

The Science of Love, Desire and Attachment | Huberman Lab Podcast #59

In this episode, I discuss the psychology and biology of desire, love and attachment. I explain how childhood attachment types are thought to inform adult attachment styles to romantic partners, and I describe some of the major theories of human mate selection, relationships and infidelity. Additionally, I explore the neurobiology and proposed subconscious processing underlying desire, love and attachment, including the roles of empathy and “positive delusion.” I outline how self-awareness can shift one’s relationship attachment style towards securely bonded partnerships. Finally, I describe specific tools and supplements that have been researched to increase libido and sex drive. Throughout the episode, I explain the science and key mechanisms underlying romantic love and outline tools for those seeking to find a strong, healthy relationship, or for those wanting to strengthen an existing relationship.

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- Welcome to the Huberman Lab Podcast, where we discuss science and science-based tools for everyday life. I'm Andrew Huberman, and I'm a professor of neurobiology and

ophthalmology at Stanford School of Medicine. Today, we are going to talk about the psychology and the biology of desire, love and attachment. Today happens to be Valentine's day, 2022. However, the themes we are going to discuss pertain to desire, love and attachment on any given day. And indeed the mechanisms we are going to discuss almost certainly were at play thousands of years ago, hundreds of years ago, and no doubt will still be at play in our minds, and in our bodies, and in our psychologies for the decades, centuries and thousands of years to come. Indeed today, I want to focus on core mechanisms that lead individuals to seek out other individuals with whom to mate with, with whom to have children with or not, with whom to enter short or long-term relationships with, and for perhaps to end those relationships or to seek relationships on the side, so-called infidelity. I'm certainly not going to encourage or discourage any of these behaviors. I'm simply going to cover the peer-reviewed scientific data on all these aspects of desire, love, and attachment. I'm going to discuss how our childhood attachment styles, as they're called, influence our adult attachment styles. Yes, you heard that right. How we attached or did not attach to primary caregivers in our childhood has much to do with how we attach or fail to attach to romantic partners as adults, because the same neural circuits, the neurons and their connections in the brain and body that underlie attachment between infant and caregiver, between toddler and parent or other caregiver, and during adolescence and in our teenage years are repurposed for adult romantic attachments. I know that might be a little eerie to think about, but indeed that is true. Now the fortunate thing is that regardless of our childhood attachment styles and experiences, the neural circuits for desire, love and attachment are quite plastic. They are amenable to change in response to both what we think and what we feel as well as what we do. However, all three aspects that we're discussing today, desire, love and attachment are also strongly biologically driven. We're going to talk about biological mechanisms such as hormones, biological mechanisms such as neurochemicals, things like dopamine, oxytocin and serotonin, and neural circuits, brain areas, and indeed areas of the body that interact with the brain that control whether or not we desire somebody or not, whether or not we lose or increase our desire for somebody over time, whether or not we fall in love, what love means, and whether or not the relationships

00:02:59 Odor, Perceived Attractiveness & Birth Control

we form continue to include the elements of desire and love over time or not. In order to illustrate just how powerfully our biology can shape our perception of the attractiveness of other people, I want to share with you the results of a couple of studies. Both studies explore how people rate other people's attractiveness. And in both studies, the major variable is that women are at different stages of their menstrual cycle. Now in the first study, men are rating the attractiveness of women according to the smell of those women. Now they're not smelling them directly. They're smelling clothing that women wore for a couple of days at different phases of their menstrual cycle. And what they find is that men will rate the odors of women as most attractive if those women wore those shirts, that clothing, in the pre-ovulatory phase of their cycle, okay? So this is not to say that men do not find women attractive at other stages of their cycle. It is to say that men find women's odors particularly attractive, if those odors were worn by women that are in the pre-ovulatory phase of their menstrual cycle, okay? Now, there was also a study that was done where women at different stages of their menstrual cycle are rating the odors of men. And a similar but mirror symmetric result was found such that women who are in the pre-ovulatory phase of their menstrual cycle will rate men's odors as more attractive than at other stages of their cycle. So the simple way to put this is that there seems to be something special about the pre-ovulatory phase of a woman's menstrual cycle that makes men rate them as more attractive during that time and women rate men as more attractive during that particular time as well. So this is a bidirectional effect. The way that the second study was done, where women are rating men was not just to smell the odors of those men on t-shirts, they did that, but they correlated that with whether or not the shirts were worn by men that were particularly physically symmetrical. They actually had these men divided into groups. It was more of a continuum rather, rated according to body symmetry and face symmetry. And women preferred more symmetrical men when they were doing the preference test during the pre-ovulatory phase of their cycle. So again, the point is that that pre-ovulatory phase of the cycle seems to create a bidirectional mutual attractiveness. Now, also extremely interesting is that this effect does really seem to have something to do with ovulation. Because in both studies, they had women that were taking oral contraception or not. And what they found was if a woman is taking oral contraception, it prevented that peak and perceived attractiveness by the men, meaning men no longer perceived a woman to be more attractive at a particular phase of their cycle. And also women taking oral contraception no longer preferred the odors of more symmetrical men during the pre-ovulatory phase of their

cycle. Now, I want to make sure that it's especially clear that it is not the case that oral contraception reduced the perception of a woman as attractive, that did not happen in these studies. It reduced the further increase in a male's perception of her as attractive. And if women took oral contraception, it prevented them from preferring more symmetrical men based on the odors of those men. Now I realize there are a lot of variables here. We've got odors, we've got symmetry, we've got menstrual cycle, pre-ovulatory, non pre-ovulatory. And we have whether or not people are taking contraception or not. But the basic finding is that depending on where women are in their menstrual cycle, influences both men's perception of them as attractive and their perception of men as attractive and oral contraception eliminates that effect. So I share with you those data to illustrate that we often think that somebody is attractive or not based on, I don't know, how they look, their skin, their hair, et cetera, but it also illustrates that their odor is a powerful cue for some people more than others. Some of us tend to be more factory driven than others. Although if you watched the "Huberman Lab Podcast" episode that I did with Professor David Buss from the University of Texas, Austin, who's a luminary in the field of evolutionary psychology and has studied mate choice and mate selection bias over decades, he's really one of the founders of that field, he emphasized findings that odor for many people is a maker or a deal breaker. Meaning, there are some people that even if somebody has all the characteristics that they're looking for in terms of kindness, and attractiveness, and values, and other features that would and should be of very high priority in selecting a mate, that if someone does not like the way that person smells, their innate body odor independent of colognes, and perfumes, and soaps, et cetera, that that's often a complete and total deal breaker. I'm sure there are some of you that can relate to that. And there's some of you perhaps for which that is not the case, and you can't even imagine that being

00:08:04 Thesis, AG1 (Athletic Greens), InsideTracker

such a powerful variable. And yet the data suggested indeed it is a powerful variable for many people out there. Before we begin, I'd like to emphasize that 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 Thesis. Thesis makes custom

nootropics. Now nootropics is not a word that I'm usually a fan of, because nootropic means smart drug. And there are a lot of different aspects to being smart or to intelligence. There's the ability to focus. There's the ability to task switch. There's the ability to be creative. And each of those different forms of intelligence or expressions of intelligence involves different brain circuits, different neurochemicals, and indeed different hormones in the body. So I think it's rather naive to think that there could be one smart drug or nootropic. Thesis understands this. And so they've developed custom nootropics that are tailored to the specific goals that you might have in terms of cognitive work, or physical exercise, or skill learning of any kind. And they tailor them to the individual. They only use the highest quality ingredients, many of which I've talked about here on the podcast. Things like alpha GPC, which I personally use, things like phosphatidylserine, which I also use on occasion. However, they've taken different combinations of those ingredients and put them into different formulations designed for particular goals or endpoints. For instance, I have Thesis nootropics that are for motivation, others that are for clarity, for mental clarity, others that I take pre-workout, others that I take post-workout, and so on and so forth. Now, in addition to that Thesis understands that not every ingredient is terrific for everybody. In fact, one particular substance that I've talked about on the podcast, Ginkgo biloba is very useful for a lot of people. However, I don't tolerate it well. I get vicious headaches from Ginkgo biloba. So none of the formulations that they've made for me include Ginkgo biloba. So again, these are custom nootropics that are tailored for your particular goals, and where the ingredients really match your particular needs, and don't include things that aren't going to work for you, or that create things like headaches. So the personalization and the targeted effects of the nootropics is really where or the power comes from. I've been using Thesis nootropics for close to six months now. And I can confidently say that their nootropics have been a total game changer for me. My go-to formula is the motivation formula. If I'm going to be training, or working out, or I need extra energy, and I use the clarity formula nowadays for any kind of writing or creative work. Those are the two that I've mainly been taking lately. If you want to try your own personalized nootropic starter kit, you can go online to takethesis.com/huberman. You'll take a three minute quiz and Thesis will send you four different formulas to try in your first month. You'll have the ability to try those different blends across that month, discover which nootropics work best for you, your unique brain chemistry in genetics. You can have a consult with them, and then they will give you the best nootropics for you. Again, that's

takethesis.com/huberman and use the code Huberman at checkout to gain 10% off your first box. Today's episode is also brought to us by Athletic Greens. Now called AG1. I've been taking AG1 since 2012. So I'm delighted that they're sponsoring the podcast. The reason I started taking AG1 and the reason I still take AG1 once or twice a day is that it covers all of my vitamin mineral probiotic needs. Probiotics are essential because they support what's called a healthy gut microbiome. The gut microbiome is vital for things like metabolism, hormone function, and also we now know our brain function, things like focus and memory and our general immune system. With AG1, I get the probiotics I need, I get the vitamins and minerals that I need to cover any nutritional gaps, if I'm not eating optimally. And even if I am eating optimally, AG1 can further support metabolism, hormone function, et cetera. In fact, whenever people ask me, what's the one supplement that I should take if I can only take one supplement? I always say AG1. I take mine early in the day. I mix it with water and some lemon or lime juice. I love the way it tastes. And I'll take it again later in the day, typically in the late afternoon. If you'd like to try Athletic Greens, you can go to athleticgreens.com/huberman and claim a special offer. They're giving you five free travel packs that make it really easy to mix up AG1 while you're on the road, in the car, on the plane, et cetera, and a year supply of vitamin D3 K2. There's a ton of data now supporting the fact that vitamin D3 is critical and that most of us don't get enough vitamin D3 even if we're getting ample sunlight. Vitamin D three is important from metabolism, hormone function, brain function, and many other aspects of our biology. So again, if you go to athleticgreens.com/huberman, you can get a special offer of the Athletic Greens, five free travel packs and the year supply of vitamin D3 K2. Today's episode is also brought to us by Inside Tracker. Inside Tracker is a personalized nutrition platform that analyzes data from your blood and DNA to help you better understand your body and help you reach your health goals. I've long been a believer in getting regular blood work done. For the simple reason that many of the factors that influence your immediate and long-term health can only be discovered from a quality blood test. And nowadays with the advent of modern DNA tests, you can also get information for instance about how your biological age compares to your chronological age, which of course is a vital measurement. Now, one of the major issues with blood tests and DNA tests out there is that people get the information back that lipid marker of one type, it might be high or low, or that a hormone of another type might be high or low, but they don't give you any for information about what to do with that information. Inside Tracker makes that all very easy to navigate. Once you get your

results back, you can click on any of those results. And Inside Tracker will immediately show you things that you can do, for instance, with your nutrition, or supplementation, or lifestyle factors to help you bring those numbers into the ranges that are appropriate for you. So it's immensely powerful, not just in terms of the measurements, but also it provides some directives that can help bring those measurements into the ranges that are best for your immediate and long-term health. If you'd like to try Inside Tracker, you can visit insidetracker.com/huberman

00:14:13 Romance: Balancing Love & Desire

to get 20% off any of Inside Tracker's plans. Just use the code Huberman at checkout. Let's talk about desire, love, and attachment. And of course, these are topics that grab tremendous interest. So it's worth us defining our terms a little bit before going any further. Of course, we can have many different kinds of loves. There's romantic love, there's love of family, so-called familial love, there's love of pets. We can even love objects, where we can feel as if we love objects. We can love certain activities. We can have friends that we love and so on and so forth. The word love is used to encompass a lot of different types of relationships. Today, we are mainly going to be focused on romantic love and the neural mechanisms of romantic love. I want to acknowledge here at the outset that most of the studies of romantic love have focused on monogamous heterosexual love. And also when we talk about studies focused on desire, and attractiveness, and attachment, that's also the case. And that simply reflects the general bias of the literature over the last 50 to 100 years. It does, of course, not rule out that similar or different mechanisms could be at play in non-monogamous relationships, in homosexual relationships, or in relationships of any kind or variation. It's also worth us defining our terms around desire. It can mean lust, it can mean the desire for long-term partnership. So we need to define our terms and throughout I will do my best to very carefully define what I mean by desire, what I mean by love, and what I mean by attachment. The formal study of love, and desire, and attachment goes back to the early 1900s. One of the classic studies on this is entitled "Love and Desire." It was published in 1912 and really focused on two opposing themes within romance. One is love which in that paper was really meant to include attachment and dependence or interdependence between individuals, right? And the other end of the spectrum being desire, or the sexual desire for another. And romance was meant to encapsulate both those things, love and

desire. And for much of the 1900s, it was thought that love and desire were on opposing ends or in a push pull. And it was the dynamic push and pull between love and desire that one could define romance. And that actually led to much of what's out there in the psychological literature. Today, we are going to explore some neurobiological studies, some studies of the endocrine system, meaning the hormone system that actually support that general model. And I'll point you toward what I think is a very useful book in thinking about how relationships can both form and last over long periods of time and how those relationships can include both desire and interdependence. I'll also talk about some studies that have really focused on why relationships succeed and why they fail, and how that relates to whether or not there is sufficient amounts of attachment and desire. So today we're going to talk about the science and indeed you'll also get some tools. Those tools should be useful to you, whether or not you happen to be in a relationship or not, whether or not you're seeking a relationship or not. I'd like to begin with an anecdote. And this is not an anecdote about my relationship history, it's an anecdote about my scientific history. When I started graduate school, the chairman of the department I was in at the time said to me, "Most PhDs last longer than most marriages." And indeed he was right. And also most marriages in this country end in divorce. I think it's about 50% with a slight skew toward more ending in divorce than persist until death do them part. But nonetheless, it's about half, and most marriages end before the eight-year period is up. Most PhDs take anywhere from four to nine years. So there was a bit of a smearing of averages there, but the point he was trying to make really landed home for me. It did not scare me out of relationships nor did it scare me out of a PhD, obviously. What it did illustrate was that there's something about our attachment machinery that can be very, very compelling, such that people take on tremendous levels of commitment. I have to imagine that most people enter marriages assuming that they're going to stay in those marriages. I don't think most people enter marriages thinking they're going to get divorced. But that if 50% of those commitments end in divorce, there must also be mechanisms by which our attachments can break. And today we're going to talk about both the forming of attachments and the breaking of attachments,

00:19:00 Animal Studies, Vasopressin & Monogamy

what can prevent those breaks in attachments, and indeed what can lead to re-

attachments. There are biological mechanisms to desire, love and attachment, that's abundantly clear. Now there's a robust and very large literature in animal models. What I mean by that are field studies and laboratory studies in primates of different kinds, such as macaque monkeys or bonobos. People have looked at these sorts of things, believe it or not, in ducks, in laboratory mice, in different types of birds, et cetera. And if you look at that literature, you can essentially find biological examples in the animal kingdom for just about any behavior that you can easily map to human behavior. So for instance, there's a species of animal called the prairie vole. In one portion of the United States, this prairie vole species is monogamous. They only mate with one other prairie vole, only raise the young with one other prairie vole for their entire life. And in another region of the United States, the same species of animal, prairie vole, will mate with many individuals, they're non-monogamous. And the major difference, at least as far as we know between the prairie voles in one location and another location is the levels of a molecule called vasopressin in the brain and body. Vasopressin is present in humans. It has numerous biological roles. It's responsible, for instance, for controlling the amount of urine that you excrete, the amount of water that you retain, and for sexual desire, as well as mate seeking. Levels of vasopressin in prairie voles are strongly determinant of whether or not a prairie vole is going to be a monogamous or non-monogamous. Why do I raise this? Well, I raise this because the literature on prairie voles is quite beautiful and has been discussed quite a lot in the popular press. You can look it up with an easily, just Web Edge search. You'll find lots of information about this, lots of news articles about this, and lots of interpretations as to how vasopressin might be involved in similar or different mechanisms in humans. Now, I don't have a problem with mapping animal studies to humans. I think there's certainly a place for that. But if we just lean back and look at the giant mass of studies in animals and their mating behavior, and their mate selection behavior, you can essentially find examples of anything. You can find examples of polygamy, you can find examples of cheating, of infidelity, you can find examples of all sorts of different behaviors that in your own mind, you can map to human behavior. But it's really hard to make the leap from animal models to humans in any kind of direct way. And so thankfully there's been tremendous work done in the last mainly 20 years or so, looking at human mate selection, human desire, human love and human attachment. So we're mainly going to focus on those studies today, and where appropriate, we will map those findings back to the findings in animals to see if there's some universal truths or some universal principles about how the neural circuits and

biological mechanisms work. But by and large, we're going to focus on human studies today.

00:22:06 Strange Situation Task, Childhood Attachment Styles

So unless I say otherwise, the data that I'm referring to today are entirely from human beings. So let's talk about attachment and attachment styles. And this will offer you the opportunity to answer some important questions for yourself, such as what is my, meaning, your attachment style in relationship? One of the most robust findings in the field of psychology is this notion of attachment styles. And this was something that was discovered through a beautiful set of studies that were done by Mary Ainsworth in the 1980s, in which she developed a laboratory condition called the strange situation task. Now, the strange situation task has been studied over and over again in different cultures, in different locations throughout the world. And in preparing for this episode, I actually spoke to three different psychologists. I spoke to a psychoanalyst, I spoke to a cognitive behavioral psychologist, and I actually spoke to a psychiatrist, excuse me, not a psychologist, but a psychiatrist with a medical degree and asked, is the strange situation task and the various attachment styles that emerge from that task, are those still considered valid? And indeed all three of them said if ever there was a literature in psychology that is absolutely tamped down and has a firm basis in both data and real world principles and real world examples, it's this notion of attachment styles. So what is the strange situation task? The strange situation task involves a parent, typically a mother in the studies that were done, but a parent or other caregiver bringing their child, their actual child into a laboratory. And there's a room with a stranger and the mother enters the room with the child and there are some toys in the room. And typically the mother and the stranger will talk. Obviously the stranger is part of the experiment, is not just some random person off the street. And the child is allowed to move about the room. They can observe the mother interacting with the other person or not, they can play with toys or not, but then at some point the mother leaves. And then at some point later designated by the experimenter, the mother comes back. And what is measured in these studies is both how the child, the toddler reacts to the mother leaving, and how the child reacts to the mother returning at the end of the experiment. And oftentimes this will have two or three different phases where the mother will bring the child in then leave, then come back in and leave. There are also studies in which the behavior of the child with

the stranger is also examined. So there are a lot of variations of this, but the basic findings are that toddlers, children fall into four different categories of attachment style. And that these attachment styles can predict many features of adolescent, teen, young adult, and even adult attachment styles, not in strange situations of the sort that I just ascribed, but in romantic attachments. I should mention also that attachment style is plastic, meaning it can change across the lifespan. So as I describe the results, I describe the different attachment styles that are out there, and if any of those resonate with you or bring to mind certain people in your life, please do not assume that those attachment styles are rigid and fixed for the entire lifespan. There are also terrific data that indicate that through specific processes, both psychological and some biological adjustments that people can change their attachment style, and that indeed people who have different attachment styles can change the attachment styles of others. But just to make very clear what the results of the study were, I want to review what the four different attachment styles are, and typically people fall into one group or another but not several. So the four patterns of attachment that were revealed by these studies, again, were revealed by examining the behavior of the child in response to the mother leaving and the mother returning, and the child's response to the stranger that is in the room with them. The first style is the so-called secure attachment style. In the nomenclature of this kind of study, these are the so-called B babies, as in the letter B, bulldog, B. Not for bulldogs, but just to designate this category. The secure attachment style is one in which the child will engage with the stranger, with the experimenter while the parent is present in the room. But that when the parent, typically it's a mother, but when the parent or other caregiver leaves, the child does get visibly upset. They might whine, they might cry, they might even tantrum a bit. However, when the caregiver, meaning the mother, or father, or other caregiver returns, the child visibly expresses happiness that the caregiver has returned, okay? So that's the hallmark of the secure attachment style. And again, this is all pre-verbal. This is happening long before the child can express how they feel with words. And the interpretation of this is that the secure child feels confident that the caregiver is available and will be responsive to their needs and their communications. So that when the child whines and, or is distressed, the parent doesn't come right back into the room. But at some point they do and they seem to have a sense of trust that if the parent or caregiver leaves that the parent will come back, and that they're happy that they do. These children are also very good at exploring novel environments after the parent is gone, and while the parent is there. And almost always,

when the parent is there, they will explore more broadly, literally in space, they'll venture out further than they will when the parent is gone. They also tend to engage with the caregiver in a way that's not immediately and completely trusting, but that over time seems to evolve from one in which they're kind of suspicious of this person to one in which they're at least somewhat trusting, okay? So these were the general contours of the secure attachment style. And fortunately, nowadays there are physiological studies measuring things like heart rate and breathing and other measures that correlate with the subjective assessment of what these children are feeling. Okay, so first category is secure attached. The second category is a so-called anxious-avoidant or insecurely attached, which are the category A babies. The children with anxious-avoidant insecure attachment patterns generally tend to avoid or ignore the caregiver, all right? Meaning the parent, and show very little emotion when the parent leaves or returns. So this is the reason they call them avoidant or anxious-avoidant and kind of insecure. There isn't this happiness or joy that the parent is back. They don't seem to express that. They do not exhibit distress on separation. And they generally tend to have some tendency to approach the caregiver when they return, but there doesn't seem to be a general expression of joy. And again, physiological measures support that as well. Things like changes in heart rate tend to be less dramatic in the anxious-avoidant insecure attachment style than in the secure attachment style. Okay, so that's the second one. The third category is the so-called anxious-ambivalent/resistant-insecure category. Okay, I didn't name these categories. So you have to blame others in this one instance. For everything else blame me, but in this instance, you have to blame the psychologists that named this category. The anxious-ambivalent/resistant-insecure category also called the C babies, for the letter C just as a categorization. The anxious-ambivalent, resistant-insecure toddlers, really, show distress even before separation from their mother or other caregiver. And they tend to be very clingy and difficult to comfort when the caregiver returns, okay? So they're distressed even before the mother leaves the room and they tend to be very clingy and really hard to calm down when the mother returns. They tend to show either what seems to be resentment in response to the parent's absence. We don't really know what they're feeling. Or some helpless passivity. And there's actually subcategorizations that the psychologists have come up with, C one subtypes and C two subtypes. We don't have to get bogged down in that. But just know that there isn't one absolute measure that says, oh, well, this person is anxious-ambivalent, resistant-insecure. They could be somewhat passive, or they could be,

seem somewhat angry at the caregiver. But the basic idea is that before and after the separation, they are clingy and difficult to comfort. They just can't seem to calm themselves down, and physiological measures of heart rate and hormone measurements such as cortisol also support that statement. And the third category of attachment style is the so-called disorganized or disoriented or D for the letter D babies. This is a categorization that was added later to this strange situation task. That is a real hallmark of developmental psychology studies. It was developed by Mary Ainsworth, graduate student, Mary Main, who I actually had the great fortune of taking a course from and learning from when I was a graduate student at Berkeley many years ago. And this fourth categorization was controversial for a while, but now is generally accepted. The key feature of the disorganized, disoriented category is that the toddlers tend to be tense and they tend to encompass a lot of odd physical postures. They tend to hunch their shoulders. They'll put their hands behind their neck. They'll cock their head to the side. For those of you listening, I'm doing this on the video version. It's not where you don't have to go see that. But for those of you that are watching this on video, they tend to constrain their body size a bit and going to odd postures that they normally wouldn't do anywhere else. So this is why it's called the disorganized or disoriented category. It seems like these children just don't really know how to react to a separation. And they just start to manifest behaviors and emotional tones that aren't observed in other situations. Okay, so we've got our four categories. I'll try and use the shortest possible names for each category. We've got category one, which is securely attached. We've got category two, which is insecurely attached, also sometimes called anxious-avoidant. Then we've got category three, which is the resistant-insecure category, which is anxious-ambivalent. And then there's this fourth category,

00:32:52 Adult Attachment Styles

the disorganized, disoriented category where they're so-called D babies. Now, what's interesting about this from the perspective of desire, love and attachment is that the categorizations of children into one of these four different categories as toddlers is strongly predictive of their attachment style in romantic partnerships later in life. Which is to me both amazing and surprising and not surprising all at the same time. Amazing because it means that, first of all, we are relatively hardwired for attachment. I think that that's incredible and beautiful, that we have designated neurons, nerve cells and

hormonal systems that are there to ensure that we have some response to a caregiver being there, or not being there, or returning, or leaving, but also that the same neural circuitries, the same hormonal responses are at least in some way repurposed for entirely different types of attachments later in life. So when we hear the psychologist talk about how we formed a template early in life based on experiences that were even pre-verbal before we had language, and those templates are superimposed on our relationships, or we should say, our later relationships are superimposed on those templates, there really is a basis for that. We now have neuroimaging studies to support, for instance, the work of Allan Schore from UCLA, showing that when a mother and child interact, either through very soothing interactions, like bottle feeding, or breastfeeding, or singing to one's baby, or putting them to sleep, that the brain of the child and the brain of the mother are entering a coordinated state of relaxation. And it's not one direction, mother to child, the child is also calming the mother. Typically these studies were done with mothers again, sometimes with fathers, but typically with mothers. And in addition to that, when the mother or other caregiver acts very excited and raises their voice, or puts a lilt in their voice, or widens their eyes, that the child will do the same. And again, there's a bidirectional interaction in that case of excitement. And there's the release of neurochemicals like dopamine into the bloodstream, whereas in the relaxation scenario and the soothing scenario, there's we know the release of things like serotonin and oxytocin. So the neural systems for attachment and the neural systems for what we call autonomic arousal for being alert and calm don't act in a vacuum. They are tethered to other people in our environment. And of course we know this, right? We sometimes hear the statement, no one can make you feel anything. I've always had a little bit of a problem with that statement. I don't think I'm contradicting anyone in particular, but you hear that a lot, no one can make you feel anything. Indeed they can, right? A physical injury can make you feel something. If somebody says something that you very much like, it can make you feel something. And if somebody says something that you very much dislike, it will make you feel something. So the idea that no one can make us feel anything isn't actually true. Our nervous system is tethered to the nervous systems of others. And that is true from the very earliest stages of our lives. And in this case, we're talking about how our templates for attachment in romantic relationships, how we find them, how we maintain them, and indeed how we break them and reform them is based on a template that was established through an entirely different set of priorities, which was how we feel safe and secure in novel environments, depending on whether or not

our primary caregiver is there or not. Neuroimaging supports that. When I say neuroimaging, I mean, brain scan support that, measures of hormones in the body and brain support that, measures of neurochemicals support that. There's simply no way around this truth, that we have a set of roadmaps in our mind that are reused for entirely different purposes later in life. That is vitally important to understand. Because if one is successful in forming romantic attachments, maintaining them, et cetera, or not, does in fact reflect the earlier templates that you've created. But as I've mentioned before, the good news is that these templates can shift over time. And one of the more powerful ways to shift those templates over time is purely by the knowledge that they exist, and the understanding that those templates are malleable. They can change through the process of neuroplasticity. Again, neuroplasticity is just a rewiring of nerve connection. That is very much present in childhood, but also very much present in adulthood. So if you're somebody who you think falls into category one, two, three, or four, or you know somebody, or involved with somebody who falls into category one, two, three, and four, the mere knowledge of that can be very useful. But you might ask, well, what do I do with that knowledge? Well, fortunately, both psychologists and biologists have started to leverage that knowledge toward establishing better, more secure bonds in adult romantic relationships. And there's a book that has really tapped into this. I think it's the first book that has really addressed this head on. And that book comes from two Columbia professors. And title of the book is "Attached: The New Science of Adult Attachment and How It Can Help You Find and Keep Love." The authors of this book are Amir Levine and Rachel Heller. Again, both of them are skilled academics and researchers who have really taken the literature that I described on the strange situation task and mapped it to adult attachment styles. And also they've mapped out ways that they've observed in their clinical practice. And that is laboratory supported for, for instance, people that have an anxious-ambivalent or what we were calling insecure attachment style, or for people that fall into the disorganized or disoriented attachment style, how they can modify that attachment style in or out of relationships in order to establish what I think

00:38:50 Secure Attachment

everybody wants, which is secure attachment. Why does everybody want that? Well, secure attachment allows people to be both in relationship, or if they choose to be on their own, or to be in relationship but physically separated from somebody else, or even

emotionally separated from somebody else and maintain what we call a stable autonomic equilibrium, the ability to remain calm, clearheaded. You might not like what's happening, but you're able to navigate that with some sense of clarity and not excessive discomfort. So, is there a goal in all of this stuff about love, desire, and attachment? Indeed, there is. The secure attachment style is the one that leads to the most stable and predictable long-term relationships. Put differently, babies, toddlers, adolescents, teens, and young adults that have a secure attachment style are more likely to find and form long-term relationships than are people in the other categories. But people in other categories can learn and eventually migrate into the secure attachment style. And I think that book "Attached..." I have no affiliation to the authors or the book itself, I should just mention that. "Attached: The New Science of Adult Attachment and How It Can Help You Find and Keep Love," really it sounds very pop psychology, yes, but it is really grounded in the research psychology literature. And there's also some interesting biology there. Another point to make about attachment styles is that it is possible. And some of you may be familiar with circumstances whereby people who are securely attached, either because they grew up in an environment where secure attachment was cultivated, or because they developed that on their own, can also migrate out of the securely attached category into insecurely attached, or into avoidant types of attachment styles as teens, or as young adults, or as adults at any age or any stage of life, by virtue of being with somebody who has a different, perhaps less adaptive attachment style, right? What this means is that if you have or you develop a secure attachment style, it's vitally important to protect that attachment style because it is possible to become anxiously attached, even if you grew up in a stable attachment framework. And again, this can happen at any stage. So if you're interested in attachment styles and how they influence adult romantic attachments, and certainly if you are a parent, I would encourage you to check out the book, "Attached." Again, it's quite good and I think that it offers a number

00:41:23 Autonomic Arousal: The "See-Saw"

of actionable tools to both form and hold onto secure attachment styles. So I mentioned that the neural circuits for child-parent or child-caregiver attachment are repurposed for romantic attachment later in life. But what are these neural circuits? What do they do? I mean, it's so attractive, if you will, to think about a brain area that controls love, or a

brain area that controls desire, or a brain area that controls attachment, but it simply doesn't work that way. As I've talked about before on this podcast and I will say again and again because it will persist to be true long after I'm gone, is that no one brain area can give rise to anything as complex as desire, or love, or attachment. Instead, there are multiple brain areas that through their coordinated action create a song that we call desire, or a song that we call love, or a song that we call attachment. Not a literal song, although there are songs about desire, love, and attachment, of course, many songs, some good, some not so good. But rather different brain areas being active in different sequences and with different intensities can make us feel as if we are in the mode that we call desire, or in the mode of love, or in the mode of attachment. But beneath all of that is this element of autonomic arousal. And I want to focus on autonomic arousal just for a bit longer, because it really is one of the three core elements by which we form and maintain loving attachments, and by which we break loving attachments. The autonomic nervous system as the name suggests is automatic. In fact, that's what autonomic means. Now it's actually the case that we can control our autonomic nervous system to some degree or another. But the autonomic nervous system controls things like digestion, our breathing, whether or not we're conscious of that breathing or not. It controls things like how alert we are or sleepy we are. And the autonomic nervous system, as I just briefly described earlier, is really something that we come into the world with. It's hardwired, all the elements are there. But through interactions with our parent, either soothing interactions, or fun, playful interactions, or dare I say, scary interactions, our autonomic nervous system gets tuned up. Meaning, we each develop a tendency to either be more alert and anxious, or more calm, or a balance of alert and calm. Now, of course, this changes across each day and depending how tired we are late in the day. If we've been awake for a while, we tend to get sleepy early in the day. If we're very rested, we tend to wake up and feel very alert. So the way to think about the autonomic nervous system is it's kind of a seesaw. We go back and forth between being very alert, we can be alert and calm, or we can be very, very alert, we can be in a state of panic, we can be fast asleep so we can be extremely calm, or we can just be sleepy, semi calm but still also alert. So think about it like a seesaw. And that seesaw has a hinge, and that hinge defines how tight or loose that seesaw is, how readily it can tilt back and forth. Our autonomic tone is how tight that hinge is. And there are biological mechanisms to explain this, but here I just want to stay with the analogy of the seesaw for now. The interactions between child and caregiver early in life take the child and the caregiver

from one end of the seesaw to the other. From being very alert in a state of play, for instance, to being nursed and being very soothed until we go to sleep. And of course, we each have a seesaw, the parent and the child has a seesaw, and they're interacting. What do I mean by that? Well, there are beautiful studies, and beautiful not in the sense that they focused on a pleasant topic, but beautiful because they were done so beautifully well, that looked at, for instance, the response of mothers and their physiologies and the response of children and their physiologies during the bombing of cities during World War II. So an unpleasant situation. But what was revealed during the course of these studies was that if the mothers were very stressed during an onslaught of bombing of the city, the children's physiologies tended to be stressed also, and persisted in being stressed long after that stressful episode was done. They actually followed that these children well out from many decades afterwards. Conversely, if the parent, and in this case, again, it was mothers that were explored in these studies, had turned this whole business of going into the bomb shelters into somewhat of a game, right? Taking it seriously, but essentially telling the children, "Okay, it's time to go," but not expressing much stress or distress, the children also didn't develop much stress, or distress, or trauma. Now there were exceptions to this, of course, but in general, that was the rule that the autonomic nervous systems of children tend to mimic the autonomic nervous systems of the primary caregiver. And the mechanisms by which this occurs has been explored. And again I just refer to the beautiful work of Allan Schore at University of California, Los Angeles. And again, his name is Schore, spelled S-C-H-O-R-E. I'm looking down briefly at the floor here because I'll just reach for the book. He has a wonderful book called "Right Brain Psychotherapy." It's a little bit technical, but if you're interested in some of the studies, this book "Right Brain Psychotherapy" details how everything from nursing of children to playtime behavior, to strange situation type task behavior that we talked about before which of course occurs when children get dropped off at daycare, or nursery school, or with babysitters, et cetera. And indeed all types of caregiver-child interactions tune up that autonomic nervous system, so that the child ends up with an autonomic nervous system that either tends to lean more towards alert and anxious, or can be very alert but calm, or can be very calm and hard to budge. Again, it's the tightness of that hinge that really underlies these attachment styles that we were talking about earlier, and not on this episode of the "Huberman Lab Podcast," but on many other previous previous episodes, such as the master stress episode, or some of the optimized health episodes. You can find these if you want at hubermanlab.com. A

lot of the tools and techniques that are recommended there have to do with readjusting the autonomic nervous system in deliberate ways as an adult. Again, I won't go into the specific tools, but for instance, the physiological sigh. This tool that I've talked about extensively of two inhales through the nose, as deeply as you can on the first one, sneaking in a little bit more air on the second one, and then a long exhale through the mouth is a way of adjusting that autonomic seesaw. It tends to make us more calm. It activates what we call the parasympathetic arm of the autonomic nervous system, which is just fancy nerd speak for it's a quick way to calm yourself down, right? Things like ice baths, or cold showers, or cold immersion, or deliberate hyperventilation by contrast, or ways in which we can deliberately increase the level of our so-called sympathetic arm of our autonomic nervous system to make ourselves more alert. Why would you want to do that? Well, you can do that to be more alert, to be more awake, if you like, or as a form of self-induced stress inoculation to be able to tolerate higher levels of adrenaline by making it a practice that you self-direct. The reason those tools are out there is because many of us, for whatever reason, we don't have to blame anyone, but because of our childhood templates, because of things that happened and didn't happen in terms of our interactions with caregivers, have autonomic nervous systems that are tilted to one side or the other more than we would like. Or in which the hinge that I'm talking about in this analogy is too loose or that is too tight. And we're stuck in a mode of anxiousness, or stuck in a mode of lack of energy. That's what those tools are really about. But at a deeper level, the autonomic nervous system is really the system that governs how we will react in response to a romantic partner being present or leaving. And I don't necessarily mean leaving the relationship entirely, although it could mean that, right? We know people, I'm sure you know people that upon the end of a relationship that they wanted very much, are absolutely crushed. And actually in researching this episode there, I discovered there's an extensive literature finding that the feelings that one has after a breakup are very much like a clinical depression in many cases. But there are individuals that can look at a breakup as a transient event that they don't interpret as going to mean so much for all aspects of their life or reshaping their view of themselves, why? Well, we have different levels of autonomic function. And depending on where our seesaw is, if you will, some of us become extremely distraught and can't recalibrate ourselves, can't adjust ourselves down from stress to calm, or can't take ourselves from exhausted to more alert if we need to do that on our own. And so that's why tools for doing that exist.

00:50:39 Tool: Self-Awareness, Healthy Interdependence

But attachment itself is about where our autonomic nervous system resides. So if I were to offer a set of tools around these topics of desire, love and attachment, I would say, first of all, you might want to think about whether or not you fall into the secure, insecure, or other attachment styles. Second, I think it is vitally important for all of us, but certainly for people that are in relationships or seeking relationships to be able to at least have some recognition of where our autonomic nervous system tends to reside both in terms of when we are with somebody and when they leave. When we are apart for long periods of time, can we calm ourselves? Can we self-soothe? Or are we very much dependent on the presence of another in order to feel soothed? Now, I absolutely want to emphasize that there is nothing wrong. In fact, there's everything right with feeling great in the presence of somebody else. That is actually a hallmark of strong and quality attachments. These days, we hear the term codependent a lot. This was a, I believe, the term was first coined by Pia Mellody. And it actually does occupy an important role in the world of trauma, trauma healing, so-called trauma bonding, topics of another episode. Actually, did an episode on fear and trauma. And we will do one all about trauma bonding with an expert at some point in the future. But codependence and codependency, the term can sometimes be misinterpreted as any dependence on another isn't good. Interdependence, a healthy interdependence, of course is good. It is the hallmark of healthy child-parent relations, sibling relations and romantic relations. But a key element of healthy interdependence is that, yes, our autonomic nervous system is adjusted by the presence of another, but that also that we can adjust our own autonomic nervous system, even in the absence of that person. That if the person goes away temporarily or permanently, that we can still regulate our own autonomic nervous system, both from states of stress to states of calm, both from states of exhaustion to states of more alertness. And of course, we all need sleep to go from exhaustion to alertness. But what I'm referring to here is the ability to regulate when distraught, or regulate when fatigued, or feeling depressed. And that is and is all about the autonomic nervous system. So as we talk about attachment styles, and we talk about infant and toddler and adult attachment styles, what we are really talking about is a complex set of neural circuitries.

00:53:11 Neurobiology of Desire, Love & Attachment

And one of those neural circuitries, which is absolutely crucial is this autonomic nervous system. So if the autonomic nervous system is one key component of desire, love and attachment, what are the other two? And what I'm going to tell you next is largely the pioneering work of Helen Fisher, who is really an anthropologist, who's become a bit of a neuroscientist and has collaborated with neuroscientists to establish brain areas and neural circuits that are associated with different aspects of attachment, love and desire. I think the first really high quality study of neural circuits associated with these themes was a paper published in 2005 in a very fine anatomical journal, perhaps the best neural anatomical journal, which is the Journal of Comparative Neurology. The Journal of Comparative Neurology has been around for more than 100 years and is considered the archival location for placing really high quality anatomy. They have tremendously high standards. And the study that I'm referring to is entitled, "Romantic Love: An fMRI," meaning functional magnetic resonance imaging, "Study of a Neural Mechanism for Mate Choice." And Dr. Fisher is a author on this paper as is Arthur Aron, and Lucy Brown. So all very fine researchers. And this study as well as several other studies using magnetic resonance imaging, things like EEG, neuro anatomical tracing, et cetera, have identified a large number of brain areas that are associated with different aspects of desire, love, and attachment. And I'll just throw out a few names of those brain areas and what they control. And then I'll tell you how those anchor to the other two categories of neural circuits essential for desire, love, and attachment. So not surprisingly the dopamine system in the brain is associated with desire, love, and attachment, and mainly with desire, although to some extent, love. Dopamine is a neurochemical sometimes associated with reward. But as some of you have heard me say before, it is mainly a molecule of motivation, craving and pursuit. And that motivation, craving and pursuit that relates to dopamine is not unique to attachment, or love, or sex, or mating, et cetera. It is a universal generic currency in the brain for pursuing something. Food when you're hungry, a mate when you want one, to mate when you want to, warmth when you're cold, et cetera, et cetera, okay? So it's not for one specific purpose. But the brain areas associated with dopamine involve, for instance, the ventral tegmental area, the substantia nigra, areas of that sort, the basal ganglia. You don't need to know these names, just understand that these are networks of neurons that tend to have put the person, you into a state of forward action and pursuit and craving and motivation. They

are not about being quiescent, relaxed, et cetera. The neural circuits for quiescence and relaxation are most associated with love and attachment, not surprisingly, and they're the neurochemical serotonin, and to some extent, oxytocin are the predominant neurochemicals involved. And those are released from brain areas, such as the raphe nucleus in the back of the brain. You may have heard that the majority of serotonin in your body is made in your gut, and indeed, that's true, but I hate to break it to you, the serotonin in your gut is not responsible for your feelings of love and attachment, at least not to a high degree. That's mainly going to be the reflection of neurons in your brain that make serotonin. And there are other areas of the brain that make serotonin as well and oxytocin as well, but they tend to be associated with the warmth and calm, and the soothing that we feel in the presence of another. And again, these are not strictly divided circuits. We can have dopamine and serotonin present in our brain and body at the same time to equal or different degrees. And we return in a little bit to what happens when levels of dopamine are very high and levels of serotonin are low and vice versa and so on, including in states of neurochemically modified states, as it were in, when we talk about things like MDMA, so-called ecstasy. But in the meantime, I want to just discuss the two neural circuits that use dopamine, that use serotonin and oxytocin, and that collaborate with the autonomic nervous system to drive what we call desire, love and attachment. And the three circuits are autonomic nervous system, we talked about that one. Then there's the nervous system components or the neural circuits for empathy, for being able to see and respond to indeed match the emotional tone or the autonomic tone of another. And then there's the third category, and this might surprise some of you, it certainly surprised me, but the data point to the fact that the third neural circuit

00:58:02 Empathy & Mating & the Autonomic Nervous System

that's very important for establishing bonds is one associated with positive delusions. So given that the neural circuits for empathy are absolutely crucial for falling in love and maintaining stable attachments, I'd like to talk about those neural circuits and what they are. Now, often when we hear empathy, we think, oh, empathy is really about listening to and really understanding what somebody else is feeling. Maybe even feeling what they're feeling. And indeed that's the case, but what do we mean by that? Right? What is it to feel what another feels? Well, what it means is that their seesaw is driving your

seesaw, or your seesaw is somehow driving their seesaw. That there's a match in terms of the tilt of those seesaws. Now it doesn't have to be an exact match, right? If someone that you really care about is very, very stressed, you could also become very stressed. That's a form of empathic matching, and there are indeed neural circuits for that. I'll describe what those neural circuits are in a moment. But sometimes the best role for us to take is actually one in which we are calm when the person that we care about or that we are romantically involved with is very, very anxious. And in a few minutes, I'll talk about how matching of emotional tone can be good or bad for the stability of a relationship, and complementarity of autonomic matching can be good or bad. In other words, sometimes it's beneficial for a relationship to go into the same state as the other. And sometimes it's more beneficial for us to not go into the same state as the other. But the important feature here is that when we talk about emotional matching or empathy or going into the same state or not going into the same state, what we are really talking about is whether or not the autonomic seesaw of one individual is driving the autonomic seesaw of the other individual. And this is a vital principle for how we fall in love and form attachments. And it's actually part of the desire and mating process itself. I would go so far as to say that one of the prerequisites to the propagation and expansion of our species is this notion of autonomic regulation. And to some extent, matching of autonomic nervous systems. Let me explain what I mean. Last I checked, the only way that new humans can be created is by way of sperm meeting egg, either in body or in dish, but sperm meets egg and then typically nine months later, we have a human baby. The process of bringing sperm to egg, right? Mating behavior, sex behavior in humans is one of autonomic regulation. And what I mean by that is the process of finding a mate, and in this case, I mean, actually someone to mate with, typically, well, scenarios vary, typically, is one of elevated autonomic arousal, meaning increased activation of the so-called sympathetic nervous system. This is related to dopamine release and it's related to epinephrine release. There has to be a pursuit or at least there has to be a mobilization to arrive in the same location whereby one can mate, right? That almost always is the case. However, the sexual arousal itself in both males and females is actually driven primarily by the parasympathetic arm of the autonomic nervous system. So while pursuit is one of alertness and sympathetic drive, as we say, again, sympathy is not really what's at play here, the word simple means together, and the activation of the autonomic nervous system toward more alert state is because of a sympathetic nervous system, meaning the co-activation together of many neurons in the brain and

spinal cord. But then the actual physiological arousal state that we call sexual arousal is predominantly parasympathetically driven, okay? To be quite direct about this, if the sympathetic nervous system activation is too high, the sexual arousal response cannot happen in either males or in females, it's inhibited. However, the orgasm and ejaculation response, which if you think about it is required for sperm to meet egg is sympathetic driven. And then after orgasm and ejaculation, the parasympathetic nervousness system kicks back in, and there's a calming and relaxation. So the arc of mating involves sympathetic arousal, okay? Not sympathy, but alertness and arousal for pursuit, then a tilt of the seesaw at least to some degree for arousal of the sort that we typically hear of sexual arousal. Then at the point of orgasm and ejaculation is back to a sympathetic response. And how can I say that? How do I know that? The sympathetic nervous system meaning neurons within the sympathetic arm of the autonomic nervous system are what drive ejaculation and orgasm. And then afterward there's a return to increased parasympathetic activation. And we don't know for sure why that happens, but it's thought that in species that pair bond, humans generally pair bond, not always, there the return to more parasympathetic activation after orgasm and ejaculation is thought to increase the exchange of pheromonal orders, odors, excuse me, and to increase pillow talk and pair bonding of different kinds, okay? So that's the seesaw going back and forth is actually built into the process by which our entire species propagates. So in some ways, every human is required to navigate that process if they want their offspring to persist. And of course, nowadays there are technologies like in vitro fertilization, intrauterine insemination, there are a variety of ways that technology has allowed people to circumvent the actual physical mating process in the way that I described. But by and large, that's the way it's done. And certainly that's the way it was done historically for if not tens of thousands or hundreds of thousands of years. That process is also what happens in all mammalian species that mate. Okay, so I'm overlooking an entire literature of animal studies that classic studies of this were done by two individuals, I'll just briefly mention them in case you want to look at the literature. There's a guy at the Rockefeller University named Donald Pfaff, P-F-A-F-F, who has done beautiful studies identifying the neural circuitry, what's called the lordosis response. Unlike in humans, the mating behavior of animals is rather stereotyped in terms of the positions that they occupy. And the lordosis response is a U-shaping or a bending up of the hindquarters of typically of rodents, but of other animals as well. The the male mounting is almost always from behind except in some species of primates. And that lordosis response is

only going to occur during particular phases of the estrous cycle. The estrous cycle is the analog to the menstrual cycle, but it's not 28 days, it's four days or some other duration in other animals, depending on the animal. The lordosis response is strongly regulated by odors, by contact and is estrogen and testosterone controlled. And then the male portion of the mating sequence in animals, the mounting and thrusting and ejaculation as they're called or mounting, thrusting, intromission and ejaculation. Those are the four scientific categories that have been described, that's presence in rodents and also in dogs where it was primarily studied by Frank Beach, who was at University of California, Berkeley for a long time. And the entire literature around the neural circuitry for sexual mating behavior in animals largely stemmed from the work of Donald Pfaff and Frank Beach and their scientific offspring, not their actual offspring. You can look at that literature, if you like. There have been human neuroimaging studies of the process that I described a few minutes ago, believe it or not, of people in brain scanners, not necessarily mating with other people, but going through that arc of arousal, sympathetic activation during orgasm or ejaculation and then the post-ejaculatory or orgasmic phase in both men and women. And the brain areas associated with those have all been mapped out now. The spinal cord areas that control things like erection, vaginal lubrication, ejaculation and orgasm, those have also been mapped out. And this has all been explored from the perspective of both basic science, just to get an understanding of how our species has sexual interactions and reproduces, but also from the perspective of, for instance, trying to repair sexual function after spinal cord injury, which is a prominent concern for a lot of people, depending on where they have their injury, but in the number of people that have spinal cord injuries. So this is both vital biological and clinical data. The neural circuits for everything that I just described reside in the autonomic nervous system and are coordinated with the neural circuits that are associated with empathy. The neural circuits for empathy, again, there are many, but mainly two structures that you should know about, the prefrontal cortex, which is how we perceive things outside of us and make decisions on the basis of those perceptions, how we organize those decisions, and an area of the brain called the insula, I-N-S-U-L-A. The insula is a really interesting brain area that allows us to interocept, to pay attention to what's going on inside our body and to split some of our attention, to exterocept. And the mating dance, whether or not it's the dinner and date portion of the mating dance, or the actual physical dance part of the main dance, or actual mating and sexual behavior, kissing or otherwise, that is a coordinated activity of two bodies, typically it's two. I

realize sometimes it's more, sometimes it's only one, but typically it's two bodies at least in the framework we're using here. That coordinated dance is one in which the autonomic nervous system of one individual in general is coordinating with the autonomic nervous system of the other individual. And the insula is essentially splitting one's attention between how we feel ourselves, how our body feels, what we're thinking with the thinking and the bodily sensations of the other. And that can be communicated, obviously, through words, it can be communicated through sounds, it can be communicated through touch, and it can be communicated through a number of more subtle cues like pupil size or whether or not, certainly in cases where we recognize the person and we know their responses, their autonomic responses under different conditions. We can assess, is the person comfortable? Are they uncomfortable? Are they more focused on me or on themselves? This is the coordinated silent dance that if we look out in neurobiological terms, we can really see is all about the autonomic nervous system, whether or not it's time to tip the seesaw to one side or the other, depending on whether or not the other person's seesaw is tilted higher or lower than the other. Okay, so we have the autonomic nervous system, and then we have this thing that we're calling empathy, which is really about autonomic matching. And again, the insula and the prefrontal cortex are neural circuits that are crucial for autonomic matching,

01:10:02 Positive Delusion, Touch

because they allow us to say, what's out there, and do I want to match to it or not? Okay? And then the third category of neural circuit that Helen Fisher and others have found to be important for desire, love and attachment is the neural circuit associated with self-delusion. What do we mean by that? Well, first of all, self-delusion implies a kind of cynicism about love and attachment. And I think it was George Bernard Shaw that said, "Love is really about overestimating the differences between individuals." Actually, when I hear that, and as I say it, I really don't like that quote. I have no bone to pick with George Bernard Shaw, but what it suggests and I think what he meant was that, in love and attachment, we tend to put so much value in the other that we forget that many of the processes that are going on in our brain and body actually could be evoked by many other people too. But I think it somewhat overlooks the enormous power of attachment and the ways in which somebody's smell, somebody's voice, somebody's everything, or

somebody's particular thing or things can really become so vital for our autonomic nervous system to feel soothed and to feel elated, et cetera. So I think that while the quote is accurate, in the one sense, I think it does overlook the neural circuits for attachment and just how deeply wired those can become for us. So I will balance that quote with an enormous number of other quotes that I won't mention, but that you can find out there that really point to how incredible the person is that one tends to be attached to that there's really only one or several people that could ever exist that could evoke those feelings from us. And of course you can read your Neruda poetry, and you can find these things all over the place, in music, and poetry, and writing. So for every cynical quote about these neural circuits being generic and could be activated by anybody, I think you'll find an ample number of opposing quotes that these neural circuits can only be activated by that special someone, or that particular person, or maybe in just a small set of those people. So what of delusion? Well, the work of Helen Fisher and others has really pointed to the fact that desire, love and attachment are three separate phases of what we call romantic relationships. That typically, not always, but typically desire tends to come first or falls in the early phase. That the process of romantic/sexual interactions, it doesn't necessarily have to be sex itself, but certainly something that involves intimacy of some kind, right? And generally touch of some kind, eventually transitions into what we call love, which eventually transitions into what we call attachment. And I should just mention touch because touch is a fundamental aspect of this whole process. There's an article, a research article, I should say, the title of it is, "Relationship-specific Encoding of Social Touch in Somatosensory and Insular Cortices." Cortices being cortex. Cortex's plural, cortices. And again, there's our friend the insula. So this is a study that explored what brain areas and what body areas are activated by specific forms of attachment and social touch. And what they found not surprisingly is that the areas of the brain that are associated with touch, the somatosensory areas, but more interestingly, the insular cortex are strongly activated by touch. So touch in the amount of touching, and proximity, and skin contact, not surprisingly activates brain areas associated with somatosensory, touch, but also the insular cortex, which again, is this brain area that links the internal or feelings about what's going on inside us and at the surface of our skin with events external. And they found activation of a number of brain areas, the amygdala, orbitofrontal cortex, and so on and so on. That's not as essential as just understanding that the insular is the place in which we start to take our experience of our internal landscape, attach that to our perceptions of the external

landscape, and then assign that a value or assign that some sort of interpretation. And positive delusion is predictive of long-term attachment. What do we mean by positive delusion? Positive delusion is the contradiction of that George Bernard Shaw quote. It's the belief that only this person can make me feel this way. This other person holds the capacity to make me feel this way physically or emotionally or both. And so, as we move from desire to love to attachment, our brain circuitry is literally getting tuned up such that that individual that we happen to be attached to, again, here thinking about monogamous relationships, but I guess for non-monogamous relationship individuals is and are the way in which our autonomic nervous system can be regulated. They actually get access to our control panel.

01:15:20 Relationship Stability

So it's our autonomic nervous system empathy and this positive delusion. Now positive delusion is critical. If you look at the stability of relationships over time, something that's been extensively studied mainly by psychologists, but now also by neurobiologists, what you find is that there are some key features of interactions between individuals that predict that a relationship will last. And those are many, but mainly fall under this category of positive delusions. I'll return to those in what those exactly look like. But there are also just a handful of things that predict that a relationship will fail over time. This is largely the work of the Gottman's, is actually a husband and wife team up at the University of Washington in Seattle. The Gottman's have, run a laboratory in the department of psychology for a long time. They've also done a lot of public facing work around relationships. And they've talked about the various aspects of relationships and interactions between people that predict either staying together or breaking up. So much so that they've established a method by which they can look at video interactions between couples and with very high degree of certainty predict whether or not those couples will stay together or break up over time. And they've identified what they call the four horsemen of relationships. These are things that essentially, almost always predict that a couple will break up. And I think the current number on this is that Gottman can predict divorce with 94% accuracy, which if you think about is pretty remarkable. So even though these are purely psychological studies, I'm not aware of any analysis of underlying physiology, there are some things that they can observe between couples that can lead them to predict whether or not a couple will stay together or break up with

94% accuracy. So what are those things? Those four behaviors, what they call the Four Horsemen of the Apocalypse [laughs] for relationships are one, criticism, two, defensiveness, three, stonewalling, and four, contempt, with contempt being the most powerful predictor of breaking up. Criticism, of course, does not mean that there's no place for criticism in stable relationships. Of course, there is. Has to do with how frequent and how intensely that criticism is voiced. Defensiveness, of course, is defensiveness. We know as the lack of ability to hear another or to adopt their stance. So lack of empathy, I think is one way to interpret defensiveness. Stonewalling, which is actually another form of lack of empathy. It's a turning off of this neural circuit that's so critical for desire, love and attachment. The stonewalling essentially means the emotional response or the request of another is completely cut off. So it's, I don't think there's been brain imaging of this, but I think, we can reasonably imagine that it involves untethering your insular response from the other and what they're dealing with, and focusing your insular response, [giggles] no pun intended, on your own internal state or perhaps the state of someone else entirely. I'll talk about infidelity in a moment. And then contempt. And contempt has actually been referred to as the sulfuric acid of relationship. I didn't say that, but Gottman and colleagues have. That it is such a powerful predictor of divorce and breakups in the future. And contempt, of course, by definition is the feeling that a person or thing is beneath consideration, worthlessness or deserving scorn. And apparently they can identify this in the videos of couples having discussions and interacting by very elaborate eye rolls, by expressions of anger in one individual when their partner is actually expressing enthusiasm or excitement about something. It's the, oh yeah, you would say that, or deep seated resentment toward the other, so much so that it's apparent that one actively dislikes the other partner. So contempt, disregard for something that should be taken into account is the other way to think about it. That runs counter to all of the neural circuits, all three of the neural circuits that we talked about before. It certainly, it is the antithesis of empathy. It is anything but a positive delusion. It's really looking at the other individual, either accurately or inaccurately as somebody that you despise. And then it is an absolute inversion of the autonomic seesaw matching that I was talking about before. It's a dissociating of your seesaw from their seesaw. They're very excited about something, you're unexcited by it. In fact, it's an inversion of their seesaw where they're excited, you're down. They're down, you are up, okay? So it's basically an inversion of all of the neural circuits that Helen Fisher and others have identified as critical for desire, love, and attachment. And therefore it's not surprising that

it is so strongly predictive of breakups, and in the case of married couples, of divorce. For those of you that are interested in the work of the Gottman's and similar work, they've written several popular books. They're fairly easy to find. We can link to one of those in the caption. But they've also developed some quite interesting online resources in their so-called Love Lab. I guess it's fortunate that they didn't call it the Hate Lab or the Breakup Lab, 'cause they focused a lot on what predicts breakups. But they've also written extensively and researched extensively in peer-reviewed studies what makes people find appropriate partners for them, and to maintain those partnerships over time. So you can go, you can search for Love Lab, University of Washington, Gottman,

01:21:22 Selecting Mates, Recognition of Autonomic Tone

or any number of their various books. I think you'll find some useful resources there. I want to shift back to the work of Helen Fisher. She's made some very interesting statements and some very interesting observations that at least to my mind map very well onto the knowledge of neural circuitry both in humans and in non-human primates and in other species. I realize that she's the only name in the game. But she's made some observations that I think are very, as we say, parsimonious, meaning they allow us to organize a lot of this stuff into some distinct frameworks. Now, she's also done some really beautiful studies that involve data from millions or even tens of millions of individuals on dating sites. So I'm going to share those with you in a moment. But before I do that, I just want to paraphrase Dr. Fisher, who said that sex drive or desire that the pursuit of someone to mate with, meaning to mate, the verb, not necessarily to find a mate, may be, she didn't say definitively, but may be a way to forage for potential love partners that the arc of this whole business is really the order that we're describing it, that it's desire, then love, and then attachment. And that oftentimes people can get confused. You may know some of these people, you may be one of these individuals who might confuse desire for attachment or might confuse love for attachment, but that there's a sequence of recruitment of these neural circuits that's established first from the pursuit of someone to mate with. And she's placed us in the context of more modern dating themes where depending on culture, people might explore several, maybe many, many individuals before, quote, unquote, settling down with somebody, at least for some period of time. I think that's an interesting framework because it circumvents a lot of the, frankly, unanswerable questions about whether or not humans were meant to be

monogamous or whether or not they weren't. Those are conversations that hold cultural context, that hold all sorts of context, that really can't be addressed in a laboratory setting. But this idea that sex drive is a way to forage for potential love partners and that love is a litmus test for whether or not longer term or deeper attachments can and will form, is one that at least makes sense to me. Later in the episode, we'll talk about this notion of sex drive and desire. I'll actually talk about some tools that have very strong data really to support them in terms of things that people can do or take to increase libido, both men and women, because there's actually quite good data on that now. But in the meantime, I want to talk about some of the work that Dr. Fisher has done in terms of categorizing people into... Again, we have four groups. These are distinct from the A, B, C, and D attachment styles described earlier. Although as I describe them, you might be able to map them somewhat onto those. And these four groups are groups that were defined through her studies of people that were, or are, I don't know if they were or if they are still on match.com, but a very extensive dataset. So again, millions if not tens of millions of individuals. The number I heard her quote, and forgive me if this is not accurate, is that in upwards of 40 million individuals, in terms of whether or not their neurochemical and hormone systems are tuned toward particular types of behaviors. What do I mean by that? Well, both men and women, males and females have both testosterone and estrogen. Typically, again, these are averages, but typically men have more testosterone than they do estrogen, and they have more testosterone than do women, and less estrogen than do women. Typically women have more estrogen than they do testosterone, again, averages. And they have less testosterone than men, more estrogen than men, and so on and so forth. But both hormone systems are active in both sets of individuals. And of course, all humans, as far as we know, manufacture both dopamine and serotonin. Dopamine, as I mentioned earlier, has a number of effects in the brain and body. But one of the primary effects is that it places us into states of motivation and pursuit for various things. There is somewhat close relationship between the dopamine system and the testosterone system in the hypothalamus, this brain area above the roof of your mouth. And the pituitary gland, which is responsible for making hormones that make the ovaries and or testes, secrete testosterone or estrogen. So there's a lot of signaling that occurs such that dopamine and testosterone tend to operate as close cousins in a system of pursuit. And conversely, the serotonin system tends to on average collaborate with the estrogen system to impart certain physiological functions and behaviors. So these aren't hard and fast, or I guess better stated, these

aren't strict black and white categorizations, but I think those general themes hold when you look at the animal and human data. So Dr. Fisher has taken some liberties, but I think they are what I would call logically, and scientifically, and neurobiologically grounded liberties in classifying individuals who are on these dating sites according to the types of things they report about themselves and the type of people they tend to match with on these dating sites, and created these four categories. The four categories are, she calls one, the dopamine category. So these are people who would have high dopamine. And again, that's just a name. It doesn't mean they have low anything else, but they are high on the dopamine scale. People who rate high on the dopamine scale tend to be what the scientists and psychologists call high sensation seeking, novel seeking. They like new things, they like spontaneity, they tend to be very adventurous. And I think that's largely true. If you look at the conditions where dopamine is super physiological, it's elevated beyond abnormal levels. Things like mania or when people take certain drugs of abuse, like cocaine or amphetamine that really raise dopamine levels up very, very high. For some period of time, they do tend to increase energy motivation and novelty seeking. And of course, drugs like amphetamine and cocaine have all sorts of deleterious effects that I don't need to go into here, but it's worth pointing out. But they don't tend to make people calm and relaxed and seek soothing interactions. Conversely, the group that Dr. Fisher calls the serotonin group tend to be more grounded in soothing activities, quiescent type activities. They actually tend to be, on average, they tend to like rules and follow rules, they tend to be homebodies, this sort of thing. They're really, you can imagine them this stable types, but they really like stability. They're not really into spontaneity as much, again, averages. And then she created two other categories, the testosterone category of high testosterone. This again, could be males or females. And then the estrogen category, again, could be males or females. And she gave these different names that I won't go into here. You can look up her work online, but she names like the director, and the follower, and things like that. But I don't really want to use those as much as I want to stick to the biological terms. So we have dopamine, serotonin, testosterone, and estrogen. Now that might seem like an unfair overgeneralization, but what's interesting is not necessarily the name or the neurochemical system, right? Those could have just been called category one, two, three and four for all that matters here. What is interesting is seeing how those different groups of individuals that she absolutely can categorize based on their self-reported preferences about behaviors and certain kinds of interactions. How those groups tend to

pair up with people in the same or opposite categories. So what her studies reveal is that people that fall into the high sensation seeking, novelty seeking, spontaneity category, the one that she calls the high dopamine category tend to pair up with, at least in the short term, tend to pair up with people who are also in that dopaminergic category. So these would be people that would spontaneously take a trip or explore something new or new restaurant. They tend to be creative and explorative types. So that group on average tends to date and mate, and potentially form long-term relationships within category. Again, averages. Individuals that she placed into the serotonin group or what she hypothesized would be a high serotonin group, again, they didn't measure serotonin, but people that tend to place value on stability, on rules, on certain forms of traditional organization at home and in relationships, those people also tended to pair up with select date, we presume mate with and form stable relationships with people in the same category. Now, individuals in the other two categories, the high testosterone group, and again, testosterone wasn't measured, but she called it the high testosterone group, but these are people that tend to be very directive, they tend to know what they want and are comfortable telling other people what they want. And from them, these are individuals that in her studies and in other studies tend to be a little bit challenging, meaning they not necessarily challenging to be around, but they tend to challenge other people, push them in order to expand their boundaries, either for sake of the relationship or just in general. And the people they tend to push are the people that they pair up with, which are the people in the estrogen category, what she called high estrogen. Again, they didn't measure estrogen, but the people in the estrogen category were the ones that described themselves and their choices in life and their preferences as being nurturing. They actually seem to like it when someone else is making the major decisions, not every decision. They certainly like to be heard, of course, in terms of their preferences. But that those two types, what she called the testosterone and the estrogen type tend to pair up. So why are these categorizations and these averages interesting to me, at least interesting enough to convey to you? The reason they're interesting to me is, again, not because of their names, these molecules were not measured in these individuals, but that they once again bring us to the themes that we addressed before, which are the autonomic nervous system and whether or not it tends to be shifted more towards alertness in action or more towards a stable equilibrium or more towards calm, and whether or not individuals are selecting for people who have autonomic nervous systems that are more or less like theirs before they even meet, right? So again, going back to

this seesaw analogy, it's almost like people who have the flat seesaw, alert but calm, but not extremely alert, not extremely overly calm in situations but in the middle, seem to be seeking out people that are also at that autonomic equilibrium. People in the, what she called the dopamine category, which are really can just be described as high sensation seeking, novelty seeking, they seem to want to pair with one another. So there's a selection for similar, in two of the groups, autonomic tone. I find that very interesting because in that decision or that preference for similar autonomic tone, it essentially eliminates a lot of the requirement for figuring out how to match one's autonomic nervous system to another. They simply find someone with a similar tendency, okay? Whereas in the other two groups that she called testosterone and estrogen, the director type and the nurturing somewhat follower type, there's an establishment of balance, but not in between two who individuals as a match, but rather on the whole in the relationship. One person is driving the novelty seeking in the course of decisions and actions, and the other person is essentially agreeing to those. Now, assuming that those decisions are good for both people. And I emphasize good for both people, because one of the themes that Dr. Fisher underscores, and I'd like to underscore here as well, is that it need not be the case that people pair up exactly according to these categorizations that I've described, dopamine with dopamine, serotonin with serotonin, testosterone with estrogen, and so on. What is important is that there be a recognition and a respect for the other types, or a recognition and a respect for the fact that both are of the same type. You could actually imagine, for instance, that two people of this high sensation seeking, novelty seeking could have a terrifically exciting relationship, but that it actually might be a relationship in which the financial stability isn't quite there, or in which the basic stability isn't there. You could imagine, for instance, a situation in which a relationship between two people of what she called the high serotonin preference would have a relationship that was actually dull, in which both of them found themselves bored at some point, or in which there wasn't enough of the dynamic tension that sometimes is required in order to keep this cycle of desire, love, and attachment going. Something that we will talk about in a moment. So the point here is not that one should necessarily pair up according to these arrangements that I described. The point is that on average, that's what tends to happen. And that through a recognition that these categorizations exist similar to the recognition that the type A, B, C, and D infant and toddler type attachments exist, that we can gain better self-awareness of who we are and how we tend to show up in romantic attachments, and thereby navigate healthier mate seeking, healthier

breakups, if the case dictates it, and in some cases healthy long-term relationships by understanding that the other person can either be similar or complimentary to us. One is neither better than the other. It's simply the case that in all romantic attachments, from the initial inception of the romantic attachment, desire, love, and attachment, there is an autonomic coordination. And of course there's coordination of all sorts of other things like food, sex, and sleep, and finances, and where people are going to live, and many other features, but that at the core of all that is a seeking of either autonomic likeness or autonomic differences. And I think that recognition can be extremely valuable in thinking about tools to enter and maintain relationships. If one thinks about their autonomic nervous system, not simply as something that is driven by external people and events, but that we can actually gain some control over through techniques of the sort that I talked about earlier and on previous podcasts, but also generally, if we are able to adjust our autonomic nervous system in order to at least appreciate or get some empathy into what someone else is experiencing, then we gain actual cognitive empathy. And this episode isn't about empathy per se, but the theme keeps coming up again and again. And I think it's worth mentioning that when you talk to psychologists, whether or not they're psychoanalyst or from another source of training, what you find is that they don't talk about empathy as a general term, they will talk about emotional empathy, they'll talk about cognitive empathy. And what I'm talking about here today is that

01:38:28 Neural Mechanisms of Romantic Attachment

yet a third category that is very strongly determinant of relationship dynamics, and that's autonomic empathy. I'm a biologist, I'm not a psychologist. So I love mechanism. And fortunately there are studies that have been done recently using modern techniques to look at neural mechanisms of romantic attachment. I mentioned earlier some of the brain imaging studies that have been done on child and mother literally imaging the activity of neurons in the brain as child is nursing, or as a mother is soothing baby, and as you learned earlier, baby is soothing mother as well. Those are remarkable studies. You may have seen some of these pictures online. You can see the silhouette of the infant and mother, and their brains and even some of the brain activation patterns, really, really beautiful studies. Similar studies have been done in romantic couples with those couples, either touching one another, touching and kissing, or in clever, I think, control experiments of the person just touching a pillow, [laughs] or something, or kissing a

pillow in order to try and create the most reasonable control for what are actually pretty complicated interpersonal dynamics to do in a brain imaging scanner. But some of the other studies that have been done recently involved so called EEG. So these are electrical recordings that are done noninvasively, putting a bunch of electrodes on the outside of the scalp. EEG is useful in that you can do it noninvasively, you can do it while people are moving and doing things, kissing, touching, et cetera. It doesn't allow one to image or to evaluate neural activity very deeply in the brain. So you can miss out on a lot of things. It's like looking at the wave structure on the ocean without actually looking into the depths of the ocean. So you can miss certain things, but if you see things generally you trust they're there, but you can't see what you don't see. Nonetheless, there's some studies that I'll just point you to and that form the segue for what I'm going to discuss in a moment, which is a study published in Scientific Reports in 2021, entitled "Investigating Real Life Emotions in Romantic Couples: a Mobile EEG Study." So this is, as the title suggests, having people wear these EEG caps of electrodes, get engage in very passionate, emotional kisses, emotional speech toward one another standing at different distances. So a lot of cool stuff that you can do that you really couldn't do in a brain scanner, because in a brain scanner, people have to be there usually in a bite bar, they're actually jaw flicked like this. I've been in one of these things. There's not a lot of moving around to be heard, at least not using the current technology. In any case, what they found was there is a shift in brain waves, brain states, things like alpha waves or just a particular frequency of brain waves in the neocortex, the outer shell of the brain just beneath the skull. And in people that are kissing or in people that are engaged in romantic speech, or I didn't actually hear what they said to one another, but what the couple seems exciting, romantic and arousing to them, they see more alpha wave activity compared to the control conditions. And there was some what we call lateralization, where the left hemisphere was more active than the right and so forth. And these studies are important because we know that the autonomic nervous systems of individuals tend to start to collaborate and actually synchronize at the level of heartbeats, at the level of breathing during romantic interactions of different kinds. But these studies are some of the first of their kind to start looking at neural synchronization between individuals. Now, the simple version of looking at this and the way I would've thought this would all go was, okay, two people start kissing, they start talking about what they find particularly romantic and arousing for them. And their brain waves will just match to one another. And that's really the basis of romantic attachment and romantic engagement in

that sort of thing. But it turns out that the opposite is true. So a really nice study published in a really fine journal, *Cerebral Cortex* is a journal that I've known about for many years, they published strong anatomy, physiology and neuroimaging. There's a study that was published, first author, Kajimura, and this paper really points... Again, this is 2021. And the title of this paper is, "Brain Knows Who Is on the Same Wavelength: Resting-State Connectivity Can Predict Compatibility of a Female-Male Relationship." Now what this study did was a little bit different. They looked at the resting or default mode activity of the brain. So rather than evoked activity, as it's called, where people are kissing or are engaged in some activity, this was a neuroimaging study, not EEG, but fMRI, functional magnetic resonance imaging, which is similar to EEG in principle, but allows you to look deep into the brain. And it has a very good resolution in time and space. So fast events can be monitored and the precise location of those events can be monitored somewhat better than EEG. And there are exceptions to this. So for you EEGers out there. EEG don't come after me with electrodes. Just understand that fMRI gives you a fuller picture of what's going on. And what Kajimura et al found was that contrary to what your reflexive prediction might be, people tend to select people that have resting brain states that different than theirs, or sometimes they found that are actually opposite to their own resting brain state. And you might say, "Well, that doesn't make any sense. I thought this is all about autonomic coordination." But actually if we go back to Helen Fisher's categorizations of the dopamine types, the sensation seeking types, that is serotonin, the stable rule following types, testosterone and estrogen types, remember that the two categories that she called testosterone and estrogen type, the director and the follower, the nurturer, I guess it would be the more accurate way, the director and the nurturer, those tend to pair up across categories, not within category. And so I think what's really needed for this field which to my knowledge hasn't happened yet, is to really start to map the neuroanatomical and neurophysiological findings of, in this case, that resting brain state is in one form in one individual, and they tend to seek out people whose resting brain state is different than theirs, not similar. That needs to be mapped onto the more subjective psychological categorizations that Helen Fisher and indeed the Gottman's and others have created, that sort of the state of the field now. And I mentioned this not to confuse you, but to the contrary, to illustrate that it's not just about finding someone just like you, and it's not just about finding someone who's opposite to you. This is actually the reason that I decided to become a biologist at some point in my life, which is that we can find verbal sayings, and stories, and examples to support just

about anything. This is not a knock on the field of psychology, as you can probably tell from today's episode. I have great respect for in reverence for the field of psychology, especially its collaboration with neuroscience and vice versa. But in the popular culture, we can find examples and sayings that support essentially anything as it relates to a relationship. For instance, I've heard and you've probably heard, absence makes the heart grow fonder. And indeed I've experienced that and I believe it's true. But I also have experienced and I believe to be true that out of sight out of mind also exists and that there will be a biological mechanism for that. The point here is that matching of same to same or same to different can both be effective in creating the desire, love, attachment process. It's a matter of, who is looking for same, and who is looking for different? And there, I think Dr. Fisher and the work of these neurophysiologist and brain imagers really does point in a direction whereby there is not one form of attachment that is going to be wholly above [indistinct] will predict good outcomes. There is not going to be a case in which opposites attract, and that's always the best rule to follow.

Sometimes it will, sometimes it won't. There is also not the case that people tend to pair up with similar. Sometimes it will be the case, sometimes it won't. Now there are certain statistics that support that statement. For instance, people, on average, people pair up with individuals of similar educational background, income, and attractiveness. That is true on average, but it's not always the case. And again, a knowledge of and a respect for the different categorizations of attachment, the different categorizations of mate seeking described by Fisher and others, and the recognition that matching of autonomic nervous systems but also mismatching of resting state brain networks

01:47:43 Autonomic Coordination in Relationships

are all at play in driving what we are calling desire, love and attachment. So in keeping with the exploration of the fact that there's a saying, or a book, or a song, or an example of pretty much any relationship dynamic, I want to now talk about an article that came out a little over 10 years ago that talked about the universality of love and the ability to fall in love. So this would be very much in line with the George Bernard Shaw quote that I mentioned earlier that "Love is really overestimating the differences between individuals." And again, I should say that is not something that I personally believe, although maybe I'm just diluting myself. I like to think that the people that we fall in love with are really special for us, that they could not easily be replaced with anybody else.

That's simply my stance. I'm not basing that on any hardcore neurobiological mechanism. But nonetheless, an article was published in The New York Times in 2015 that related to some psychological studies that were done, as well as some clinical work, as well as some, what I would call pop psychology or things that fall outside the domains of academic science. And the whole basis of this article was 36 questions that lead to love. And it involved a listing out indeed of 36 questions, divided into set one, set two, and set three that progressed from somewhat ordinary questions about life experience and self-report to more, let's call them deep questions about people's values and things that are emotionally close to them. And I'll just give an example of a few of these. You can find this easily online by just putting into your search engine, 36 questions that lead to love. Some of the questions in set number one, where for instance, what would constitute a perfect day for you? For what in your life do you feel most grateful? Kind of standard questionnaire stuff. In set two, what is your most treasured memory? What is your most terrible memory? So these, as you can tell, are drilling a little bit deeper into one's personal experience and emotional system. And then set three, questions 25 through 36 are things, what is a very embarrassing moment in your life? When did you last cry in front of another person and by yourself? What is something that's too serious to be joked about? So it's going deeper into one's emotional system. And even questions like, of all the people in your family, whose death would you find most disturbing and why? So pretty, pretty heavy stuff there at the end. Now, the reason this article got so much traction, and the reason I'm bringing it up today is that there was a statement that was made in and around this article that if two people went on a date or simply sat down and asked each other these questions, and each answered these questions and the other was paying attention carefully and at some level emotionally responding or not out responding, but certainly paying attention to the answers of the other person, that by the end of that exchange, where one person asks 36 questions and the other person answers all 36, and then the other person asks all 36 and the other person answers all 36, that they would fall in love, right? Which seems like a ridiculous thing. And yet it is the case that people who go through this exercise report feeling as if they know the other person quite well and feeling certain levels of attachment or even love and desire for the other person that they were, would not have predicted, excuse me, would not have predicted had they not gone through that process. So what's going on in this exchange of questions and answers of a progressively more emotional and deep level? Well, what I predict is going on is that inside of that exchange, people are creating a delusional

story about the nature of the exchange being a reflection of some deeper attachment. And so even though people are just exchanging words, they're not physically touching, they are not, at least not at the point where they're running these kinds of questionnaire studies. They may touch afterwards for all I know, and probably did in some cases, but they're not exchanging life experience in an immediate way. They're not actually going off into the world and doing things together yet. They are simply exchanging narrative. But we know based on recent studies and I've covered this before on this podcast, but I'll mention again, there was a study published in Cell Reports, a Cell Press journal, excellent journal showing that when individuals listen to the same narrative, their heart rates tend to synchronize or at least follow a very similar pattern, even if they're not in the same room listening to a given narrative. Whereas in this case, people are facing one another listening to the narratives of each other. Certainly they are having autonomic responses. And it stands to reason that their autonomic nervous systems are synchronizing much in the same way that the Cell Report study found that people will synchronize their autonomic nervous systems to a shared, heard story from another. In other words, whether or not we hear a story, watch a movie, listen to a song, or exchange our own individual stories, our autonomic nervous systems have the potential to map onto one another. So I'm not all that surprised that people find that they fall in love, in quotes, after answering these questions to one another, because essentially the way these questions are laid out is they establish a narrative. They establish a very personal narrative and the other person is listening very closely. And we don't have physiological or brain imaging studies to support what I'm about to say, but the reasonable interpretation is that that's causing some autonomic synchronization. So if you want to try this on a date or even it's actually been hypothesized that this could be useful for existing couples, even if they already know the answers to some of these questions. And that doesn't surprise me either. I think the autonomic coordination is present during mating behavior, it's present during shared experience of the outside world, movies, concerts, watching one's children with somebody else, et cetera. And it's established by sharing one's own narrative of their own personal experience. So I don't want to seem overly reductionist. I'll never propose that all of our sensation, perception, action and experience in life boils down to us just being bags of chemicals and the action of those chemicals, or any aspect of our nervous system. And yet in looking across the psychological literature of development of attachment, in the psychological literature of adult and romantic attachment, and what makes and breaks those attachments, it's very

clear to me. And I think courses through the literature multiple levels, that autonomic coordination is absolutely key for the establishment of desire, love and attachment. In fact, I talked earlier about how our actual conception is born out of autonomic coordination of one sort or another. So again, it doesn't necessarily mean that autonomic nervous systems always be synchronized in the case of the two categorizations that Fisher proposed of the director/testosterone type and the nurturing follower/estrogen type. It was actually the coordination but in opposite directions of individuals that fall into each of those categories that led to more stable attachments or the seeking out of those attachments, I should say. But nonetheless, it's, at least to my mind, very clear that autonomic coordination is a hallmark feature of desire, a hallmark feature of what we call love, and a hallmark feature of what we call attachment. And that the breaking of attachments were the failures of desire, the failures of love, and the failures of attachment over time in line with the work of Gottman and others. And in even just simply what's required for mating behavior is also reflected in the autonomic nervous system. But in that case, a failure to coordinate

01:56:13 Infidelity & Cheating

the autonomic nervous systems in some sort of concerted way. Any discussion about desire, love, and attachment would be incomplete if we didn't talk about the dreaded infidelity and cheating. Much has been made of infidelity and cheating and whether or not people who are higher on dopamine and sensation seeking tend to cheat more or less. Frankly, I don't think there's any solid evidence for that. I think there are a lot of examples that we can draw from in our own lives and in the lives of others that would generally support one or the other model, but I'm not aware of any decent physiological studies or psychological studies that really point to that. For instance, I would never say that the serotonergic phenotype as described by Fisher is less prone to cheat, or that the people who have an insecure attachment are more likely to cheat, et cetera, for instance. I don't think those correlations have been drawn in any kind of meaningful way yet. So I would be cautious about assigning them without that evidence. However, there are some interesting studies involving, again, neuroimaging and some subjective measures in humans, meaning asking them questions that they're good ways to tease out lies from truths in these sorts of studies and whether or not people tend to find their partner or others more or less attractive depending on how people feel about

themselves. And I think this is a very interesting aspect to desire, love, and attachment for the following reason. You hear a lot out there that in order to form a really strong relationship, you have to have a good relationship with yourself, or you have to love yourself. Or you often hear for instance that it's exactly when you're not looking for a relationship that you're going to find one. You hear this stuff, right? But none of that is really grounded in any studies. Again, that's like out of sight out of mind, or absence makes the heart grow fonder. There are many life examples to support those statements. And there are many life examples to support statements to the opposite. There's a particular study that I found. This was published in *Frontiers in Psychology*, but it's an experimental study that involves neuroimaging. The title of this study is "Manipulation of Self-Expansion Alters Responses to Attractive Alternative Partners." And I love the design of this study. What they did in this study is they took couples and they evaluated members of that relationship for what's called self-expansion. Now self-expansion is a metric that involves one's perception of self as seen through the relationship to the other. And this is something that was developed by, the authors are Aron and Aron. So they have the same last name. So I'm assuming this was either a sibling team or a somehow related team or a romantic couple team. A-R-O-N and A-R-O-N, Aron and Aron, in 1986, proposed this self-expansion model of close relationships. And they proposed "That people are motivated to enter relationships..." I'm reading here. "In order to enhance the self and increase self-efficacy." In other words, that one of the reasons why many people enter relationships is that it makes us feel good about ourselves and more capable. And I would see that as a healthy interdependence, not necessarily codependence. This is especially strong at the beginning of a relationship, it turns out, when people are forming pair bonds, and it's the case that pleasure, arousal and excitement, again, all hallmark features of autonomic nervous system function, pleasure, arousal and excitement, give rise to self-expansion, meaning to self-efficacy. So what this self-expansion model is really about is how great other people that we are close to and romantically attached to can potentially make us feel, in terms of what they say, in terms of what they do, in terms of the way in which we believe they feel about us. So it doesn't necessarily have to involve explicit statements of them telling us how great we are, or them doing great gestures for us, but how we actually feel they feel about us. Turns out to be a very strong parameter in terms of how we feel about ourselves and the relationship overall. Now, some of you out there are probably thinking, "Oh yeah, isn't there this thing of the love languages?" Right? I don't have any neuroscience to support,

I think, the love languages, I'm not super familiar with this, and I didn't list it out, but that some people are... Their autonomic nervous system, if you will, tends to be very responsive to gifts, or to quality time, or to physical touch, or acts of kindness. I think I've got a few of these right. I probably have a few wrong. Anyway, they're easy to find online. And people do tend to have a bias toward two or three of these things that are especially meaningful for them. And when I hear meaningful, I hear they tend to push the autonomic nervous system and neurochemical systems of the brain and body in a direction that makes us feel good as opposed to lousy or neutral. In any event, this study looked at whether or not people have high levels of self-expansion through the actions or statements of their significant other, and how that influences their perception of people outside the relationship. Meaning how attractive they perceive people outside the relationship to be, turns out to be strongly influenced by, A, whether or not their self-expansion is very strongly driven by the other person that they are involved with, that they're in the romantic relationship with, and whether or not that's being expressed to them. So here's how the study went. First of all, they rated or categorized individuals on the basis of the self-expansion metric. Some people have more of a potential to experience self-expansion through others, right? Some of us feel great about ourselves and we're topped off, the others don't feel so great about themselves, but they can feel much better in response to praise, in particular praise or self-expansion type behaviors or statements from people that we really care about. And still other people are a mixture of the two. They moderate levels of both. So they rated them on this scale. And then they had people experience self-expansion narratives. They heard their significant others say really terrific things about them and about the relationship, in particular, that the relationship that they have was exciting, novel and challenging. So that was one form of self-expansion. And they went into some detail as to why that was the case in their particular relationship. Or they heard a narrative from their significant other about strong feelings of love between the two that had been experienced previously in the relationship. So in the one case, it directed more towards them. And in the other case, it's more about the relationship itself. And then they did brain imaging of one person in the relationship while that person assessed the attractiveness of people outside the relationship. And what they found was that people who were primed for this self-expansion had lower activation of brain areas associated with assessing others' attractiveness than did the people who experienced a lot of self-expansion. Now the takeaway from that, at least the way I read the study is if you're with somebody who

really benefits from or experiences a lot of self-expansion, unless you really want them to pay attention to the attractiveness of other people, it stands to reason that they would benefit from more self-expansion type gestures or statements, okay? Not so much centered on the relationship. We have such a great relationship. There's so much love, it's so great, that too, but in the context of this study and these findings, that the person is really terrific, that the relationship that they've created together is really exciting, novel, and challenging, that there's a narrative around the relationship that really has a lot to do with the dynamics between the individuals, in particular, that the person who really likes self-expansion is vital to that dynamic, okay? So it's not looking down at the relationship as a set of equals. There is this bias written into this of that this person is really essential for the relationship. I'm not saying this is something that anyone has to do. I'm not saying this is right or wrong. This is just what the data say. But what's remarkable is that in the absence of those statements, people who have, or that rate high on this scale of self-expansion rate attractive alternative partners as more attractive. Now, that's interesting to me, because it may mean that their actual perception of others is changing. It's not that their opportunity to see others is changing, right? This is not a matter of them somehow getting access or no access to attractive alternative partners. Again, attractive alternative partners, literally the language in the title of this paper, they're still seeing all these attractive people. It's just that if they're feeling filled up, in air quotes, psychologically filled up, emotionally filled up, autonomically filled, enhanced in the language that we're using today by the self-expansion narrative, well then the same set of attractive faces appear less attractive to a given individual. Now, whether or not this predicts cheating or loyalty, [laughs] I certainly can't say. That would be very hard to assess in neuroimaging. And there, of course, people rarely if ever report accurately their cheating behavior. There's some studies in which confidentiality is assured to the point where people seem to be more trusting and willing to reveal cheating behavior. But if you look at the statistics on cheating behavior, it's very hard to track because people lie all the time about their cheating in and outside of the context of psychological and neuroimaging studies. But I find this study, again, the title, "Manipulation of Self-expansion Alters Responses to Attractive Alternative Partners" to be absolutely fascinating, because again, it points to the fact that the interactions with our significant others shapes our autonomic arousal, shapes our perception of self and thereby shapes our perception of other potential partners in the outside world, or shuts us down to the potential of other people in the outside world. So when I hear statements such as, it's

important that you love yourself in order to really fall in love with somebody else, or it is when one is not looking for a relationship that they're most likely to fall in love and form a stable relationship, I can filter that through these findings to say that it's really the person who needs a lot of self-expansion, stimulating statements or actions coming from other people that is most prone to seeing other potential partners out in the world as attractive. And in this sense, we can return to the autonomic nervous system as a glass that it can be filled up through various contexts. It can be filled up through our own ability to regulate it. It can be filled up through other people's ability to enhance our sense of wellbeing. And in some sense, this points to an idea where it is true that the better that we can feel about ourselves in the absence of any self-expansion type input from somebody else really does place us on more stable grounds, such that when we do receive that praise, or we do receive those acts of kindness, or service, or physical touch or whatever they are, that we are able to further enhance the way that we feel, but that we don't necessarily tether all of our feelings of self-worth or self-expansion to that one individual. So you might think that if person A can only receive the self-expansion from the statements, from the action of the they're involved with, person B, that that will form a very stable bond, but what this study points to is the fact that that's a very unstable bond. That person A is actually very susceptible to the attractiveness of others, because they're so desperately attached to this notion of self-expansion, even if they don't realize it. And so this really does point to the idea that, well, it is important to link our autonomic nervous systems to establish desire, love, and attachment that we want to have a stable internal representation of ourselves, a stable autonomic nervous system

02:08:56 "Chemistry", Subconscious Processes

to some degree in other so that we can be in stable romantic partnership with another individual, if that what we're really trying to do. So until now, I've been weaving together studies from the field of experimental psychology and the fields of neuroscience in particular neuroimaging. But if you recall back to the very beginning of the episode, when I was discussing how odors, and how hormones, and how even birth control can shape people's ratings of attractiveness of others, you'll realize that there's a deeper layer to all this, which is that our biology that resides below our conscious awareness, things like our hormones, things like pheromones even are shaping the way that we choose, interpret and act with other potential romantic partners or the romantic partners

that we already have. Now, this cannot be over-emphasized, right? No matter how much we would like to create a top-down description, meaning from the cortex and our understanding of things onto what we find attractive, who we find attractive, what we enjoy, what we don't enjoy in the pursuit in romantic interactions with others, there always seems to be, and indeed, there always is a deeper layer in which our subconscious processing drives us to find a particular person to be particularly attractive, or in which we have chemistry with somebody, or in which we lack chemistry with somebody. And I would say that one of the more exciting, fascinating, and indeed mysterious aspects of desire, love and attachment are those subconscious processes, those things that we call chemistry, right? I mean, people will report, for instance, that somebody's smell is just absolutely positively intoxicating for them, or that somebody's smell is absolutely repulsive to them and they don't know why. That the taste of someone's breath, and I don't mean that in any kind of poetic sense, I literally mean the taste of somebody's breath in some cases can be very exciting to somebody. And believe it or not, we can taste each other's breath. I talked about this in the chemical sensing episode some months back, but we actually have receptors for taste and smell that engage in coordinated action, such that we can't really separate taste and smell at some level. And this is especially true when it comes to the formation of romantic relationships and what we call chemistry. Now is chemistry absolutely required for forming stable attachments for love and for desire? No, of course, they're not. But in general, these are primitive mechanisms that exist in all animals, they exist in special forms in humans, but that they drive us toward behaviors that will, as the theory goes, lead to love and attachment. Not always, as Dr. Fisher pointed out that sex and sex drive is one way to explore potential love relationships, and to explore potential attachments, which, of course, are major investments that extend well beyond one night, or a week, or a vacation, or even a year. When we talk about stable attachments, in general, that means long-term attachments in humans. Now, there is a biology to all of that chemistry stuff. And the studies of oral contraception and men finding women more attractive at certain phases of their menstrual cycle, and women finding men more attractive at certain phases of the women's menstrual cycle point to the incredible power

02:12:44 Tools: Libido & Sex Drive

of those deeper biological mechanisms. In the "Huberman Lab Podcast," I discuss both

science and science-based tools. And so I'd be remiss if I didn't actually cover some of the tools that relate to those deeper biological mechanisms. Now, the hormones, testosterone and estrogen are almost always the first biological chemicals and hormones that are mentioned, and described, and explored when thinking about desire, and love and attachment, too, for that matter since love and attachment stem from desire. I did an entire episode about the biology of testosterone and estrogen and ways to optimize testosterone and estrogen. You can easily find that episode at hubermanlab.com. It's timestamped, there you can find all sorts of information about how certain behaviors or absence of behaviors drive up or down testosterone and estrogen. I also dispel some myths about sexual behavior and things like masturbation and how they relate to testosterone and estrogen, as well as some myths about how those hormones change across the lifespan. I also talk about the role of exercise, I talk about supplementation, and I also talk a little bit about hormone replacement therapy, although that will be the topic for a future episode. So if you're interested in the biology of testosterone and estrogen, two hormones that absolutely influence things like libido and desire, please check out that episode as well as what I'm going to talk about in just a moment here. The simple stereotyped version of the hormones, testosterone and estrogen are that testosterone drives libido or increases it aka sex drive, and that estrogen somehow blunts it or is not involved in libido and sex drive. And that is simply not the case. As I describe in that testosterone and estrogen optimization episode and as I'll tell you now, yes, testosterone and some of its other forms like dihydrotestosterone are strongly related to libido and sex drive and the pursuit and ability to mate. However, the hormone estrogen is also strongly associated with libido and mating behavior. So much so that for people that either chemically or for some other reason have very low estrogen, libido can severely suffer. So it's a coordinated dance of estrogen and testosterone in both males and females that leads to libido or sex drive. So I absolutely want to make clear that it's not a simple relationship between testosterone and sex drive, or estrogen and sex drive. Both are required at appropriate ratios. Now, with that said, there are things that can shift libido in both men and women in the direction of more desire or more desire to mate, either to seek mates or to mate with existing partners. And there's a quite solid literature around a few of those substances. Now, a common misconception is that because dopamine is involved in motivation and drive that simply increasing dopamine through any number of different mechanisms or tools will increase libido and sex drive. And that's simply not the case either. It is true that some level of

dopamine or increase in dopamine is required for increases in libido. However, because of dopamine's relationship to the autonomic nervous system, and because the autonomic nervous system is so intimately involved, no pun intended, in sexual activity in seeking an actual mating behavior, as I described earlier, it's actually the case that if people drive their dopamine system too high, they will be in states of arousal that are high enough such that they seek and want sexual activity, but they can't actually engage the parasympathetic arm of the autonomic nervous system sufficient to become physically aroused. There's a whole description of this that awaits us in a future episode. But I'll summarize now by saying for people that are taking substances just simply to increase dopamine in order to increase libido, that can be a potentially hazardous route to follow. Because depending on whether or not that dopamine level is high enough that it puts them into a mode of seeking mates or mating, but they can't adjust their autonomic nervous system during actual mating behavior, what essentially is I'm saying is it can place people into a chronic pursuit but in inability to perform sexually. And this is true for men and women. Okay, so I would just caution people against just thinking, "Oh, a lack of libido is simply a lack of dopamine." That is not the case. It could be from lower levels of dopamine, but it could also be for other reasons. And so these systems, these signaling systems and these neurochemicals are very intricate. And just simply ramping up dopamine has actually been found, for instance, in amphetamine and cocaine users, there's a phenomenon in which they become hyper aroused, but can't perform sexually. This is also true for people who take elevated levels of other recreational drugs or who take antidepressants that increase the dopamine system too much, right? Dosage has to be worked out with your physician, with your psychiatrist, such that mood is enhanced and the various aspects of a healthy wellbeing, mind and body are enhanced, but not so much so that that what we call the arousal arc is locked with the seesaw in the sympathetic drive position such that sexual arousal can't occur, okay? So this is an important point to make, because I think that a lot of people are under the impression that if they just drive up testosterone, increase dopamine, and generally get themselves into high states of autonomic arousal that that's going to increase the libido. But that's simply not the way the system works. It's that seesaw and that seesawing back and forth that is the arc of arousal that we talked about earlier. Now, there are substances, legal over-the-counter substances that fall under the categorization of supplements that do indeed increase libido and arousal. And so I'm going to talk about some of those in the context of peer-reviewed literature now. I want to be clear, however, that these are by no

means required. Many people have healthy libidos or have libidos that are healthy for their life and what they need and want. And as always in any discussion about supplementation, you absolutely have to check with your physician. I don't just say that to protect us. I say that to protect you. Your health and wellbeing is dependent on you doing certain things and not doing others, and everybody is different. Nonetheless, there are studies that point to specific substances that are sold over the counter that at least in the United States are legal and that have been shown to be statistically significant in increasing measures of libido. There are many such substances, but three that in particular have good peer-reviewed research to support them are Maca, M-A-C-A, which is actually a root. Tongkat Ali, also sometimes called longjack,

02:20:20 Maca (Maca root)

I didn't name them, forgive me, and Tribulus, or Tribulus, it's sometimes called. I'm going to talk about each of these in sequence. But on the whole, the studies on Maca are quite convincing that consumption of two to three grams per day of Maca, which generally is sold as a powder or a capsule, typically consumed early in the day, because it can be somewhat of a stimulant, meaning it can increase alertness and you wouldn't want it to interfere with sleep by taking it too late in the day. But in studies that include both men and women of durations anywhere from eight to 12 weeks of athletes and non-athletes, and different variations of Maca, turns out there's black Maca, red Maca, yellow Maca. There are a bunch of different forms of Maca. But that they can increase subjective reports of sexual desire, independent of hormone systems. Meaning, it does not seem at least based on the existing literature that Maca increases testosterone or changes estrogen, at least not on the time scales that these studies were done, or with the measures that were performed in these studies. But that Maca, again, consumed in doses of anywhere from two to three grams per day, has been shown to significantly increase libido. And in fact, those dosages of Maca have been shown to offset so-called SSRI induced sexual dysfunction. So there are various routes to sexual dysfunction. The SSRIs are selective serotonin reuptake inhibitors. They go by name brands like Prozac and Zoloft, and there are many others now on generic forms and so forth. Those don't always, I should point out, lead to sexual dysfunction. There's a dose dependence. Some people do quite well on SSRIs and don't have any issues with sexual function. Other people suffer quite a lot from sexual dysfunction while taking SSRIs, highly

variable. You need to work with a physician, a qualified psychiatrist. But nonetheless, everything I've been saying about Maca thus far has also been explored in the context of SSRI induced sexual dysfunction. The paper that I'm referring to here is "A Double-Blind, Randomized, Pilot Dose-Finding Study of Maca Root..." It goes by the name L. meyenii. These always have fancy names. And the Latin names in biology are always more complicated, but it's Maca root. "for the Management of SSRI-Induced Sexual Dysfunction." First author is Dording, D-O-R-D-I-N-G. This was a study done at Mass General, which is one of the satellite locations around Harvard Med. It's associated with Harvard Med, that found significant improvements in libido when people were taking a pretty low dose. It was actually in this case, just 1.5 grams per day, up to a high dose, three grams per day of Maca. And they were doing this in 20 remitted depressed outpatients. So these are people that had depression, their depression was successfully treated with SSRIs, but they were suffering from some of these SSRI related sexual effects and Maca seemed to offset some of those effects significantly in this population. The other studies exploring the lack of effect on serum testosterone in adult healthy men was a 12-week study, again, consuming anywhere from 1.5 to three milligrams, meaning one, excuse me, 1500 milligrams to 3000 milligrams or placebo. So again, this is 1.5 up to three grams of Maca or placebo, and they rated sexual desire, depression, and other measures such as testosterone in the blood. Again, no change in testosterone or estrogen estradiol levels in men treated with Maca and those treated with placebo. But nonetheless, there was a significant and positive effect on libido with this dosage of 1.5 to three grams per day of Maca. And there are several other studies that also show this. Again, in people that taking SSRIs and people that are not taking SSRIs, in chronically over-trained athletes, this was also found to be the case. So seems like across the board, Maca is a fairly useful supplement for those that are seeking to increase their libido. And there are fewer studies involving women, but there are a few such studies that also point to the same general positive effect on libido in women taking Maca at equivalent doses to those I just described. I think it's noteworthy that Maca supplementation does not seem to adjust testosterone or estrogen levels to any significant degree, but it does change libido. I think that points to the fact that there are multiple systems in the brain and body that influence libido, not just testosterone and estrogen. And indeed we know that to be the case. Things like PEA, which is a substance found in chocolate and is a substance that some people supplement, is known, for instance, to increase sexual desire, but also the perception of sexual

experiences as more stimulating for instance. So there are a lot of pathways in the brain, in particular, in the hypothalamus, this ancient area of our brain, that harbors neurons and hormone secreting cells, including neurons that can shape our perceptions of even just our tactile experience of others and their attractiveness.

02:25:58 Tongkat Ali (Longjack)

And indeed can shift levels of desire, independent of changing levels of circulating hormones. Another substance that has been shown to increase libido across a range of human populations is so-called Tongkat Ali. I've talked a little bit about this before on the "Huberman Lab Podcast" in reference to testosterone. And I've talked about it extensively as a guest on other podcasts. Tongkat Ali goes by a number of different names. One of them is exceedingly difficult for me to pronounce. It's *Eurycoma longifolia*, also called longjack. But Tongkat Ali is the typical name. This is an herb, there's a Malaysian version and an Indonesian version. My understanding is that the Indonesian variety of Tongkat Ali is the one that is most potent for its effects on libido. Previously, I've talked about Tongkat Ali taken in 400 milligram per day capsules as a means to increase the amount of free, meaning unbound testosterone. So testosterone has a both bound form and an unbound form. Very briefly, the bound form is bound to albumin in the blood or to so-called sex hormone binding globulin. When it's bound, it can't be biologically active at many cells. It is important that some of it be bound in order to get a time release and proper distribution of testosterone through the body, but is the unbound free testosterone that can really have its most potent effects. And there's some evidence that Tongkat Ali can increase the amount of unbound so-called free testosterone by lowering sex hormone binding globulin, although it is almost certain that it has other routes of mechanism as well. Nonetheless, there are some reports of Tongkat Ali increasing libido. One particular article, last author, or I should say last name of first author, excuse me, Ismail, I-S-M-A-I-L. This was published in *Evidence-Based Complementary and Alternative Medicine*, it's from 2012. Reports a significant increase in libido and sexual function. There are other studies, not a lot of them, not as many robust, controlled, quality peer-reviewed studies as there are from Maca. Nonetheless, a number of people, men and women that I know do take Tongkat Ali and it seems to work well for them. The question always comes up around discussion of supplements. Do you need to cycle these things? The only way to determine that is really to do your blood

work, monitor liver enzymes, monitor hormone levels and so forth. So I simply can't say whether or not you need to, or you don't need to cycle them. Typically Tongkat Ali and Maca are not cycled in any regular kind of way that I'm aware of. But again, you really need to check with your doctor if you're going to initiate taking any of these things. And you certainly should do your best to monitor

02:28:56 Tribulus terrestris

your blood work as well as subjective measures in evaluating whether or not they're working for you, safe for you and so forth. The third and final substance/supplement that I want to touch on as it relates to libido is called Tribulus Terrestris. So that's T-R-I-B-U-L-U-S, terrestris, T-E-R-R-E-S-T-R-I-S. This is a commonly sold over-the-counter supplement for increasing testosterone, for fitness purposes and so on. Whether or not it actually does that to a meaningful degree, isn't clear. But I'm aware of four peer-reviewed studies that were focused on both males and females ranging anywhere from 18 years old all the way up to 65 plus. They say 65 plus. I guess it could be 70, it could be 80. I don't know. But a fairly broad age range where people took anywhere from 750 milligrams per day divided into three equal doses. So 750 total per day divided into three equal doses of Tribulus or placebo for 120 days. This particular study was focused on females. And according to the female sexual function index questionnaire, no significant difference between any of the groups, however free and bio-available testosterone increased in the group taking Tribulus Terrestris, total testosterone did not reach statistical significance. So this is the inverse of what we see with Maca, where there do seem to be increases in testosterone, which would predict that there would be increase in libido. In this case, this was postmenopausal women, there was no increase in libido. There was an increase in testosterone. I mentioned it only because there might be instances in which people want to increase their testosterone. It does seem that Tribulus, at least in that population is capable of doing that. Now there's a separate study that was done, a double-blind study lasting anywhere from one to six months that had a clear and significant increase in libido. Now this was taking six grams. So that's 6,000 milligrams of Tribulus root for 60 days. And it did seem to increase various aspects of sexual function. And there was what appeared to be a substantial 16.3% increase in testosterone, but in this particular study because of the variability across individuals that did not actually arrive at statistical significance. Now, there were a number of other

studies that explored the role of Tribulus, in particular, in females. And one of those studies was a study that was actually quite short, it was two to four weeks. It involved 67 subjects. These were subjects that had experienced a loss of libido and took Tribulus divided into two equal doses, compared that to placebo. And they did see a significant improvement in these measures of sexual desire and function on this female sexual function index. So there is some evidence that Tribulus can be effective in increasing testosterone in certain populations, in increasing sexual desire and function in certain populations in particular in females. I think more studies are certainly needed. But these three substances/supplements, Maca, Tongkat Ali, in particular, Indonesian Tongkat Ali, and Tribulus can indeed create significant increases in sexual desire. And in some cases by adjusting the testosterone and estrogen system, in some cases not by adjusting the testosterone and estrogen system. Again, pointing to the complexity of neurochemicals and features that adjust things like libido aka desire. So we covered a lot of material today related to desire, love, and attachment. And yet I acknowledge that it is not exhaustive of the vast landscape that is the psychology and biology of desire, love and attachment. Nonetheless, I hope that you found the information interesting and hopefully actionable in some cases

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covered on Instagram and Twitter. During today's episode and on many previous episodes of the "Huberman Lab Podcast," we discussed supplements. While supplements aren't necessary or appropriate for everybody, many people derive tremendous benefit from them, for things like enhancing sleep, enhancing focus, or as discussed today for enhancing libido and desire. If you want to see the supplements that I take, you can go to Thorne, that's thorne.com/u/huberman. And there you can get 20% off the supplements that I take. And if you navigate deeper into the Thorne site through that portal, thorne.com/u/huberman, you can also get 20% off any of the other supplements that Thorne makes. We partnered with Thorne because Thorne has the absolute highest standards with respect to the quality of the ingredients in their supplements and the precision of the amounts of those supplements. Thank you for joining me for today's discussion about desire, love, and attachment. And last but certainly not least, thank you for your interest in science.