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 discussing dopamine.
Dopamine is a topic that I've covered before on this podcast, and many people have heard of dopamine.
Most people know that dopamine is involved in pleasure, to some extent or another.
And nowadays, people are starting to appreciate that dopamine is also intimately involved with motivation, drive, and pursuit.
Well, today you're going to learn that indeed, dopamine is responsible for all of those things, but you are also going to learn that dopamine is critical for overcoming procrastination, for ensuring ongoing motivation, and indeed for ensuring confidence.
In fact, we are going to talk about the relationship between dopamine and motivation and confidence at the level of neurobiological circuitry, and we are going to cover tools that will allow you to leverage your dopamine in order to have a maximum motivation to overcome sticking points, which include things like procrastination, but also by understanding the neural circuits in the brain and body that release and use dopamine, but more importantly, by understanding what are called dopamine dynamics.
That is, what gives rise to big peaks in dopamine, or troughs in dopamine, or what's referred to as our baseline level of dopamine, which turns out to be our baseline levels of motivation and feelings of well-being.
By understanding how those things relate to one another, I assure you that by the end of today's episode, you will be in a far better position to understand why you become amotivated, why you procrastinate, how to ensure motivation on an ongoing basis, and even how to leverage effort and the desire to become motivated as a way to do just that, to become more motivated.
Today's discussion is not about psychology, although I will center around practical everyday examples and offer many, many tools that you can implement if you choose.
Today's discussion is really about pulling apart these things that we call motivation, reward, pleasure, procrastination, and understanding them in terms of their dopamine dynamics.
Whether you've heard me or others talk about dopamine before, or whether or not today is your first exposure to the topic of dopamine, today's episode is really designed to give you the biological and practical knowledge so that you can leverage your dopamine circuitry and your dopamine levels as well as tools to adjust dopamine circuitry and levels in order to optimize mental health, physical health, and performance.
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 Helix Sleep.
Helix Sleep makes mattresses and pillows that are the absolute highest quality.

I've talked many times before on this and other podcasts about the critical role that sleep plays in allowing you to be awake and alert and have a good elevated mood throughout the day.
Sleep is just fundamental to our mental health, physical health, and performance, and there's no replacing great sleep.
A key thing we all need in order to get excellent sleep is to have an ideal sleep environment.
Helix mattresses are designed for your unique sleep needs in order to ensure that you get the best possible night's sleep.
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I matched to the Dusk mattress.
That's the one that works for me.
And since sleeping on the Dusk mattress now for well over two years, I've been sleeping better than I ever have before.
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Just go to helixsleep.com slash Huberman, take their two-minute sleep quiz, and they'll match you to a customized mattress, and you'll get up to $350 off any mattress order and two free pillows.
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Today's episode is also brought to us by Whoop.
Whoop is a fitness wearable device that tracks your daily activity and sleep, but also goes beyond that by providing real-time feedback on how to adjust your physical training and sleep schedule and other activities throughout your day in order to optimize your health.
I've been working with Whoop on their Scientific Advisory Council to help advance Whoop's technology
and mission of unlocking human performance, not just for athletes, but for everybody.
As a Whoop user, I've experienced the health benefits of their technology firsthand.
For instance, it tells me, of course, whether or not I had a good night's sleep or a poor night's sleep by giving me a sleep score.
It tells me the percentage of rapid eye movement, sleep to slow wave sleep.
But Whoop also tells me, for instance, whether or not certain activities during my daytime, such as naps or training or training of a certain amount of intensity, how that's impacting my sleep and vice versa.
If you're interested in trying Whoop, you can go to join.whoop.com slash Huberman.
Again that join.whoop.com slash Huberman today and you'll get your first month free.
Today's episode is also brought to us by Roka.
Roka makes eyeglasses and sunglasses that are uniquely tailored to the needs of athletes and everyday people.
The company was founded by two all-American swimmers from Stanford and everything about

Roka eyeglasses and sunglasses were designed with the biology, the visual system in mind.
I've spent a lifetime working on the biology, the visual system, and I can tell you that your visual system has to contend with enormous number of challenges in order for you to be able to see clearly.
Roka eyeglasses and sunglasses are designed such that when you go from one environment to the next, like a brightly lit environment to a less, a brightly lit environment, you don't notice that transition.
You always see with perfect clarity.
Another terrific thing about Roka eyeglasses and sunglasses is that many of the performance glasses out there that are designed for sport make people look like cyborgs, which if you want that, they do have those options, the cyborg options as I call them, but they also have many options where the aesthetic is more of the sort that you would wear to dinner or to work or anywhere that you happen to be.
If you'd like to try Roka eyeglasses or sunglasses, go to Roka, that's R-O-K-A dot com and enter the code Huberman to save 20% off your first order.
Again, that's Roka R-O-K-A dot com and enter the code Huberman at checkout.
The Huberman Lab podcast is now partnered with Momentus Supplements.
To find the supplements we discussed on the Huberman Lab podcast, you can go to livemomentus spelled O-U-S livemomentus.com slash Huberman.
I should just mention that the library of those supplements is constantly expanding.
Again, that's livemomentus.com slash Huberman.
Okay, let's talk about dopamine.
What is dopamine?
Dopamine is what's called a neuromodulator, which simply refers to the fact that it's a chemical that modulates or changes the electrical activity of other cells.
The cells I'm referring to are neurons.
Neurons are just nerve cells.
You have a brain and a spinal cord and the neurons in your brain and spinal cord connect to one another and they connect to different areas of the body, including basically every organ of your body and every organ of your body communicates back to your brain and spinal cord through direct or indirect pathways.
For instance, you have neurons in your gut that sense what sorts of nutrients you've eaten or drank and then send neural signals, electrical signals up to the brain.
And indeed that whole process happens to be modulated by dopamine.
Even as a neuromodulator has the basic property of either ramping up, increasing or decreasing the activity of other neurons.
And that's done by adjusting things like electrical potentials and things of that sort that we really won't go into this episode, but that I promise to get into in detail in a future episode if you're interested in the biochemistry and biophysics of neurons and things of that sort.
So we have this neuromodulator dopamine and we know that that neuromodulator can increase or decrease the activity of other neurons.
So then we have to ask ourselves, where is dopamine released in the brain and body?

And what specific types of neurons is it impacting?
In other words, what specific types of functions does dopamine have?
So there are basically five circuits within the brain that use dopamine as the primary neuromodulator and those five circuits engage different but related functions.
So I'm going to go through them one by one relatively quickly, giving you a little bit of nomenclature and some sense of what each of those circuits looks like and what it does.
The first circuit is the so-called nigrostriatal pathway.
So in the back of the brain, there's an area called substantia nigra.
So named because the neurons, they are actually very dark, they actually contain pigment.
You'd be able to see this.
If I were to slice up a brain, you'd see two dark regions in the back.
That substantia nigra, substantia nigra contains neurons that are chock a block full of dopamine, but they release that dopamine in a brain structure called the striatum.
The striatum is involved in a movement, both the initiation of movements and the suppression of movements in so-called go action and no go suppress action pathways, a topic for a future podcast.
The second brain circuit that uses and leverages dopamine to a great extent is a so-called meso limbic pathway.
Now you'll also in a moment hear about the mesocortical pathway.
So today I'm going to talk about these somewhat interchangeably at times, but where it's important for me to differentiate between them, I will do that.
Both of these pathways initiate from a set of neurons in the so-called ventral tegmental area or VTA, I will use that acronym, VTA.
The VTA functions in close partnership with a different brain structure called the nucleus accumbens or NA.
I don't think I'll call it NA today.
I'll talk about VTA, ventral tegmental area, and I'll talk about nucleus accumbens.
For sake of today's discussion, you can lump those together if you want.
Neurons in those areas project a bunch of different places, but in the meso limbic pathway, those neurons are projecting to areas of the brain like the hypothalamus, which sits right above the roof of your mouth and is responsible for a lot of basic functions, things like maintaining your body temperature for libido and the pursuit of sex, for hunger, for the generation of signals to the pituitary gland that caused the release of hormones and other things into the bloodstream.
The connections, which I sometimes refer to as projections, from the neurons in the VTA and nucleus accumbens to the hypothalamus are basically using dopamine to modulate the output of a lot of different things that happen in this hypothalamus that controls a lot of, we could call them primitive functions, but they're really basic functions for survival.
The other pathway out of the VTA and nucleus accumbens is to the cortex.
That's why it's called mesocortical pathway.
This is a very different pathway out of the VTA and nucleus accumbens than the one I just described a moment ago.
The pathway I'm talking about now, the mesocortical pathway, projects to the prefrontal cortex,

which is a structure that many of you have perhaps heard of, but even if you haven't, it's important to know this is an area that resides right behind your forehead and that in humans compared to other species is greatly expanded in terms of its size and complexity of function.
It evolved in everything from planning and executing of action to making good or bad decisions depending on context.
In fact, one of the primary functions of prefrontal cortex is to really understand context, whether or not, for instance, you are alone in your room where certain behaviors are appropriate, whether or not you are at work where other behaviors are appropriate, understanding what the context is and therefore what sorts of actions need to be generated and suppressed.
In fact, a guest on the Huberman Lab podcast, and this is a guest whose episode hasn't aired yet described this beautifully.
He's a neurosurgeon and he said, the way to think about the prefrontal cortex is it's basically an area of the brain that says, or no, not now to other brain regions in order to suppress action.
And we know this because people that have damage to the prefrontal cortex often can't suppress their impulses.
So the pathway from VTA and nucleus accumbens to the prefrontal cortex is absolutely critical for today's discussion because we are largely going to be discussing motivation, drive, pursuit, procrastination, and all sorts of things that have to do with our feelings about context, whether or not we want to do something or not, whether or not we feel we should or we shouldn't, whether or not we feel we failed the last time or there's a high probability of success the next time.
Prefrontal cortex does many, many things, but when thinking about dopamine's role in the prefrontal cortex, that is when thinking about this mesocortical pathway, we really want to think about how dopamine is activating or changing our propensity to do certain things and get us into action or prevent us from doing certain things and prevent action.
So basically you can think about the mesocortical pathway as a circuit that really governs all of the major choices that you're going to make in life about what to do and what not to do toward your goals and away from the things that you want to avoid.
Now the fourth dopamine pathway in the brain is the so-called tuberoinfundibular pathway and this is not one we're going to focus on too much today.
This is a pathway that relates to connections between the brain and your pituitary gland.
Your pituitary gland being that gland that's, as I mentioned a moment ago, is also receiving input from the hypothalamus and is releasing a bunch of hormones into your bloodstream, things like luteinizing hormone, follicle stimulating hormone, things like melanocortin hormone.
There are hormones that are impacting everything from the function of the ovary and females to the function of the testes and males.
It's governing things like cortisol release under stress, thyroid hormone, meaning it's regulating thyroid hormone release, and on and on.
Dopamine has a very powerful impact on the output of the pituitary.
So again, that's probably a topic for a future episode, but it's important in reviewing the

different brain circuits that use dopamine as a neuromodulator that I mentioned that one.
And there's a fifth one, and this fifth one is not often discussed, and again, won't be the main topic of today's discussion, but for thoroughness and for clarity, it's important that we mention it.
This is the circuit within your retina, that is the pie crust like lining of neural tissue on the back of your eye, because remember, your eye is actually part of your brain that got extruded from your brain during development.
Those two eyes that you see in the mirror and that you see in other people are actually two pieces of central nervous system, and within the retina, which is the neural portion of the eye, within the neural retina, dopamine is responsible for adapting to different light conditions so that you can see clearly both in the evening and when it gets darker, you can still see a bit.
And in the morning when it's very bright, you don't really have to make adjustments to your visual system in order to see clearly your visual system does it for you.
And one of the ways that it does that is through the neuromodulator dopamine.
So today we are not going to discuss the retinal dopamine pathways or the tuber infundibular dopamine pathways, and we won't really talk so much about the nigrostriatal pathway.
I'll say one more thing about it and then I'll leave it alone.
We are going to talk about the mesocortical pathway and we might touch on the mesolimbic pathway a little bit as well.
So today we're mostly going to talk about mesocortical circuitry and function and dopamine within the mesocortical circuit.
And the reason that we're doing that is that today's discussion is really about motivation, procrastination, goal setting and pursuit.
It's very important to understand that neither dopamine nor the mesocortical circuit cares about any specific goal or pursuit.
This is a circuit that uses dopamine in order to pursue anything.
Now, of course, some people have a greater propensity to pursue things like work or goals in athletics or relationships or a combination of those.
Other people, unfortunately, have a greater propensity to pursue things like drugs of abuse.
What are drugs of abuse?
Drugs of abuse tend to be drugs that increase levels of dopamine to the extent that other types of pursuits in life that are adaptive for us like work, relationship, school, etc. become irrelevant.
In fact, the definition of addiction that I use and that I believe really matches the neurobiology very well is that addiction is a progressive narrowing of the things that bring us pleasure.
The functioning of the mesocortical pathway, however, allows us to toggle or switch back and forth between different types of pursuits of all the sorts that I've mentioned earlier.
If we can understand how that mesocortical pathway works just a little bit, in particular, when dopamine is released and when it's not released, what dopamine does when it's released to our sense of motivation and drive.

If we can understand a little bit about how our recent dopamine history, that is, whether or not there is dopamine in our system already dictates whether or not we are going to feel motivated in the next five, 10, 15 minutes, hours, days, and weeks.
That is all very easy to understand.
I promise I'll explain it to you in a simple way, but I want you to get a circuit into your mind.
I want you to envision that there are these neurons, little nerve cells in the VTA and nucleus accumbens.
Those neurons make dopamine.
They send their projections that we call axons, which are like little wires, and they can release dopamine into the prefrontal cortex.
Now you already know, because you learned it a few minutes ago, that the prefrontal cortex then can ensure that certain behaviors take place and other behaviors do not take place, that shh, or quieting that we talked about earlier.
With that in mind, let's now take a look at how dopamine is released and let's keep two things in mind.
There are peaks in dopamine.
That is, dopamine is released into the frontal cortex where it has these effects of activating or suppressing action.
We can think of those as peaks in dopamine.
If I call it a spike, that means an increase and then a decrease.
If I call it a peak, it's an increase and then a decrease.
There can also be troughs in dopamine.
What do I mean by that?
Well, we have peaks in dopamine and that peak in dopamine can rise up and then go back to what we call baseline, or there can be a trough.
It can go below baseline.
The two key things to understand about dopamine is that we have dopamine peaks that are triggered
by certain behaviors, certain compounds, drugs, or substances, food, et cetera, and that we have a dopamine baseline.
Our dopamine baseline is our reservoir of dopamine.
It's how full or empty our dopamine pool is.
That dopamine pool is the pool of dopamine that we use in order to create those dopamine peaks.
When those peaks come down, sometimes they go back to baseline and sometimes they go to lower than baseline, which we call the trough.
If any of this seems confusing, I want you just to imagine a wave pool.
This is an analogy that was given to me by one of our podcast guests, which is Dr. Kyle Gillette, who's an obesity specialist and works on a number of things related to endocrine hormone function, including testosterone, estrogen, and both men and women.
I want to check out his episodes on hormone health.
They're fascinating and actionable.

He's a tremendous wealth of knowledge, and he has this analogy for how dopamine works in our brain and body, and that analogy is this notion of a wave pool.
If you've ever seen a wave pool, it's basically a concrete pool, and there are waves within it, duh.
Those waves can be of different heights, so they can be little ripples, and we can think of those as little mini peaks, or they can be big waves.
They can be really big crashing waves.
If the height of those waves and the frequency of those waves is very, very large, some of that water, which here I'm using as an analogy to dopamine, can slosh out of the wave pool and the baseline drops.
However, if those peaks are small enough or they are seldom enough, well, then the baseline, that is the water level in that pool, stays more or less constant.
I think this is an excellent analogy for how dopamine works in the mesocortical pathway as it relates to motivation and pursuit and all those sorts of things, because we really need to think about how the peaks and the baseline relate to one another, and this is very important.
The peaks and the baseline are not independent of one another, they relate to one another.
Now you have in your mind a wave pool, and just understand that if you get a great big huge wave, maybe one of them, it will crash out, and some of that water will splash out.
The baseline will go down a little bit, but if you get big peak after big peak after big peak, pretty soon you're going to empty that pool, whereas if you have smaller waves or less frequent big waves, well, then the baseline will stay relatively constant.
So let's think about dopamine peaks and baselines, and let's remember that for every peak, there's a trough.
What do I mean by that?
Well, when you have a wave, you also have the bottom of the wave.
When you have a mountain, you have the bottom of the mountain.
When we think about dopamine peaks and dopamine baselines, we have to include that trough because
that trough, that is the level of dopamine below baseline, really dictates whether or not you are going to feel motivated to pursue something or not.
So I'm going to give you a visual in your mind.
The visual in your mind is an increase in dopamine that's triggered by your desire for something, and really could be your desire for anything.
If you're hungry and you're thinking about, oh, I really want a sandwich, I really want to, let's think, what sandwich would I want right now?
Really nice roast beef sandwich on sourdough with a slice of Swiss tomatoes, slice of pickle.
Here I'm describing the sandwich that I would want.
So if you're hungry and you're thinking about that, dopamine starts rising.
This is crucially important to understand.
Dopamine is not just released when we get the reward, when we get the thing that we're pursuing.
It is released in anticipation of what we want.

That increase in dopamine is by no happenstance, no mistake relates also to our propensity and desire to move.
Remember earlier, I told you there's a separate circuit of dopamine that triggers movement and that when it's depleted is causing things like deficits and movement related to Parkinson's or other movement disorders.
Well, that's not pure coincidence.
That's because desire and the need to move in order to pursue and reach goals are one in the same process.
So if I desire a sandwich or I desire a cup of coffee or I desire some water when I'm thirsty, there's an increase in dopamine that we could call a little mini peak in dopamine.
But then here's the key thing.
Very soon after I realized my desire for something, that peak that was caused by the desire comes down and drops below baseline below the level of dopamine that it was prior to even thinking about the sandwich or the coffee or the glass of water.
And it's that drop below baseline that triggers my desire to go out and find that sandwich, that coffee, that water or that blank, insert whatever it is that you happen to desire action or substance of any kind or person, et cetera.
So that drop below baseline is fundamental to the whole process and that drop below baseline was triggered by the preceding peak.
So let's say that I desire a sandwich, there's an increase in dopamine, then very quickly it comes down below baseline just a little bit.
Now I'm in pursuit of the sandwich I'm looking for where I can get that sandwich, I can order it perhaps to be delivered, I can go out and find it.
Now is the stage in which I have to think about what are the different stimuli that is the things in my environment that signal whether or not I'm likely to get that sandwich or not.
And so for instance, if I were to go into my phone and order food on a nap or walk down the street and see the sign for a deli, that's a cue that I'm likely to relieve that drop in dopamine and get not just back to baseline, but that I'll get a peak in dopamine.
And indeed, that's what happens.
If I find that deli, I go into the deli, they're open, they're making the sandwich that I want, they make my sandwich and great, I get that sandwich and that sandwich will have some degree of inherent reward to it, some degree of my liking it or not liking it.
So let's say I like it, it's not the best sandwich I've ever had, but all I'm doing is comparing my desire for that sandwich to the sandwich that I actually got an eight.
And chances are it's going to relieve that craving, meaning it will take that dopamine that had fallen below baseline up, up, back to baseline.
And if I like the sandwich, it's going to indeed increase that dopamine again to another peak.
Now, if I love the sandwich, like it's the most delicious thing that I've ever tasted my entire life, well, then I'll get a big peak in dopamine when I consume that reward.
However, chances are that sandwiches more or less as I expect it to be, which is pretty good.

I'll eat it and I'm fine.
What do I mean by fine?
Well, there's a concept called reward prediction error.
Reward prediction error says that the dopamine that it is experienced, that is, that's released from the VTA and nucleus accumbens, is going to be of a certain value.
And that value is going to be compared to the desire and expectation of what I thought I was going to get.
So if you take what you actually got minus what you expected, that's reward prediction error.
So if the sandwich is basically what I expected to get fine, dopamine comes down basically to a baseline level that's pretty standard for me and is basically the baseline level I had before I ever thought about the sandwich at all.
If the sandwich completely surprises me and is completely amazing, just an amazing sandwich, well then the level of dopamine that I experienced when I consume that sandwich is going to be even greater and it's going to be that minus what I expected.
So there it's a bigger reward prediction error in the direction of higher peak by consuming the sandwich.
And then of course there's the other possibility, which is the deli's closed or the sandwich they make me is lousy or it doesn't taste good or something happened in the consuming of that sandwich that just makes a bad experience, in which case, if we take that reward experienced minus reward predicted from the initial craving, well then it's going to be less than what I expected and therefore the baseline drops below where it was prior to even desiring the sandwich.
Okay, so all of this might seem a little bit complicated, but it's all very simple.
Desire for things increases dopamine, but then our level of dopamine drops below baseline and it's that drop below baseline that triggers the motivation to bring that dopamine level back up by going and pursuing the thing that you wanted in the first place.
Now, of course, as this is happening, you're not conscious of your dopamine levels.
You experience this as context dependent craving and pursuit because remember the prefrontal cortex is involved in context setting and craving and pursuit because it relates to action and movement, which is one of the general features of the dopamine system.
So you can start to see how this is a beautifully designed system and you can also see how it's a perfect system for desire and pursuit of anything, not just sandwiches as I'm giving you in this somewhat trivial, but everyday and therefore applicable example.
So just by understanding reward prediction error and especially by understanding that a craving triggers a peak in dopamine that makes you motivated, but then drops your level of dopamine below baseline, which makes you even more motivated.
You are already halfway through the conceptual aspect of today's podcast because if you can understand that, you will understand why, for instance, when you initially want something or you think you want something, it puts you into motion, but then pretty quickly you're starting to feel the pain of not having that and that is also contributing to your desire to pursue that thing.
This is a subtle effect, but if you watch for it, you'll start to see it or experience

it within yourself.
Your craving for things is not just about craving for those things per se.
It's also a desire to relieve the pain of not having those things.
And if you can internalize that and start to develop an awareness around it, you will be in an amazing position to leverage all sorts of aspects of the dopamine system in order to increase your motivation, especially when things get really hard or when you have the propensity to procrastinate, which is something that we'll get into a little bit later in the podcast.
I'd like to take a quick break and acknowledge one of our sponsors, Athletic Greens.
Athletic Greens now called AG1 is a vitamin mineral probiotic drink that covers all of your foundational nutritional needs.
I've been taking Athletic Greens since 2012, so I'm delighted that they're sponsoring the podcast.
The reason I started taking Athletic Greens and the reason I still take Athletic Greens once or usually twice a day is that it gets to be the probiotics that I need for gut health.
Our gut is very important.
It's populated by gut microbiota that communicate with the brain, the immune system, and basically all the biological systems of our body to strongly impact our immediate and long-term health, and those probiotics and Athletic Greens are optimal and vital for microbiotic health.
In addition, Athletic Greens contains a number of adaptogens, vitamins, and minerals that make sure that all of my foundational nutritional needs are met, and it tastes great.
If you'd like to try Athletic Greens, you can go to athleticgreens.com slash huberman, and they'll give you five free travel packs that make it really easy to mix up Athletic Greens while you're on the road and the car on the plane, et cetera, and they'll give you a year's supply of vitamin D3K2.
Again, that's athleticgreens.com slash huberman to get the five free travel packs and the year's supply of vitamin D3K2.
Now I'd like to talk about the dynamics of dopamine release with a little bit more detail.
This is something I've never covered on any social media post or on any podcast, either this one or as a guest on other podcasts, because on the face of it, it might seem a little too detailed.
Like, why is he telling me all this?
Isn't it just enough to know that there are peaks and troughs and baselines and dopamine?
Well, it turns out that if you can understand what that peak and trough are really about, in other words, what's really happening when we zoom in on that peak and trough, you'll be in an amazing position to overcome procrastination and essentially pursue any goals in an ongoing
basis.
So I'm very excited to share this information with you because I do think that it has tremendous actionable power.
What I'm about to describe relates to a number of different findings that have been made mostly over the last five to 10 years, although to be quite direct, mostly within the last five

years.
And it has to do with the fact that the peak and trough and baseline that I talked about a moment ago that are associated with craving, they look like a peak followed by a trough followed by a return to baseline and maybe another peak, if you get the reward or a drop below baseline, if you don't or you don't like what you got.
But if we were to zoom in on that peak and the reward, in other words, to really zoom in on the whole process and start thinking about the circuitry, that is the neurons in VTA and nucleus accumbens and how it relates to the frontal cortex in a bit more detail.
What we discover is nothing short of amazing.
What we discover is that whenever we're pursuing something, we are always looking for cues as to whether or not we are on the right path to achieve that thing.
And we are also setting a mindset or a context within our brains as to whether or not we are confident or pessimistic as to whether or not we're going to achieve that thing.
Now, this is vitally important for anyone out there who finds it hard to get motivated and stay motivated.
It's also vitally important for anyone who's psychologically minded in any way.
You don't have to be a psychologist, but psychologically minded in any way and wonders why is it that some people are just so motivated and other people have such trouble with motivation?
Why is it that some people require perfect conditions in order to achieve things?
And other people just seem to manage to pursue things no matter what.
It also relates to the fact that some of us are very good at achieving our goals in one context and not so much in another.
So here's what you need to understand.
I'll stay with the example of the roast beef sandwich just because we already have that in mind, but you can replace roast beef sandwich with essentially any goal.
The queue that we're going to likely get what we want.
So for instance, the sign that there's a deli on the corner or that I open my phone and that there's an app that represents a restaurant that sells the particular sandwich that I like.
That queue, as I mentioned before, increases dopamine.
You see that and like, oh, okay.
And subconsciously, there's already a signal that's initiated by that dopamine that I'm on the right path.
Then as I mentioned, dopamine drops below baseline, that's further contributing to my desire to go pursue that sandwich, either with my thumbs on my phone through the app or with my feet and walking to the deli standing in line and so forth.
Then as I mentioned before, there is a peak in dopamine of varying height, depending on how satisfying I find the reward to be when I actually get that sandwich, get that goal.
Now keep in mind, there is some time delay between the queue, the app, the deli, et cetera, and when I get my sandwich.
That gap is going to be different for different things.
So in pursuing a four-year degree, it's going to be four years if the diploma is your goal.
If it's an exam you're studying for, it might be a week long.

And there will be many other signals in between that initial queue that, hey, the reward likely lies down this path, in this textbook, on this dating app or at that deli.
There are many other queues.
Those queues come in subconsciously and involve everything from how long the line is at the deli to whether or not you're seeing the types of people on a dating app that you'd like to see, whether or not they're responding to you, whether or not someone's texting you back or not.
All of those queues are integrated and adjusting your baseline level of dopamine all the time as you go to pursue that goal.
So what the dopamine system does is it doesn't just compare the height of the peak at the beginning.
I desire that to the reward that you got.
We talked about reward prediction error.
That's the first grade version of reward prediction error.
It's also taking into account all the things that happen in between, and all of that is serving as a queue for the eventual reward, and all of that is funneling into what we call reward prediction error.
In other words, the dopamine system is very good at subconsciously parsing what are the things that happen between wanting and getting, and that's part of the learning that dopamine achieves.
And indeed, there are specialized circuits from the VTA and nucleus accumbens that are involved in just the learning of how we achieve or don't achieve specific types of rewards that we desire.
So this is called reward contingent learning because it's learning the contingencies of what led up to a reward or what didn't lead up to a reward.
At the same time, end in parallel, there's an ongoing release of dopamine in the background, and that ongoing release of dopamine that has nothing to do with learning is really just sort of a propeller that's driving us in the direction of whatever it is that we're trying to pursue.
So I realize for some of you, this might seem like unnecessary or perhaps even an overwhelming amount of detail, but it's actually quite simple.
Your brain is trying to figure out what happened prior to getting or not getting a reward, and it's comparing what you wanted compared to what you got.
At the same time, the dopamine system initiates a motivation signal that takes you through that entire round of pursuit.
And those three things, there's the stimulus, the desire that I want that.
That's the first thing that leads to that peak, the peak drops a little bit below baseline, and it triggers motivation.
The motivation is the second thing.
The motivation is dopamine release also, but from a separate set of neurons within this circuit, driving you forward.
And the entire time that it's driving you forward, it's paying attention to what's there along the way, even if you don't realize it consciously.

And then there's the reward itself or the lack of reward itself.
So those three components, the learning contingency, which has to do with the stimulus and the reward and everything that happens in between, and the propeller nature of dopamine, as I'm referring to it, those all combine into a total learning so that after you get the sandwich or after you finish the exam or after you go out on a date or after you do anything that you desire to do, that system that originates in the VTA and nucleus accumbens and goes up to your cortex, it learned.
It learned many things.
It learned the contingency between stimulus and desire or motivation and whether or not you succeeded or not.
It's basically a scoreboard for how you did, given what just happened.
So actually it's all very simple.
In fact, if you can understand even just half of what I just said, you are now in a far better position to understand everything from addiction to motivation to procrastination, and it will make sense of all the tools that I'm going to talk about next, which will allow you to overcome procrastination points, to overcome deficits and motivation, and indeed to reset your motivation in an ongoing way so that you can reach your goals.
Okay, so let's take everything that I just told you and set it aside.
It's still important, but let's just set it aside.
You don't have to think about any of those details or names or anything.
Let's just think about addiction because in biology and in psychology, frankly, it really often pays to think about the extremes first and then work our way towards more typical circumstances.
And with that said, addiction, unfortunately, is very common nowadays.
I just heard a statistic in fact that there is an 80, 80% increase in alcohol use disorder among women in the last 30 years.
I talked a little bit about this in the episode that I did about alcohol and health.
Again, I want to be very clear.
I'm not somebody that is completely against alcohol for adults provided they're not alcoholics.
Turns out two drinks a week, probably fine health wise, zero would be better.
If we're honest, zero is better than any alcohol.
But two drinks a week is probably fine.
Past two drinks, you start running into problems.
And yet many, many people out there, male and female alike suffer from alcohol use disorder, also called alcoholism.
The same is also true for things like methamphetamine or cocaine or other types of substance addictions.
And the same is also true for a lot of behavioral or what are sometimes called process addictions.
Things like sex addiction or video game addiction or any type of behavior that frankly is leveraging the dopamine system, but that engages this progressive narrowing of the things that bring someone pleasure such that nothing else is really salient.
Nothing else is really pulling them in in the way that their video games or sex or pornography or alcohol, pick your substance or, you know, behavior that you see out there or hopefully

not, but that you might suffer from an addiction to.
So what's happening in addiction?
Well, addiction involves dopamine, among other things, often the opioid system, et cetera.
But if we were to think about what's the stimulus in an addiction and what's the peak in dopamine and then what happens after that peak, it all becomes very clear as to why addiction happens and why it's so pernicious.
So for instance, let's take cocaine.
Cocaine causes dramatic increases in dopamine very, very fast.
So if somebody craves cocaine, what are they craving?
They're craving that dopamine peak.
They're craving the increased level of alertness.
They're craving a number of things associated with the feeling of being under the influence of the drug, but the stimulus for it simply becomes that line of cocaine or in the case of crack, that crack rock that they're going to smoke.
God forbid they're mainlining it, you know, they're shooting into a vein.
What happens is they snort, smoke or inject cocaine and dopamine levels almost immediately go up, up, up, up, up, up to a very high peak.
Okay, so the time gap between the stimulus and the dopamine is very, very short.
So short in fact, that there's really no other contingencies in between that the mesocortical system has to learn.
In fact, what is the system, quote unquote, learn?
It learns cocaine equals massive amounts of dopamine equals feeling euphoric and energetic, et cetera.
And in doing that, it reinforces the whole circuit so that that short, we can even say hyper short contingency is really what the system wants.
So much so that longer contingencies of say putting in the hard work of, you know, generating a fitness program or a professional program for yourself or a education program, which takes not just many days, but many weeks and years.
Well, none of that is going to lead to peaks in dopamine that are as high as the peak in dopamine associated with cocaine.
So that tells us something critical.
It is both the duration between desire and effect.
And when I say effect, I mean the rewarding properties of dopamine that are experienced.
That's important.
So very short gaps teach the system to expect and want short gaps, makes it very hard to pursue things that take longer.
So when we say it's the short or in this case, hyper short distance or time between the stimulus and the dopamine, what we're really talking about, if we were to plot this out on a, on a board or on a piece of paper is the steepness of the rise of that peak.
It's very, very steep.
The peak in dopamine is coming up very fast after the desire.
And in addition to that, and this is very important, the higher the peak in dopamine and the faster the rise to that peak, the further below baseline, the dopamine drops

after the drug wears off.
Okay.
So in the case of cocaine, it's a very fast and very large rise in dopamine followed by a steep drop and very deep trough in dopamine below baseline.
You say, okay, so there's pleasure, then there's lack of pleasure.
Ah, but it's worse than that.
Because it's not just lack of pleasure.
If you recall what we talked about a little bit earlier, that drop below baseline triggers the desire and the pursuit for what?
For more.
And so this sets in motion a vicious loop where people start pursuing peaks and dopamine that can come very fast without much effort.
And that's one of the ways in which addiction starts to take hold.
Now, there's a simple way to think about this and to remember if you want to avoid this whole thing.
The first one is obvious.
Don't do cocaine.
Don't try it.
Don't use it.
Certainly don't get addicted to it.
Those are all sort of one in the same, frankly.
I don't know many people that despite opinions to the contrary that use cocaine recreationally, that don't at some point run into either a financial, psychological, physical or some other problem.
The other thing that's absolutely critical to keep in mind, and this was discussed in my colleague, Dr. Anna Lemke's book, Dopamine Nation and on this podcast, excellent book, by the way, I highly recommended if you haven't read it already, it's a fascinating exploration into dopamine as it relates to addiction, not just drug addiction, but other types of addiction.
Again, the name of that book is Dopamine Nation.
We'll provide a link to it in the show note captions.
The other thing that happens after those big, fast increases in dopamine caused by things like cocaine is afterwards when it quickly drops below baseline, it takes a much longer time to get back to the original baseline than it did prior to using the drug.
And worse still is that the peaks in dopamine that are created from more consumption of cocaine leads to progressively lower peaks and deeper troughs below baseline.
So the whole system is shifting away from pleasure and more to pain and the desire for pursuit of the drug.
This is a terrible situation, and it's a terrible situation that's not just unique to cocaine.
In fact, if we were to look at the averages, and again, these are averages of the height of the peaks in dopamine that are created by different substances and the rates at which those peaks take place, because remember, the time to peak is just as important as how high that peak goes.

We see some pretty interesting numbers.
So for instance, and again, these are averages based on neuroimaging combined with what are called PET scans, positron emission tomography, combined with blood draws and a number of other data from both animal and human studies, you find is that at baseline, just kind of on a background of no drug taking of any kind, the neurons in the venture to mental nucleus accumbent area are firing at a rate of about three to four per second, releasing dopamine.
So that's your baseline of dopamine release.
Your forebrain is always seeing a little bit of dopamine from that system.
If you were then to anticipate food and you're relatively hungry, that would double.
So this probably happened when you decide to eat lunch today, if you were hungry prior to eating lunch, it doubles in the anticipation of the food.
And then depending on how much you enjoyed that food, it might triple or quadruple, it might be lower than it was during the anticipation as we talked about before.
So there's an approximate doubling under conditions of desiring and consuming food.
Let's take nicotine as the next example.
For people that use nicotine, either smoking, vaping, snuffing or dipping, all routes of nicotine administration that I covered in our episode about nicotine, there's about a 150% increase in the rate of dopamine neuron firing.
Cocaine is going to increase the rate of dopamine output into the prefrontal cortex by about 1000%.
Okay.
So what you're really talking about here is a 10 fold increase in the amount of dopamine that's released into the prefrontal cortex as measured by the rates of firing of these dopamine neurons.
Decimphetamine is going to be anywhere from 1000%, anywhere up to 10,000%.
It really varies depending on the potency of the drug and a few other factors.
And here's where perhaps it gets a little more interesting.
Some of you are probably wondering about caffeine or about sex or about video games.
Now they're the numbers very tremendously.
And it's really important to understand that across the board, not just for caffeine, sex, video games, but also for nicotine, alcohol and other substances and what we call motivated behaviors, some of which are part of a healthy life like eating and reproduction, you know, provided it's, you know, age appropriate, context appropriate, you know, species appropriate, consensual.
Well, then we considered adaptive.
It's not well, then considered not maladaptive.
Some people will sit down to play a video game, they really like video games and as they're sitting down, they will experience a five-fold increase in the rate of dopamine output from their nucleus accumbens for other people.
It's going to be a 10-fold increase for other people like me who don't like video games very much.
I don't have anything against them.
I don't dislike them, but it doesn't do much for me.

It might not cause any increase whatsoever.
It might even cause a decrease in dopamine.
So there's a lot of individual variability for sex.
It turns out to be a range.
So the typical range that's cited in the literature is anywhere from a four to five-fold increase in the rate of dopamine neuron firing.
However, there are certain individuals for which that number is doubled.
Caffeine is a little bit of a special circumstance because caffeine has the property of not just causing the release of dopamine, but increasing the amount of dopamine receptors over time.
And there aren't a lot of excellent measurements of the amount of dopamine released as a function of caffeine intake in different populations of humans.
It's mostly animal studies.
But what we think based on the gestalt, based on the overall picture of the literature is that it's an approximate doubling of the dopamine signaling that's coming out of the VTA nucleus accumbens to prefrontal cortex when we anticipate and when we drink our coffee.
Again, I really want to be clear that for all of these things, these are relative levels and they are distribution.
So if we were to plot them out on paper, you would see that these are not bar graphs.
These are overlapping curves to some extent.
So some people are going to achieve more dopamine release or less dopamine release from one behavior or substance.
However, it's very clear that cocaine, methamphetamine, even heroin for that matter, are way out on the right-hand side of the curve, causing enormous increases in dopamine very quickly.
And the other things that we described have, again, a distribution that is more leftward shifted on this imaginary plot that I'm creating.
It's a lot of individual variability.
However, it's fascinating that dopamine is the single molecule that's causing the craving and pursuit and experience of all of these substances and behaviors.
And the learning of all of that craving pursuit and actual experience is what predicts whether or not we will re-engage, reuse that substance or not re-engage in a behavior or not and how frequently we will do that.
So that's addiction.
But if you understand how the height of those peaks in dopamine and the rate to reach those peaks and the troughs that result and how long the troughs take to get back to baseline, if you understand or a little or all of that, you're really in a terrific position to understand how to leverage the dopamine system for the pursuit of healthy goals and behaviors.
I should mention one thing about recovery from addiction, which is that the reset of all that dopamine circuitry from unhealthy to healthy often involves, depending on the addiction, 30 days of complete abstinence.
That 30 days of complete abstinence inevitably involves a lot of pain and discomfort and craving, anxiety, insomnia, et cetera, that relates to the big trough in dopamine that inevitably occurs.
Now, of course, there are some addictions such as severe alcohol addiction and in some

cases opiate addiction that immediate and sustained abstinence cannot be used as the tool.
Somebody really needs to work with an addiction specialist and sometimes there needs to be a tapering off of the substance.
For other addictions, it can be quote unquote cold turkey.
And then of course, there are other addictions, particular food and sex, but sometimes even things like video games for which the desired outcome is not necessarily to eliminate the behavior completely, but to set some constraints around the behavior so that it's not occurring to the exclusion of other pleasurable things in life and adaptive things in life.
And for that, there is the requirement for what are called a binding behaviors.
We'll get back to binding behaviors later, but binding behaviors are behaviors in which people bind their behavior around a particular substance use or around a particular behavioral addiction like sex, video games, et cetera, in space and or time in space, meaning they might only engage in those particular behaviors in certain places and certain times when it's context appropriate.
And there are numerous examples of binding behaviors in space and time, and it all has to do with clamping or directing when the engagement with the dopamine releasing behavior is going
to occur.
So what's happening when people decide to go cold turkey or they use these binding behaviors?
Well, what's happening is that people are engaging the specific circuitry within the prefrontal cortex.
That as I mentioned at the beginning of the episode are important for context setting.
So in the cases of binding behaviors, the prefrontal cortex is essentially getting trained up to understand that, okay, certain things like food or perhaps sex or perhaps video games, they're okay if they are done or consumed in appropriate amounts or in particular context.
That requires the context setting goal directed behavior that the prefrontal cortex is responsible.
Okay.
So for the last 10 or 15 minutes, we've been talking a lot about addiction and actually this is not an episode about addiction.
However, if you understand a little bit about the dopamine dynamics and addiction, you can leverage that knowledge towards healthy adaptive goal pursuit and achieving your goals.
So let's think about that in the context of what generates dopamine peaks, what generates desire to pursue goals, what causes our readout of whether or not we achieved a goal or not.
In other words, what allows us to learn how to pursue goals of different kinds, not just get good at achieving one kind of goal, but really understand and get really, really good at setting goals and pursuing goals of different kinds that are adaptive in different areas of life because we all are going to have to pursue goals in school, work, relationships, fitness, mental health and on and on in order to be our best selves.
That's clear.
Well, all of that is possible using the same basic set of dopamine circuits and the same basic dynamics of dopamine.
So for instance, if we are going to feel motivated at all, that is, if we are going to wake up

in the morning or have any period of time during our day in which we feel like we are capable of pursuing goals, we are going to have to have a healthy level of baseline dopamine. In other words, we are going to have to have enough dopamine in the wave pool, enough water in the wave pool that is before we can generate any waves or peaks in dopamine, let alone troughs and the rest.

So how do we achieve a healthy baseline level of dopamine?

Well, there we can really look to some foundational practices, practices that perhaps you've heard about on this podcast before and that to some of you might seem a little mundane, although some of them are a bit more sophisticated, maybe even esoteric.

The good news is that we can all control these things and they don't require purchasing anything, but they do require some degree of regular upkeep and effort.

Those things include what I call the very basics.

Now the very basics put in the context of today's discussion are the things that put water in the wave pool.

Those are going to be getting sufficient amounts of quality sleep each night, something that we've done several episodes on and have online toolkits for.

So you can see the master your sleep episode, the perfect your sleep episode, the light and health episode.

If you want to skip all that and just get right to the tools, we have a sleep toolkit or it's actually called the toolkit for sleep that you can access at hubermanlab.com completely zero cost.

You just go there and download that toolkit.

Getting sufficient sleep each night literally restores your dopamine reserves.

It allows dopamine to be present.

And for you to have a level of baseline dopamine that will allow you to even consider your goals in any kind of meaningful or reasonable way.

Second, there are practices that are supported by the scientific literature to increase your baseline level of dopamine that are independent of sleep, but are similar to sleep.

And I like to refer to these as a non sleep deep rest.

This is not meditation.

There's actually very little evidence that meditation of the traditional kind of, you know, sitting eyes closed, third eye sent focusing on your, a third eye center, which is this area behind your forehead.

There is very little evidence that that increases levels of dopamine.

There is a place for meditation in the context of today's discussion, but I'll repeat.

Meditation itself is a focusing exercise.

It is not known to increase dopamine.

However, non sleep, deep breaths, so-called NSDR, very similar, although different to what's sometimes called yoga, Nidra, which is where you lie there.

You do a sort of body scan, some long exhale, breathing, NSDR is very similar.

You can find a link to a zero cost NSDR on YouTube.

It's a 10 minute long one.

There are also 20 and 30 minute ones out there also on YouTube, but I'll provide a link to

the 10 minute one.
Those have been shown to increase the amount of dopamine in your dopamine reserves by up to 65%, which is a remarkable number.
So quality sleep, non sleep, deep rest, AKA yoga, Nidra, very powerful ways to keep your baseline level of dopamine at a sufficient level.
In addition to that, nutrition, no doubt plays a role in your baseline level of dopamine because tyrosine, the amino acid is the rate limiting enzyme for the synthesis of dopamine.
Tyrosine is present in varying levels in different foods.
You can look those up online.
You can just simply put in a search for tyrosine levels in different foods, everything from particular cheeses, like Parmesan cheese as high levels of tyrosine, certain meats, certain nuts, certain vegetables, without getting into details and specifics, you can find those there.
But you need proper nutrition and therefore nutrients in particular tyrosine in order to have sufficient levels of baseline dopamine.
The third thing on the list, and again, these are things that we come back to almost every episode, but I don't think they can be repeated enough because these are really things that we need to focus on every 24 hours.
You might be able to skip a day here or there if you get sick or you're traveling or you have some major life event, but really every 24 hours, we need to re-up our sleep.
We need to re-up our nutrients, even if you're fasting, you're re-upping your nutrients from stored sources within your body.
The third thing is sunlight, morning sunlight in particular.
I've done extensive episodes about this.
Check out the episode on lighting your health if you want all the details, but you want to try and view sunlight as early in the day as possible, five to 10 minutes on a clear day, minimum 10 to 20 minutes on a cloudy day, minimum 20 or 30 minutes on a very overcast day, minimum without sunglasses.
Don't stare at the sun.
Please don't damage your eyes.
Look off slightly off from the sun, but yes, you want to face the eastward towards the sun and on those cloudy days.
That's especially important to do.
Why?
Well, viewing morning sunlight increases cortisol early in the day, which is excellent.
Because you want cortisol elevated early in the day and you want it lower later in the day.
And because of the relationship between the cells in your eye that sense sunlight, specifically morning sunlight, believe it or not, that happens and signal to your hypothalamus and the relationship between the hypothalamus and the pituitary and other endocrine organs, it sets in motion a dopamine related cascade in neuromodulators, dopamine and hormones that lead to states of wellbeing, elevated mood, alertness, et cetera, throughout the day.

It also helps your sleep at night, but today we're talking about dopamine.
So yes, believe it or not, that morning sunlight exposure does increase your levels of dopamine, not just cortisol.
And fourth on the list is going to be movement, exercise of varying kinds.
Be resistance training.
Could be cardiovascular training.
That does increase levels of dopamine.
Here we're not talking about achieving peaks in dopamine.
That could be accomplished through setting a personal record, a PR or through sprints or heavy lifts or learning some new dynamic movement.
What we're really talking about here is getting into a regular exercise program of if not every day, at least five days a week, a mixture of cardiovascular and resistance exercise.
That we also know is known to elevate and maintain an elevated level of baseline dopamine.
So it's not just about the euphoria you feel during or after exercise.
It's also about the baseline level of dopamine that's achieved through regular movement and engaging in movement.
And if you're asking, how could that be?
Well, you already know the answer.
The circuits in the brain and body that generate movement, not just goal seeking, but movement itself, as I mentioned earlier, that nigrostriatal pathway.
And yes, that circuit is separate from the VTA, nucleus accumbens to cortical circuit, the mesocortical circuit that we've mainly been focusing on today, but they interact.
And so by engaging in regular movement, you ensure that you're maintaining elevated levels of baseline dopamine, which is what you want if you're going to be able to engage in any kind of motivated pursuit behavior of any kind.
So those are the fundamentals that will set the level of baseline dopamine in your system.
A couple of key points.
Yes, there is variation based on both genetics and circumstance in baseline levels of dopamine.
Someone's going through a particular hard time.
Or if somebody inherited a gene in the dopamine synthesis pathway that simply affords them higher levels of baseline dopamine, we likely know these people, they seem hyper motivated all the time, not just based on prior success, but they just seem to have a lot of energy and a lot of go drive, you know, you talk about activation energy.
Some of you may know what that term means, others of you won't having low activation energy is great.
It's the amount of energy that it takes to get into action to pursue adaptive and meaningful, healthy goals.
Some people just seem to have lower activation energy and higher levels of dopamine are probably associated with that.
Some of us have lower levels of baseline dopamine, regardless, everyone needs to engage in the foundational things that I just mentioned a few moments ago, every 24 hours or at least strive to, there is no escaping that I'd like to just take a brief moment and thank one of our podcast sponsors, which is 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 blood work is the only way that you can monitor the markers such as hormone markers, lipids, metabolic factors, et cetera, the impact your immediate and longterm health.
One major challenge with blood work, however, is that most of the time it does not come back with any information about what to do in order to move the values for hormones, metabolic factors, lipids, et cetera, into the ranges that you want.
With inside tracker, changing those values becomes very straightforward because it has a personalized dashboard that you can use to address the nutrition-based, behavior-based, supplement-based approaches that you can use in order to move those values into the ranges that are optimal for you, your vitality, and your longevity.
Inside tracker now includes a measurement of apolipoprotein B, so-called APOB in their ultimate plan.
APOB is a key marker of cardiovascular health, and therefore there's extreme value to knowing your APOB levels.
If you'd like to try Inside Tracker, you can go to insidetracker.com slash Huberman to get 20% off any of Inside Tracker's plans.
Again, that's insidetracker.com slash Huberman to get 20% off.
Now there are things that can increase one's baseline level of dopamine further, and some of those get us into the realm of supplements and prescription drugs, but for now, I just want to mention a few of them that are purely behavioral in nature, are zero cost, and that have been shown in the research literature to increase baseline levels of dopamine for long periods of time.
This is important because if any of you are out there listening to this thing about peaks and troughs and baselines, you might be asking, wait, what's the difference between a baseline and a peak, really?
Because if, for instance, you get a big peak, well, that's a peak in the baseline, so how do you distinguish between peak and baseline?
And well, there's a trough, and let's say that trough lasts an hour.
Is that hour-long trough your baseline, or where's your set point?
How do you establish your set point, and more importantly, how do you raise your set point?
Ah, well, if you're not already asking that question, I just asked it for you.
I define an increase in your baseline level in dopamine to be anything that increases dopamine for more than one hour.
You know, when we think about cocaine and fetamine, pornography, sex, caffeine, things of that sort, regardless of how long one engages in a bout of those behaviors or substances, the increases in dopamine are going to be relatively short-lived on the order of minutes to an hour, sometimes longer.
Now, I didn't say that's how long you're engaging in the behaviors.
I said that's how long those increases in dopamine are going to occur, even if you were to continually engage in those behaviors.
And remember, with continual engagement in a dopamine spiking behavior, behavior that

increases dopamine peaks, the height of those peaks, remember, gets lower and lower and lower, especially in a short amount of time, and then drops below baseline.
There are tools and techniques that you can use to elevate your baseline level of dopamine for long periods of time.
And here, again, this is done in addition to the basic tools that I mentioned a few moments ago.
The simplest one for which there are excellent data, and here I'm referring to data published in the European Journal of Physiology, I'll provide a link to this, is that exposure of your body up to the neck to cold water, and it doesn't have to be super cold, by the way, to cold water has been shown to increase baseline levels of dopamine and the other so-called catecholamines, which include norepinephrine and epinephrine.
But for sake of today's discussion, dopamine in particular for not just one, but at least two, and probably as long as four or five hours.
There have been some additional scientific studies after the paper I just mentioned, and it's really remarkable.
You can accomplish this a number of different ways.
You could get into a cold shower in the morning, and I do recommend doing this in the morning.
And in that case, it's okay to get the water on your head.
In fact, I recommend it.
You could get into an ice bath, you could get into a cold plunge.
In these circumstances, I'm not suggesting this for sake of increasing metabolism or fat loss.
You know, the whole discussion around deliberate cold and metabolism and fat loss has become a little bit controversial, so we won't go there now.
Mostly because we're focused on the clear ability of deliberate cold exposure to increase dopamine for long periods of time, aka your dopamine baseline.
The ways to do this vary depending on the temperature.
So for instance, there are data pointing to the fact that if you want to get a long lasting increase in your baseline dopamine, you could take a very cold shower or cold plunge or ice bath for a very brief period of time, anywhere from 30 seconds to two minutes, maybe three minutes, but probably 30 seconds to two minutes.
Now you might ask, what is very cold?
Here I have to be careful because I don't want to recommend anything that's going to cause anyone to have a heart attack or going to shock or anything of that sort.
It's going to vary by person depending on your level of cold tolerance.
So what I recommend is if you are going for the short exposure, long dopamine release approach, that is 30 seconds to two minutes, that you start warmer than you think you need to and then you ease into it over a few days, but we're really talking about ranges and temperature from anywhere from about 37 degrees Fahrenheit to about 55 degrees Fahrenheit.
Again, be careful, approach it with caution and ease into it.
I do recommend doing this early in the day and I should mention not after strength or hypertrophy training because within the six hours after strength or hypertrophy training, this deliberate cold exposure, especially immersion up to the neck can suppress the

strength and hypertrophy adaptation that the training is designed to accomplish.
So that's one approach.
The other approach that's supported by the literature to increase baseline levels of dopamine for very long periods of time, in fact, this is the original approach, is to get into warmer water, so not warm, but warmer, so 60 degree Fahrenheit water up to the neck and to stay there for about 45 to 60 minutes.
The reason I don't think most people will do that or that most people would prefer a shorter, colder exposure protocol is that most people don't have 45 to 60 minutes each morning to get into water and sit there and in that study, they actually had them sitting in lawn chairs basically in the shallow end of a pool up to their neck for a full 60 minutes and then measuring dopamine release and so forth.
So there are a bunch of different ways to do this.
I should emphasize I don't think you need to be super precise about the temperature and even the duration, what I recommend is find a temperature that's uncomfortably cold to you meaning that you feel agitated and you want to get out, but that you're confident you can safely stay in.
And again, I can't give a simple prescriptive to everybody, but this is known to increase baseline levels of dopamine significantly, in fact, double them or more for long periods of time, meaning hours up to four, maybe even six hours into the day, which is one of the reasons I suggest doing this early in the day.
I happen to get into a cold plunge or take a cold shower first thing in the morning.
I do go outside and get my sunlight first sometimes, sometimes I do the cold first.
It really depends on my circumstances and how I'm feeling that day.
I don't think it really matters which one you do first, but you want to try and get both of those in early in the day because you really want the catecholamines and cortisol elevated early in the day.
Okay.
So that's deliberate cold exposure.
We already talked about exercise.
So if you're doing your exercise early in the day, there's no reason why it couldn't be done in concert with this deliberate cold exposure.
I recommend doing the deliberate cold exposure first for the reasons we talked about a few minutes ago.
And then of course there are compounds, both prescription and over the counter compounds that can indeed raise your baseline levels of dopamine for an hour or more.
And when I say an hour or more, it really depends on individual variation in terms of how quickly you metabolize dopamine and it depends on individual variation in how you manage or tolerate different dosages of drugs and different types of drugs.
So the typical drugs, and here I'm talking about legal prescription drugs for increasing dopamine are things like Ritalin, Adderall, Modafinal and Armodafinal also tap into this system.
And I did an entire episode about ADHD, which is the typical context in which you hear about these prescription drugs, but assuming it's prescribed by a doctor for either clinical

reasons like ADHD or for other reasons, all of those compounds do significantly increase baseline levels of dopamine for many, many hours.
It's absolutely clear and it's one of the major reasons why those drugs are so effective in increasing motivation and attention.
Then there are compounds that are sold over the counter, things like amino acids such as L-tyrosine itself, that's a very commonly sold and used amino acid.
It's present in a lot of so-called pre-workout formulas.
I as many of you know, I'm a fan of single ingredient supplements for the most part, aside from foundational supplements like AG1, which give you many, many micronutrients kind of all together, because it would be nearly impossible to consume each of those as individual ingredients and get the right amounts, et cetera.
But for all other supplements, I'm a big believer in parsing what you need and what's most effective for you in single ingredient formulations.
And the typical ways in which people work to elevate their baseline levels of dopamine with supplements are using either L-tyrosine, which as I mentioned earlier is the rate limiting enzyme for dopamine, or by using what's called mucuna purines, which is actually very similar to Aldopa, which is the treatment for Parkinson's.
Mucuna purines actually comes from the velvety outside coating of a certain bean.
I know it sounds really esoteric, but that's actually where it's found in nature.
And it's really 99% Aldopa.
And I confess, having tried mucuna purines, having examined the scientific literature on mucuna purines, there is some evidence that it can increase dopamine, especially in that tuber infrandibular pathway, because it can tap into some of the hormone related functions of the pituitary.
It does increase alertness and mood, it might even increase libido, motivation, et cetera.
But the effects of mucuna purines tend to be very much of the increasing the peak in dopamine and then very quickly dropping that peak.
In other words, the peak trough phenomenon, not for increasing baseline levels of dopamine.
Now, it's likely different for people with Parkinson's who are taking prescription drugs that are similar to mucuna purines.
So if people have Parkinson's oftentimes, they are prescribed things like Aldopa, which is in the pathway to dopamine synthesis.
Or they are prescribed things like bromocryptine, which will indeed increase dopamine.
And I do realize that some people use those prescription drugs recreationally, which I don't recommend.
Those drugs can be used to increase baseline levels of dopamine, but more typically they cause peaks in dopamine and troughs in dopamine, which is why I do not recommend them.
They are not going to allow you to accomplish what you want.
If your goal is more motivation, et cetera.
In fact, they are likely to do the opposite, give you a big peak in alertness and then a crash that can include depressive symptoms and just not feeling very good.
El tyrosine, however, has been examined in the scientific literature and at reasonably low dosages has been shown to increase circulating and available levels of dopamine both in the

brain and body and lead to increase cognitive performance and in some cases physical output.
I'll provide links to a few of these studies, but the two that I really parsed most finely for sake of this episode really just focus on taking El tyrosine under conditions where your baseline levels of dopamine are reduced due to stress.
And under conditions where there's no stress and people are trying to increase their baseline levels of dopamine for sake of improving cognitive function.
The first paper is entitled Effective Tyrosine on Cognitive Function and Blood Pressure Under Stress.
I'll provide a link to this in the show note captions.
And it's one of many papers really dating back to the early nineties exploring how relatively high frankly relatively high dosages of El tyrosine taken under conditions of stress allow people to rescue some of their cognitive function in terms of working memory tasks and other kind of cognitive tasks, visual pursuit tasks and so on.
The second paper is entitled Tyrosine Improves Working Memory in a Multitasking Environment.
And the second paper is perhaps more interesting because it involves exploring the use of tyrosine supplementation basically taking tyrosine about an hour before a cognitive task or set of cognitive tasks that involve a lot of multitasking and working memory.
Working memory for those of you that don't know is your ability to maintain small batches of information in your mind for relatively short periods of time.
So for instance, if I tell you my phone number or the phone number where I grew up 4932931, if you can remember that chances are you'll remember it for 30 seconds, 60 seconds, but that you won't remember it tomorrow because there's really no reason to a lot of the tasks that we do throughout the day involve working memory and working memory is very subject to interference from other tasks that we happen to be doing, like looking at our phone or having a conversation or trying to navigate through a city involves a lot of attention.
And this study shows that tyrosine improves working memory, especially in the context of multitasking and having a lot of conflicting goals.
And they did a number of really nice experiments here.
Again, it's a small study, not that many subjects, but it's one of several papers.
In fact, this is the paper that kind of set in motion, the domino of other papers exploring the efficacy of L-tyrosine for cognitive performance.
They looked at working memory tasks, of course, but also auditory visual tasks and they involve some interference of visual cues and things of that sort.
And they saw some really interesting effects.
Basically when we need to attend to multiple things at the same time, L-tyrosine can help us do that, at least as it relates to memory.
When I say L-tyrosine, what I really mean is having your baseline levels of dopamine elevated can really help navigate multitasking environments, especially as it relates to working memory and this is true under conditions of stress and under conditions of not stressful.
You might say, well, isn't multitasking stressful itself?
Yes, it can be, but when we talk about under conditions of stress, we're talking about people who are sleep deprived, we're talking about people that are under other kinds of psychological or physical stress.

L-tyrosine can help in that context as well.
So as I mentioned before, in these studies, they use very high dosages of L-tyrosine.
So high that actually I don't recommend them.
They did measure stress hormones.
They did measure blood pressure and things of that sort, but I want to caution you, I do not recommend, I will say it again, I do not recommend following the dosages that were used in these two studies because they are exceedingly high.
They used 100 milligrams per kilogram of body weight of L-tyrosine one hour prior to these cognitive tasks.
Now, I weigh about 220 pounds, I'm a little bit lighter than that.
So that's 100 kilograms approximately translated from this study.
That would mean that had I participated in the study and I wasn't in the placebo group, but I was in the L-tyrosine group, I would have been given 10,000 milligrams of L-tyrosine, which is 10 grams of L-tyrosine.
I do not recommend that.
In fact, there are papers showing that as little as 500 milligrams, but perhaps up to one gram, that is 1000 milligrams or 1500 milligrams, a gram and a half of L-tyrosine taken 30 to 60 minutes before a cognitive or physical task can increase baseline levels of dopamine for extended periods of time and thereby improve performance on those mental or physical tasks.
So if you are somebody who's interested in trying L-tyrosine, please know that the increases in baseline levels of dopamine can be substantial.
They are long lasting, which qualifies them as baseline increases as opposed to peaks.
And I would say you should also start with the lowest possible dose.
So for most people, 250 to 500 milligrams is going to be a reasonable starting dose, depending on your body weight, smaller people start with 250, larger, maybe 500.
Keep an eye on whether or not you're combining it with caffeine or with any other stimulants.
And keep in mind that, again, the bigger the peak in dopamine, the bigger the trough in dopamine afterwards.
So pay attention to whether or not you experience a crash that same day or the next day.
But chances are, if you're using a relatively low level of L-tyrosine, so anywhere from 250, maybe 500 milligrams or 1000 milligrams of L-tyrosine prior to cognitive or physical work and taken early in the day, by the way, because this can act as a bit of a stimulant, that you're going to achieve these long lasting increases in baseline dopamine.
But please also keep in mind that I always, always suggest that you engage in the proper behaviors and you disengage from the improper behaviors as a first line of offense on any health goal.
So now you know how to set your baseline levels of dopamine at the highest possible level.
You of course want to guard that baseline level of dopamine very carefully.
So for instance, you want to avoid any kind of behaviors or substances that are going to peak your baseline level of dopamine very high or very sharply, or if you do engage in those types of behaviors, whatever they may be, that you are well aware that your baseline level of dopamine will drop far below what it was after that peak has fallen.

You will be essentially in the quote unquote trough.
If however you find yourself in that trough, you now have the knowledge to understand that that trough will resolve if you wait enough time.
That baseline level of dopamine that you were at prior to the peak will come back.
You will feel better.
However, most people don't know that.
And as a consequence, when they feel that low, that is they feel kind of a motivated, maybe a little bit depressed, maybe a lot a motivated or a lot depressed following some quote unquote peak experience.
What they end up doing is thinking about what caused that peak experience and then go back and try to reengage in the behavior and try and regenerate that peak experience.
But you now know that that is a terrible strategy.
In fact, that strategy will only lead to diminished peaks from the same experience.
It will lead to, in many cases, pursuing more and more intense experiences to try and recapitulate, recreate that big peak, which won't work.
Or even worse, people start stacking and combining different dopamine increasing behaviors in order to try and obtain something like that initial peak.
When in fact, all they need to do, all you need to do is simply wait.
Because the way that the dopamine circuitry is arranged is that it's not just about pleasure, as you know, it's about motivation, desire, pursuit and pleasure.
And it also has everything to do with pain and discomfort.
Now, when people hear the word pain, they often think, oh, pain, okay, so a physical pain or intense emotional pain.
But today, we're going to talk about pain a little bit differently.
We're going to talk about the pain associated with the trough and dopamine that occurs after a big peak in dopamine as a period in which pain and effort go hand in hand.
And I'll return to this in a moment, but I want you to just note that in your mind, kind of earmark that in your mind.
Because what we're about to talk about is how to leverage that pain and to use effort as a way to not just get out of the trough more quickly, but actually to get back to a higher level of baseline as you exit that trough.
Meanwhile, I really want to harp on this one point that I made a moment ago, which is that after some big experience, so it could be a vacation or a night out partying or the birth of a new child, all of these are well known phenomena that lead to troughs or deficits in dopamine afterwards, which can cause a sort of postpartum depression.
Postpartum depression is a phrase normally used to describe literally postpartum, postbirth of a child depression.
And that has many causes, not just related to dopamine baselines, although it does involve dopamine baselines, but it has hormonal aspects and other aspects as well.
But postpartum depression is also used to describe any time that our baseline dopamine has gone down way, way below what it was prior to some recent peak or exciting, exhilarating win or behavior, a couple of things that one can do in order to get out of that trough more quickly.

The first one is simply to wait with the understanding that you will get out.
I know that sounds overly simplistic and maybe a little bit brutal, but I think most people don't realize this.
They don't realize that the dopamine circuitry does take time to replenish and it has everything to do with restoring both the synthesis of dopamine as well as what's called the readily releasable pool of dopamine.
So dopamine is packaged in these little spherical things that we call vesicles, those vesicles are released from the ends of nerves.
So in this case, we're talking about the nerves that originate again in VTA and nucleus accumbens and send their little wires up to the prefrontal cortex.
And that's where dopamine is released and that readily releasable pool of dopamine takes time to replenish and that can take several days in order to replenish.
Just knowing that can help you through that process.
And of course, then it raises the question, is there anything that you can do to accelerate that process?
And indeed there is and indeed this is what I consider not just something to get you out of a trench of kind of lower mood and motivation, but actually what represents the holy grail of motivation.
Today, I'm going to talk about this pain effort process as a very powerful way to get out of sticking points, but more importantly to get into a mode where effort and reward can actually accelerate your progress along any path to any goal and in a way that you can do it repeatedly.
And this is not simply taking mechanisms from biology and painting names on them.
Rather, this is leveraging mechanisms in biology that are well defined in the animal and human literature that have parallels to the addiction and addiction recovery literature.
But they have been shown in specific circumstances to really allow people to engage in motivational pursuits in a variety of contexts, school, relationships, work, etc.
In an ongoing way and in a way that never depletes their baseline of dopamine to the point where they have to do a lot of extra work to get it back and in a way that allows them to be really motivated in a variety of contexts in an adaptive way.
So what we're really talking about here is regardless of your genetics, regardless of who your parents are, which obviously you couldn't select, being able to leverage your dopamine system in order to be maximally motivated when you want to be and indeed to avoid procrastination.
I'd like to tell you about a classic experiment that I've described once before in this podcast, but frankly, this experiment is so crucial.
I don't think it can be described enough.
This was an experiment that was done at Stanford many years ago and involved children, but it's actually been repeated in adults.
The experiment involved observing a classroom of young children.
So these were kids about kindergarten age, a little bit older, and observing which activities kids like to do in their free time.
They're structured time where they had to, these are little kids where they play blocks

or they had to sing or they had to write or do what they could, or I suppose draw, they're probably not writing significant prose at that age, but then they had free time where they could do whatever they wanted.
And what the researchers did was observe the children who selected by their own choice to draw pictures.
So there were some tables out with crayons and markers and paper, et cetera, and there were some kids that would just naturally go to that activity every day because they liked that activity and they measured how much of the free time these children elected to use their free time drawing, doing these different art projects.
And then what they did was they started introducing rewards to these children.
They started putting a gold star or in some cases a silver star on their pieces of artwork and telling them what a good job they did.
And the kids really liked that.
In fact, who wouldn't, right?
They're not only doing an activity that they like, but they're also getting a reward for it.
So you can probably see where this is all going.
What they were doing was they were increasing the amount of dopamine that these children experience.
And again, in parallel experiments done with adults, if you take adults who enjoy a particular activity, you let them do activity and then you start rewarding them for that activity, especially when you surprise them with a reward for an activity they already like, they report that being a much more pleasurable experience than had they just done the activity.
Then what they did with these children and in the experiments with adults, done later on was they cease giving them the reward and then they observed what percentage of their free time they spend doing that activity, drawing.
And what they observed was, you guessed it, a drop in the total amount of time that the children elected to do this activity that initially they were doing quite a lot.
In other words, their total satisfaction or desire or motivation to engage in this activity dropped below what it was prior to ever receiving a reward.
And again, this has been repeated in a variety of contexts in different populations, different cultures, different countries, men, women, boys, girls, lots of different backgrounds.
So what this tells us is everything you already know, which is that reward prediction error is not just about the desire to do something and you carrying it out and it being pretty good, amazing or not good.
I always like to joke that the nervous system sort of codes things into three bins.
You can think about this in terms of food or any type of experience.
It can either be yum.
Yes.
I really liked that.
Yuck.
I really don't like that.
Or meh is kind of so-so.

What the scenario led to where rewards were received for an activity that people already like to do and then removed was that an activity that at one point was a yum becomes a meh. And that all reflects a drop in baseline dopamine.
Why? because the activity that the children or adults liked combined with the gold star or the monetary reward or praise that children and adults seem to like compounded to create a bigger peak in dopamine and therefore a bigger trough in dopamine.
And if you're already wondering whether or not their desire to engage in that activity eventually came back, it did indeed.
So essentially what I described all matches precisely with dopamine reward prediction error and the fact that peaks in dopamine give rise to subsequent troughs in dopamine that if one waits long enough, allow baseline levels of dopamine to return to normal.
And of course, the amplitude of that dopamine peak has been varied by giving more money or less money in different scenarios, nearly all the different derivations of the experiments that you could imagine that map on to the dynamics of dopamine release that we've been talking about during this episode all played out exactly as one would have predicted based on the neural circuitry and the dynamics of dopamine.
I recommend that you leverage this knowledge to make sure that any activities that you enjoy to do, whether or not you enjoyed a little or a lot, but especially if you enjoy it a lot, that you guard and protect by making sure that you don't start layering in or attaching reward or other sources of dopamine releasing behaviors or substances to that specific behavior. Or if you do that you don't do it terribly often.
Now, how often is terribly often we'll get to that in a moment, but let me give you an example from my life just as an example, but you will likely have and you'll know people that will have different examples.
I love to exercise.
I know to some people this might seem foreign, but I love to exercise.
I love to do resistance training.
I love to run.
I am not one of those people that doesn't like the experience of exercising, but likes the feeling afterwards quote unquote.
I hear that a lot.
I don't like to exercise, but I love the way I feel afterwards.
I love physical training and I love the way I feel afterwards, but I mostly love the feeling during.
I don't know why I'm wired that way.
I can't say that I'm somebody who likes to do hard things across the board.
There are plenty of difficult things in life that I dread or that I'm sort of meh about, but for me, hard exercise, intense exercise of a particular kind, resistance training and running in particular, both give me a young, yes, I love this kind of feeling.
And yes, it persists for me quite a long while afterwards, both for sake of the way that it changes my neurochemistry, but also my sense of satisfaction, but I just simply love it.
Now years ago, I discovered that if I drink a couple of black coffee or an Americano or a double espresso or some Yerba mate, that my workouts can be quite a bit more intense.

I can run further and then I also discovered that if I were to take a pre-workout energy drink or I took say 300 milligrams of Alpha GPC and 500 milligrams of phenolethylamine and perhaps even 500 milligrams of L-tyrosine and perhaps did that alongside the caffeine in the Yerba mate, then yes, absolutely.
I really liked those workouts.
I could be like a laser in terms of focus.
I could exert even more effort, put on some music and I could achieve even better performance.
And then I also discovered that I could export that protocol of caffeine Yerba mate in various supplements to my cognitive work.
So when I was studying or writing papers or writing grants or in the laboratory, when I was doing experiments with my hands in those days, cutting brain tissue and staining it and working really long hours.
And I discovered that all of those things, all of those behaviors compounded with my love of exercise and my love of doing science and gave me these big peaks in what to me felt like even important experiences.
They felt unlike anything else.
They were just so, so peak in their nature, which was great.
And it did indeed enhance my performance.
However, while it did not create a dependency for those different substances, caffeine, supplements, et cetera, what I noticed was that in the days and sometimes weekends afterwards, even though for much of my career, I confess I've worked weekends as well.
But I would notice that I'd experienced a real trough and energy.
I just would not feel that good.
And then if I kept up those behaviors consistently and I was consistently adding in these other, let's just call them what they are, dopamine releasing or stimulating behaviors and substances that my enthusiasm for physical training or running or for doing experiments actually started to diminish.
And this was really discouraging to me at the time because I started to think, okay, maybe I'm burnt out.
Maybe I have adrenal burnout, which by the way, doesn't exist, folks.
Your adrenals don't burn out.
There is something called adrenal insufficiency syndrome.
You can overstimulate your system by way of too much adrenaline, epinephrine and norepinephrine, but that's a separate thing.
There's no such thing as adrenal burnout per se, but I didn't know that.
So I thought, gosh, I'm really burnt out when in fact, it's now obvious to me what I was doing.
I was combining too many dopamine releasing or stimulating behaviors and substances for things that I already enjoyed doing as behaviors, namely exercise and doing experiments, anything related to science actually.
So what this means is not to avoid taking things or doing things that amplify your amount of dopamine, but to be very cautious about how often one does that and how many different dopamine stimulating behaviors or compounds one stacks, especially in terms of taking

those things or stacking those things in and around behaviors that you already really enjoyed doing.
I was essentially just creating another version of the kids in nursery school or first grade with the gold star experiment.
I was basically just doing the exact same thing.
And when I realized that, and I changed my relationship to those compounds, I didn't eliminate them all together, but I started realizing, for instance, that I didn't need to double up on yerba mate and coffee every workout.
Sometimes I would do one.
Sometimes I would do the other.
Frankly, I always do one or the other.
It's rare that I ever do any kind of physical training without some caffeine first.
And I do my physical training typically in the early part of the day.
So that's fine.
Doesn't interfere with my sleep.
I might do a hike without caffeine, but if I'm in a weight trainer, I'm going to run.
I tend to drink coffee beforehand or have yerba mate.
Or if I occasionally, meaning about once every third, sometimes every other, but usually about every third workout, I'll take 300 milligrams of alpha GPC, maybe occasionally, maybe every third or fourth workout, and these are resistance workouts, mind you, not running.
I'll take 500 milligrams of Altair scene or more typically 500 milligrams of phenolethylamine.
And very, very rarely, maybe once every two or three months, I might stack all of those things together prior to a workout.
But of course, I'm always mindful to also include workouts or runs or bouts of cognitive work so that could be grant writing, prepping for a podcast, et cetera, where I don't do anything prior.
Maybe just my caffeine because I have a baseline level of caffeine that I use each day to function like many people.
There's a baseline level of caffeine that just allows us to function if we're a perpetual user of caffeine.
I talked a lot about this on the episode in caffeine.
But the key here is be cautious.
I would say be very cautious about stacking and layering in too many dopamine peak inducing behaviors all at once on a regular basis.
The key point here is if you are somebody that can engage in these intrinsically joyful activities for you, these activities that you're really motivated to do, whether or not it's skiing or playing music or dancing, et cetera, without the need to layer in additional dopamine releasing mechanisms or compounds or activities, well, then I highly recommend you do that because then you are essentially making yourself one of those fortunate few that does not require additional stimuli and therefore can hold on to that pleasure, can hold on to that intrinsic pleasure and motivation to engage in these behaviors over time, which frankly, there is no replacement for.
There is no pill or bottle or potion or motivational speech or podcast or book that can replace

intrinsic motivation.
Intrinsic motivation is perhaps the holy grail of all human endeavors and behaviors because it encompasses so much of what brought us to this point in our species evolution and also what brings each and every one of us closer and closer to our goals.
And if it's happening with enjoyment without the need to layer in additional tools, well, then you have really tapped into the source.
And when I say the source, I don't mean it in any kind of mystical way.
I think it's quite clear by now that when we hear about Chi from Eastern Medicine or we talk about motivation, drive and pursuit in Western neurobiological languages that relates to dopamine or we hear about the source, maybe in my podcast episode with the one and only Rick Rubin, incredibly productive music producer who's as in just an unbelievable track record in terms of creative endeavors and he talks about the source, we're really talking about the same thing, which is this set of circuits within us that allow us to identify what we want and then lean into effort and then to do that in a persistent way that allows us to reach our goals.
And if we can do that with an intrinsic sense of pleasure, well, that is nothing short of magic.
But of course, it's not magic, it's science.
And of course, most people are not concerned about trying to protect the things they already enjoy in order to make sure that they can continue to do those things and enjoy them.
Most people are thinking about how they can engage and pursue things that are less than pleasurable to them or how they can continue to engage in motivated behaviors when the going gets tough or, and this is a big one, I hear this over and over again as a request to cover on this podcast, how people can overcome procrastination.
What we're going to talk about now is how the dynamics of dopamine release that you already are aware of, plus an additional dynamic that we haven't quite talked about can allow you to leverage dopamine in a way that really will bring you to the holy grail of motivation and drive, which is when effort starts to become the reward itself.
In other words, when friction becomes the reward, I know that sounds crazy to some of you, but when friction becomes the reward, you can pass from an idea and a goal, no matter how daunting to successful completion of that goal, while experiencing what essentially will feel like pleasure the entire time.
Now, that doesn't mean it will be bliss the entire time, but what is very possible is to leverage the dynamics of both dopamine peaks and dopamine troughs in order to not just maintain your baseline level of dopamine, but to also pull yourself out of any kind of procrastination or other kind of overthinking trenches very quickly and get back into a mode of pursuit.
So how do we make effort the reward?
You may have heard about this in the context of so-called growth mindset.
Growth mindset is the incredible discovery and research papers from my colleague, Dr. Carol Dweck in the psychology department at Stanford.
And there are others such as David Yeager at the University of Texas, Austin, who have leveraged the so-called growth mindset as a tool that young people and adults alike

can use in order to get better at anything.
And the basic contour of growth mindset is to adopt the mindset that if you can't do something or if you can't do it well, that you can't do it or can't do it well yet.
It's that word yet that's really key.
And there are a number of different tools and techniques that people use to adopt growth mindset, but it all starts with that relationship to not being able to do it yet.
Now, that all sounds pretty straightforward when you tell yourself, but when we are in a performance context, when we expect ourselves to be able to motivate or when we expect ourselves
to be able to perform and we can't, that often sets up a downward spiral of motivation because we are so used to being attached to the relationship between desire, motivation and outcomes.
Reward prediction error.
We want something, we want that A in class or we want to learn how to dance or we want to be able to do this physical skill of another kind or learn a language or get the mate we desire or make the relationship work or make the business work on and on.
And then we get the outcome that we don't want and our confidence for lack of a better word drops over time.
Oftentimes that leads to situations where we are not motivated.
We are a motivated.
It can even lead to situations where we are downright depressed.
There's also circumstances where people, myself included, of course, procrastinate.
We know we should do something, but somehow we can't get motivated.
We know that if we put in the effort, we'll get there, but we can't do it either because we don't like the activity or we're just not feeling great.
Now we could be quote unquote, not feeling great, not feeling motivated because our dopamine baseline is low.
And so I absolutely encourage everybody to take a look at themselves anytime they're in a motivated state, take a look at the landscape of their life, not just at that moment, but in the preceding days and weeks and ask whether or not you've been tending to those foundational things that we talked about earlier, whether or not you are engaging any other of the tools that we talked about earlier to see if you can get into a motivated state.
However, if all of those boxes are checked, you answer, yes, I'm doing all those things.
I'm just not motivator.
I'm just whatever reason I just procrastinate.
I don't know.
I don't want to do it or I'm not feeling motivated.
Well then there's a very potent set of tools that you can leverage to overcome states of lack of motivation, overcome procrastination, and indeed can help you deal with things like overthinking as it relates to procrastination and lack of motivation as well.
So the way this works is the following.
If you recall, a peak in dopamine is followed by a trough in dopamine.
That trough in dopamine is experienced as pain or wanting or craving.
That pain that I'm referring to is actually a craving or a wanting.

And it's a craving or wanting for a specific state that you would like to achieve that is different than the one that you're in.
You want to get out of that trough.
And as you recall from earlier in the episode, that trough is the stimulus for the ongoing release of dopamine that provides the propeller, the motivation to go forward and seek some goal.
So when we are not motivated, when we are in a so-called a motivated state or when we are procrastinating or when we just sort of can't seem to get in gear, the key to getting out of that pain trough is one of two things.
I already told you earlier, you can just wait, can wait till your motivation comes back.
And a lot of people do wait.
In fact, they procrastinate.
They start doing other things that are less painful than the state that they happen to be in when they are trying to get into gear to go work out because they realize not everyone wants to do that or to study or to have a hard conversations, whatever it is.
And what do they do?
They start engaging in activities that we and indeed they would not consider pleasurable activities.
For instance, cleaning the house.
So seemingly out of nowhere, they start engaging in these activities that normally are not intrinsically pleasurable for them.
They're not highly motivated to do them as a replacement for doing the very thing that they quote unquote need to do or ought to do and that they're procrastinating to do.
What they're essentially doing here is a mild type of addiction replacement.
In other words, rather than be in the painful state and wait for it to pass, they're doing things that give them some sense of accomplishment ostensibly to give them the sense that they're completing things.
And perhaps, and I don't know because I'm not in the psychology of knowing what other people are thinking, perhaps in order to generate the momentum in order to get engaged enough or motivated enough to study or work out or whatever activity it is that they're trying to avoid through procrastination.
Now what's interesting about this dynamic is first of all, it's extremely common.
And second of all, a lot of people will use this as a tactic so that they get very close to the deadline to complete something and then they go into a sort of pseudo panic and then use anxiety as a way to leverage their mental and physical resources to complete that thing.
Now, how do I know the contour of this so well?
How do I understand the inner dynamics of it?
Well, part of that relates to my work as a neurobiologist and reading the papers that I'll mention to you in a moment.
But it also relates to the fact that I'm somebody who waits quite a while right up until the sort of last minute possible to complete something for activities that I don't want to do.
Something I've been working on my whole life.

In any case, I'm very familiar with the procrastination process.
So how can we overcome procrastination?
Well, it turns out that there are findings from within the addiction literature that turn out to be very powerful towards leveraging our way out of procrastination.
And it has to do with this, you already know, because I've told you probably a dozen times now, that the depth of the trough after a dopamine peak is proportional to how high that peak was and how steep it was, how quickly that peak occurred.
It turns out that not only is the depth of the trough proportional to that, but the rate at which you get out of that trough is proportional to how steep that trough is.
Let me explain this for you in as clear terms as I possibly can.
Imagine you're in an a motivated state, you're just not feeling motivated, you're procrastinating.
You may think, okay, the thing to do here is something, I'll clean the house, I'll take care of some bills, I'll do something, or I'll just wait.
Those approaches, as we talked about before, generally don't work or at least don't work quickly, or they lead you right up to the deadline and that's the deadline that forces you to get something done, or you just don't get it done and you don't succeed in your goal.
That happens a lot as well.
However, if you were to take that state of being unmotivated, of procrastinating, and actually do something that's harder than being in that a motivated state, in other words, doing something that's more effortful, even painful, you can rebound yourself out of that dopamine trough much more quickly.
So what do I mean you want to put yourself in a state that's worse than or harder than the state that you're in, or do something, quote unquote, more painful, and here I want to be very clear.
I'll say this three times, but I'm going to say it for the first time now.
When I say more painful, I do not mean doing any kind of tissue damaging or psychologically damaging behavior or anything of that sort that's going to render you injured or not well, even in the short term.
That's not what I'm referring to.
Okay, let's just get that one out of the way.
What I'm referring to is the fact that, for instance, if you're feeling a motivated, but you find yourself cleaning the house as a way to procrastinate, you can say, well, cleaning the house is harder than sitting down and doing nothing.
But actually in that moment or in those moments, that's not the case or else you wouldn't be doing it.
The reality is that the dopamine system works according to what feels hard or easy in the moment.
In other words, if you're feeling a motivated, you need to do something and put yourself into a state that's harder than the state you're in.
So for instance, if you're sitting around feeling a motivated or you find yourself tending to tasks that are irrelevant to the goal that you really should be focused on, you need to put your body and mind into a state of discomfort quickly.

And the way to do that is to either engage in some tangential activity, meaning an activity not related to your goal that puts your body into a very different state.
So here again, I'll default to the obvious one, which is something like cold shower or cold immersion, which not only increases dopamine long-term or over several hours rather, but for most people is experienced as pain.
That pain causes a rebound out of that dopamine trough faster than it would occur if you had just stayed in that a motivated state and waited for it to go away or done something like cleaning up that for whatever reason felt like it required less friction.
When I say friction, I mean limbic friction.
Your limbic system is always in this dialogue with your forebrain and limbic friction goes two ways.
Limbic friction can be you're tired and you don't want to do something.
And so you have to quote unquote, motivate to do it, energize yourself to do it.
Or limbic friction can be that you're nervous and scared and anxious to do something and you have to calm yourself in order to lean forward into action in order to do that thing despite the anxiety.
I realized this can be a little bit confusing as a concept.
So I want to go into a bit more detail.
Let's imagine that you or somebody else does not like to exercise.
You don't want to exercise and you're trying to get your minimum of five days per week exercise and you're just not motivated to do it.
There are a couple of different techniques to doing this.
Assuming you've taken care of all the baseline stuff, all the foundational stuff we talked about earlier and you're just not getting in gear and you find yourself checking your phone or maybe you're tending to some tasks, obviously those things are quote unquote easier for you, meaning they cause less limbic friction than engaging in exercise.
The typical advice would be just exercise for one minute.
Just get one minute of exercise or five minutes and then use the successful completion of that one or five minutes as a milestone that allows you to then move to the next milestone and indeed that approach can work and it's exactly what I'm describing here when I say that you're in a state of lack of motivation or procrastination or both and you need to put yourself into a more painful, not less painful state.
So what do you do?
You push up against that friction and you exercise for a short while and then that pops you out of that trough.
That's possible, but for a lot of people, even that won't be possible because they just can't get motivated or they do that one minute or five minutes and they're just like, okay, I'm still in the trough.
I'm not actually feeling that great.
In those circumstances, it makes sense to do something that's tangential to the whole path that you're trying to pursue, this goal that you're trying to pursue that is, believe it or not, much worse than just being a motivated.
And when I say worse, I don't mean picking some task that normally you don't like to

do, but now you're willing to do.
I mean, literally thinking about what would be worse than being in this state again without causing yourself tissue or psychological damage.
What would be worse?
Well, cold water would be worse for many people, very cold water.
So the key is to figure out something that for lack of a better way to put it really sucks, really sucks and yet is safe.
And by doing that, you steep in the trough, you steep in the slope of the trough, which we know brings you back to your baseline level of dopamine more quickly.
Now for some people that will be deliberate cold exposure through cold shower ice bath.
And I have to tell you that if you're cringing as I say this, well, then there you go.
You now have a tool that you know you cringe even when you just think about and therefore represents a great tool for you.
So if I'm procrastinating to do something I really need to do, should I just simply wait for that procrastination to evaporate?
No.
Will it eventually evaporate?
Maybe.
The deadline eventually surface that will trigger me into an anxious or activated state that will allow me to complete what needs to be done.
Maybe.
Hopefully.
But better would be to get out of that a motivated state, that state of procrastination quickly.
And to do so, you need to leverage something that's painful.
So for instance, I heard a beautiful lecture recently done by Dr. Anna Lemke at Stanford School of Medicine discussing dopamine and some of the things in her book and some newer findings as well.
And somebody in the audience asked her the question, does meditation increase dopamine?
Now earlier we talked about how non sleep deep rest and yoga, Nedra has been shown in the scientific literature to increase dopamine.
But I also mentioned earlier that classic forms of meditation, whether eyes open or eyes closed, so called open monitoring or closed monitoring, meditation sitting there or lying there and focusing does not increase dopamine levels per se.
However, for most people, especially people who find it hard to meditate or who don't do that practice very often, meditation is effortful, getting into meditation and staying in meditation is effortful.
So if you find yourself in a state of procrastination, oftentimes a brief five to 10 minute meditation where you absolutely do not allow yourself to do anything besides close your eyes, focus on your breath.
And when your mind drifts get back to your breath is not only extremely difficult and extremely frustrating, unless you're a well practiced meditator, but it's often difficult and frustrating not just to do but to get into that practice and not just to get into that practice but to maintain that practice for that mere five to 10 minutes because it's

just not a natural state for us to be in we have to force ourselves.
So it is effortful.
In fact, it qualifies as a basically available almost anywhere, anytime type of effortful activity that if you dislike it, perhaps even as much as some people dislike deliberate cold exposure will then perfect, you now have an additional tool in your kit that you can use anytime you are feeling a motivated and procrastinating.
Now there are numerous examples I could give and hopefully there are numerous examples that you're thinking about.
The key is to have a short list of about five different effortful aka painful activities that you can employ anytime you're feeling a motivated or in a state of procrastination, keeping in mind that the goal is not what you accomplish inside of that activity, although it is important that you actually engage in that activity.
I actually have to make myself meditate in that five to 10 minute little bout of effortful or painful activity, but it's not about achieving an outcome.
It's about forcing your body and mind into a deeper state of pain and discomfort.
In other words, taking yourself from that trough that you're already in and steepening and deepening that trough, because in steepening and deepening that trough, we know that the return from that trough to normal and even elevated levels of baseline dopamine is going to be faster and more robust.
And in doing that, you will quickly find yourself back into a motivated state because not only does it teach you that doing hard things is possible, that's sort of a more of a subjective cognitive learning, but it actually taps into the very neurochemical system that allows you to then feel motivated and capable to pursue the larger goal, which is the thing you're really concerned about after all.
So as is often the case, perhaps always the case on this podcast, we covered a lot of material.
We covered dopamine and what it is we talked about the circuitry and the different kinds of circuitry focusing mainly on this mesocortical pathway that is so vitally important to motivation for any goals.
Talked about the relationship between peaks and troughs and baselines and the foundational tools that allow us to set and maintain a healthy baseline level of dopamine, as well as ways to protect that baseline level of dopamine.
And we talked about how to get ourselves out of states of procrastination and a motivation by not just waiting out those troughs and dopamine, but actually making those troughs and dopamine steeper by engaging in things that are effortful and things that we really don't want to do in those moments, provided that those things are safe.
We can get out of those dopamine troughs more quickly and back to our dopamine baseline or even above baseline.
And we talked about what I really view as the holy grail of motivation, which is to be able to learn to attach reward to the effort process itself and to do so by not just understanding, but also learning to subjectively recognize and somatically experience release of these different stressful chemicals within our body.
I realized this was a lot of information and yet throughout I've tried to highlight tools

that you can use that range from behavioral to nutritional supplementation tools, cognitive tools and keep in mind that all of these different segments of the podcast is always our timestamps, so if you feel the need to go back and listen to any of these in order to get clearer understanding, we've made that easy to do so.
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Thank you once again for joining me for today's deep dive discussion into dopamine and its practical applications, and last but certainly not least, thank you for your interest in science.