

**Huberman Lab #13 - The Science of Emotions & Relationships**

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## Introduction

Welcome to the Huberman Lab podcast where we discuss science and science-based tools for everyday life. My name is Andrew Huberman and I'm a professor of neurobiology and ophthalmology at Stanford School of Medicine. This podcast is separate from my teaching and research roles at Stanford. It is, however, part of my desire and effort to bring zero cost to consumer information about science and science-related tools to the general public. In keeping with that theme, I'd like to thank the sponsors of today's podcast.

Our first sponsor is InsideTracker. InsideTracker is a personalized nutrition platform that analyzes data from your blood and DNA to help you better understand your body and inform your health goals. I'm a big believer in getting blood tests taken because it's simply the only way to get in-depth data about your metabolic factors, hormones - all the things that inform your immediate and long-term health. Nowadays, there are also excellent DNA tests that can further inform you about your immediate and long-term health. Now, the problem with most blood tests out there is that you get information back - you get a lot of numbers - and they'll tell you whether or not your numbers are in normal range, or high, or low - but they don't inform you what steps to take as a consequence. In addition, they can often be very confusing - what all the factors are and what they really mean. InsideTracker has a dashboard and a platform that makes interpreting all that information really easy. It also points you in the direction of certain lifestyle factors - exercise, nutrition, etc. - that you might want to change in order to bring the numbers into the ranges that you want. So, InsideTracker is something that I've been doing for some time now and it's really helped me inform the choices. For instance, I've swapped out some of the foods that I was eating regularly. I found out I was actually too high in certain vitamins and minerals. I was too low in others. It's really helped me adjust my diet and my exercise regimes and it really gives me the confidence that I'm on the path to long-term health. So, if you want to try InsideTracker, you can go to [insidetracker.com/huberman](https://insidetracker.com/huberman) to get 25% off any of InsideTracker's plans. Use the code "huberman" at checkout. That's [insidetracker.com/huberman](https://insidetracker.com/huberman) to get 25% off any of InsideTracker's plans and use the code "huberman" at checkout.

Our next sponsor is ExpressVPN. ExpressVPN is a virtual private network that keeps your data safe, and secure, and private. It does that by routing your internet activity through their servers and encrypting it so that no one can see or sell your data. I started using ExpressVPN because my bank account got hacked. I still don't know exactly how it happened, but it was an absolute mess. I lost money. I lost a lot of time. I wouldn't want to have it happen to anybody. When that happened, I talked to my friends in the tech community and they told me that even though you think your internet connection is secure - oftentimes, it's not. So, I tend to use internet connections on planes, and hotels, and cafes - but also at home. And I was told that even at home, your data may not be as secure as you think. And so, with ExpressVPN, your data is absolutely secure - so are your online activities. The great thing is you don't even notice that it's operating. It's running in the background. You just turn it on and it goes without you realizing that your data is being protected. It doesn't interfere with any of your online activities. So, I use ExpressVPN when I travel - anytime I'm outside the house - when I'm at work - and when I'm at home. If you want to try ExpressVPN, you can

go to [expressvpn.com/huberman](https://expressvpn.com/huberman). And if you do that, you'll get an extra three months free on one of their one-year packages. That's [expressvpn.com/huberman](https://expressvpn.com/huberman) to get three months free on a one-year package.

The final sponsor of today's podcast is Magic Spoon. Magic Spoon is a zero sugar, grain-free, keto-friendly cereal. As I've mentioned before on the podcast, I'm neither ketogenic - nor am I all-meat - nor am I vegan. The way I eat is that early in the day, I fast. And then, sometime around noon, I eat my first meal - and that meal is always low-carbohydrate. And then throughout the day, I maintain a low-carbohydrate diet. The fasting and low-carbohydrate diet during the daytime optimizes alertness and wakefulness. I want to be awake and be able to work. And then, at night is when I eat my carbohydrates because it facilitates the transition to sleep. So for me, Magic Spoon is a terrific snack in the afternoon. I'll sometimes even have it with lunch. And the reason I like it is because it tastes really delicious and it's compatible with the keto-friendly or - you know - keto-like meals that I eat throughout the day. They come in a variety of flavors: cocoa, fruity, peanut butter, frosted. I particularly like the frosted because it tastes like donuts, in my opinion. And I love donuts. As a consequence, I love Magic Spoon cereal. I can consume it. It tastes like a pastry. And it has zero grams of sugar and it's compatible with this nutritional regimen I mentioned earlier. If you want to try Magic Spoon, you can go to [magicspoon.com/huberman](https://magicspoon.com/huberman) to grab a variety pack. Use the code "huberman" at checkout and get \$5 off your order. That's [magicspoon.com/huberman](https://magicspoon.com/huberman) and use the code "huberman" to get \$5 off.

This month, we're talking all about the science of emotions and tools related to the science of emotions. We've talked about the science of stress and resiliency - tools to access more calm - tools to raise your stress threshold to become more resilient. We've talked about motivation and the role of the dopamine system.

I'd like to make a couple of announcements about some new resources. The first one is that we have now captioned all the Huberman Lab episodes in English and in Spanish. We were able to do that thanks to your support of our sponsors and on Patreon. So now, all of the podcasts have a captioning feature on YouTube. And those were done by experts. So, while there might be the occasional error - for the most part, they're very precise. We've done that so that people that prefer to consume the content in Spanish or that like to read the content from the English subtitles can do so. And we're going to continue to expand the number of languages that are captioned for the Huberman Lab podcast. So, we want to thank you for that resource. It's now available for all episodes.

In addition, in previous episodes, I've talked about NSDR - or non-sleep, deep rest. NSDRs come in a variety of different forms. There's self-hypnosis. I pointed you to some resources for that previously. There's yoga nidra. NSDR is really about achieving calm quickly and doing that in a self-directed way - for many reasons - in order to access sleep more readily, in order to de-stress very deeply, in order to replace sleep that you've lost. It also seems to aid neuroplasticity. It can enhance the rearrangements of connections in the brain that occur during learning. There's

scientific support for that. There's a link in today's episode caption to a new site. This is a YouTube video that was brought free of cost by the folks over at MadeFor - a company that's been a sponsor of the podcast previously. So, this is an NSDR script that doesn't contain any of the intentions or some of the more typical language of yoga nidra. Instead, it's focused purely on the breathing protocols as well as - includes a - sort of - body scan where you direct your attention to different locations around your body. It has all the core elements of non-sleep, deep rest but is distinct from yoga nidra. I just offer this to you as a resource if you'd like to use it. It's about 30 minutes long and should be very effective in bringing you into deep states of relaxation for all the reasons I mentioned before.

### **Emotions - Subjective Yet Tractable**

So, let's talk about emotions. Emotions are a fascinating and vital aspect of our life experience. It's fair to say that emotions make up most of what we think of as our experience of life. Even the things we do, our behaviors, and the places we go, and the people we end up encountering in our life - all of that really funnels into our emotional perception of what those things mean - whether or not they made us happy, or sad, or depressed, or lonely, or awe-inspiring. Now, one thing that is absolutely true is that everyone's perception of emotion is slightly different - meaning your idea of "happy" is very likely different than my idea of what a state of happiness is.

And we know this also for color vision, for instance. Even though the cells in your eye and my eye that perceive the color red are identical right down to the genes that they express, we can be certain based on experimental evidence - in what are called psychophysical studies - that your idea of the most intense red is going to be very different than my idea of the most intense red. If we were given a selection of ten different reds and asked, "Which one is most intense? Which one looks most red?" And that seems crazy. You would think that something as simple as color would be universal. And yet, it's not.

And so, we need to agree at the outset that emotions are complicated. And yet, they are tractable. They can be understood. And today, we're going to talk about a lot of tools to understand what emotions are for you to understand what your emotional states mean and what they don't mean. And in doing that, that will allow you to place a value on whether or not you should hold an emotional state as true or not true - whether or not it has meaning or it doesn't - as well as whether or not the emotions of others are important to you in a given context. We're going to talk a lot about development. In fact, we're going to center a lot of our discussion today around infancy and puberty. We're also going to talk about tools for enhancing one's emotional range and for navigating difficult emotional situations. I am not a clinical psychologist. I'm not a therapist. But I do have some background in psychology. And today, I'm going to be drawing from the psychology greats - not me - but from the greats of psychology who studied emotion - who studied emotional development - and linking that to the neuroscience of emotion. Because nowadays we understand a lot about the chemicals and the hormones and the neural circuits in the brain and body that underlie emotion. So, while there's no one single universally true theory of emotion - at the intersection of many of the existing theories, there are really some ground truths. So today, we're going to visit those ground truths. We're going to talk about the tools that emerge from them. And

we're going to talk about some absolutely wild and wacky experiments that people are doing out there right now - that I don't necessarily recommend you do - of inhaling different types of hormones and trying to get attached more quickly. You're actually going to do some experiential stuff today if you'd like. There's some things that you can do in real-time while listening to the podcast in order to tap into some of the mechanisms that I'll be referring to. So, today's going to be very interactive in a way that previous podcast episodes have not.

### **Where Emotions First Developed**

If we want to understand emotions, we have to look at where emotions first develop. In fact, this is a critical central theme if you want to understand brain science and psychology. There's a rule in neuroanatomy - because if you look at 50 different brains of humans or you compare the brains of dogs and humans, there are a lot of differences - certain things are the same, but certain things are different - and the rule that every good neuroanatomist knows is that if you want to understand what a part of the brain does, you have to address two questions. First, you have to know what connections does that brain area make? What is it connected to? Where does it get inputs from? And where does it send inputs? So for instance, if there's an area of the brain that gets direct input from the neurons in the nose, you can be pretty certain that it has some role in analyzing smell - in measuring something about odors - or analyzing something about odors. Now, if it also gets input from the eye, you can also conclude that it gets input from the visual system - that it cares about light and photons. This is sort of obvious. And yet, you need to know that connectivity and you need to know what's called the developmental origin of that structure. You need to know where it was early in development because things move around a lot as the brain develops. The brain, of course, is this more or less squishy thing floating around in some liquid that's stuffed inside your skull. And as a consequence, things move around a lot. They are not always in the same place in two different species or two individuals of the same species. So, you have to know where they started out because where they started out informs what they do as well.

And when we're talking about emotions, we cannot point to one area of the brain. We can't say that's the area of the brain that's responsible for emotions. There is this so-called limbic system that has been linked to emotions in various ways. We're going to talk about that today. But the limbic system is just one component of the inputs to create emotions. It's not the place for emotions. You can't go in and lesion one location in the brain and eliminate emotions entirely. It just doesn't work that way. So, first of all, we have to ask: What are the circuits for emotion? What are the brain areas for emotion? Nowadays, there's a lot of debate about this. For years, it was thought that there might be circuits - meaning connections in the brain that generate the feeling of being happy, or circuits that generate the feeling of being sad, etc. That's been challenged. In fact, Lisa Feldmann Barrett has been the person who's really challenged this head on and has very good evidence for the fact that such circuits probably don't exist. And yet, I think there's good evidence for circuits in the brain - such as limbic circuits and other circuits - that shift our overall states - or our overall level of alertness or calmness - or whether or not they bias us toward viewing the outside world or paying more attention to what's going on inside our bodies. If none of this makes sense right now, I promise it will make sense soon. But the important thing to understand is that emotions do arise in

the brain and body. They arise because there are specific connections between specific areas in the brain and body.

And if we want to understand how emotions work, we have to look how emotions are built. And they are built during infancy, adolescence, and puberty. And then, it continues into adulthood. But the groundwork is laid down early in development when we are small children. So, let's think about what happens to a baby that comes into the world. A baby comes into the world. You were born into this world without really any understanding of the things around you. Now, there are two ways that you can interact with the world and you're always doing them more or less - to some degree - at the same time. Those are interoception: paying attention to what's going on inside you - what you feel internally - and exteroception: paying attention to what's going on outside you. Hold that in mind, please. Because the fact that you're both interocepting and exterocepting is true for your entire life and it sets the foundation for understanding emotions. It's absolutely critical.

As an infant, you didn't have any knowledge of what you needed. You didn't understand hunger. You didn't understand toys when you first came into the world. You didn't understand cold, or heat, or any of that. When you needed something, you experienced that as anxiety. You would feel an increase in alertness if you had to use the bathroom. You would feel an increase in alertness if you were hungry and you would vocalize. You would cry out. You would act agitated. You might coo. You might do a number of different things, but all you knew was what you were feeling internally and then, your caregiver - whoever that might have been - would respond to that. So, you would feel some agitation. A caregiver would come and make a decision, "Oh, you need food" - and give you milk - or change your diaper - or wrap you in a blanket if you were cold. But they didn't know if you were cold. They could just assume that you were cold. So, this is actually really important to understand - that a baby - when you were a baby and when I was a baby, we didn't have any sense of the outside world - except that it responded to our acts of anxiety, essentially. Now, this isn't Freudian theory, right? It's - it - there are components of it that are embedded in Freudian theory, but all developmental psychologists agree that babies lack the ability to make cognitive sense of the outside world. But in this feeling of anxiety, and registering one's own internal state, and then crying out to the outside world - either through crying, or subtle vocalizations, or even just cooing - making some noise - we start to develop a relationship with the outside world in which our internal states - our shifts in anxiety - start to drive requests and people come and respond to those requests, hopefully.

And the reason I say "hopefully" is that we've all heard, presumably, about these cases of neglect. There are a lot of cases where if you neglect a baby - you neglect an adolescent or a teenager - development doesn't go well. And we'll touch on some of those, but those are really extreme cases. They're sort of like the - parallel to experiments that are often done in the laboratory with animals - where you've probably heard of these "enriched" environments - where they'll give mice a bunch of toys, and they'll give them some different foods every once in a while, and they'll house them together with other mice. And what you find is that the animals - they will say, "Oh, their brain is thicker and their neurons have more branches to them" - and all that. But that's really comparing

deprivation with normalcy. What we want to center on today, instead, is: What happens when things go well? And why things might not go well in certain circumstances is interesting. But to me, not as interesting as what healthy emotional development looks like. And if you haven't achieved healthy emotional development, what can be done as an intervention at later times in order to rescue that?

So, the baby - you as a baby - you're flopping around there in your crib. You're getting care where you need it and when you need it, presumably. And this gets to the basis of what emotions are about - which are - emotions are really about forming bonds and being able to predict things in the world. That's really what emotions are about. Whether or not the baby feels angry, or happy, or sad - we don't know. We can guess, but we don't know. In fact, most of the time, we don't even know how we feel - let alone how other people feel. And that's true for adults. So, if I ask you how you feel right now, I don't know that you could tell me in any kind of rich language - that I would say, "Oh, I really understand." If you said you were very, very depressed or very, very happy, I'd have some sense because of how extreme that is, but I don't know that I would really know. And I don't think you know how I feel right now either. I could be furious right now or I could be very happy. You don't have any idea. Now, of course, we have these things called expressions. Our pupils dilate. There are various cues of how people feel. We're going to talk about those cues, but you really don't know.

### **Tool - Mood Meter App**

And at this point, I actually just want to pause and mention a really interesting tool that is trying to address this question of: What are emotions? And what do they consist of? That you can use if you'd like. This is an app. I didn't develop it. I don't have any relationship to them. But the app was developed by people at Yale - by groups at Yale who do research - and it's called "Mood Meter". And it's actually quite interesting. I think it's either free or it's 99 cents. Again, no business relationship to them. But what they're trying to do is put more nuance - more subtlety - on our words and our language for - for emotions and be able to allow you to predict how you're going to feel in the future. And it's actually quite interesting. I'm on the app right now - and I know you can't see this - but it's called "Mood Meter" and you can find on Apple or Android. And you go into it and ask you - it says to me, "Hi, Andrew. How are you right now?" And I click the little tab that says, "I feel..." and I can either pick: high energy and unpleasant, high energy and pleasant, low energy unpleasant, or low energy pleasant. And I would say, right now, I feel high energy/pleasant. So, I just revealed to you how I feel. So, I click on that. And then, it gives you a gallery of colors and you just move your finger to the location where you think it matches most. And as you do that, little words pop up. I know some people are looking at this on audio - or listening to this on audio only - so it'll say, "motivated, cheerful, inspired." I would say, I'm feeling, right now, cheerful." So, you click that. And then, you just go to the next window and it just says, "What are you doing?" And this feels like play to me, but I'm going to call it work. And then, that's it. And then, what it does is it basically starts to collect data on you. You're giving it information and it starts to link that to other features that you allow it access to if you'd like. And it starts helping you be able to predict how you're going to feel at different times of day. It's actually quite accurate in certain ways - quite interesting. And it points to a couple really interesting features - which is that we don't really have enough language to describe all the

emotional states. And yet, there's some core truths to what makes up an emotion. And I want to review that twice during today's podcast, because this can really help people - kids and adults - understand better what they're feeling and why - and when best to engage in certain activities - and thankfully, when best to avoid certain activities too.

### **The Architecture Of A Feeling - 3 Key Questions To Ask Yourself**

So, the way this works is the following. You need to ask yourself at any point - you could do this right now if you'd like: What's your level of autonomic arousal? Autonomic arousal is just the continuum - the range - of alert to calm. So, if you're in a panic right now, you are like 10 out of 10 on the arousal scale. If you're asleep, you're probably not comprehending what I'm saying - although, maybe a little bit. But let's say you're very drowsy, you might be at a 1 or a 2. So, you always have to ask: Where are you on the arousal scale? And then, there's this other axis - this other question - which is - what we call valence. Now, valence is of value. Do you feel good or bad? I would say I feel pretty good right now on a scale of 1 to 10, I'm like - I don't know - I feel like a 7. Got good night's sleep last night. Had a good walk with Costello this morning. I'm fed. I'm hydrated. I feel good. So, I'm like a 7. So, I'm alert and I feel pretty good. And then, there's a third thing - which is how much we are interocepting and how much we are exterocepting, alright? So, how much our attention is focused internally on what we're feeling and how much it's focused externally. And this is always going to be in a dynamic balance. So, for instance, if you're really, really stressed, oftentimes, that puts you in a position to be really in touch with what's going on in your body. If you start having a lot of somatic - a lot of bodily sensations - like your heart is beating so fast that you can't ignore it, then you're really strongly interoceptive. But also sometimes, you're really stressed because someone's stressing you out, or somebody sends you a text message, or makes a comment about a YouTube thing you posted or something and you're really triggered by it. That never happens to me. But if it does happen to you, then you're exterocepting. So, there are these three things - how alert or sleepy you are - that's one. How good or bad you feel - that's two. And then, whether or not most of your attention is directed outward or whether or not it's directed inward. And much of what we call emotions are made up by those three things.

And so, let's return now to development, but tuck that away and just - kind of - think about it. Alert versus asleep. Good versus bad. And focused internally or focused externally. Because when I looked at the whole of the - of all the theories of emotion that were out there, there were a lot of different components to them. But they all seem to center back to these same three features in some way - or to some degree or another. And it can be very powerful to understand and look at your emotions through that lens.

### **Bonds & Predictions**

So, let's return to the infant. There's the baby in the crib. It's mostly interocepting. As caregivers bring it what it needs, you hope - milk, diaper changes, etc. - a warm blanket, if it's cold - pull off the blanket when the baby's fussing and it's too warm - because babies get too warm also. It starts to intero - exterocept - excuse me - I misspoke. I want to be very clear. It starts to exterocept. The baby starts to look into the outside world and start making predictions. It starts wondering how



much it needs to cry or predicting, "Well, if I cry like a little bit, then mom comes over and I get my milk." Or, "If I cry a lot, mom doesn't come over and give me milk. So, I need to really scream at the top of my head." Okay? So, babies are starting to evaluate and do all this, but they're not doing it consciously. They're doing this strategically in order to relieve anxiety.

And I won't propose that that's what we do into adulthood. But a lot of what we do in adulthood is when we feel something, we start exterocepting. Some people are much better at just sitting as a container and just interocepting and paying attention to what they're feeling internally. But most people do a little bit of a balance of both. We start - we don't feel good, so we look for an item of food that might make us feel better. We're feeling anxious heading into the dentist or something like that, so we text somebody. We do this almost reflexively. It's not always conscious. So, infants do this and we continue to do this. We start to now balance our interoceptive and exteroceptive focus - our looking inward and looking outward.

And as we do that, we're starting to figure out what gets our needs met. Remember, emotions are really there to form bonds and to make predictions. And so, our needs are going to be met to some degree or not. Sometimes, sadly, there is neglect. Sometimes people don't show up for us the way that we would like. And in general, our - our responses to that have to do with whether or not - we predict whether or not they would or not. When we expect something and it doesn't happen, it's a big letdown. That was the discussion about dopamine last episode.

So, the many theories of emotion - the triune brain theory - that you have a primitive and evolved brain - something that's a little bit on shaky ground these days. The idea that Darwin proposed - that there are these universal expressions of emotions. The work of Helen Fisher on love - that you have circuits in the brain for lust, circuits in the brain for love, and circuits in the brain for long-term bonds. As well as the work of Lisa Feldman Barrett, saying that emotions are contextual that they have a social component. And - I'll be talking more about this - but the work of Allan Schore, a clinical psychologist and researcher at UCLA - about right-brain/left-brain and its role in emotional development. All of them have strong elements of this idea of paying attention to what's going on inward and outward.

As a young creature - an infant and young toddler - you were mainly focused inward and you started to understand what was going on outward as a way of predicting what would bring you relief - what would remove your anxiety. And that's where the fundamental rules of your experience - your emotional experience - were laid down.

### **Quick Recap**

Now I realize that's a lot of information - and it's somewhat of an academic talk - but there were two tools in there that I just want to highlight. One is the Mood Meter app. If you're interested in it - can give you some insight into the different kinds of nuance within emotions and allow you to actually predict emotional states. If you want to try that, then you might find that interesting.

The other one is this idea that there are three axes to emotion - three continuum - that interact - the level of alertness and calmness, how good or bad you feel, and whether or not you're mainly

focused inward or outward - because those are going to form a useful toolkit for the information going forward.

### **A, B, C, D Babies**

So now, let's talk about what kind of baby you were - because that actually informs your emotionality now. These are classic. They're actually famous experiments done by Bowlby and Ainsworth. Anyone that studied psychology or has taken a psychology class might have learned about this. This is this classic experiment of what was called "the strange situation task" in which - and I'm describing it very coarsely here I realize - but a mother and child come into the laboratory. Yes, this has now also been done with fathers. The baby and the mother - or father - play together for a bit and then, the mother leaves. The mother leaves for some period of time and then comes back. And the research is devoted to understanding the response of the child when the caretaker - the mother or the father - returns. Most all children - not every child, but most children - will cry when their primary caretaker leaves. They don't like that. And there are good reasons for that. They formed a bond and an attachment and we will talk about some of the deeper chemical reasons for those bonds. However, the experiment is focused on the return of the caregiver because Bowlby and Ainsworth - and many of their scientific offspring and colleagues - identified at least four patterns that babies display when their caretaker returns.

And they group these into group A, B, C, D. So much so that the kids were referred to as A babies, B babies, C babies, or D babies. You may know which one you were, but the categories are really interesting. The first babies are the A babies. So, these were kids that would get upset when their caretaker would leave. But when their caretaker would return, the infant would respond with happiness - with what looked like delight. They would go to the caretaker. They seemed happy. If they had been fussy before or sad, they felt relieved. These are referred to as secure attached kids. So, they have a healthy response to separation and they have a healthy response to reengaging with the caretaker. The B babies - as they're called - were less likely to seek comfort from their caregiver when the caregiver would return. So, they would sometimes continue to play with their toys or they would be with the - they had an adult in the room while the parent was gone. They would stay with them. It was sometimes complicated and nuanced, but these were referred to as avoidant babies. Don't run away with any conclusions about the language here just yet. It's not clear that avoidant babies become avoidant adults, but bear with me. The C babies would respond to the return of the caregiver with acts of annoyance. They seemed kind of angry. So, it wasn't that they ignored them. They seemed kind of angry. And those were referred to as ambivalent babies. Not to be confused with A babies. These are the C babies - were the ambivalent babies. So, the infant's reaction to the returning caregiver were inconsistent. They - it seemed like they wanted to bond with them again, but that they seemed kind of annoyed. I think we've all felt this way before with people that we care very much about - especially people we care very much about. And then, the third category - the D babies - were the disorganized babies. That's what they called them. They weren't disorganized in that they were messy. The child avoided interactions with everyone and acted fearful when the caregiver returned. And their behavior didn't really change whether or not the caregiver was there or not. And that fourth category was actually added rather late in the course of this research. I

should mention these experiments have been repeated with a huge variety of different contexts. There was work done by Mary Main at UC Berkeley and many others looking at all sorts of variations on this theme. But over time, it made it clear that certain babies are able to feel secure upon re-engaging with their caregiver and others don't - or they're confused about it. So, we probably don't know whether or not you were an A, a B, or a C/D baby unless you were in these experiments and somehow you had that knowledge.

### **Glue Points of Emotional Bonds - Gaze, Voice, Affect, Touch**

But, this work - this classic work - opened up a huge set of important questions that relate to: What is the re-establishment of the bond really about? I mean - what's actually being figured out here is not whether or not there are four categories of babies. That's interesting. But it, presumably, is more interesting to focus on: What is it that defines a really good bond, a secure attachment, or an insecure attachment, or an avoidant attachment? And the four things are gaze - literally eye contact - and doesn't have to be direct beaming eye contact with no blinks like people would accuse me of before. It can just be gaze that - you know - people look at each other. You see couples. They look at each other. They don't always stare at each other long periods of time. Sometimes they do. Vocalizations - so, what we say and how we say it. Affect - or emotion - so, the way that we express - you know - crying, smiling, etc. And touch - those four things. And you probably could add a fifth dimension once language and written language develops - which is written word, exchange of letters, exchange of texts, exchange of things of that sort. Emails are another way in which people can bond. But gaze, vocalization, affect, and touch are really the core of this thing that we call social bonds and emotionality.

Now, that's important. We know, for instance, that there are brain areas like the fusiform face area - which is deep in the brain - that is responsible for the processing of faces. Children's recognition of their parents' faces and voices is extremely accurate and strong. Likewise, parents' recognition of their child's vocalizations - not just voices, but cries - are remarkable. I - if you've ever had the experience of being in a party with somebody who has small children and you're talking to them and all of a sudden they hear something but you don't. It's as if they've got wolf hearing and all of a sudden they go running into the other room and, indeed - you know - the kid is like - I don't know - some kid is beating up their kid, or their kids beating up some other kid, or the kid has done - injured themselves, or feels emotionally injured. This perception of voice is - there's very good evidence to support the fact that we are tuned to the frequencies of - of voices and vocalizations of people that we care about. That's not just true in rodents, and in birds, and other mammals. It's definitely true in humans as well. And babies are very tuned-in to the sound of their - of their mother's voice. Even - yes, while they're in the womb. There's this whole world of what's called "motherese" - which is the - the particular style of speech that mothers and other caretakers - now, we know - use with children. So, those are the core elements, right? How you look at somebody and how they look at you - what you say, what they say - what they seem to be feeling and what - how that makes you feel - smiles - frowns. If you know someone really well, you can read inflections and like even little subtle things like, "They don't really believe me" - or "Oh, they're really excited by this" - or "Oh. You know, now I know what they're thinking." That kind of processing - some people are more

- better at it than others, but everyone's better at doing that with people that we recognize and know. In fact, couples come to know each other exceedingly well. So much so that it can both benefit and injure their relationship to constantly be making these perceptions. But there's a range. Some people are more tuned-in to this than others. And that probably has roots in the sorts of attachments that you form early on. So, Bowlby and colleagues developed these ABCD-thing and it has a lot to do with face processing, and gaze, and vocalizations, and touch. And all those happen on return with the mother, but they weren't parsing those. They weren't looking at them individually.

### **Interoceptive-Exteroceptive Axis**

So, this raises a really interesting question, which is: What is it when we feel something? Is it because of something that happens spontaneously in us? It's a memory or it's something that we realize, we saw on the internet, or we got news about somebody. You know - nowadays, people get so much information about the people they know - both the people they like and dislike - by way of viewing online activities. So, they're exterocepting and then, it's impacting your internal state. And it's clear from most all of the theories of emotional health that an ability to recognize when your own internal state is being driven primarily by external events as important for being able to emotionally regulate, right? People who are constantly being yanked around by the external happenings in the world, you would say are emotionally labile.

They are not in control of their emotions. Even if they're calm all the time, if that calmness only arrives because they're in a placid environment and then - you know - you put a cracker in that environment and they freak out. Well then, they're not really calm. They are - they're calm insofar as there isn't something disturbing in the environment. So, how much your - the outside environment disrupts your internal environment has everything to do with this balance of interoception and exteroception - and it very likely has roots in whether or not you were secure attached or insecure attached - disorganized or ambivalent - as a baby.

Now of course, you can't travel back in time and know, but there are some hints as to what kind of emotionality each of us has by examining two periods of development. One is adolescence and puberty and the other is adulthood. So, while we can't travel back in time, there is an exercise that you can do to address - at least in this moment - whether or not you have a bias for exteroception or a bias for interoception - whether or not you are better - at least in this moment - at paying attention to what's going on internally or externally. And of course, this will vary with circumstance. I think we all know people that - maybe it's you - you go to a party, and you get there, and everyone seems to be talking and having a really good time, and you're wondering whether or not you have any food in your teeth - or whether or not there's something on your face - or whether or not your hair is right - or whether or not you said something the wrong way - whether or not you're turning red. People also experienced this a lot with public speaking. It's not just about learning to clamp your level of stress. It's also about how much you're exterocepting - how much you're out of your head - they call it - but how much you're focused on the events around you versus the events inside you.

Actually, it's interesting. When you talk to people who are very effective athletes or they have very high-stress/high-consequence jobs, they talk about this notion of getting out of your head. You only have so much attentional resource and it can be split between two things. You'll see that in a moment. It can be anchored to one thing. It can be fully focused on what's going on internally or it can be fully focused on what's going on externally. And if you want to be effective in the world - "effective" being in quotes - it is useful when in very dynamic environments - especially social environments - to have a lot of your attention focused outward as opposed to trying to pay attention to whether or not you're saying things correctly or the timbre of your own voice. That is more or less destructive for the ability to engage socially.

### **Exercise - Controlling Interoceptive-Exteroceptive Bias**

So, here's the exercise. You can do this. Please don't do this if you're driving. But let's just try and illustrate or allow you to experience this interoceptive-exteroceptive balance and the extent to which you can move interoception and exteroception deliberately. If you close your eyes right now and concentrate on the contact of any portion of your body - with say the chair or your car seat - although, please again don't do this while you're driving - anywhere that you are - even if you're just standing up or you're in the kitchen - you're lying on the couch - and trying to bring as much of your attention to that point of contact as possible. And then from there, you're going to move your attention even more deeply into, say, the sensation of what's going on in your gut. Are you full? Are you empty? Are you hungry? Are you not? Is your heart beating? At what rate? What's the cadence of your breathing? Basically bringing your focus and attention to everything at the surface of your skin and inward. So, I'm going to do a rare thing on the Huberman Lab podcast. I'm going to introduce about 5-8 seconds of silence in order to allow you to do that a little bit.

Okay. Now, this is an exercise that you can continue afterward if you want to extend how long you do this. But now, try and do something that for most people actually is a little bit harder - which is to purely exterocept. Put your eyes, or your ears, or both on anything in your immediate space - one thing. And I would restrict that thing to something small enough that at least in your field of view, it would occupy 20% of your field of view. So, it doesn't have to be a pinpoint unless the pin is right in front of you and you're holding it real close. I would say look across the room - pick a panel on the wall, or a leg of a table, or something - and try and bring as much of your attention to that as possible. And again, I'll take about five seconds of silence to allow you to exterocept.

Okay. So, what you probably found is that you were able to do that, but that some degree of interoception is maintained. It's hard to place 100% of your attention on something externally unless it's really exciting - really novel. If you've ever watched a really great movie, presumably, you're exterocepting more than you're interocepting until something exciting happens and then you feel something. You're actually tethering your emotional experience to something external. And now, you can also do this dynamically. You can decide to focus internally and then externally. You can decide to split it 50%/50% or 70%/30%.

One can develop - you can develop a heightened ability to do this. And the power of doing that is actually that when you are in environments where you feel like you're focused too much internally and you'd like to be focused more externally, you can actually do that deliberately. But as you've noticed, it takes work. It involves taking your attentional spotlight - and what we call the aperture of your attention - and narrowing that aperture to either the self, or something externally, or splitting the two. And yet, there are practices that have been developed that center on moving interoception and exteroception from one being more heavily weighted than the other - more focused outward or more focused inward. And it's dynamic. And the circuits in the brain that underlie intero- and exteroception aren't exactly known, but they are anchored in the areas of the brain that are involved in attention - like the frontal eye fields and areas that - when you third-person yourself - when you can see yourself doing something - like if you put your hand out in your environment and you focus on your hand, you know that that's your hand as opposed to some random object. There is the brain that are involved in that and recognizing the location of self relative to the rest of your body. These exercises are really what are at the core of these development of emotional bonds because as we mentioned before, these four things: the gaze, vocalization, touch, and affect - those are happening very dynamically. So, if somebody winks at you, you're paying attention to their wink. But then, you also notice how you feel. Then they might say something. Then you might say something. This is very dynamic. So, if it seems overwhelming to try and interocept, and exterocept, and then shift the balance - you do that all the time. Your brain and nervous system are fantastic at doing this.

Now, some people have a very hard time breaking out of a very strongly interoceptive mode. Some people have a harder time breaking out of their exteroceptive mode. It's very interesting to note the - the extent to which we have biases in how interoceptive or exteroceptive we are. Remember those three axes that we talked about earlier. You have valence - good or bad, you have alertness - alert or calm, and you have interoceptive or exteroceptive bias, right? And it's going to differ across the day. It's going to differ across the lifetime. It's certainly going to differ according to whatever it is that you're engaged in. But early in development, you start off with this interoceptive bias. You are starting to develop expectations - predictions - about how the outside world is going to work - and you are trying to figure out the reliability of outside events in people. And where things are reliable - when people are reliable, we are able to give up more of our interoception. There's literally trust that our interoceptive needs - our internal needs - will be met through bonds and actions of others.

And this starts to veer toward the discussion about neglect and trauma. We are going to devote entire episodes, probably an entire month, to trauma and PTSD. But these - those have roots in what we're talking about now. And it's important to internalize and understand what we're talking about now in order to get the most out of those future conversations. So, if all of this seems like a lot of information and very complicated, I just invite you to pay attention from time to time, how much you happen to be interoceptive or exteroceptive - because emotions and the intensity of those emotions will grow or shrink depending on how much we're interocepting. If we are feeling extremely sad and there is an outside event that made us sad, chances are there's going to be a

balance, but that the extreme grief - the extreme sadness - is going to lead us to mostly interocept. Whereas when - when we're feeling extremely happy, the same is true. You know, something great happens in the world and we're just going to feel it. Most of our perception - most of our awareness is going to be on an internal state. So, we are always tethered to the outside world - to some degree or another. That was true when you were an infant, and it was true when you were an adolescent, and it's true as an adult.

### **Quick Note**

So, now I want to just pause. Just shelve the discussion about interoception/exteroception for a moment. And I want to talk about what is arguably the second most - if not equally important - aspect of your development as it relates to emotionality - and as it relates to this - what I call trust - but this ability to predict whether or not things in the outside world are reliable or not reliable in terms of their ability to help you meet your interoceptive needs. And that period is puberty. So, up until now, we've been talking mainly about psychology - not a lot of biology - not a lot of mechanism. And now, we're going to transition into talking about mechanism - hormones, receptors, etc. Puberty is an absolute biological event. It has a beginning and it has a specific definition - which is the transition into reproductive maturity. So, there are a lot of hormonal changes, yes. There are also a lot of brain changes. And most people don't realize it, but the brain changes occur first. The brain turns on the hormone systems that allow puberty to occur. Puberty is occurring earlier nowadays than it did in the past. The current numbers that I was able to find is that in females and girls, the transition is starting around age 10 - whereas in boys, it's about age 12. That's going to differ by way of a number of different factors. Those are averages. So, depends on where you are in the world - depends on all sorts of things.

### **Leptin**

One of the primary triggers for puberty is actually body fat. This is interesting. The peptide hormone leptin - some people call it a peptide - some people call it a hormone - but it meets both definitions depending on how you look at it - is made by fat. So, leptin had a lot of popularity in the '90s because it was discovered as being produced by fat. And it was seen in animal studies that it could promote leanness. It actually communicates to the brain that there's enough body fat in order to allow the metabolic factors and processes to occur to liberate more fat. This is why people have trouble losing that last five pounds. It's because leptin levels are very low. This was actually the basis for the whole cheat day - refeed thing - that the idea was if you eat a lot for one day a week while dieting hard, that you can signal to the brain that there's enough leptin. I don't know if that's the reason or whether or not the cheat days just provided some psychological relief - probably both. But in any case, leptin is made by body fat. And when there's enough leptin, it signals the brain to trigger puberty.

There was a paper published in the mid '90s in the journal *Science* - excellent journal - showing that leptin could be injected into younger females that would not have yet gone into puberty and you could accelerate the onset of puberty with leptin. So, more body fat - the earlier puberty. That's true. Leptin is also involved in various growth effects in the body, generally. And it's interesting.

Very obese children don't necessarily undergo puberty earlier. Sometimes they do, but they do tend to be larger boned. Their bones actually grow more quickly and they tend to have higher bone density because leptin is also involved in bone density.

### **Pheromonal Effects**

The whole issue of onset of puberty also has some really interesting social effects. And I want to really highlight that most of these effects are so-called pheromone effects. Remember, hormone is a substance secreted from one area of the body - travels and impacts tissues and cells elsewhere in the body. A pheromone is a chemical that's released by one member of a species that goes and acts on and impacts other members of that species or even other species. So, for instance, rodents are very good at detecting the urine - the urine and the scent markings of large carnivores that want to eat them. So, that's a pheromonal interaction.

Whether or not there are pheromonal effects in humans is very debated. I did a post on this on Instagram a little while ago about some pheromone effects that were reported in humans. And I had a couple people come at me saying, "Look, it's never really been shown in humans that there's a pheromonal..." - what's called the vomeronasal organ - there's something called Jacobson's organ. It's rudimentary. Some people have it. Some people don't. Very controversial. So, I want to point out that human pheromone effects are controversial. Although, I think there's - in my opinion, there's ample evidence for them. Synchronization of menstrual cycles for - many people report. Then, people say there's some studies that show that it's not true. Then, there have been some data showing very impressive pheromonal effects of female partners being able to detect the odor of their significant others on t-shirts that were washed several times. So, they can't consciously perceive it, but they say, "This one smells like them. This one smells like my partner." And indeed, the match was way above chance. So, there does seem to be weak pheromonal effects - at least in my opinion - when I look at the data - but much more needs to be done.

So, one of the more interesting pheromone effects that impacts puberty - at least in animal models - is the so-called Vandenberg effect - which is if you take a prepubertal female - so, a female that has not undergone sexual maturation - and you introduce a novel male that is not the father or a brother - not a sibling - she will undergo puberty almost immediately. So, this is really striking. For years, this was thought not to occur in primate species, but there was a paper published last year in Current Biology - Cell Press journal - excellent journal - showing that mandrills, a particular type of primate - they exhibit this Vandenberg effect.

There are also all sorts of other pheromone effects. There's the - the most infamous one is called the Bruce effect - where the introduction of a novel male to a pregnant female animal causes spontaneous miscarriage. And that effect seems to be protected against by the presence of the father. So, another - you know - the - these - interpretation of this - and I want to really highlight that this is - these are animal studies - but the way this works is that if a pregnant female is in the company of the male that impregnated her, then her young are protected by his scent presence or his pheromone presence. But if he's gone and a novel male shows up, there's a tendency for her to



spontaneously miscarry - and essentially, for the fetus to be lost. Now, whether or not this occurs in humans is still very controversial. But nonetheless, these pheromone effects exist. And that one is called the Bruce effect - named after Hilda Bruce - who is the scientist that discovered it.

The one that's relevant to the puberty discussion is the Vandenberg effect - which I mentioned a few minutes ago - which is a novel male showing up. It has to be a sexually competent male, so he has to have already passed through puberty. And his presence triggers activation of puberty in a female that otherwise would have remained prepubertal for longer. Again, whether or not this happens in humans - unclear.

### **Kisspeptin / GnRH / LH**

Well, what can we be sure about when we think about puberty? Puberty is triggered by a number of different factors. There are changes in GABA expression in the brain - an inhibitory transmitter. One of the more interesting molecules that triggers puberty in all individuals is something called kisspeptin - K-I-S-S-P-E-P-T-I-N - kisspeptin. Kisspeptin is made by the brain and it stimulates large amounts of a different hormone called GnRH - gonadotropin-releasing hormone - to be released. Gonadotropin-releasing hormone then causes the release of another hormone called something like - called luteinizing hormone - or LH - which travels in the bloodstream and stimulates the ovaries of females to produce estrogen and the testes of males to produce testosterone. Kisspeptin has other effects as well, but those are some of the main ones as they relate to puberty.

This is interesting because, at this point, the testes in males start churning out tons of testosterone in order to trigger the development of secondary sexual characteristics - body hair and all the others - deepening of voice, etc. And in females, estrogen is doing various other things - breast development, etc. Normally, in an adult, somebody who has passed puberty, a big increase in gonadotropin-releasing hormone and luteinizing hormone would eventually be shut down because the way that the brain works - the hypothalamus and the pituitary are actually measuring how much hormone is in the blood and if testosterone, or estrogen, or any other hormone goes too high, they shut down the release of things like luteinizing hormone. It's a way - called a negative feedback loop. It basically is like a thermostat in a house. It's more complicated than that, but once levels get too high in the bloodstream, it shuts down. But kisspeptin is able to drive very high levels of these hormones in an ongoing way so that puberty can commence and can continue. And incidentally, kisspeptin has now become yet another of the panoply of - of hormones, and peptides, and cocktails that athletes take in order to try and stimulate natural hormone production - essentially to create their own performance-enhancing drugs endogenously. No judgment there, but that's a fact. There's a lot of kisspeptin use. People - I'm not - I'm truly not suggesting anyone do this. But people are buying and injecting kisspeptin for the specific reason that even past puberty, can stimulate the large increases in things like estrogen - large increases in testosterone and things of that sort.

It has a number of psychological effects too - seems to have big effects on libido, etc. All these things, of course, are subject to feedback loops. So, they don't work indefinitely. And I'm going to

highlight - again, I'm not suggesting anyone do it. But I do like to pay attention to what's out there. And kisspeptin - because it wasn't discovered that long ago - is one of the things that you don't often hear about when people talk about performance-enhancing drugs or therapeutic endocrinology. These things also have therapeutic uses in the endocrine setting. So for instance, kids that don't undergo puberty or kids that are hypogonadal or adults that are hypogonadal - they're not making enough hormone - will take things like kisspeptin among other things. So, that's how puberty happens at the biological level - gets triggered by leptin and kisspeptin - and then, this young child is now a different creature to some - to some extent. Not just because they're reproductively competent, of course, but because there's a shift in a number of the things that underlie these social bonds. There are - there's a marked shift in a number of the things that allow children and adults to engage in predictive behavior about each other. And the whole nature of adolescence and puberty is to take a - a child that was a generalist and to make them a specialist. And this is very important as it relates to the conversation about emotionality. But it's important in terms of all aspects of brain function, and in terms of learning, and in terms of who each and every one of us will and has become.

### **Puberty & Adolescence**

In adolescence and in childhood - sure, there are some genetic biases - you know - hair color, eye color, height, and things like that - a lot of that's programmed into the genome. There are other genetic biases too, of course - that we inherit. But it's in adolescence and puberty that we go from, essentially, being somewhat good at a bunch of things or somewhat poor at a bunch of things to becoming very good at a few things and very poor at a lot of other things. And that's because of the relationship to puberty and neuroplasticity. This ability to change the brain in response to experiences starting to taper off such that by our early 20s, it's harder to achieve. Now, the transition from generalist to specialist is one aspect of adolescence and puberty, but the other is the formation of social and emotional bonds.

And most of what consumes the minds and waking hours of adolescence and children who have gone through puberty and going through puberty is questions about how they relate to social structures, who they can rely on, and how they can make reliable predictions in the world now that they have more agency - that they are physically changed. In fact, you could argue that puberty is the fastest rate of maturation that you'll go through at any point in your life. It's the largest change that you'll go through at any point in your life in terms of who you are because your biology has fundamentally changed at the level of your brain and your bodily organs - all your organs - from the skin inward.

So, I want to visit a little bit of the research about some of the core needs that occur during puberty and adolescence - not just for parents or for the people that might be in puberty and adolescence, but also so that people can reflect on which of the sort of boxes were checked off for them as they approached emotional maturity. So, there's a terrific review article that was published in the journal *Nature*, which is - if not the premier, then certainly among the top-three premier journals in the field of science - about the biology of adolescence and puberty - as well as some of the core needs

and demands that have to be met for successful emotional maturation during that time. We'll - we will provide a link to that, but I just want to highlight a few of the things that they place in the final table. I don't want to go through all the results right now because you could do that on your own if you'd like. They mainly highlight a lot of the changes in neurons and neural circuits. For instance, I'll just highlight one. There's a connection between the dopamine centers in the brain and an area of the brain that's involved in emotion and dispersal. Dispersal is very interesting. What you observe in animals and humans is that around the end of adolescence and during the transition to puberty - both because of changes in the brain and changes in hormones - there's an intense desire on the part of the child to get further and further away from primary caregivers. Not permanently, they always return - similar to a child that walks off, and then looks back and sees everything's safe, and then continues on. During adolescence and puberty, both in animals and in kids, there is - it almost seems like there's a bias for action and the action is always in the direction away from the primary caregiver. Now, as soon as I say that, I can just imagine in my mind that somebody out there is saying, "Well, no. My kid - as soon as they hit puberty, they just wanted to stay home with us all the time." That's not typical. It happens, but it's not typical. Mostly, there's a desire to start spending more time with friends, more time with peers, and less time with adults. And I find it extremely interesting to note that that's not just true in humans. That's true in other primate species. That's true in rodents. That's true in almost every other mammalian species. So, there's something about these hormones that don't just allow sexual reproduction. They don't just change the brain, and bodily organs, and the shape of - of us. They also bias us towards dispersal - getting further and further away from primary caregivers, in particular. So, parents of teenagers or future teenagers, it is not just normal. It is baked in to the biology of humans to disperse around adolescence and in the teen years.

So again, I just want to highlight a few of these - what were listed as intervention strategies to promote healthy adolescence and puberty. And it's very interesting because the entire article - and I should mention, who wrote this article - apologies. One of them is a friend of mine. The first author is Ronald Dahl - not the children's book author I'm assuming. No, from the School of Public Health at University of California, Berkeley. And Nicholas Allen, Linda Wilbrecht, and Ahna Ballonoff Suleiman - forgive me for the pronunciation of the last one. I know Dr. Wilbrecht quite well. She's done the work on dispersal - is quite well known for that work. And it's a very extensive review, but I think you can find it - you'll find it accessible. A lot of changes and thickness of the brain at different stages, etc. But I think most people will be interested in what that translates to in the - in the real world. And what's interesting is during puberty, there's increased connection - connectivity, as we call it - between the prefrontal cortex, which is involved in motivation and decision-making - being able to suppress action for making long-term goals possible - as well as dopamine centers and the amygdala. So, there's this really broad integration and testing. I think this is the key element here - testing of circuits for emotions and reward as they relate to decisions. And I think that's useful because when you look at the behavior of adolescents and teens, they are testing social interactions. They are testing physical interactions with the world. Oftentimes, they're engaging in unsafe behavior and you can't justify - I would never try and justify that with the underlying neurology, but the neuroscience points to increased connectivity between areas of the brain that

are related to emotionality and to threat detection - like the amygdala - but also reward. So, it's a time of testing behaviorally - how different behaviors lead to success or not. It's how different behaviors lead to fear states or not. Now, of course, you could say that of any stage of development, but it seems like puberty is a very, very heightened stage in which testing of contingencies - good or bad - is taking place. And of course, this is happening - it's operating in a body that's now more capable than the infant. So, an infant can hurt - can damage themselves through error, but it's harder for them to damage themselves through deliberate planning, you know? That's why it's important, of course, to lock up all the medications in the house. Make sure infants can't get to them. But it's not likely that the infant is going to devise an extremely diabolical plan to get into the cabinet to get a certain substance - whereas a teenager might, right? So, you can start to map the neurology onto some of this emotional exploration. I do realize that this episode is about emotions. Puberty is a time in which the internal state of the person or the animal is being sampled and tested against different exteroceptive events. Only now, they are able to guide those events with more agency. It's no longer just about whether or not the caregiver is bringing you milk or bringing you food. Now, of course, the parents will all say, "Yeah, but I'm paying for everything that they're doing. I'm paying for the car and I'm paying for the food." Ah, true. But the biology doesn't care about the source. The child or the adolescent is now able - the teen, really - is able to now sample many, many more exteroceptive events through behavior.

So, some of these recommendations are interesting. The theory is that one of the motivations is to learn to mitigate the risk of famine and malnutrition. As teenagers get older, they start questioning whether or not their parents are everything they thought they were - whether or not they're the greatest thing that ever was - or the worst thing that ever was, perhaps. - including, whether or not they will be able to provide them resources. So, they test whether or not they can actually feed themselves - whether or not they can support themselves. Although rarely - not - certainly it happens, but rarely are they really taking care of themselves - although, some teens are forced to take care of themselves, of course - because parents and other caretakers aren't available. The recommendations that map to the biology include later - there's been a big push for later start times in schools to match their shifts in circadian rhythms and the need for extended sleep - something we talked about during the sleep episodes - to insist on sleep interventions for youth who are at increased risk for mental health problems. Almost every mental health issue is supported by getting regular quality sleep of sufficient duration. Sufficient duration is going to vary from person to person. Leveraging different kinds of social relationships that reinforce positive behavior. This is starting to sound like - kind of a - boilerplate stuff. And yet, really the goal is, during puberty, to encourage as many safe forms of interaction that allow children - teens, really - and adolescents - I keep calling them children, but what I mean are people - children going through puberty - that allow them to test this thing of autonomy so that they can start to make good assessments about their exteroceptive events that they are selecting and how those make them feel internally. So, they're essentially doing a buffet. The buffet has now broadened to not just include the events and experiences that their parents and other caretakers bring them, but they can now expand the buffet into things that they can provide themselves.

And so, adolescents and puberty is really seen as the period of development in which one's self-samples for these two elements that we talked about at the beginning - which are: How do I form bonds? And how do I make predictions about what will make me feel good at a level of interoception? Some of that might sound a little transactional - you know - that all we're trying to do is figure out how we can bond with people so we can get what we need so we can feel how we need. I think that's true to some extent. Of course, there's a richer, more abstract aspect to relationships too - which are - you know - in relationships you can access things you couldn't do before. You can cooperate. There's things like teamwork. You can do all sorts of things. But in terms of the biology, it's clear that there's this stage of development where more autonomy - more physical capability - is triggered by these hormone changes in the brain and these peptide changes in the brain and body. And that, nonetheless, brings us back to the exact same model that we started with an infancy of alert or calm - feel good or feel bad. - primarily exterocepting - primarily interocepting. So, I keep going back to this. I'm sort of like a repeating record on that because the same core algorithm - the same core function - is at play throughout the lifespan. And that's a useful framework, in my opinion, because it allows you to sort through all the data and information that's out there about, "Well, this area - the stria terminalis is active..." - or "The basolateral amygdala is active..." - or "Gray matter thickening..." - or "This hormone..." - or "That hormone..." - and return to a kind of kernel of - certainly not exhaustive truth - it doesn't cover all aspects of emotionality - but at least establishes some groundwork from which you can start to evaluate how different behaviors might or might not make sense - how certain emotional responses might or might not make sense - regardless of the age of the person or the organism.

### **Right-Brain / Left-Brain**

A discussion about emotions would not be complete without talking about the right-brain/left-brain stuff. And this is a very interesting aspect of sociology, psychology, and neuroscience. There's a theory of emotional development that I find particularly interesting - which is from Allan Schore at UCLA - that talks about how most of our testing of bonds and relationships is the seesawing back and forth between very dopaminergic - so, driven by dopamine - or serotonergic - or driven by serotonin states. And this starts with infant and mother or infant and father. I talked a little bit about this in the previous episode, but just to remind you - or for anyone that didn't hear about it - that during development, healthy emotional development clearly begins with an ability for the caretaker and child to be in calm, peaceful, soothing, touch-oriented, eye-gazing type of behaviors. Those really drive serotonin, the endogenous opioid system, oxytocin - things that are very calming and are centered around pleasure with the here and now - as well as excited states of what we're going to do next. There's actually a - kind of - characteristic sign of the dopaminergic interaction where both caretaker and child have our wide-eyed. The pupils dilate. That's a signature of arousal. They get really excited. Oftentimes, the baby will look away if it gets really excited. That - those are signatures of dopamine release in the body. And in adolescence, these same things carry forward - where their good bonds are achieved through hanging around - watching TV - just - kind of - playing video games, or texting together, or talking - whatever it is that the soothing local activity happens to be - as well as adventure and things that are exciting. So, it could be sports. It could be shopping. It could be a summer adventure. It could be the next big

thing. And so, this kind of seesawing back and forth between their different reward systems seems to be the basis from which healthy emotional bonds are created. And I invite anyone who's interested in this to look up some of Dr. Shores' work. I think I misspoke on the last episode. He's not a psychiatrist. He's a clinical psychologist and psychoanalyst, but has deep rootings in neuroscience. So, it's - I think - a fascinating aspect. But the way it's framed in that book, and in his book, and in some of the language around that - is around the right-brain/left-brain. And we've all heard this stuff before - that the right-brain is thought to be the emotional side. This is the characteristic thing that you hear out there. That the right-brain is holistic - that it's emotive. And that the left-brain is logical, sequential, and analytic. And that's not what Shore was proposing. There are some right-brain/left-brain differences. But the idea that the right-brain is synthetic, holistic, and emotive and that the left-brain is logical, sequential, and analytic is false. There is zero neuroscience evidence for that whatsoever. We're going to address this in more detail during a month talking about learning, and memory, and dementia.

### **Language / Math**

But let's talk about some truths - some differences - between the left-brain and right-brain because we can't have a discussion about emotion without doing that. The left-brain - at least for people who are right-handed - is linguistically dominant - meaning most of language is centered in the left side of the brain for right-handed people. If you were a left-hander and you were forced to become right-handed, chances are this is still true because of when language gets laid down in the brain. For left-handers - people that naturally write with their left hand and always did - language is still mostly in the left side of the brain, but it's also found more often in the right side of the brain. So, it's not as lateralized as we say. It's kind of distributed between both. So right-handers, most of your language is coming from the left side of your brain. Left-handers, it's probably a little bit more evenly distributed. And there are some variations - whether or not you're a hook-righty or a hook-lefty. There's all sorts of nuance to this, but that's the general aspect. So, language tends to be centered in the left side of the brain. And that includes lexicon, grammar, syntax - all of it. Except for one - and we'll talk about one aspect of language that seems to be more right-brain - that's very interesting. There does seem to be some arithmetic advantage. So, ability in math - in the left side of the brain. And I'm going to talk about how all this was discovered in a minute.

### **Prosody**

And the right-brain, however, is linguistically primitive. Most people don't realize this because the right-brain is always described as the emotive side. It's super emotional and holistic, but it's actually linguistically primitive. And there's a way that that's been teased out through experiment. It's very good at manipulating spatial things and visual-spatial tasks. It's primarily handling that stuff. But it's sort of non-language - except one aspect. And there isn't a ton of evidence for this, but the evidence is strong - which is prosody. Prosody is the lilting and falling of language. So, a good example would be Italian. I don't speak Italian. I only know a little bit of Italian. But most of the Italian I know is when my Italian colleagues have said to me, "Ma cosa dici?" - which means like, "What are you trying to say?" or "What are you saying?" I probably - you know - I think I'm getting that right. Basically, they're saying I don't speak Italian - which is true. Or, because one of them

knows and loves Costello very much, they always say "un pigrone" which means "big lazy guy" - which accurately captures Costello. So, even those few examples, right? "Ma cosa dici? Un pigrone!" There's a lot of lilt and fall in Italian. Other languages not so much and it varies by language. One of the reasons I find Italian so beautiful - not the Italian I speak, but the Italian that other people speak - so beautiful to listen to is that - that prosody and the - the shifts in intonation are really quite remarkable. It's almost like a sing-song - listening to the - to them speak. And I used to like to go to scientific meetings and I'd always hang out with the Italians because I have some good friends in Italian labs, but also because they always knew where the best food was. Their standards for food are incredible. They would rather starve than eat terrible pasta and the pasta they do find and that they're willing to eat, is always fantastic. But in addition to that, they always brought a guitar. They were a lot more fun than a lot of my other colleagues to hang out with at meetings.

### **Spatial Information**

So in any event, the right-brain is doing things that are more about manipulating spatial information. And I'll talk about this more in a future episode, but I - this was discovered in split-brain patients - so, people that lack connection between the two sides of the brain. And this had to be teased out through very complicated experiments - people like Roger Sperry - who won a Nobel Prize for this - who was at Caltech - Mike Gazzaniga and others - figured out these lateralized differences. But let's just try and demolish the myth that - you know - the right-side is synthetic, and holistic, and emotive and that the left-side is logical, sequential, and analytic - that you're a "left-brain person" or a "right-brain person". Nothing could be further from the truth. There's no scientific evidence to support that. And there's a few lesion studies that can tease out effects that make you think that's what's happening, but the really careful work points in a totally different direction.

### **Oxytocin**

We can't have a complete conversation about emotions, and bonds, and social connection without talking about oxytocin. Oxytocin has come to such prominence in the last decade or so and seems to be everywhere anytime you hear a discussion about neuroscience and the brain or hormones and the brain. Oxytocin is released in response to lactation in females. It is released in response to sexual interactions. It is released in response to nonsexual touch. It's released in males and females. And indeed, it's involved in pair bonding and the establishment of social bonds in general. How it does that seems to be by matching internal state. It seems to both increase synchrony of internal state somehow. Maybe it sets a level of calmness or alertness - that seems like a reasonable hypothesis - as well as raising people's awareness for the emotional state of their partner. And again, this brings us back to this alertness-calmness axis and this interoceptive-exteroceptive axis. In order to form good bonds, we can't just be thinking about how we feel. We also need to be paying attention to how others feel. And we're evaluating a match. We're trying to see whether or not there seems to be some sort of synchrony between states. And oxytocin both seems to increase that synchrony and increase the awareness for the emotional state of others.

## **Mirror Neurons**

Now, I know many of you are probably screaming, "Mirror neurons! Mirror neurons! Mirror neurons!" As some of you may know - and some of you, perhaps, may not - are neurons that were discovered in animals and humans for their ability to respond when people engage in certain physical actions like lifting of a pen. But the same neurons would respond when somebody watched someone else lift a pen. So, they were really mirrors of - or representing - mirrors of behavior - both in self and in others. Mirror neurons are very controversial. There are many neuroscientists - who I respect a lot - who don't think they exist because they look at the data. And the data - at least in their mind - were overinterpreted in the realm of empathy and in assigning value to the emotional states of others. And when I look at the literature, my opinion is that, indeed, there are neurons in the brain that clearly represent the actions of others, but it's not clear that they're wired into the emotion and empathy system in any direct way. And I think the growing consensus is that mirror neurons - while the name is terrific - is - and it's so catchy and encompasses so much of what you would love for it to encompass - but that the data don't really support that. But this is controversial and I'm perfectly happy to get experts on here that could debate it better than I could.

## **Prediction Neurons**

There are, however, neurons in the brain - that were discovered by my colleague Keren Haroush at Stanford when she was working in Nomsiv's lab - that clearly point to the fact that primate species are making assumptions and are trying to predict the behavior of other members of their species. It's an experiment I don't have time to go into in real detail. We should probably just get Keren on here. For those of you that are familiar with the prisoner's dilemma - which is really a - a model of cooperation. You can either cooperate or one can - one member of a given interaction can cooperate and the other one won't - or you can - you can both not cooperate. There are ways in which you can solve this so-called prisoner's dilemma by looking at previous behavior and making predictions about the likely next behavior that the other individual will engage in. And there do seem to be neurons that are doing these sorts of predictions or computations. And I - again, I'll go into this in more detail in the future. So, rather than think about mirror neurons like neurons for empathy, I think it's more correct to think about neurons that are trying to predict the behavior of others. And that's - as we said - one of the core features of emotions - which are to - to establish bonds - and through those bonds, to be able to predict behavior.

## **Tool - Intranasal Oxytocin**

So, oxytocin is one component of this ability to predict others' behavior and to guide our own behavior. So, here's some experiments that involve the administration of intranasal oxytocin. This is actually - people - now, I think you need a prescription - although, in some places you don't. There are people who are taking intranasal oxytocin in order to try and increase the depth of bonding. And I don't recommend you do that. I've never tried that. Whatever oxytocin I've released, I've made without an intranasal exogenous application. But what's been reported is increased positive communication among couples. So, people have taken intranasal oxytocin in studies. So, that study - just - if you - for those of you who'd like, was published in *Biological Psychiatry* - which my psychiatry colleagues tell me is a fine journal. And the title is "Intranasal oxytocin increases positive



communication and reduces cortisol levels during couple conflict". They have them fight or they have them fight without - with and without oxytocin. So, interesting - very much in line with the idea that oxytocin is the quote unquote "trust hormone". That's in keeping with that. That was a 2009 paper.

There's other evidence, for instance, that men report a greater sense of connection and intimacy with their partners during sex after taking intranasal oxytocin. There are studies in autistic children giving them intranasal oxytocin as a way to try and help them establish better social connection and quote unquote "empathy" or theory of mind. I've talked about theory of mind before - or understanding of what other children and adults are experiencing. So, you know - oxytocin does seem to create these general effects. And how nuanced they are in one situation or another, I don't know.

I - I'm aware and I was told - and I'm definitely not recommending this - that there's a marketed oxytocin/ketamine nasal spray. Now, I have no idea - maybe someone can put in the comments - why you'd want to combine oxytocin and ketamine. I can't imagine why. Ketamine is a dissociative anesthetic that's used for the treatment of PTSD. It used to be used as a recreational drug. It's - it's - it's very similar to PCP. It seems quite dangerous, in fact. I don't know why those two things would be combined - why one would want to combine them. But there are products out there that seem to combine those two things. And I - and I'm not certain why one would do that, but it's interesting to note that it's happening.

A particularly interesting study about oxytocin is that - that was published in the journal Neuroscience - which is a good journal - that oxytocin modulates social distance between males and females. So, this is interesting. What they did is they gave oxytocin to people that were in monogamous relationships. And then, they evaluated the extent to which the - in this case, the males in those relationships - would pay attention to - visual attention to - attractive - other potential partners. And it seemed like - the general takeaway from the study is that oxytocin administration seemed to promote monogamous behavior. So, behavior that was in line with monogamy of the relationship that they were in - as opposed to foraging for potentially new mates. Now, of course, these are somewhat artificial experiments - or very artificial experiments - depending on how you interpret them. But the general theme is that oxytocin is promoting monogamy. It's promoting pair bonding. It's promoting an understanding of the internal state of others - which requires enhanced exteroception for those particular others. So, not just generally having them look everywhere and see what's going on in the world, but particularly paying attention to the emotional states of others.

### **Tool - Vitamin D & Melatonin**

I'm sure several of you will be asking, "Well, what can I do to increase oxytocin?" - if that's your goal. There's some evidence and I invite you, again, to go to [examine.com](http://examine.com) or another such site - like PubMed - if you want to forage PubMed - that vitamin D is required for proper production and in some cases, can increase levels of oxytocin when supplemented - which is interesting. And that -

believe it or not - melatonin - our old friend melatonin - which I have pushed back against as a supplement for sleep because of some of the - what I view as untoward side effects of melatonin in most cases. But it seems like melatonin in some cases can - can prime the system for slightly increased oxytocin release. There's even one report - although, it didn't look that strong to me - that low doses of caffeine could increase oxytocin release. But that, to me, falls under the category of what was once described as: "A drug when injected into a person or animal is always effective at producing a scientific paper" - meaning that you can get a result, but the result isn't always so robust. So, you always want to read past the titles, and the abstracts, and get into the meat of the paper. And when I did that, the effects were pretty negligible with caffeine on oxytocin, but it's interesting that vitamin D and melatonin may have some positive effects on oxytocin release. But like I said, many people are just taking oxytocin directly through these intranasal sprays. I'm pretty sure it's prescription in most places, but check. And again, I'm not recommending anybody do that. I've never tried it. I don't know that I will. I think I'm going to stick with the oxytocin that I've got.

### **Vasopressin**

The other molecule that we make that's extremely important for social bonds and emotionality is one that we're going to talk about more in the month on hormones - but that's vasopressin. Vasopressin suppresses urination. It was actually developed - it's made by the body, but it's - it was developed as a treatment for something called diabetes insipidus - where people urinate excessively - and they actually risk dehydration, and they can lose a lot of electrolytes, etc. So, it causes water retention. Alcohol consumption inhibits vasopressin. So, large amounts of alcohol may people excrete a lot of fluid and so forth. Vasopressin has effects on the brain directly. It actually creates feelings of giddy love. It also increases memory in very potent ways. There's a whole biohacking community that has been dabbling with vasopressin for some time. I have never tried it. I certainly don't recommend it. It is prescription and it is a pretty serious compound to start - you know - messing with - because it has so many different effects in the body. It's - it's interesting because it creates the sense of giddy love. It's - it's also used somewhat as an aphrodisiac. So, it's similar to oxytocin. It also has very interesting effects on monogamous or non-monogamous behavior. This, again, we will revisit in the future.

### **Prairie Vole Experiments**

But there's a beautiful set of experiments that have been done in a little rodent species called a prairie vole. It turns out there are two different populations of prairie vole. Some are monogamous. They always mate with the same other prairie vole. And some are very robustly non-monogamous. They mate with as many other prairie voles as they can. And turns out that levels of vasopressin and/or vasopressin receptor dictate whether or not they're monogamous or not. And there's actually some interesting evidence in humans - when you - when people report their behavior - assuming they're reporting accurately - that vasopressin and vasopressin levels can relate to monogamy or non-monogamy in humans as well. We're going to talk about this in the month on hormones.

## Vagus Nerve

If we're talking about the neuroscience of emotions, we have to talk about the vagus nerve. I described what the vagus nerve is in a previous episode - that it's these connections between the body and the viscera - including the gut, the heart, the lungs, and the immune system, and the brain. And that the brain is also controlling these organs, so it's a two-way street. There's this big myth out there that I mentioned before that "stimulating the vagus" in various ways leads to calmness - that it's always going to calm you down. And that is false. I just want to repeat. That is completely false.

In fact, there was just a paper - yet another paper - published the other day - which is fantastic - which is from David McCormick's lab up at the University of Oregon. It's published in *Current Biology* - excellent journal - showing - I'm just reading the title, "Vagus nerve stimulation induces widespread cortical and behavioral activation". I've read the paper. It's fantastic. It illustrates, yet again, stimulation of the vagus increases dopamine release - increases activation of the brain alertness. It is a stimulant of alertness. It is not calming people down.

Now, this is interesting, in light of emotionality, because of work that's been done by many groups. But in particular, I'm going to focus on the work of a colleague of mine - Karl Deisseroth at Stanford - who's a psychiatrist - but has also developed a lot of tools to adjust the activity of neurons in real-time using light and electrical stimulation, and so forth. I'll refer you to an article in *The New Yorker* that was published about this a few years ago. I'm going to read a brief excerpt. I'll put the link in the caption as well. He's talking to an extremely depressed - suicidally depressed - patient who has a small device implanted that allows her to adjust her vagus nerve activity. Now, vagus stimulation was originally developed for the treatment of epilepsy. It's now being used for various other purposes. Vagus stimulation can even increase plasticity it seems. So again, increasing activity of the vagus increases alertness. And it's just incredible to see what happens in real-time to emotionality when the vagus is stimulated. Again, not calming, but activating alertness. They're in his office and they're talking and he asks her how she's doing and she describes how she's been doing as - previously as, "going pancake" - which, for her, just means totally laid out flat - not much going on. She talks about how she doesn't want to pursue a job. She's really depressed. And he says, in typical good psychiatrist fashion, "Well, that's a lot to think about." That's actually the quote. And they talk about her blood pressure, etc. And then, she says, "You know, mood's been down - just spiraling down" - talks about insomnia, bad dreams, low appetite. So, this is severe depression. This is what we call major depression. And then, she requests, "Can we please go up to 1.5 on vagus stimulation?" She'd been receiving 1.2 milliamps of stimulation every 5 minutes to 30 seconds, but was no longer able to feel the effects. So he says, "Okay, I think we can go up a little. You're tolerating things well." They start the stimulation and quote, "In the course of the next few minutes..." - her name was Sally - "...underwent a remarkable change. Her frown disappeared. She became cheerful describing the pleasure she had had during the Christmas holiday and recounting how she'd recently watched some YouTube videos of Deisseroth. She was still smiling and talking when the session ended and they walked out to the reception area." So, this is just by stimulating and activating the vagus.

Now, why am I bringing this up? Well, for several reasons. One is the vagus is fascinating in terms of the brain-body connection. Two, I'd like to keep trying to dispel the myth that vagus stimulation is all about being calm. It's really about being alert. I don't know how that originally got going backwards, but it's about being alert. And once again, level of alertness or level of calmness is impacting emotion. That this axis of alertness and calmness is one primary axis in emotion. It's not the only one because there's also this valence component of good or bad. And it's certainly - those two aren't the only ones because there's also this component of interoceptive-exteroceptive that we talked about earlier. And there will be others too. Again, it's not exhaustive. But I find it fascinating and it really brings us back to where we started - which is: What are the core elements of emotion? And what can you do about them?

### **Quick Recap**

And before we close up today, I just want to make sure that - even though I've mentioned some tools. I talked about the Mood Meter app. I talked about oxytocin and some of the things that impact oxytocin. I talked about some of the ways that you can conceptualize emotions. This business of how you conceptualize emotions is really the most powerful tool you can ever have in terms of understanding and regulating your emotional state - if you're willing to try and wrap your head around it, I realize it's not the simplest thing to do. But rather than think of emotions as just these labels - happy, sad, awe, depressed - thinking them - thinking about emotions - excuse me - as elements of the brain and body that encompass levels of alertness - that include a dynamic with the outside world and your perception of your internal state - and starting to really think about emotions in a structured way - can not only allow you to understand some of the pathology of when - you know - you might feel depressed or anxious - or others are depressed and anxious. But also, to develop a richer emotional experience to anything. Now, of course, I don't expect that as you're out there interacting with friends, and you're watching TV, and experiencing life that you should be parsing every bit of your experience in some sort of reductionist and mechanistic way. That's not the goal here. But for those of you that are practitioners - teachers of any kind - for those of you that are kids - for those of you that are trying to understand what your emotional life and your consciousness - dare I say the word - really consists of - I do believe that these are fundamental elements that are well-supported by the science across a variety of researchers doing things from a variety of different perspectives - and some of whom agree with one another and some of whom don't. So, I offer it to you as a source of knowledge from which you can start to think about your emotional life differently, I hope - as well as others - in a way that builds more richness into that experience, not that detracts from it.

### **Psychedelic Therapies - Psilocybin & MDMA**

One last point as it relates to that. Many of you have asked me about psychedelic therapies that are now emerging - things like psilocybin and MDMA. We are, of course, going to dive into that topic deeply. We have an expert guest coming on to discuss that topic. Those compounds clearly affect the aspects of emotionality that we were talking about today: calmness, alertness - valence, good or bad - interoceptive/exteroceptive positioning. And so, rather than just do a - kind of - cursory exploration of those compounds and what the therapeutic and scientific community is thinking

about them and how they function, I think it's more important to embed that framework in our thinking so that when we address psychedelics and we address other sorts of therapies - cognitive behavioral therapy - different types of emotive therapies that relate to individuals and couples, etc. - that we are able to think about them with some sort of structure and rigor rather than just talk about them as a bunch of chemicals that produce these amazing experiences that people need to tell you about. Because if there's one truth, it seems that psychedelics seem to promote activity of storytelling about psychedelic experience. But that itself is not really what the therapeutic community and the academic communities are interested in. They're interested in trying to understand the universal truths - the universal biological shifts and psychological shifts that occur in the clinical use of those compounds. And so, we're going to hold off for now, but we will get to them.

## **Conclusion**

Once again, we've covered an enormous amount of material today. It's really the equivalent of two - if not three - university lectures in one podcast episode. I want to thank those of you that have supported the podcast and point to ways in which all of you can support the podcast. Many of these are cost-free. The first is to please subscribe on YouTube and as well, to hit the notifications button so that when we release new videos - which typically is every Monday for the full-length episodes - but we also now have short clips - that you'll be notified. As well, if you could subscribe on Apple and Spotify and leave us a review on Apple. You have the opportunity to leave us a five-star review if you think we deserve a five-star review. Please tell your friends, and family, and coworkers about the podcast if you think the material would be of interest and informative for them. And if you want to send them links, that's terrific too. We also have a Patreon account. It's [patreon.com/andrewhuberman](https://patreon.com/andrewhuberman) and there you can support us at any level that you like. In addition, if you could check out our sponsors. We always provide links to those sponsors in the captions. That's the best way to support the podcast. And several of you have asked about supplements. I talk about supplements in various episodes. We've partnered with Thorne because we think Thorne has the very highest levels of stringency in terms of the purity of the contents and the amounts of the contents. They really put in the bottle what's listed on the bottle - which is not true for a lot of supplement companies. If you want to see the supplements that I take - as well as get a discount on those or any of the other supplements that Thorne makes - you can go to [thorne.com/u/huberman](https://thorne.com/u/huberman) and you can get 20% off any of those supplements or any of the other supplements that Thorne makes. So, that's Thorne - [T-H-O-R-N-E.com/u/huberman](https://thorne.com/u/huberman) - to get 20% off any supplements that Thorne makes. And last but certainly not least, I want to thank you for your time and attention. And thank you for your interest in science.