 00:22:21.970 I have one slide in between, but then I will I will go to that description. So here is what we found in the in the 3 tracks in the previous slide was a cartoon we find around 7% of the frames there occur during the same sleep to be correlated with each of the 3 tracks and a lot of capacity of the network was left.

NOTE Confidence: 0.883347690105438

00:22:22.700 --> 00:22:32.450 In Gray area, possibly too quickly code new information. So we thought they the network is pretty efficient given at least the way we run the our experiments.

NOTE Confidence: 0.917393863201141

00:22:33.410 --> 00:22:37.640 There is not a lot of overlap between these the content of these frames so there.

NOTE Confidence: 0.879897356033325

00:22:38.860 --> 00:22:43.960 Probably activating different tractors and it was sequential activity across time during the sleep.

NOTE Confidence: 0.881281912326813

00:22:45.380 --> 00:22:53.480 Is the cartoon of how we envision the network sequential activity? This is during the sleep individual cells?

NOTE Confidence: 0.858424186706543

00:22:53.990 --> 00:23:05.780 I often use this analogy with with this subway map and we're not too far from New York or Boston so which we probably witness in reality, what it what it's it's a special map.

NOTE Confidence: 0.90398234128952

00:23:06.460 --> 00:23:18.620 In the station so each cell is noted by capital letter and in each cell could be envisioned as a station and then a sequence through those stations would essentially.

NOTE Confidence: 0.899077713489532

00:23:19.190 --> 00:23:37.990 Denote the line so here is the red line running through several stations here is the blue line. This will be tracked to you. Notice

that sells BNC can participate in Encoding multiple information. This is another way of efficiently. I guess storing and Encoding and storing information.

NOTE Confidence: 0.882199347019196

00:23:38.540 --> 00:23:52.060 Finally, another example of the Green Line and just one Gray line that we find occuring during the sleep activity and then it's not yet allocated in this in this design of 3 only.

NOTE Confidence: 0.910745084285736

00:23:52.830 --> 00:24:19.550 So that the fact that we can compute the percentages of individual frames allocated to future experiences allowed us to generate in principle. I an estimate the capacity of the network. So here are the 3 points shown here. They each take around 7% of total about 20% of of network capacity and we simply do the linear extrapolation of the activity and found it.

NOTE Confidence: 0.838977515697479

00:24:20.400 --> 00:24:31.290 It is unlikely that the network a pastoral exhausted before the animal has been on 15 tracks in each others to directions, which are this. The sales are directness.

NOTE Confidence: 0.867499470710754

00:24:32.350 --> 00:24:38.160 Specific they have specific directions productivity, so this will be 30 templates so.

NOTE Confidence: 0.847751021385193

00:24:38.750 --> 00:24:44.070 There's a static view this does not assume any plus this day going on and does not assume multiple rooms and.

NOTE Confidence: 0.898080110549927

00:24:44.770 --> 00:24:56.930 We thought, This is a good approximation of what might be happening certainly bigger than 0 as people. Speaking out because people have strong before, but he left the left some questions about the size of this capacity.

NOTE Confidence: 0.87994658946991

00:24:57.890 --> 00:25:02.260 So we decided in one of the study to address.

NOTE Confidence: 0.757094204425812

00:25:03.140 --> 00:25:03.790 The.

NOTE Confidence: 0.882227778434753

00:25:04.920 --> 00:25:12.730 Trade off we think between speed of encoding information, which people it could be useful for an then capacitively network, which may appear to be limited at somebody.

NOTE Confidence: 0.86544531583786

00:25:13.270 --> 00:25:36.930 So another way to display just what I showed about 2 slides ago with the with the hexagons in the cartoon is this way, so each circle is a cell and then the black cells are cells that are active in a certain environment. This will be during sleep. This will be during the run an the internal model that we proposed of extended sequences.

NOTE Confidence: 0.902301907539368

00:25:37.460 --> 00:25:54.840 Will be described just like that? You have a long sequence of activity during the sleep and then very similar not identical, but very highly correlated sequence during the run, so this will have a very high efficiency of encoding information because there is not a lot of pluses to a new one shot learning can occur.

NOTE Confidence: 0.870775163173676

00:25:55.350 --> 00:26:00.000 But you have as I mentioned somehow low capacity of about 15 tracks.

NOTE Confidence: 0.694714248180389

00:26:00.780 --> 00:26:01.480 The.

NOTE Confidence: 0.881435930728912

00:26:02.880 --> 00:26:15.840 Dogma in the field before 2011 with externally driven activity will basically have a blank slate in the sleep. So this will lead to very high capacity of encoding information you just encode on the run anything that.

NOTE Confidence: 0.869495272636414

00:26:16.560 --> 00:26:24.610 Drives the selectivity and their multiple of those but whoever low efficiency because you most likely need to establish trust is to be repeated activity.

NOTE Confidence: 0.917577147483826

00:26:25.850 --> 00:26:27.590 So we were wondering.

NOTE Confidence: 0.86294686794281

00:26:28.440 --> 00:26:37.510 Weather amid model would be able to achieve high capacity in high efficiency and a good analogy could be with language here that.

NOTE Confidence: 0.859490275382996

00:26:38.090 --> 00:26:49.940 You have long sentences that exist in the vocabulary and just use those and just make it up. Today right give it a few times and then in the you, you deliver it with some editing every time.

NOTE Confidence: 0.881601452827454

00:26:50.490 --> 00:27:16.540 Were you created the novel right? That is not going to be super efficient or you? Can have slides or you can have words in other vocabulary that exist. You don't need to create them letter by letter on the spot, but then you can combine them in multiple possible ways eventually and create new centers in right now. Those with pretty much the same vocabulary. So we were inspired by linguistics and we we tried to see whether this model is true.

NOTE Confidence: 0.367705374956131

00:27:17.670 --> 00:27:19.220 So.

NOTE Confidence: 0.882142961025238

00:27:20.040 --> 00:27:32.110 Back to the set of hypothesis and questions that I launched within the last three slides or so. the Super Campus expressed productive codes? Is this strong correlation between a sleep in future run.

NOTE Confidence: 0.839059293270111

00:27:33.330 --> 00:27:37.810 Possibly leading to some predictive code, or is just a quality of thing.

NOTE Confidence: 0.860815584659576

00:27:38.500 --> 00:27:57.750 The second what is the underlying Arolla Syntax and then here I mentioned this chunking of information in a shorter neural sequences and finally I have to get to that by the end. When and how does temporary compressed sequence coding emerged during the animal development right? How does this activity emerges even?

NOTE Confidence: 0.852865159511566

00:27:58.590 --> 00:28:06.290 So the first 2 questions were answered in a study led by Cafe Lu Associate in my lab.

NOTE Confidence: 0.876359403133392

00:28:06.800 --> 00:28:30.260 And here is the classic design that we use a lot of people use in starting place of sequences that is to put to let animals sleep in a naive state and this will be the pre run sleep. Everything is related to this run, then the animals run on a linear track is 1.5 meters long. So it allows expression of a a good long sequence in a good number of cells.

NOTE Confidence: 0.858982384204865

00:28:31.980 --> 00:28:41.390 On the track and then we let the animals sleep and we look at replay replay, and we can study the predicted patterns from pre to run.

NOTE Confidence: 0.851913034915924

00:28:42.120 --> 00:28:53.680 We let the animals run again and sleep again and then we also let the animals around on the next 2 tracks. As I shown and then they slip again? So this time, then income income passes that all that activity.

NOTE Confidence: 0.867592334747314

00:28:55.110 --> 00:29:22.720 But for the time being, a lot of activities related to the program slip. I don't know activity. So what did we find here is something that we've reported but we look at the patterns slightly different so this is a collection of about 76 else. Not all of them shown and the focus is or not two cells that like to fire in this order so in that describe your dinner at the Top cell likes to fire before the bottom cell in this frame and this frame.

NOTE Confidence: 0.431066513061523

00:29:23.380 --> 00:29:24.180 Ann.

NOTE Confidence: 0.88716983795166

00:29:25.630 --> 00:29:36.390 Fires in the opposite order in the middle frame and then again, resume its preferred order. What looks like before order and then their frames in which one so far is the element does not so this is a good?

NOTE Confidence: 0.942467570304871

00:29:37.120 --> 00:29:40.340 Representative sample of what happens during the sleep.

NOTE Confidence: 0.894553184509277

00:29:40.940 --> 00:29:53.870 So we were wondering how many, the activity that given cell that we decided to look on. It depends on how many cells being active before in that particular order that we were looking for.

NOTE Confidence: 0.497327864170074

00:29:54.530 --> 00:29:55.380 And.

NOTE Confidence: 0.896810054779053

00:29:56.210 --> 00:30:07.260 Given our original description of the extended replace sequences. We were thinking. The number is is very large what we found instead is that the dependency order meaning.

NOTE Confidence: 0.880707442760468

00:30:07.860 --> 00:30:21.040 The group of the number of cells that proceed. This cell in activity during sleep. There is repeated over chance is actually 1.5. So it's between one into cells it like to file.

NOTE Confidence: 0.855167925357819

00:30:21.660 --> 00:30:25.500 Like the fire before a particular cells, so you would have at most a triplet.

NOTE Confidence: 0.893484055995941

00:30:26.050 --> 00:30:29.960 They would they would like to recur higher than my channel so that was the starting point.

NOTE Confidence: 0.843545436859131

00:30:30.500 --> 00:30:37.170 Of indicating that maybe the network does operate in this chunk mode word versus long sentence.

NOTE Confidence: 0.503894448280334

00:30:38.220 --> 00:30:40.170 Model so.

NOTE Confidence: 0.910985827445984

00:30:41.330 --> 00:30:46.710 We build a Markov chain model in a transition matrix and all you need to know from this is that.

NOTE Confidence: 0.872536778450012

00:30:48.830 --> 00:31:00.370 When we look at order preference in sell order firing we find that we find that preference so some values are highest levels are low for instance, this 50.

NOTE Confidence: 0.819859862327576

00:31:00.960 --> 00:31:06.060 2 likes to fire a lot after sale 3132.

NOTE Confidence: 0.893544852733612

00:31:06.560 --> 00:31:12.150 And this is not always the case so we get a lot of combinatorials here and.

NOTE Confidence: 0.817763328552246

00:31:12.730 --> 00:31:20.630 Can get a probability of sale be filing update and so on for for all the 7080 sales every cord from?

NOTE Confidence: 0.913733065128326

00:31:21.360 --> 00:31:25.030 So we try to use this transition matrix and.

NOTE Confidence: 0.895353376865387

00:31:25.990 --> 00:31:30.570 Basically build a long sequence by multiplying this probabilities, so if they proceeds be.

NOTE Confidence: 0.861782431602478

00:31:31.250 --> 00:31:38.230 But the .7 probability and be proceeds, see with say .5 probability that we multiply this probabilities to.

NOTE Confidence: 0.876911818981171

00:31:39.380 --> 00:31:46.580 Get at the probability of ABC happening. So so that in that can be allocated to the 30 still long sequence or so.

NOTE Confidence: 0.903578698635101

00:31:47.110 --> 00:31:50.830 And then we try based on this predicted pattern too.

NOTE Confidence: 0.855377376079559

00:31:52.140 --> 00:32:10.230 Investigate whether we can at least reproduce the sleep sequences. So it's Li predicting its own activities. So we testing. This model and we find the numbers that expressed the percentile. It's over a random distribution of a million possible dummy possibilities or sort of possibilities.

NOTE Confidence: 0.849712312221527

00:32:10.780 --> 00:32:27.310 So we find that the slip sequences, literally rested 100% file. I mean, it slipped predicting sleep, whereas randomly generated shuffled type of sleep activity. It's much. It's much worse at predicting its own sleep so.

NOTE Confidence: 0.909750759601593

00:32:27.810 --> 00:32:31.560 The metal works, but it's not much scientific advancement here.

NOTE Confidence: 0.919525861740112

00:32:32.260 --> 00:32:37.490 So we decided to use this model in trying to predict a sequence during the run based on the.

NOTE Confidence: 0.840205550193787

00:32:38.380 --> 00:32:41.520 Pairwise activity of multiple sales during the sleep before.

NOTE Confidence: 0.88988983631134

00:32:42.310 --> 00:33:03.020 So here is the sequence of place cells and these are just for example, the two cells that like to fire and sleep in this order and we generated a million possible sequences outside 1,000,000, - 2 possible sequences outside these 2 run sequences direction. One and then direction do not shown.

NOTE Confidence: 0.908437967300415

00:33:03.560 --> 00:33:07.430 So we generated distribution of probabilities.

NOTE Confidence: 0.702119946479797

00:33:08.660 --> 00:33:12.170 Of Placer survey place on sequences from sleep.

NOTE Confidence: 0.705966114997864

00:33:12.920 --> 00:33:16.000 And we plot it as a log.

NOTE Confidence: 0.880518674850464

00:33:16.570 --> 00:33:23.290 Value and then it's not log normal lognormal distributed so if you take the log. It's appears normal distributed.

NOTE Confidence: 0.912585079669952

00:33:23.810 --> 00:33:27.170 And then we added the probabilities of the exact.

NOTE Confidence: 0.891546189785004

00:33:27.770 --> 00:33:47.480 The probability of predicting the exact 2 sequences from sleep and we assess where do they land in this distribution and it turns out? They they have a pretty high probability. Compared to the shuffle ones there, not the highest predictable probabilities. But they are among the very highest that the network and do so that.

NOTE Confidence: 0.888165175914764

00:33:48.410 --> 00:33:59.630 OK, that was evaluated here for 6 animals in 2 directions of movement soul ended. We ended up with 12 templates to be tested just like that, and and here we were plotting is the percentile.

NOTE Confidence: 0.84980046749115

00:34:00.390 --> 00:34:12.750 Where this real sequence lands on this distribution of a million possible cases of play some sequence of equal length and we find initially surprisingly but.

NOTE Confidence: 0.882968604564667

00:34:13.490 --> 00:34:27.230 Now, not that surprisingly that sleep is pretty good at predicting the order or constraining the order in which the place. I'll fire in the future run at above 95% are in every single animal at least for One Direction.

NOTE Confidence: 0.881892561912537

00:34:28.950 --> 00:34:47.870 So this is for very first run, which is adjacent to the sleep that the animal has just they will just recorded from when we went back to this time and kind of run activity, but all refer to the verifier sleep. We find a very similar pattern. This will be the chance level this will be the.

NOTE Confidence: 0.931673049926758

00:34:48.490 --> 00:34:50.930 Distribution if there would be no predictability.

NOTE Confidence: 0.860608637332916

00:34:51.540 --> 00:35:02.000 Future run sequence from sleep proceeding sleep. But here we find a very skewed very close to 100%. I'll distribution for all run activities.

NOTE Confidence: 0.866369247436523

00:35:02.790 --> 00:35:20.530 That followed the slip session there is adjacency. Temple adjacency effect in which the first sequence is better predicted, and the

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following ones. But they both they will significant and finally we validated is finding on the other data set that we've been working on from the Jackie Group.

NOTE Confidence: 0.851962208747864

00:35:21.050 --> 00:35:36.490 They recorded from 4 animals times 2 directions of movement. There was 8 templates 8 sequences and we find 6 of them to be at 190 above 9595% that so the metal works across multiple datasets an it's now.

NOTE Confidence: 0.783552646636963

00:35:37.320 --> 00:35:40.800 Hear from a lab in Oxford, it works for them, too, so that it's.

NOTE Confidence: 0.873613655567169

00:35:41.650 --> 00:35:48.420 We hope to be able to use it and more people to use it to decode activity on multiple aspects of brain.

NOTE Confidence: 0.716029524803162

00:35:49.320 --> 00:35:51.490 Research so.

NOTE Confidence: 0.908616781234741

00:35:52.210 --> 00:36:07.640 This indicates the sleep has says the ability to generate patterns. That constrain how the network will fire when the animal goes out in the world to run regardless of the external environment, so there's something that the external I cannot bypass entirely.

NOTE Confidence: 0.862513601779938

00:36:08.380 --> 00:36:19.550 So we decided to look at the prediction of the predictive coding from its complimentary part which is the prediction error. So we

NOTE Confidence: 0.872816503047943

00:36:20.130 --> 00:36:29.360 We decided that external environment when I decided that we realized that external does influence. This this sequential activity.

NOTE Confidence: 0.917205035686493

00:36:29.940 --> 00:36:35.320 And we try to understand what happens with that change in.

NOTE Confidence: 0.850228548049927

00:36:35.980 --> 00:36:50.780 And predicted activity so here we're starting from the run sequence and this is a cartoon, but really look looks just like that. There they look like that. We have a sequence of place cell firing abcd and so on.

NOTE Confidence: 0.876732468605042

00:36:52.030 --> 00:36:54.570 That occured during the run.

NOTE Confidence: 0.86393415927887

00:36:55.640 --> 00:37:08.220 But was not predicted that 100 percentile from the activity during sleep. In fact, the sleep predicted. This sequence to occur. Maybe the at its best right so we know something must have happened.

NOTE Confidence: 0.883649110794067

00:37:08.800 --> 00:37:16.340 Between sleep and run such that this cells, called see that was predicted to fire in this location between G and age.

NOTE Confidence: 0.842829525470734

00:37:17.100 --> 00:37:39.920 Now fires between BND and we essentially got to this by exhaustively moving the place. One place sell at the time and recomputing. The predictability from sleep and we found this. This factor right so we decided to use this editing of network activity to test.

NOTE Confidence: 0.848978042602539

00:37:40.660 --> 00:37:50.440 The prediction error signal so in fact, we divided the pairs functional pairs between adjacent neurons in 3 classes.

NOTE Confidence: 0.841627717018127

00:37:51.000 --> 00:37:53.270 One we call intrinsic unlikely so.

NOTE Confidence: 0.87431925535202

00:37:53.900 --> 00:38:07.140 This was not predicted by the intrinsic patterns of activity, so was unlikely by those by those patterns. There's a bit of a phenomenal description is not have any method would do it, but it's a blank intrinsic unlikely type of functional connectivity.

NOTE Confidence: 0.87988269329071

00:38:07.750 --> 00:38:10.480 Or you can call it also new functional connection.

NOTE Confidence: 0.900640487670898

00:38:11.230 --> 00:38:23.150 There's a class of connections that remain unedited. They didn't seem to contribute to this prediction error and finally there. Some connections there were lost the connections that were.

NOTE Confidence: 0.896761178970337

00:38:24.020 --> 00:38:32.180 Sort of indicated to be strong enough during sleep that did not last till the next run session, so we call this intrinsic likely.

NOTE Confidence: 0.885157823562622

00:38:32.880 --> 00:38:47.080 Right so we have these connections here between BND which was lost because she is now in between. And these 2 connections were lost because see moved and then 3 new connections were were created and then a lot of them remain unedited.

NOTE Confidence: 0.880694031715393

00:38:47.830 --> 00:39:14.530 So 1st question was where does this editing happened preferentially an does it happen preferentially and we find that particular at the end of the tracks. This is the middle to end either 2 and then they kind of flipped so we compare middle and ends and we find that most of the editing either in as we call it location extractor location, insert happen at the ends compared to the middle of Jackson at the ends this, where this is where the reward is which has been previously associated with protection error signal.

NOTE Confidence: 0.767135679721832

00:39:15.160 --> 00:39:20.010 And also there more cues there supposed to running on a track.

NOTE Confidence: 0.83592814207077

00:39:20.950 --> 00:39:23.810 So we decided to look.

NOTE Confidence: 0.901898622512817

00:39:24.460 --> 00:39:29.550 At the predictability of these functional connection from the slip before compared with asleep after.

NOTE Confidence: 0.920898795127869

00:39:30.190 --> 00:39:39.380 If experience change something in the network is there any type of preferential consolidation or increase of those connections over the others?

NOTE Confidence: 0.878876566886902

00:39:40.250 --> 00:39:49.200 And again surprisingly, but probably not so surprisingly the intrinsic unlikely connections were stronger in the post run slip compared to the previously.

NOTE Confidence: 0.883669674396515

00:39:49.940 --> 00:39:53.600 But not the unedited which didn't seem to change.

NOTE Confidence: 0.883305549621582

00:39:54.460 --> 00:40:02.850 Value and then not intrinsic likely, although in the book, Jackie data set. They actually went down so there's a penalization on the fact that they have not been used.

NOTE Confidence: 0.868772208690643

00:40:03.530 --> 00:40:07.840 In the run, so here is a summary of the data showing that.

NOTE Confidence: 0.860137939453125

00:40:08.400 --> 00:40:10.930 This is the difference between post and pre run.

NOTE Confidence: 0.79779326915741

00:40:11.540 --> 00:40:15.240 Activation of this of this functional connections.

00:40:15.860 --> 00:40:26.000 So a simple cartoon model will show the network has a lot of potential connectivity between neurons when the animal runs this will be during pre run sleep?

00:40:26.750 --> 00:40:34.950 When the animal runs this is the sequence. There is being activated a lot of it comes from constraints living sleep, some of it comes from.

00:40:36.770 --> 00:40:38.030 Factors.

00:40:38.730 --> 00:40:48.390 Postley probably from the external environment and then these connections are stronger. The thickness of the line will be showing that these are strengthen compared to before but not the rest.

00:40:51.330 --> 00:40:51.860 So.

00:40:54.000 --> 00:41:06.040 We decided to go further with this type of analysis in the predictive coding and prediction error and understand the nature of the chunking of activity and 1st of all.

00:41:06.710 --> 00:41:16.900 Demonstrated that exists So what we did. We took the long sequence of places and we chopped it into and kept the order of place cell firing within each half, but then we swap the haves.

00:41:17.440 --> 00:41:23.840 Such that there's a new connection here, but all the other connections are the original ones. They look are doing the run.

00:41:24.410 --> 00:41:37.830 And we did that for smaller and smaller chunks of Placer activity and we did that multiple ways of one of them was by number of cells, including in each chunk essentially looking for? What is the size of the essential chunk that when?

00:41:38.730 --> 00:41:42.310 Reduced affects the predictability from sleep an?

NOTE Confidence: 0.875546395778656

00:41:43.250 --> 00:41:52.260 To our satisfaction we find that initially, dropping the cells. The place of sequences in half and simply swapping the order of the two house.

NOTE Confidence: 0.872503101825714

00:41:52.930 --> 00:42:02.830 Or 3 or anyway, bided by cell number will be about the same thing did not affect the predictability so that that's a sin away robust effect but when we?

NOTE Confidence: 0.837153077125549

00:42:03.640 --> 00:42:15.790 Essentially affected the organization of place cells as it occured to 2. Three and 4 cell type of size right so we chopped? Which of the network too?

NOTE Confidence: 0.896350383758545

00:42:16.450 --> 00:42:24.930 2 details we probably affected something that was a building block. There was required for this type of predictability to work.

NOTE Confidence: 0.874152719974518

00:42:25.560 --> 00:42:29.690 The same thing as shown here is a difference too.

NOTE Confidence: 0.774468302726746

00:42:30.300 --> 00:42:31.190 100% tile.

NOTE Confidence: 0.909067451953888

00:42:32.090 --> 00:42:33.040 Essentially, the same thing.

NOTE Confidence: 0.518630146980286

00:42:34.110 --> 00:42:34.600 So.

NOTE Confidence: 0.892426013946533

00:42:35.410 --> 00:43:04.310 This would indicate that there is something about a triplet plus minus one cells that that could be a fundamental unit of organization in the hippocampus and then we went on to look for them are are groups of neurons firing in exact same or the repeating higher than by channels and what is the size of that junk and we find again this is a this plot against percentile among shuffles everything signific will be above the dotted line and we find that triplets are indeed the most frequent.

NOTE Confidence: 0.875170767307281

00:43:06.300 --> 00:43:13.110 Sizes would chunk chunk of sequential activity that occurs higher than by chance, but also doublets and then.

NOTE Confidence: 0.771952092647552

00:43:13.840 --> 00:43:17.030 Groups of 4 cells so to group these.

NOTE Confidence: 0.787276566028595

00:43:17.840 --> 00:43:21.030 Short sequences into one word we use the word tablet.

NOTE Confidence: 0.870810687541962

00:43:21.570 --> 00:43:29.240 That is not a triple is not a quadruplet it. It's something that that hopefully will will define what is happening here?

NOTE Confidence: 0.920039653778076

00:43:31.680 --> 00:43:33.900 How does it look how?

NOTE Confidence: 0.88528311252594

00:43:34.990 --> 00:43:45.040 How the templates are tablets look in asleep and in particular with regards to how these neurons this tablets will be played during the run's place else.

NOTE Confidence: 0.871242702007294

00:43:45.560 --> 00:43:55.240 We marked all the places we found in this particular animal by the location of the two cells there occur during the sleep.

NOTE Confidence: 0.905418157577515

00:43:56.160 --> 00:43:57.120 In this order.

NOTE Confidence: 0.905011057853699

00:43:57.770 --> 00:44:07.800 And with a certain time lag how they ended up being places. It's it's too much here to mark all of that. I think it would be a lot of animation required. But we are very interested in those that ended up being adjacent.

NOTE Confidence: 0.878948867321014

00:44:08.580 --> 00:44:18.200 So the sales that, like to fire 1 after the other and they were playing. Also, 1 after the other's place cells and there's a number of those, though not all of them have that.

NOTE Confidence: 0.891075909137726

00:44:18.760 --> 00:44:37.100 So then we computed the correlation between try to estimate if there is any correlation between the distance in time. During the sleep and the distance in space. They are actually being decompressed right. This time they're not being compressed that they've been decompressed from uh.

NOTE Confidence: 0.869283258914948

00:44:37.930 --> 00:44:47.420 Compressed way of firing during the sleep into a place cell sequence during the run and we find that correlation exists for both 2, three and 4.

NOTE Confidence: 0.883852601051331

00:44:48.430 --> 00:44:49.510 Long sequences.

NOTE Confidence: 0.873344838619232

00:44:51.910 --> 00:45:03.670 Alright so this looks like a very interesting and never been shown to be honest never been probably conceived that the brain network in the C1 area functions. Not quite in long extended sequences.

NOTE Confidence: 0.894923388957977

00:45:04.180 --> 00:45:14.430 Which they caught the whole network but in fact in this small chunks and we were wondering whether the size of what the group of limited group of known as they were recording from could be a factor in determining the size of cells.

NOTE Confidence: 0.869576513767242

00:45:14.960 --> 00:45:21.420 So again we went to the our data set also to the our friends data set which had more cells.

NOTE Confidence: 0.595425367355347

00:45:21.990 --> 00:45:22.410 And.

NOTE Confidence: 0.717216551303864

00:45:22.960 --> 00:45:25.310 Plotted the correlation or plotted.

NOTE Confidence: 0.894809305667877

00:45:26.150 --> 00:45:34.620 A scatterplot essentially of average tuplet length as a function of number of sales recorded and found that that number stayed around 3:00.

NOTE Confidence: 0.86091947555542

00:45:35.290 --> 00:45:45.000 Weather we had 30 sales recorded over 100 by cells being recorded, so we've done this phenomena's newer codons because there seems to be some.

NOTE Confidence: 0.846995115280151

00:45:45.970 --> 00:45:55.940 Relative rigidity to this, the size of the minimal group of neurons that do fire in more more than by channels in the exact same order.

NOTE Confidence: 0.879664838314056

00:45:56.740 --> 00:45:57.460 In the network.

NOTE Confidence: 0.893446803092957

00:45:58.330 --> 00:46:17.170 And then since triplet now seems to be the unit then we simply play the 2nd order. Markov chain model in which we use, not just the previous sale. But the previous 2 cells to predict activity book to constrain activity during the run at the sequential level from sleep and we find that that is also the case. These are the percentiles operate ability.

NOTE Confidence: 0.886616051197052

00:46:18.150 --> 00:46:33.310 So coming back to our model, we can now reveal what were sitting before that we believe there is an internal organization there is interplate motives that can ensure the network to have high capacity high efficiency as opposed to the other two models, which wich gone.

NOTE Confidence: 0.849366545677185

00:46:35.720 --> 00:46:41.110 In words supercouple network generates prediction and productive in prediction error codes.

NOTE Confidence: 0.09841612726449997

00:46:41.740 --> 00:46:42.030 If.

NOTE Confidence: 0.847221672534943

00:46:43.190 --> 00:46:51.750 If you navigate very well in the sensory type of literature. Predictive coding is much more use. Their I think with the first uses in the pro campus, but is.

NOTE Confidence: 0.851498246192932

00:46:52.580 --> 00:47:03.880 It was a pretty attractive type of term to use an second neuron 2 plates are hypothesize to represent the building blocks of people compliment organization and temporal sequences in the middle model.

NOTE Confidence: 0.879063904285431

00:47:04.630 --> 00:47:19.800 An A question there is always interesting to address preconfigured sequential patterns are used to encode normal space information. Not just there to show the network is configured in some way but it's actually being used to encode novel information.

NOTE Confidence: 0.564085602760315

00:47:21.590 --> 00:47:22.280 So.

NOTE Confidence: 0.885239124298096

00:47:27.400 --> 00:47:37.970 If if a lot of structure is present during the sleep before an experience but also in asleep after the experience I already alluded to this selective plasticity.

NOTE Confidence: 0.904589176177979

00:47:38.570 --> 00:47:48.820 What is the role of experience so one is that but if we still want to look the way most people do but they extended sequences? Do we find any signs of plasticity so here would be?

NOTE Confidence: 0.885267376899719

00:47:49.440 --> 00:47:59.780 The decoded projector of the animal from the sleep before run and here is the decoder activity. These are examples from the slip after the experience and you see, there are fairly similar, but not quite identical.

NOTE Confidence: 0.883507430553436

00:48:02.340 --> 00:48:12.910 In a sense that the replay. This would be occurs significantly more more frequently than the pre playing so the network represents better.

NOTE Confidence: 0.900112926959991

00:48:13.680 --> 00:48:18.700 The spontaneous activity during sleep represents better the recent experience, then it was representing it before.

NOTE Confidence: 0.8966024518013

00:48:19.200 --> 00:48:24.130 But Interestingly and these are different methods to look at it. Interestingly, the difference that we would.

NOTE Confidence: 0.866782009601593

00:48:24.830 --> 00:48:32.080 Tentatively called plasticity as it must smaller than the way that the amount of the configuration that ever had.

NOTE Confidence: 0.906408905982971

00:48:32.890 --> 00:48:35.850 It's pretty much like your cognitive.

NOTE Confidence: 0.816267311573029

00:48:36.590 --> 00:48:42.170 World before and after listening to my talk is is a.

NOTE Confidence: 0.871269047260284

00:48:43.500 --> 00:48:50.670 Is pretty much the same plus plus the little plasticity that my talk induced into your but I would not?

NOTE Confidence: 0.868415594100952

00:48:51.460 --> 00:49:10.760 I will not be fooled into thinking that you're a completely you know cut ours. Yeah, completely different person or your your cognition is fundamentally different so keeping the scale. We think and experience on a linear track and this is the very first time, naive annual runs on the leaning back. I think it it gets as normal as one can.

NOTE Confidence: 0.871097147464752

00:49:11.520 --> 00:49:16.300 That does induce some pluses, but there is minimal compared to the network reconfiguration.

00:49:18.330 --> 00:49:30.510 So quick very quick summary of what I've shown so far in terms of compressed, temporal sequence of firing. This is the phenom. This is how play cell sequence looks like when we decode the activity during the run.

00:49:32.740 --> 00:49:58.700 We can estimate the the error or the precision of that method by the decoding by plotting the actual trajectory of the animal. This is the position in this is time as the animal moves from one end of the tractor another and here with the heat map unplugging the decoded position of them based on ensemble are active neural activity, taking all the Spikes is this is not a place in people.

00:49:59.420 --> 00:50:06.000 Anything like that, so we see that the metal is pretty good, and then the phenomenal preplay that depicted already trajectory like.

00:50:06.740 --> 00:50:29.710 Processes before the actual experience I'll introduce briefly the data sequences, which is related to the cartoon that I showed you this is what we believe is happening during state of a solution in which past current and future locations. This is distance in time are being bound within a data oscillatoria event to.

00:50:30.370 --> 00:50:34.520 Potentially induce plasticity the one that we've described.

00:50:35.110 --> 00:50:41.780 And then as the animal goes to sleep. There's the phenomenal replay by which the network depicts projectors the animals has taken.

00:50:42.630 --> 00:50:49.140 And finally the plasticity would just described by which replay represents better the experience then.

00:50:49.710 --> 00:51:06.960 So we think that these phenomena here, particularly and data sequences play a role in encoding of novel information. At least the special one and then the plasticity begins the process of consolidation,

which is a sign that some process of consolidation of normally newly encoded information occurs.

NOTE Confidence: 0.878304183483124

00:51:07.920 --> 00:51:20.010 So for the remaining of the talk I'd like to investigate. What is the development on timeline of all this phenomenon and link that with the ability of 4 new memory as as we and our audience develop.

NOTE Confidence: 0.882365465164185

00:51:21.640 --> 00:51:37.250 So this is what roughly what was known before we started experiment. Uh this is these are audience around post Natal Day 14, their eyes are opening so visual information can start impinging on the network and around P 2324.

NOTE Confidence: 0.825219333171844

00:51:37.970 --> 00:51:53.340 Another log of what we call in humans, infantile easier the end of that period has been described so the around this age experiences are able to create long lasting map episodic type memories on in in rats.

NOTE Confidence: 0.866515934467316

00:51:54.010 --> 00:52:13.290 And on the electrophysiological level around post, Natal Day 17 place sells the Scion place cells appear to mature their place filled meaning they fire in a particular location, but not throughout the environment and finally the grid cells, which send a strong input to play sales actually developed later.

NOTE Confidence: 0.896390438079834

00:52:13.930 --> 00:52:22.910 So these are important timelines, P1517 and P2122 and then be 2324 they were going to use in our experiment.

NOTE Confidence: 0.80021858215332

00:52:23.920 --> 00:52:28.680 So these are experiments were led by Guzman for Oak and IMP student.

NOTE Confidence: 0.871595740318298

00:52:29.260 --> 00:52:39.930 And there's quite a bit of methodology here, I thought. Maybe it's worth using one slide to describe it. We've used Silicon probes mobile Silicon probes one implanted on each side of the brain.

NOTE Confidence: 0.870406031608582

00:52:40.460 --> 00:52:52.300 Each of 32 recording size total of 64, the configuration is like that, about 20 Micron. In between the sites and this is how they target CA. One area in one of the boxes for that exactly the Age.

NOTE Confidence: 0.879921615123749

31

00:52:54.770 --> 00:53:12.690 So we implant them about 3 days before the recordings. We plan to start recording and then we scan. Those ages is a total of 19 successful developing animals that were recorded from each being naive to to the experience right. We're not when I considering second day.

NOTE Confidence: 0.886399269104004

00:53:13.560 --> 00:53:15.400 As part of the experiment for this part.

NOTE Confidence: 0.908518373966217

00:53:16.140 --> 00:53:18.460 So we started but well, we ended up with twenty one.

NOTE Confidence: 0.878468751907349

00:53:19.170 --> 00:53:22.780 Recorded rats from P-15 all the way to be 24 hours, their first day.

NOTE Confidence: 0.859079957008362

00:53:23.500 --> 00:53:37.160 Probes are lower to the sea owner of the campus and this is a good case, but not the only one in which we record summer. Currently, 67 neurons distributed across all the recording sites. This is a good hit of 8 out of 8 sites.

NOTE Confidence: 0.697846233844757

00:53:38.150 --> 00:53:40.580 Drinks being recording cells.

NOTE Confidence: 0.827861964702606

00:53:41.090 --> 00:53:50.240 And one stable recordings are obtained and we should experiment, which is the typical pre run sleep. Dinovo first time ever running on a linear track and then post run sleep?

NOTE Confidence: 0.901788890361786

00:53:52.150 --> 00:54:07.780 One important question was whether the rats at this age are even performing this behavior. And here I'm showing location of their location on the track versus time passed, you can see they initially rest a little bit. At one end, where we place them and then they start running they rest again.

NOTE Confidence: 0.874097585678101

00:54:08.290 --> 00:54:13.240 And then they keep running and they do it pretty much like an adult would do better sometimes.

NOTE Confidence: 0.899249851703644

00:54:13.980 --> 00:54:17.870 So there was never an issue starting from Peanut MP 15.

NOTE Confidence: 0.889598309993744

00:54:18.880 --> 00:54:27.320 And then we plotted the place cell sequence is just as I showed for the adult but across development again. The novel experience all the time.

NOTE Confidence: 0.914014160633087

00:54:28.020 --> 00:54:31.640 As you can see the places are a little bit detuned, they mature.

NOTE Confidence: 0.867961943149567

00:54:32.270 --> 00:54:40.930 As shown before around P17. Even then, there's still room to improve their tuning so we group the animals into.

NOTE Confidence: 0.867499768733978

00:54:43.230 --> 00:54:52.580 They groups so P 1516 and this will increase the cystic power and reduce the number of animals for phenomena that we don't think happen at the single day level.

NOTE Confidence: 0.874584496021271

00:54:55.220 --> 00:55:03.920 So the 1st question was to test where the during the run. Our bodies in decoding algorithm can detect can can.

NOTE Confidence: 0.8579181432724

00:55:04.450 --> 00:55:07.750 Depict the trajectory that the animal has taken so run.

NOTE Confidence: 0.440968453884125

00:55:08.270 --> 00:55:10.020 Decoding.

NOTE Confidence: 0.884285271167755

00:55:10.610 --> 00:55:41.800 So this in yellow is the position of the animal you can see that NNN heat map is our decoder. The results of the query can see a bit of errors, particularly the in the middle of the track at 3:15 and then then that decoding improves with age and we show that here. It goes from 11 centimeter error. When I want me to track this time to about 4 but all of these errors are much, much smaller than when we scrambled a identity of cells and run again this so this is a this is proof that the network even as Earl SB15.

NOTE Confidence: 0.873082101345062

00:55:41.800 --> 00:55:47.600 Despite not individual cells, not being very well tuned to individual locations in on the track.

NOTE Confidence: 0.841588377952576

00:55:48.130 --> 00:55:49.670 Is able to perform special coding?

NOTE Confidence: 0.910779774188995

00:55:51.720 --> 00:55:55.560 So the first thing we wanted to know is whether during the run.

NOTE Confidence: 0.860446631908417

00:55:56.230 --> 00:56:08.440 So when during the run the network, the ability of the network to relation rebind past current and future location. Within a data cycle, which we and others think is important for plasticity.

NOTE Confidence: 0.859644174575806

00:56:09.120 --> 00:56:24.030 Emerges so this is an example from the adult this is position. This is time phase and we can see this look ahead and look back type of phenomena. The network does by which past current and future looking are bound within a data cycle.

NOTE Confidence: 0.858523845672607

00:56:25.110 --> 00:56:39.180 An interesting quite very interesting, Lee only around P 2324, which is the same age where infantile amnesia ends and ability of of rodents to form what looks like episodic memories lost again to the output.

NOTE Confidence: 0.878796100616455

00:56:41.750 --> 00:56:49.100 This emerges at 2324 but we do not see experiment. We do not see any clear sign of data sequences during.

NOTE Confidence: 0.837977349758148

00:56:49.700 --> 00:56:50.480 Before that.

NOTE Confidence: 0.885549604892731

00:56:51.240 --> 00:57:12.500 This is quantified here we have an algorithm to add this quadrant with this squadron. One and 3 and then subtract 2 and 4 and then divided by the sum so it is an index of how look ahead and look back. This is binding occurs and we find that at P 2324, there is much higher than 95% of chance.

NOTE Confidence: 0.862608075141907

00:57:13.010 --> 00:57:17.910 And about like the values in the adult but not at 2122.

NOTE Confidence: 0.89564847946167

00:57:19.570 --> 00:57:38.730 So we decided to compare and test whether the experience repeated experience within the day so in half of the animals that showed up before, but in half of the animals. We let them run again after the second sleep. So there are 2 running sessions and we were wondering that at the same age if that recent experience was sufficient to.

NOTE Confidence: 0.886126041412354

00:57:39.560 --> 00:57:56.150 Speed up this type of phenomenon and so we, we primarily looked at P 2122 second round versus first run and we find that there is not different whereas B 2324 versus B 2122, so the age difference, dage effect was much longer.

NOTE Confidence: 0.800365746021271

00:57:57.070 --> 00:57:59.400 So age was experience has been.

NOTE Confidence: 0.906586110591888

00:57:59.960 --> 00:58:02.160 At least attempted to clarify here.

NOTE Confidence: 0.884320795536041

00:58:04.170 --> 00:58:09.100 So this happens during the run and we wanted to know.

NOTE Confidence: 0.839051187038422

00:58:09.730 --> 00:58:13.820 When does briefly emergent when does experience there occurs during the round.

NOTE Confidence: 0.8310546875

00:58:14.470 --> 00:58:30.210 Induce plasticity such that we can see replayed representing better the experiment and then pray so this role will be devoted to replay replay across ages. This is in the adult this is just one example of of each particular replaying we find it.

NOTE Confidence: 0.878834784030914

00:58:30.870 --> 00:58:49.870 At 3:15 sixteen the network is able to decode and these are at least 6 neurons recorded simelton not single is able to record individual locations. This is position in this is time across time, but no sequence as we saw, here and this is not only the ends we could be somewhere in the middle.

NOTE Confidence: 0.87680596113205

00:58:50.580 --> 00:58:53.740 So the network does a instead of abcd?

NOTE Confidence: 0.808022022247314

00:58:54.260 --> 00:58:58.090 Right later on, and gradually.

NOTE Confidence: 0.906734883785248

00:58:58.590 --> 00:59:09.060 Longer trajectory depicting frames are being detected so it be 1718. We see some signs of sequential activity, both in the sleep before and after.

NOTE Confidence: 0.862283945083618

00:59:10.090 --> 00:59:14.210 And up until 2122 replay is not stronger than playing.

NOTE Confidence: 0.851373612880707

00:59:15.050 --> 00:59:29.520 And finally in what we called Stage 3. We see adult like phenomenon in which both reply reply are present and replace stronger than so experience induced changes that over lasted experience into sleep?

NOTE Confidence: 0.844034671783447

00:59:30.610 --> 00:59:37.740 This is summarised here in stage one both replaying replayer below chance, then they both above chance.

NOTE Confidence: 0.859527349472046

00:59:38.340 --> 00:59:42.600 In Stage 2, but they're not different and then finally replaced on that replay.

NOTE Confidence: 0.891906321048737

00:59:43.390 --> 00:59:53.650 These individual location depictions are not that fewer that random, they occur in about 20% of cases at this age and then there.

NOTE Confidence: 0.816685259342194

00:59:54.420 --> 00:59:58.060 The Lord Chancellor in the adult so they've never been reported for saying about.

NOTE Confidence: 0.860250473022461

00:59:59.760 --> 01:00:01.610 Alright so final slide.

NOTE Confidence: 0.892682313919067

01:00:03.600 --> 01:00:11.250 So with summarize the age dependent stages in the development of compressed, temporal sequences particular those 3 stages.

NOTE Confidence: 0.91720575094223

01:00:12.310 --> 01:00:20.940 In the first one. We think the network performs representation of individual locations. Wichita logically could be quite meaningful that they're not actually been moving much.

NOTE Confidence: 0.922194957733154

01:00:24.100 --> 01:00:30.630 Later, the animals start exploring more and more and then representations of increasingly longer trajectory's occurs.

NOTE Confidence: 0.863928198814392

01:00:31.560 --> 01:00:42.250 Network reconfiguration emerges and develops into more longer sequence is probably more complex too. And then we don't detect any experience dependent temporal sequence plasticity.

NOTE Confidence: 0.910339891910553

01:00:43.020 --> 01:00:49.300 And finally in Stage 3, which coincides with the emergence of episodic like memory's.

NOTE Confidence: 0.595686435699463

01:00:49.850 --> 01:00:51.340 Describer Adalah brothers.

NOTE Confidence: 0.874688565731049

01:00:52.010 --> 01:01:01.620 We see coordinated emergence of data sequences that are binding past current and future locations. And then experience dependent plasticity in temporal sequences.

NOTE Confidence: 0.86210972070694

01:01:03.260 --> 01:01:22.250 So with that I'd like to thank you for the attention and then the lab woodsman in the development cafe in the predictive coding and tablets and the address of the lab and this is the funding starting with seed funding. From here and then growing up a little bit into NIH and hopefully more to come.

NOTE Confidence: 0.729686260223389

01:01:22.930 --> 01:01:24.550 Thank you.