

Heather Berlin

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so thanks for having me it's really a pleasure to be here so I'm gonna talk to you a little bit about well why why I got interested in neuroscience and really it was because I had this burning question this piece of matter right this three-pound piece of matter how does it create all of our subjective experience in all of our feelings our thoughts our emotions everything we experience from the moment we wake up until we go back into a deep dreamless sleep and this has been sort of my lifelong fascination it's a quite complex piece of machinery you know it's made up of these little cells called neurons which basically are sending information their their bits of information you can think of it like that and there's about 100 billion neurons in the human brain and each one of those neurons has about a thousand to 10,000 synapses or connections which means that there are about a hundred trillion connections in the human brain which is you know more connections than there are stars in the Milky Way and that that's pretty enormous and now there's a lot of money being funneled into trying to map out the human brain and I think that's a really it's a it's a noble effort and it'll give us a lot of information but even if we could map out every single connection in the human brain it still won't give us the answer about why those neurons firing and those neural chemicals slushing around give us our subjective feelings and you can think of the brain as sort of an information processing machine and it encodes again all of our thoughts feelings and perceptions it's quite complex a piece of machinery but the real interesting bit is that although there's a whole field dedicated to studying the neural basis of consciousness much of what happens in this piece of machinery is happening outside of awareness it's affecting our behavior it's affecting the decisions we make and we're only becoming consciously aware of even our feeling of agency of our intention to make a decision after the brain has already decided and we can see that using different imaging techniques so the question is what's happening in the unconscious what's guiding our behavior and how is that instantiating in the brain what's the neural basis of these unconscious processes that are motivating our behavior and and again we're only aware of this very very little bit about what's happening and most of it is a post hoc explanation about why we do things which might not really be the reason why we're doing things in the first place so how can we test this in the lab well we can use simulates either presented very quickly so a person claims not to have seen it but the brain is still processing it or we can present stimuli that's presented in a very subtle form so again the brain is processing it but the person claims to not be consciously aware of it so here's an example so

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raise your hands if you can see the subliminal message here okay just a couple handful of people I know what you guys are thinking okay a couple more so it's really interesting you once you see it you can't not see it I'm gonna point it out here in the negative space it says s e X you see really obvious blatantly obvious and 'there's the the bees and where's the birds and the bees and the flowers are kind of like loving towards each other if you can see so there are all these subtle messages in there now once you see it you can't unsee it if I show you this in an hour you'll see sex right away but what's really interesting about using these kinds of stimuli is that the physical stimuli see is exactly the same but what changed was your perception was in your mind so the photons hitting your retina being processed by your visual cortex remains constant but what change was your perception and that's what we want to check is the neural basis of your perception what change in your mind when you saw it versus when you didn't because the physical stimulus remains exactly the same and this kinds of information is getting into your brain and being processed all the time outside of awareness because consciousness has a very limited capacity if you had to consciously be aware of every bit of information that was coming into your brain all day long it would be overwhelming it would be maladaptive but the unconscious is virtually limitless and so it can process a lot more information and it filters out only the very very necessary things that should have come to the the tipping point when it finally comes into awareness but you get these subtle bits of information all the time like this is just always a funny example I don't know how this got through the editors of Parents magazine I think it's sending the wrong the wrong message but somehow that got through this is a another another one raise your hand if you can see the subliminal message here raise your hand oh you guys awesome that's it Wow so you all see the nine dolphins here in the negative space why what is your go-to CP so what what's interesting about this is that pre-puberty they automatically see the nine dolphins that's what they see post puberty you see this other image but you know again it's the same exact stimuli but we're perceiving it in different ways depending on you know what we've been exposed to perhaps so what's out there in reality does not necessarily correlate to how we're perceiving the world the brain is interpreting physical stimuli and and manipulating it and there's all sorts of visual illusions so here's another example if you look at squares a and B it might be hard to see up here here's here's a square a and square B they look as if they're different colors right different shades different shades but actually they're exactly the same shade and it's just the shadow illusion so

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you can see if you remove the shadow and draw a line between them they're exactly the same shade and no matter how much you know this consciously the brain still makes this approximation because it says oh there's a shadow here we must lighten it up to make up for it a similar phenomena if you remember this dress-- phenomena we're right it was sort of it was really blue and black but some people saw it as white and gold or some Saudis blue back and that's because there was light hitting it so some people's brain made an approximation and lightens it up a bit and others darkens it up a bit so again what we perceive in her mind's eye is not necessarily correlated with what's there in reality so we want to again try to track the neural basis of consciousness of what we're perceiving and we can also use these bi-stable images so here for example we can prime you if I gave you words like you know the wise or you know elderly or those kinds of words you might see the old older woman here that's her nose and mouth and her chin and her eye but if they gave you words like youthful and vigorous you might see the young woman who is looking away with thee that's her eyelash that's her nose that's her chin that's her ear so you see two different things within the same image and they'll switch back and forth in your mind's eye but you'll never see them both at the same at the same time similar kinds of Biggers are here like this Necker cube which you can the face the face of it will go back and forth in your mind's eye you'll either see this as a duck or as a rabbit but never never at the same time so the what we want to track is for example when you see the old woman versus when you don't what's happening in your brain how can we track these neural correlates of consciousness and there's a variety of proposals for the neural correlates of consciousness imadori I'm not gonna go into all these I'm just giving you an example of some of the kind of ideas that are out there and there's an array of them and so but there are a few kind of concepts that have I think held the test of time and held and have kind of proven to have some validity based on a variety of experiments and one is that what it looks like in the brain when something comes into consciousness is that you have these coalition's of neurons that start to fire together so you can think of in the brain these groups of neurons it's like a Darwinian competition between groups of neurons it's like an election and you know you have a group of neurons that are trying to suppress the other group of neurons and then one group comes into power and that's what's in consciousness and I'll stay there for a few seconds if you attend to something you can stay there longer until another group of neurons comes into consciousness and that's kind of the ebb and flow of conscious perception I like to use the analogy analogy of like a Twitter feed because if you think if each tweet is like a neuron firing and if enough people start

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tweeting about something at trends and that's what comes into our collective consciousness until something else takes over that's kind of kind of what it's like but it's important to remember that it's happening across the whole brain so this is looking at a neural network if this is just a bird brain just pretty pretty simplistic but you can see yet how complex it is so you have these coalitions of neurons that are occurring across these large circuits throughout the brain and then one question is well what brings these neurons together and one idea is that they start to fire in sync now it's not that they fire all exactly at the same time because that would be like an epileptic seizure but they're they're firing in coordination if you think of it like an orchestra playing you know when they're warming up their instruments they're all out of sync but they're not all playing the same note but when they play a symphony when they all come together but sort of what it's like with these the synchrony of neurons firing together and I also use the analogy of of like a wave you know not everybody's standing up at the same time but they're not all standing up randomly but they're kind of doing this coordinated action now some theories and this is a very popular theory this is now called the global neuronal work space model of consciousness and what what it says is what they find is that when something is presented subliminally it activates these early parts let's say what it's presented visually supplementally it'll activate the primary visual cortex and you can see here you have a spike of activation early on right after the image is presented and then as something comes more into consciousness it starts the kind of reverberate through the brain and starts to activate higher-order areas of visual awareness and you can see this sort of wave of activation moving forward in time and then when it reaches consciousness you get activation in these prefrontal areas and these kind of feedback loops and that happens around 300 milliseconds after the presentation of the information so the more brain activation in a way the more it comes into conscious awareness and lots of studies are showing this so one theory suggested that there might be something about this time period that when you get a kind of spike of activation at around 300 milliseconds and start showing that's when you see the sex and then it comes up into your prefrontal cortex so this one theory by Stanza Hain was that you know if you've used stimuli whether it's conscious or subliminal you show identical EEG activation or electrical activation in the brain for the first two hundred and seventy milliseconds and then if this stimuli remains subliminal that brain activation tapers out but if it comes into consciousness you get this sudden burst of widespread activation at around 300 milliseconds after the stimulus that's characterized by this EEG signal which is called p-3b signal and that some have called that the neural

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correlate of consciousness that activation the p-3b but this recent study just came out which showed that the p-3b signal could be detected during unconscious processing of stimuli so what they did was they presented stimuli all the stimuli was presented subliminally unconsciously they masked it so they would show either the word left for seven milliseconds followed by sort of a mask which blocks it so you're not consciously aware of it and then occasionally they would show the word right which was called the oddball and what they found is that the rare stimulus the word right produced a strong p3b signal widespread across the brain so what this shows is that this is evidence that the p-3b signal is not necessarily it's not the neural correlate of consciousness because this was happening outside of awareness it might just be a signal of sort of this complex sustained unconscious brain activation and this contradicts that global neuronal work space theory so what next well this very popular theory now is called the integrated information theory of consciousness which was created by Giulio Tononi who's actually a psychiatrist and he does sleep research and what he said and it's I'm not going to get into the details of it but it's basically an information processing theory that says any any substance any any kind of mechanism that has a high degree of integrated differentiated information will have the property of consciousness so it's kind of like just a law of the universe like like the law of gravity so and it just happens to be that the brain is one of those pieces of machinery that has a high degree of integrated information and so you know integrated meaning that let's say if you had your camera and he had two pixels and one of the pixels goes out well that's not gonna affect the pixel next to it right that's not integrated but if one pixel goes out and it would affect the other one that would be a degree of integration of information and so you can see the more it sort of integrated the information the more conscious that system will be so all these studies are well and good and they're very interesting but again what about the unconscious that's where a lot of the interesting stuff is happening and most of the studies and neuroscience that are looking at the unconscious will look at like whether you see it or don't right do you see the word sex or don't you see the old woman or not which is kind of like a static unconscious it's devoid of emotion of motivation of meaning so what I was really interested in is this or the dynamic unconscious the Freudian you know really rich contextual unconscious and Freud was a neuroscientist and he actually when he was coming up with all of his theories he was trying to map them out in the brain and this actually is Freud's diagram of what he thought the neural basis of repression was he thought you had like this information going one from one neuron to the next but then it gets sidetracked in this side cathexis and pushed away and relegated to the

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unconscious so the interesting thing about Freud is I don't think he was right in everything he said but with the modern tools that we have where we can now peer into the brain why not test out some of his theories and see if it holds true given what we know today about neuroscience because he didn't have the tools that we have now to really look at the brain and see how these theories of the mind were instantiated in the brain so I'm just going to go over a couple of studies that are beginning to look at the neural basis of the dynamic unconscious and these studies didn't necessarily specifically set out to kind of explore the neural basis of psychoanalytic ideas but they do in a maybe a non direct way so this was an interesting study that came out of Chris Fritz group in London looking at the neural basis of subliminal motivation and what they did is they showed people in fMRI so fMRI was looking at blood flow to different parts of the brain they showed them either a penny or a pound I'm sorry penny or a pound and the pound being worth much more than the penny and they masked it on either side with these images so all the person claimed to see was these images and and and the pound or the penny was presented for either 1750 or 100 milliseconds and the person claims to only consciously see the money when it was presented at a hundred milliseconds but they were told either way whether you saw it or not to just squeeze this lever and the harder they squeezed the more sort of it would go up and the more money they could win and they were told just squeeze either way so sure enough when they were presented consciously with the pound they were more motivated they squeezed harder but when they were told to squeeze when it was presented subliminally they still would squeeze harder for the subliminally presented pound so something was getting in there and then what they did is they looked at what was happening in the brain in both these conditions and what they found is that whether it was presented subliminally or super liminal II they had similar activation in a subcortical part of the brain called the ventral pallidum which is part of the basal ganglia and this is part of the evolutionarily older reward system center in the brain so what this is saying is that it suggests that there's this sort of bottom-up decision-making process where the ventral pallidum is part of a circuit that's first weighing the words and deciding and only after does it then interact with the higher levels the more conscious levels of the brain the prefrontal cortex and so often the prefrontal cortex is the last to know or you're the last to know so I kind of like to talk about it in a very general sense we can think about two systems in the brain roughly speaking you have the evolutionarily older subcortical areas here in red like the striatum which is like processing reward look I've just talked about the amygdala which is processing emotion you have areas that are involved you have areas that are involved in

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memory these are evolutionarily older some people call it your reptilian brain it's motivating you for going for immediate reward and pleasure and avoidance of pain and then you have that those urges balance with the more recently evolved these areas and blue the prefrontal cortex which is thinking about the long-term consequences of your actions so you might say okay I want that piece of chocolate cake right now and then the prefrontal cortex says well wait you know summer is coming maybe I want to look good in that bikini and then you know they go back and forth and eventually you come to some kind of a you know consensus but if you have damage to the prefrontal cortex or which is like your brake system and you know in 40 in terms you can think of these sub critical areas like your it impulses right and this the prefrontal cortex is like your super-ego or you can think about it the accelerator and the brake if there's damage to the brake system or if it's under activated by a neurochemical imbalance and you can get impulse control disorder problems you can't control your impulses who needs all sorts of things even people with ADHD people with who can't control their emotional outbursts those kinds of things or you know you can have too much acceleration so you can have an intact brake but you can have too much activation from these subcortical areas or you can have a problem in the connectivity between these two systems or there can be a genetically related imbalance but either way when there's an imbalance in these systems it can lead to to a variety of different psychiatric illnesses but getting back to Freud these subcortical you know impulses he was right when he talked about these defense mechanisms we have when we suppress things when we repressed them when we push them outside of awareness unwanted memories or emotions and just to clarify suppression is the conscious pushing away of an unwanted memory or emotion so when you push something out of a you say oh you know I'm having a fight with my significant other but I need to work I need to focus I'm gonna push it out of out of my conscious mind repression is when that happens unconsciously so something happens to you it's very traumatic it's automatically relegated to the unconscious and then there's dissociation which is when you split off and you only have awareness of these traumatic events in different brain States quickly I'm going to go through a couple of studies which are starting to point out the neural basis of these processes one is this study where people have to learn word pairs like what does that ordeal Roche and then in one paradigm and they were put in the fMRI scanner and one paradigm they were told one of the words in the board pair or deal and they were told don't think of the word that goes with ordeal so they were told to suppress it now you might think the white bear thing well if you don't don't think of a white bear that's the first thing you think of but because they had this extra

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step they didn't say don't think of rote she said don't think of the word that goes with ordeal it actually works they were able to suppress information then they had a response condition where they said I want you to think of the word that goes you know with this word pair and then a baseline where they were told nothing and they behaviorally you can see when they were given a memory task after in the suppression condition they actually had decreased memory for the word Roch let's say in this case so they actually were suppressing the memory and what was happening in the brain is that you actually had increased activation in areas of the prefrontal cortex which you can see here especially the dorsal lateral prefrontal cortex and decreased activation of the hippocampus which is having to do with memory so you're actually having an active process where you're pushing things outside of awareness what about suppression though well repression sorry repression happens automatically and that's that's very difficult to study in lab so we use this technique which is actually called continuous flash suppression in order to measure repression but here basically you just have these two like Mondrian images we have one I sorry you have one Mondrian image presented to one eye and let's say an angry face to another eye the angry face is very salient and normally that would that would breakthrough you'd be consciously aware of it and what happens is that even though these two images are presented one to each eye all the person who claims to see is this Mondrian image because it's so salient it's the splashing image it suppresses the other and so with this technique you can present stimuli to people in full view without them being consciously aware of it and they use this technique in this study where they use continuous flash suppression and they presented in one part of the visual field either left or right visual field a naked woman or a naked man and then they they presented and the other eye this image and all they claimed to see was the flashing Mondrian image and the test was basically to see where is a person unconsciously attending to and we tested they tested this by giving them as little cavora patch it's hard to see but it's either it was tilted a little bit clockwise or counterclockwise and it was either presented to the left or the right visual field they measured how quickly the person can say what direction it was facing the idea being that the quicker they can say it means they were early were attending to that field of space and so using this technique they were able to see where people's unconscious attention was and the interesting thing about this study is they gave it to heterosexual men and women and homosexual men and they found that sure enough the heterosexual women paid way more attention to the area of space where the naked man was and interestingly homosexual men had that same response where they paid more attention to where the subliminally

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presented naked man was men paid more attention to where the subliminally presented woman was okay at all pretty interesting but really why I think this is getting at repression is that okay when there was a naked woman women there was no change in where the women attended but when there was a naked man the men actually diverted their attention away unconsciously to the naked man which Freud might call repression so you know journeys come up with these novel ways to measure and then we can start looking at what's happening in a person's brain when this is occurring finally dissociation this is a process again when people split off so the other if you can think of it like pushing unconscious or unwanted things down into the unconscious this is kind of compartmentalization pushing it off into one compartment and not having access to these memories in another and usually these people have two different brain States they have one which is called the neutral well now let's call it used to be called multiple personality disorder but now it's called the dissociative identity disorder basically because the idea is that they have one identity that's been broken off into pieces rather than multiple personalities but in one identity state they don't have access to those traumatic memories or events in the traumatic identity State they do and what's really interesting is that they can have different physiological arousal to stimuli when they're in these different states they can have different allergic reactions to things and they can even have different EEG responses and this was an interesting case of a woman who claims to be blind in one state now imagine that you're physically able to see and then keep her eyes open and try to not see right it's almost it's impossible however she claimed to not see and all these tests they gave her of her optics looked as if she was blind in the state and then the gate they gave her a test where they did this flashing checkerboard image and measured her brain activation in the primary visual cortex which is where the visual information goes right away it's really early on in the processing and what they found is in the sighted state she got a very distinct EEG activation to the flashing checkerboard but in the state she said she was blind she didn't she had a flatline v1 we call it primary visual cortex which is very difficult to explain which means the suppression had to occur very early on in the visual process that the level perhaps of the thalamus we wanted to explore further but then she she got better so that was good for her but not for the science but what's interesting is that a lot of you and I and I taught I am a while back in Switzerland and I remember talking about this case and there were people are just like well that doesn't even exist that disorder and you know the thing I think that's interesting about uncovering things with neuroscience is that it gives you some kind of tangible evidence so these people are reporting these symptoms but they're subjective right

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just like consciousness is subjective but if we can show something physically point to something objectively then it legitimizes what people are experiencing subjectively and this was actually one of the first studies that was done looking at structural differences in people with dissociative identity disorder and actually found that they had smaller significantly smaller hippocampi hippocampus here and you can see a midget eye here then healthy people and so there are physical changes and one idea is that you know what's interesting is that people who experience trauma and didn't develop dissociative identity disorder actually had larger hippocampus and amygdala so maybe that's a protective factor or maybe having exposure to trauma early on while the brain is developing because because we know cortisol can affect the development of the hippocampus so if you have high cortisol levels at critical stages of development it can actually cause shrinkage of the hippocampus so that could be the reason as well it's hard to say we don't know but there are physical changes and in just this other study they had people who can self control when they switch between these two states and they had given therapists transcripts of actual traumatic memories which they claimed happened to them when they were in their traumatic state but when they were in their neutral state they claim that never happened to them and then they were given the therapist just neutral memories that they they claimed happen to them in either state and they read these these patients these scripts the traumatic memory scripts and the neutral memory scripts when they were either in the traumatic identity state when they said yes that happened to me or the neutral state and then they did all sorts of measures looking at fMRI looking at physiological measures like heart rate blood pressure and this is really interesting they found that when they were in the neutral state you can see this side here is the they were red the neutral memory script and this is the traumatic memory script and you can see when they're in the neutral state what you have here is what that's heart rate frequency they claimed it didn't happen to them and then sure enough they don't get an increased heart rate but when they're in the traumatic state they claim it did happen to them and they do the same thing with blood pressure and so on so when they're in these things they claim that didn't happen to them and they're not even getting the physiologic responses to those memories so there's such a level of suppression that they're not even really responding which is pretty amazing and the question is what's happening in the brain well they we see that when they're in the the neutral state when they're keeping those memories at bay it actually all those areas in red you have increased

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activation a lot of prefrontal activation it's an active state it takes more cognitive energy it takes more brain power so to speak to keep things at bay that's why perhaps when you and Freud was right you know when you release your defenses when you let go of that prefrontal cortex that's suppressing things it allows these unconscious memories and emotions to come to the surface and that's what things like psychotherapy tries to do you know people take certain drugs to get to those states you know but it doesn't have to be that it could be meditation and so I started getting interested in this what can get people to decrease prefrontal activation decrease the defenses so we can access these traumatic memories and emotions which is very therapeutic when they come to the surface and they can be reintegrated in the brain in a neutral way so they're no longer threatening and they're no longer affecting people outside of awareness in negative ways or in negative behavioral patterns that they keep repeating and so the sort of last part of my talk is that is the more recent work that I've been getting interested in is looking at how can people get in these states without drugs and you know in a positive way and one thing that struck me was when people are improvising when they're being creative during improvisation and one thing that really struck me was freestyle rap so when people are freestyle rapping and I know it sounds like a very novel kind of thing but if you I saw it once and I thought wow that's like free association they're in the moment they have to stay on beat it has to make sense it has to rhyme you don't have time to analyze and think and we know think about what other people are thinking you're in the moment you have to do it there's no so you have to let go you have to let go so my question is what's happening in the brain when people are in this state when they're improvising so I'm going to give you a little sample so you can see what I mean this is of a rapper who the first part of the rap is going to be it's the written rap part and then the part in the middle you'll see is improvised and then I'll go into a little bit of a study which we're starting now where we're going to compare rappers in the scanner when they're doing memorized rap verses improvise to see the difference in their brain so here is the sample so you can get an idea of what I mean and how sort of impressive I think it is performance feedback revision see the jeans are like a text with a hundred thousand pages and revisions occur in the random changes that come from mutations and when they see the light that's the performance that's the phenotype and natural selection well that's the feedback side that's about who survives and whose genes catch rise in the next generation yes what I'm saying is that a rat performance like this is the best illustration for the way that descent with modification works as the performance is necessary to change the words to decide which have an impact and which to send

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back to the drawing board in fact I just did that when you failed to react cause any line can change and mutations occur when I improvise on stage cause up until this moment everything I said was off the page but now it's time for me to switch it up and do a little freestyle section I'm gonna try to make it specific so that I can beat your cheater detection yes I might be a bit of a tough back to follow at the Hammersmith Apollo that's why the intervals next but I'm a massive apostle of science yeah that's the way that it goes with these craziest flows this is me just improvising trying to say what I know I wanna make a mistake that just does me rocking the rhythm and trying to introduce a little bit of mutation into the system aha I might just come with these freestyle cipher and flows so I'm gonna sing rhymes with the Bible code he's been analyzing them up and jumping the mother and surprising him but you know I'm kind of the best at this I'm not a geneticist but I kind of understand the things that they've been expressing like every human being on this planet is relatives which means every relationship is relatively incestuous which this couple demonstrates nice one excellent this is the way that I'm wrong in the rhythm this is what you call the agnosticism rationalism but man all of these critics have been pissing off Robin it's talking about godless liberals what come on this warning godless liberals of that we got quantum physics and we got ideas about evolutionary altruism okay and some people might try to say that way humanism is the new religion but it's not because our ideas are open to revision see that's the difference right here I'm trying to speak this stuff clear and if you like that yeah then you can make some noise back to me [Applause] not just I'm trying to flip it to this risen yes this is me introducing more randomness into the system but this is my little concept it's kind of simplistic it goes like this performance feedback revision so if you want to know about evolution this is the definition like this performance feedback revision and if you want to check it out again I got CDs you can get them performance feedback revision so anybody here can use this concept to learn how to do anything if you want performance feedback revision so say with me performance feedback revision thank you okay so that happens to also be my husband little Africa so I got to put him in the scanner that's him in the scanner there I don't know if you can see it but he had holes in his socks I don't know why he decided to wear holey socks but anyway then this is actually his brain um so we had him do freestyle and memorized and you can see that part there is missing that's the part that I said do with listening it's completely gone that's right I had to throw that in there but this study was based on a preliminary study that was done basically in a smaller group which the findings show that when they're in the rappers are in this freestyle phase you compare to the memorize phase you get a unique pattern of

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brain activation you get decreased activation here these areas in blue in the dorsal lateral prefrontal cortex and remember the study before when they were suppressing the memory of the word pair you actually had increased activation in dorsal lateral prefrontal cortex but here you're decreased and so that's bringing down the defenses now this part of the brain has to do with self-awareness has to do with making sure your behavior conforms to social norms so when you're in that flow state you kind of lose your sense of self you lose your sense of time and place the moment you become too self-aware you step out of it and it messes up your performance and it could be with anything with also with sports as well you know if you're in the midst of playing tennis if you start thinking like oh what angle should I hit the ball in order you lose it and you know the heel so they also had increased activation here on the medial prefrontal cortex and that has to do with internal generation of ideas so you have this flow of information that's coming from within the filter system is taken off so novel associations between ideas can be made and it allows for creativity it's that flow state that people talk about that really is associated with positive emotions and people strive to get into that state what's interesting is another study that was done by Charles Limb's group in jazz improvisers and again they were played like a keyboard while they were in the scanner they were even to kind of do that with their hands and they didn't memorize or improvise piece and there was a similar pattern of brain activation you had decreased activation here in the dorsal lateral prefrontal cortex and increased activation in the medial prefrontal cortex again so they're in this similar kind of flow state where you release your inhibitions and the idea is that things can bubble up from the unconscious it's coming from from within the the other thing that I couldn't was interested in is well what about comedy improv and it turns out that there's actually been so far nothing published looking at what happens in the brain when comedians are improvising there has been a study which looks at what happens in your brain when you're appreciating when you're viewing humor and what they found is they showed people like either the Simpsons or Seinfeld and they found that when things were funny you have this humor detection phase where you get activation in like temporal areas of the brain temporal parietal areas that have to do with making associations between ideas and really comedy is to do with novelty so when we find something it takes a sharp turn that we didn't expect it surprises us we find that funny and this part of your brain the temporal areas or making or looking at sort of past knowledge of what we know and the new information that's coming in and comparing it and finding something novel and then we get the humor appreciation phase where you get activation in these reward centers of the

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brain I'm running out of time but slate the one thing is just that there are differences between men and women and their appreciation of humor which they found that they showed men and women different either humorous or non humorous cartoons and when they were funny they had similar patterns of activation again they had that temporal parietal Junction which is about making associations between ideas and dorsal lateral activation but women actually had more dorsal lateral activation which means that they were basically analyzing the kind of the they were analyzing the semantic structure of the jokes more but then when they found them funny they actually in the humor appreciation phase they had it's hard to see here but they had this this red peak here significantly greater activation in the reward center of the brain so when they did find them funny they got more pleasure out of them and we think that this has to do with expectations so the men were expecting it to be funny so when it was they just got this little kind of bit of pleasure but when it wasn't funny they were actually disappointed you can see this green up here but the women when it wasn't funny there I go well that's what I expected but when it was there was this huge so basically women are harder to please but when they're pleased they're very pleased and finally the you know one study then this is preliminary data on presenting from some colleagues that hasn't been published yet but they actually did look at comedians from themselves when they were creating humor and they gave them these Cathy's cartoons and they were told to either create a funny or a mundane caption for them and they looked at what happened to brain when they were creating funny or mundane captions and they found interesting similar parts the brain they're active the temporal parietal Junction I talked about that makes associations between ideas novel associations and the striatum the reward center of the brain but what was interesting is that the order of activation is reversed so even though those same areas of the brain are active when you're appreciating humor when the comedian is creating it they actually have the striatum part the reward center is active first and then the Association areas which is interesting so they're almost like getting a little bit of a kick because they're about to say something funny even though they might not even know what they're about to say yet I mean they also found that professional comedians had more temporal Junction activation which means they were like making these associations they were better at making these associations and less medial prefrontal activation which means it took them less effort to come up with something funny and the other thing that I just want to say about these states is that to get into the to get into these improvising States again you don't necessarily need you know drugs and this kind of thing these all these

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other States these similar states mental states have similar brain States as the improvising brain or flow States so things like during hypnosis during daydreaming during certain types of meditation during REM sleep where you lose your sense of self of time of place that allows for a novel association between ideas and for creativity and people lose their sense of focus it's associated with positive emotions and one thing that I'm going to look at now is is there a similar pattern of like a kind of neural signature of improvisation or creativity across different art forms so you know what about when people are painting or during theatre improv or comedy improv or dance improv you know do these brain states look similar across different disciplines and you know so the more I kind of look into the brain and how it works the more I'm kind of filled with just how complex and amazing it is and still how little we know even with all the advances we've had now and we ultimately need an overarching theory of consciousness so we can tell you know does a computer have it does a does a fetus have it does a bee have it we won't know that until we really have an overarching theory but what we can do with the knowledge we have so far I think is we can try to look inwards and understand ourselves better understand our unconscious motivations or drives our fears try to bring them into consciousness and the more sort of you know know thyself the more we can understand our unconscious drives perhaps we can live in harmony with ourselves and live you know according to our own personal goals and be more happy and I think it's like with therapy and these kinds of things are trying to bring these unconscious processes to the forefront and that's pretty important and ultimately that hopefully leads to wisdom which is having experience knowledge of oneself and good judgment and I'll leave it there thank you you