

The Science of Making & Breaking Habits | Huberman Lab Podcast #53

In this episode, I review the science of habit formation and habit elimination and how the process of neuroplasticity (brain rewiring) underlies these processes.

I describe two new systems for habit formation. The first system is grounded in the neuroscience of brain states and our ability to perform (and to avoid) certain tasks at different phases of the 24-hour day. The second system focuses on 21-day habit formation and consolidation.

I also discuss "task bracketing" as an approach to enhancing habit formation and eliminating unwanted habits and the neural circuits that underlie task bracketing in the basal ganglia (a brain region for generating and stopping behaviors). I also review the science of dopamine rewards and how to apply that knowledge to shaping habits.

The science and tools in this episode ought to be helpful for anyone looking to build better habits and eliminate unwanted habits for school, work, fitness, relationships, creative endeavors, and more—indeed for any person or situation where behavioral changes are needed.

#HubermanLab #Habits #Neuroscience

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Links:

Excellent review on science of habits -

<https://www.annualreviews.org/doi/abs/10.1146/annurev-psych-122414-033417>

Meta-analysis on habits -

<https://journals.sagepub.com/doi/full/10.1177/1539449219876877>

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- Welcome to the Huberman Lab Podcast, where we discuss science and science based tools for everyday life. [mellow music] I'm Andrew Huberman and I'm a Professor of Neurobiology and Ophthalmology at Stanford School of Medicine. Today we're talking all about habits. In particular, we're going to discuss the biology of habit formation and the biology of how we break habits. I think we can all appreciate the value of having habits. Habits organize our behavior into more or less reflexive actions so we don't have to think too much about performing the various behaviors that, for instance, allow us to brush our teeth or which side of bed we roll out of in the morning. And then of course, habits can be more elaborate too. We can be in the habit of exercising at a particular time of day. We can be in the habit of eating certain foods. We can be in the habit of saying or saying certain things. But of course, there are many habits that don't serve us well, or that perhaps even undermine our immediate and long term health goals and psychological goals. And even some habits that can really undermine our overall life goals. So today we're going to talk about making, meaning forming, and breaking, meaning stopping, various habits. There's a lot of information out there about habits. You'll find this in the popular sphere. There are books, there are articles, there are workshops, and so forth. However, lesser known is that there's a whole neuroscience of habit formation and habit breaking. And there's a whole field of psychology devoted to understanding habit formation and habit breaking. And within those scientific literatures, I think there are some real gems that, at least to my knowledge, we haven't paid too much attention to in

the popular sphere. So today, we're going to talk about the biology of habit formation and habit breaking. I'm going to boil these down to some very explicit steps that anyone can use. My reasoning for doing that is, first of all, it's the end of 2021. Many people are thinking about new year's resolutions. They're thinking about leaving some things behind from 2021 and previous. And acquiring some new behaviors, taking on some new challenges, and trying to bring new things to their lives. But regardless of when you're listening to this, the programs that I'll outline are grounded in the neuroscience and biology of habit formation. And they map very well to what the psychologists have described, in terms of habit formation and breaking. So today you're going to learn a lot of science,

00:02:30 Athletic Greens, InsideTracker, Helix Sleep

you're also going to come away with some practical tools and I'm certain that regardless of your present state or goals, there'll be something of value to you. 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 Athletic Greens. Athletic greens is in all-in-one vitamin, mineral, probiotic drink. I started taking Athletic Greens way back in 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 is that because of the ingredients it contains, I know that I'm covering all of my foundation needs for vitamins, minerals, and probiotics. There is a wealth of knowledge now pointing to the fact that the so-called gut-brain axis is important for our brain health, for our metabolic health, for our hormone health, for our immune system, so the probiotics, vitamins, and minerals really support that system. And many of the other things it contains generally support our health, in terms of neural system, meaning the brain, the spinal cord, et cetera. Basically, Athletic Greens has all the things I need, nothing I don't, and by taking it once or twice a day, I always feel better and I know that I'm covering all my bases. If you'd like to try Athletic Greens, you can go to athleticgreens.com/huberman to claim a special offer. They'll give you five free travel packs that make it very easy to mix up Athletic Greens while you're on the road, in the car, or on the plane, et cetera. Plus, a year's supply of vitamin D3, K2. Again, go to

athleticgreens.com/huberman to claim this special offer of the five free travel packs plus a year's supply of vitamin D3 and K2. Today's podcast is also brought to us by InsideTracker. InsideTracker 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 most of the factors that impact your immediate and long-term health can only be analyzed from a quality blood test. And nowadays, with the advent of modern DNA tests, you can also get insight into your particular needs for your genetic type. Now, a major issue with a lot of blood tests and DNA tests out there is you get the numbers back, you get a lot of information back, but you don't know what to do with that information. InsideTracker makes that very easy. They have a personalized platform where you get your numbers and it points to specific things that you can do, in terms of behavioral protocols, meaning things you perhaps should do more of or less of, nutritional protocols, things that you perhaps should ingest more of or less of, and various things that you might consider for more elaborate, directed approaches to adjusting the numbers in your blood and DNA profiles. Another feature of InsideTracker, is that it has what's called "The Inner Age Test". This test allows you to see what your biological age is and compare that to your chronological age. Of course, your biological age is the one that you can control and that's the one that's really important to your immediate and long-term health. If you'd like to try InsideTracker, you can go to insidetracker.com/huberman to get 25% off any of InsideTracker's plans. That's insidetracker.com/huberman to get 25% off. Today's episode is also brought to us by Helix Sleep. Helix Sleep makes mattresses and pillows that I truly believe are the best out there. I've been sleeping on a Helix mattress for about a year now and it's the best sleep I've ever had. One thing that makes Helix mattresses really unique is that they are tailored to your unique sleep needs. You can go to their website, you take a quiz, it only takes about two minutes, and it will match your body type and sleep preferences to a particular mattress. So, it will ask you questions such as, "Do you sleep on your side, you back, or your stomach?" "Do you tend to run hot or cold during the night?" Maybe you don't know. You answer those questions and it matches you to the mattress that's right for you. For me, that turned out to be the Dusk Mattress, D U S K. I wanted a mattress that wasn't too firm, not too soft. Anyway, I matched to the Dusk. I've been sleeping on a Dusk Mattress, as I mentioned before. It's been the best experience for me. My sleep is so improved. So if you're interested in upgrading your mattress go to

helixsleep.com/huberman, take their two-minute sleep quiz, and they'll match you to a customized mattress for you. And you'll get up to \$200 off all mattress orders and two free pillows. Again, go to helixsleep.com/huberman, take their quiz, match to the mattress that's right for you, and if you decide to purchase it, you'll get up to \$200 off all mattress orders and two free pillows. They have a ten-year warranty and if you want to try it out, you can do that for 100 nights risk-free. They'll even pick the mattress up for you if you don't love it,

00:06:52 Habits versus Reflexes, Learning, Neuroplasticity

but I'm pretty confident that you will. Again, helixsleep.com/huberman is where you'll find the Helix mattress for you. Let's talk about habits. And anytime we're talking about habits, that means our nervous system learns something. Now, many people think that habits are just like reflexes, but pure reflexes are things like the eye blink reflex. You know, something comes towards your eye and you don't want it to get in your eye, you'll blink. Or if you happen to step on a sharp object, or get too close to something that's too hot, you'll reflexively move away. Those aren't habits. Those are what we call hard-wired reflexes. Habits are things that our nervous system learned, but not always consciously. Sometimes we develop habits that we're not even aware of until they become a problem or maybe they serve us well. Who knows? But the fact of the matter is that habits are a big part of who we are. What we do habitually makes up much of what we do entirely. In fact, it's estimated that up to 70% of our waking behavior is made up of habitual behavior. So, you can imagine that there's a lot of biology, meaning cells and hormones and neural pathways, et cetera, that are going to support development of those habits. So if habits are largely, learned, consciously or unconsciously, we have to ask ourselves, what is learning? Well, learning is neuroplasticity. Neuroplasticity is simply the process by which our nervous system changes in response to experience. We have to ask, what changes? Well, what changes are the connections between neurons. Neurons are just nerve cells. They communicate with one another by electricity and by sending chemical signals to one another that inspire the next neuron and the next neuron to either electrically active or not. But at the end of the day, neuroplasticity is about forming new neural circuits, new pathways by which certain habits are likely to occur, and other ones are less likely to occur. So, we've got habits. We have that habits are learned, we have that learning involves neuroplasticity,

00:08:51 Goal-Based Habits vs. Identity-Based Habits

and that neuroplasticity involves changes in the connections between neurons, nerve cells. Okay, so that describes habits through the lens of neuroscience and biology, but as many of you are well aware, there are popular books about habits and there's a whole psychological literature about habits, and those two areas point to some very interesting aspects of habits that I think are worth mentioning. First of all is this notion of immediate goal-based habits versus identity-based habits. Immediate goal-based habits are going to be habits that are designed to bring you a specific outcome as you do them, so each and every time you do them. So for instance, it might be that you want to develop a habit of getting, you know, 60 minutes of zone II cardio each day, or perhaps 3-4 times per week, as we head into the new year. I've talked before on the podcast about the fact that the scientific literature and the health literature really points to the incredibly positive effects of getting 150 minutes to 180 minutes per week minimum of what's called zone II cardio. Zone II cardio is basically any cardiovascular exercise that gets you moving, and your heart pumping, and breathing, but not so hard that you can't hold a conversation, and so that kind of puts you at the threshold of just being just able to have a conversation that's a little bit strained, but if you were to exercise a little bit harder, you know, run a little bit faster, et cetera, you wouldn't be able to talk while you did it. There's a lot of literature that points to that as a healthy practice. So maybe you're somebody that wants to get more of zone II cardio, for instance. That would be an immediate goal-based habit if your goal is to get that cardio, maybe 4 times a week. Every time you do it you check off a little box and you say, "Okay, I did it." You met the goal. That is different than so-called identity-based habits where there's a larger, over-arching theme to the habit, where you're trying to become, quote unquote, "a fit person". Or you're somebody who wants to be an athlete or something of that sort. It's where you start to attach some sort of larger picture about yourself or what it means for you to do that habit where there's both the immediate goal, right? Complete the exercise, complete the session, or whatever it is, check off that box. But that you're linking it to some sort of larger goal. Now, why am I making this distinction? I mean, first of all, I'm not the one to first make this distinction. Others have made the distinction between identity versus immediate goal-based habit formation. But the reason I'm making the distinction is that pretty soon in our discussion today we are going to talk about dopamine, a molecule that's

associated with motivation and reward, that we make in our brain, and how different schedules of dopamine release predict where we will stick to a habit or not. And in particular, whether or not we will be able to form that habit quickly

00:11:40 How Long It (Really) Takes to Form a Habit; Limbic-Friction

or not. Now, this is absolutely critical to understand for the following reason. Another thing that you'll hear out there in the literature is that it takes 21 days to form a habit. Some people say 18, some people say 21, some people say 30 days, some people say 60 days. So which one is it? Does it depend on the habit that one is trying to form? Or does it depend on the person that's trying to form the habit? Well, it turns out that there's excellent peer-reviewed data on this. There's a study published in 2010, first author Lally, L A L L Y. This study found that, for the same habit to be formed, it can take anywhere from 18 days to as many as 254 days for different individuals to form that habit. The reason I bring this up, is that I always get asked, "Is it true that it takes 21 days to form a habit?" "Is it true that your nervous system changes in six days" "when you're doing something repeatedly?" And the answer is, as I mentioned before, it's highly variable. What I didn't tell you actually, is what specific habit they were looking at in that Lally study. And it's interesting that the specific behavior was a health-related behavior. That's pretty relevant to our discussion here, on the podcast. Which was taking walks after dinner. There's actually a really nice literature showing that walks after a meal can speed glucose clearance from the blood stream, can be beneficial for not just weight loss, but cardiovascular health, et cetera. So a walk after dinner seems pretty straightforward, right? Well, in order to form that habit, it took some people 18 days and other people 254 days. How did they know when they formed the habit? Well, they were doing it about 85% of the time and they also reported not having to spend that much mental effort in order to get into to the mode of taking a walk after dinner. So, for those of you listening, some of you might be thinking, "I can't believe that it would take certain people 254 days" "to get into that habit." As I said, people are highly variable and if you can't form one habit easily, it doesn't mean that you can't form other habits easily. The mystery of why certain people can form certain habits more easily than others? Probably has something to do with how people manage what's called limbic friction. Now, limbic friction is not a term that you're going to find in the formal neurobiological literature or even some of the psychological literature. It's, frankly, a term that I coined to encompass

a number of different pieces of the psychology and neuroscience literature. Limbic friction is a short-hand way that I use to describe the strain that's required in order to overcome one of two states within your body. One state is one of anxiousness, where you're really anxious and therefore you can't calm down, you can't relax, and therefore you can't engage in some particular activity or thought pattern that you would like. The other state is one in which you're feeling too tired or lazy or not motivated. Both of those states, feeling too alert and too calm, if you will, relate to the function of the so-called autonomic nervous system, a set of neurons and hormones and chemicals in your brain and body that act as sort of a see-saw. You're either alert or calm. You're either asleep or stressed. Those two states are not compatible with one another. You've probably heard of "wired and tired" but that's really once you've been very stressed for a long time, to the point where you're exhausted. What does the autonomic nervous system have to do with any of this? Well, limbic friction is a phrase that can be used to describe how much effort, how much activation energy you need in order to engage in a particular behavior. So, using this Lally study as an example, some people would eat dinner, and then say, "Oh, that's right, I've been trying to develop the habit" "of taking a walk after dinner." "So, let's get up and go." Other people will feel like, "I just don't want to do it today." They're going to feel too much limbic friction and that limbic friction could arrive, again, from one of two sources. It could be because they are too tired to do it or it could be because they're too anxious and distracted in order to do it. So, this is a key distinction. A lot of habit formation has to do with being in the right state of mind and being able to control your state of body and mind. So as we march forward, what you're going to find is that this phrase or this term, limbic friction, is going to be a useful metric or a way for you to touch in with yourself and address whether or not you are likely to be able to form a certain habit easily or whether or not it's going to be very challenging. And I'm going to teach you a way to measure your degree of limbic friction. That is, how much activation energy it will take in order for you to execute a new habit. And I'm going to teach you how to measure your limbic friction

00:16:07 Linchpin Habits

and activation energy for how likely it is that you're going to be able to break a habit that you don't want to have. The other key concept for us to address that's really mainly found in the books and articles out there about habits, is this notions of what I call

linchpin habits. Linchpin habits are certain habits that make a lot of other habits easier to execute. Now, the sorts of linchpin habits that I'm referring to are always going to be things that you enjoy doing. I'll just give you an example from my life. I happen to like exercise. Not all forms of exercise, but I happen to like resistance training and I happen to like running. So I'm personally in the habit of getting cardiovascular exercise 3 or 4 times per week. Maybe 30-60 minutes per session. And I'm in the habit of doing resistance training 3 or 4 times per week, typically also for about 45 to 60 minutes per session. Now, I enjoy those, and for reasons that I'll get into a little bit later, I enjoy those activities typically early in the day because of the neurochemistry and the various types of hormones, et cetera, that are associated with performing those activities. But I really place those activities under the umbrella of what I call linchpin habits. Why? Because those particular habits are easy to execute because I enjoy them. But they also make a lot of other habits easier to execute. Things like being alert for work, things like making sure that I get good sleep the night before, things like hydration, things like making sure that I eat the foods that are better for me than some of the other foods that maybe I would more reflexively reach to if I weren't doing that training. So certain habits act as linchpins, meaning that they shift a lot of other things. They can control and bias the likelihood that, in this case you or me, will perform other habits that are harder to access, that we have less of an affinity for. So again, there's three concepts that we need to include here. We've got identity-based versus goal-based habits. We've got the concept that typically different habits take different periods of time to adopt, depending on the person and the habit. And that there are these, what I call linchpin habits. Certain habits that make other habits easier to execute. And those linchpin habits always, always, always are things that we enjoy doing. So our goal throughout this episode is for you to identify which habits are easy for you to perform, which ones are hard for you to perform, and which habits you want to break. If you want to grab a pen and paper, you can do that. Or if you want to dictate some of that into your phone, you can. But right now, actually, if you just want to think about these concepts, you can always go back later, I'll be sure to spell out a very specific way that you can chart out a map towards forming particular habits and breaking particular habits later on. What I'd like us to do at this point is to take that concepts of limbic friction

00:18:55 Mapping Your Habits; Habit Strength, Context-Dependence

and for you to ask yourself what habits you perform on a daily basis, and these could be things as basic as brushing your teeth before breakfast, or brushing your teeth after breakfast. It could be, for instance, that you get exercise or you get it at a particular time of day, or even that you take a particular route to work, right? We are very habitual and we tend to do things more or less over and over in the same way, unless we intervene in ourselves. That's just the way that we are wired. So now I'd like you to shift to thinking about a particular aspect of habits and that's habit strength. Now, you all have different habits. You probably brush your teeth at a particular time of day, you probably exercise at particular times of week, you probably go to the refrigerator in a very habitual way. We are incredibly habitual organisms. Unless we intervene in our habits, they tend to carry out the same way that they always have once they've formed. So you can do this exercise now, you don't have to write this down if you don't want to, but you certainly are welcome. We're going to evaluate what's called habit strength. That's not a concept that I created. Habit strength is something that you will find in the psychological literature. Habit strength is measured by two main criteria. The first, is how context-dependent a given habit is. So, context dependence is, if you go from one environment to the next, do you tend to do the same thing, in the same way, at the same time of day? So, for instance, brushing your teeth first thing in the morning. Maybe some of you do that before breakfast, maybe some of you do that later, maybe some of you, like me, don't even eat breakfast. But when I travel, I tend to brush my teeth at more or less the same time of day relative to when I wake up as I do when I'm at home. So it's context independent. So it's a very strong habit, right? There are certain behaviors, like perhaps what you eat, or, you know, perhaps how you dress, that are context independent, that you might perform one way in one context, and another way in another context. The other aspect of habit strength is how much limbic friction is required to perform that habit on a regular basis. This is extremely important because if you are in the process of building habits and consolidating those habits, then it's probably going to take more limbic friction to execute those habits. What do I mean by that? Well, let's say you set out to get, let's say 45 minutes of zone II cardio exercise every day, 5 or maybe even 7 days a week. Well, if at first you're highly motivated, limbic friction might be pretty low. Limbic friction is how much top-down, meaning from your fore-brain to your limbic system, the part of your brain that generates autonomic responses, how much limbic friction, meaning conscious over-ride of your state is required in order to engage in that particular behavior. So, if you're feeling particularly tired and you don't want to get out of bed, and you don't want

to go out and do your zone II cardio, then there's a high degree of limbic friction. It takes, some people think of it as motivation, but motivation is a bit of a vague concept, whereas limbic friction involves specific neural circuits and you can think of it in a more or less quantitative way. You can think of that your body is very tired, so it's going to take more limbic friction in order to get into action. Right? You're going to have to overcome more limbic friction, excuse me. Whereas if you're very, very alert, there's less limbic friction because you're moving toward something that's action oriented. However, the inverse is also true. Let's say that you are trying to get into the habit, or you're in the early stages of forming a habit to meditate regularly. That's a pretty quiescent or calming activity, so if you're somebody who comes home from work and you're very anxious and you have a lot of work to do and you have to deal with a bunch of things, there's a lot of limbic friction to overcome in order to get into that calm state. So these two aspects, context dependence, whether or not you're like to do the thing regardless of where you are. Right? On travel, at home, on vacation, with people around, not people around, et cetera. And how much limbic friction is required to execute that habit,

00:22:55 Automaticity

will tell you whether or not that habit is deeply or just shallowly embedded within your nervous system. The goal of any habit that we want to form is to get into what's called automaticity. Automaticity is fancy language for the neural circuits can perform it automatically, and that's the ultimate place to be. All right, if you have all these goals and things that you want to be doing on a regular basis, you'd love for them to be habitual because it takes less mental and physical effort, less limbic friction, in order to execute those. And so much of what's out there, again in the popular psychology literature, in books that you'll find on the bookstore shelf and on Amazon, and in the airports, are about how to get from that mode of high degree of limbic friction to automaticity. And they offer a number of different ways, I think many of which are useful, trying to get you to organize different types of habits into different bins, like value-based, and goal-based, and trying to persuade you that structuring habits at the particular times of day or in a particular way are going to be beneficial, and indeed, I think they have helped a lot of people. So what I'd like to do is to take the scientific literature of how the nervous system learns and engages in plasticity, and apply that to habit formation,

00:24:03 Tool 1: Applying Procedural Memory Visualizations

habit maintenance, and if so desired, how to break particular habits. I'd like to give you a particular tool that's gleaned from the research psychology literature. I should mention that I learned about this from an excellent review article that's available online. It's called Psychology of Habit. The authors are Wendy Wood and Dennis Ruenger, this is published in Annual Review of Psychology. The Annual Reviews series is a very high quality series. There are annual reviews of neuroscience, annual reviews of psychology, annual reviews of nutrition science, et cetera. For those of you that are interested in exploring review articles that are grounded in hundreds of quality, peer-reviewed studies, the Annual Review series is really terrific. Certainly among the best, if not the best. And they also tend to be quite long and quite comprehensive. So this review, Psychology of Habit by Wood and Ruenger, is excellent. And here I'm more or less paraphrasing from them, so I want to be clear that these are their words, not mine. They're talking about the various ways that habits form in the nervous system and they mention, with each repetition of a habit, small changes occur in the cognitive and neural mechanisms associated with procedural memory. So I just want to talk for a second about what procedural memory is. In the neuroscience of memory, we distinguish between what's called episodic memory and procedural memory. Episodic memory is a recall of a particular set of events that happened, whereas procedural memory is holding in mind the specific sequence of things that need to happen in order for a particular outcome to occur. So think of it like a recipe or a protocol, or for the sake of exercise, it's like sets and reps, or a particular course that you're going to run or cycle, or the number of laps you're going to swim and how you're going to perform it. It's very clear that for anyone trying to adopt new habits, getting into the mindset of procedural memory is very useful for overcoming that barrier that we call limbic friction. How do you do that? Well, a simple visualization exercise, or it doesn't even have to be done eyes closed. You know, often times we hear visualization exercise, you think about sitting in a lotus position, eyes closed, you know, trying really hard to visualize something. Doesn't need to be anything like that. It can simply be, if you are deciding to adopt a new habit, to just think about the very specific sequence of steps that's required to execute that habit. And I'll use a trivial example, but this could be applied to anything. Let's say I want to get into the habit of making myself, or someone else in my household, a cup of espresso every morning, I would actually think through each of those steps. Walk into the kitchen, turn

on the espresso machine, draw the espresso. Walking through each of those steps, from start to finish, and it turns out just that simple mental exercise done once can shift people towards a much higher likelihood of performing that habit regularly, not just the first time, but as they continue out into the days and weeks that follow. So that's remarkable to me and the literature is really robust. Just one mental exercise of thinking through what are the sequence of steps required in order to perform this habit from start to finish can shift the likelihood of being able to perform that habit from unlikely or moderately likely, to very likely over time. And that's because it pulls from this process that involves our hippocampus and our neocortex and other areas of our brain and nervous system, that engage in procedural memory. It shifts the brain towards a mindset, if you will. It's more of a neural circuit set, would be more accurate. But a mindset/neural circuit set of doing things in a particular sequence, which allows that limbic friction to come down and increases the likelihood that we're going to perform that thing.

00:27:48 Hebbian Learning, NMDA receptors

Simple tool but very powerful too, according to the psychology literature. And actually, the cellular and molecular mechanisms that underlie that sort of procedural memory, stepping through phenomenon are known. In this article I mentioned, this beautiful review, they talk about so called Hebbian learning. Donald Hebb was a psychologist in Canada and birthed this field that has now lasted, gosh, more than 50 years and is still very strong in neuroscience and psychology of Hebbian learning. Hebbian learning is when particular neurons are co-active, meaning when they fire together, they tend to strengthen their connections with one another. And it has a number of different cellular and molecular features that we don't have to go into in detail, but for those of you that want to know, I know some of you are hungry for a little bit more neuroscience, this involves things like NMDA receptors and methyl-D-aspartate receptors. NMDA receptors are really important I think for everyone to understand. So I'll just tell you a little bit about them. These are receptors that are on the neuron's surface and normally they don't contribute much to the activity of those neurons. Those neurons are perfectly capable of doing their thing without activation of this NMDA receptor. But when a neuron gets a very strong input, a strong stimulus, that NMDA receptor triggers a number of mechanisms that recruit to the surface of the neuron more other receptors. In other

words, it makes that neuron more responsive to input in the future such that it doesn't require so much input. In other words, it takes a neuron that is very unlikely to fire and makes it more likely to fire. So this procedural stepping through of the steps of the recipe or the series of actions steps that are involved in sitting down to study and writing for an hour, or generating exercise, whatever is the habit that you're trying to learn. When you're doing that exercise, it's not as if your nervous system thinks you're actually performing that behavior. Your nervous system isn't stupid. It's actually a lot smarter than that. It knows the difference between a thought and an action, but when you do that, it sets in motion the same neurons that are going to be required for the execution of that habit. And so when you actually show up to perform that habit, it's as if the dominoes fall more easily. It's a lower threshold, as we say, in order to get the habit to perform. So, Hebbian learning, NMDA receptors, all that nuts and bolts stuff. Really the guts of the mechanisms of how this works. But for those of you that just want to be more habitual about certain things, be able to perform certain things more reflexively, that you would like in your life, simply take the time, do it once, maybe twice, and just sit down, close your eyes if you like, and just step through the procedure of what it's going to take in order to perform that habit. The psychology literature, as I mentioned, and also the neuroscience literature, strongly supports the fact that it is going to make it far easier for you to adopt and maintain that habit. And if you are somebody who used to perform a habit, and you don't understand why you dropped it, and you're frustrated with yourself, and you're trying to figure out how you can get back into that habit, well by all means, lean right back into that habit, but if you're having trouble doing that, also just use the procedural memory exercise in order to shift your nervous system towards a higher likelihood that you will return to that habit

00:31:00 Tool 2: Task Bracketing; Dorsolateral Striatum

just the same way I described for trying to initiate a new habit. So now I'd like to discuss a second, and what I think is perhaps the most powerful tool for being able to acquire and stick to new habits. This tool is rooted in what we call neural circuits and I do think it is important to understand a little bit about how those neural circuits work. For those of you that are saying, "Just tell me what to do." I have to say, as I always say, understanding a little bit or a lot of underlying mechanism will help solidify these concepts for you and will help ensure that the tools that I offer are going to make sense

and that they're going to make sense in differing contexts and for different types of habits that you're trying to learn. So, rather than just tell you what to do, I'm going to tell you how this particular tool works, and then in doing that, you should be able to apply it to any habit, under any conditions. The tool that I'm referring to is something called task-bracketing and the neural circuits associated with task-bracketing are basically the neural circuits that are going to allow you to learn any new type of habit or break any habit that you'd like to break. We have in our brain a set of neural circuits that fall under the umbrella term of the basal ganglia. The basal ganglia are involved in action execution, meaning doing certain things, and action suppression, not doing certain things. In the experimental realm, these are referred to as go, meaning do, or no go, don't do, certain things. And some of us fall more into the category of we find it very easy to do certain things, but harder to not do other things. Some people have a lot of no go type circuits that are very robust, and they have a lot of behavioral constraint, but they have a harder time getting into action. And some people have a perfect balance of both, but I've never met one of those people. So again, drawing from, more or less paraphrasing from this beautiful review that I described earlier in Annual Review of Psychology, excuse me, by Wood and Ruenger, task-bracketing involves a particular set of neural circuits within the basal ganglia, so I'm going to describe this here, again paraphrasing, a sensory-motor loop. Sensory means just input coming in about sight, sounds, taste, et cetera. And then the motor systems, the systems of the brain and body that generate action, taking that information and generating action. So it turns out that there's an area of our basal ganglia called the dorsolateral striatum, we can use the acronym DLS. Again, dorsolateral striatum. Dorso means up. Lateral means to the side. So dorsolateral. And striatum is a subdivision of the basal ganglia. And it's very important for the establishment of behaviors that are associated with a habit, but not necessarily the habit itself. And beautiful studies in both animals and humans that record the activity in the dorsolateral striatum find that the dorsolateral striatum is associated, meaning it becomes active at the beginning of a particular habit, and at the very end and after a particular habit. Hence the phrase task-bracketing. It brackets the habit. Now, other sets of neurons are going to be active during the actual execution of the habit, but what the literature on the dorsolateral striatum tells us is that we have particular circuits in our brain that are devoted to framing the events that happened just before and as we initiate a habit, and just after and as we terminate a habit. In other words, it acts as a sort of marker for the habit execution, but not the execution of the habit per se. This is very

important because task-bracketing is what underlies whether or not a habit will be context dependent or not, whether or not it will be strong and likely to occur even if we didn't get good night's sleep the night before, even if we're feeling distracted, even if we're not feeling like doing something emotionally, or if we are, you know, completely overwhelmed by other events. If the neural circuits are task bracketing, are deeply embedded in us, meaning they are very robust around a particular habit, well then it's likely that we're going to go out for that zone II cardio no matter what, that we're going to brush our teeth no matter what. I'm fact, brushing our teeth is a pretty good example because, for most people, even if you got a terrible night's sleep, even if everything in your life is going wrong, chances are, unless you're very depressed, if you're going to leave to work, or even if you're not, that you're going to still carry out the behavior of brushing your teeth in the morning. I would hope so, actually. But you are probably less likely to perform particular habits that are not what you deem as necessary. But if you think about it, brushing your teeth, exercise, eating particular foods, maybe engaging socially in particular ways, you are the one that places any kind of value assessment on which ones are essential, and which ones are negotiable. So task-bracketing sets a neural imprint, a kind of a finger print in your brain, of this thing has to happen at this particular time of day so much so that it's reflexive. And as we'll talk about in a moment, there's a way that you can build up task-bracketing so that regardless of what it is you're trying to learn, there's a much higher probability that you're going to do that thing. And when I say learn, meaning let's say you're trying to acquire a habit that for you is really challenging. Maybe it's that you're going to write for an hour a day on a book project that you've been thinking about or you're going to work on mathematics, or you're going to do any sort of thing that for you there's a lot of limbic friction. While it is important to think about the sequence of events that would be required in order to engage in that behavior, that procedural memory visualization exercise we talked about before, that will help, there's a way also that you can orient your nervous system towards this task-bracketing process, so that your nervous system is shifted or oriented towards the execution of a given habit. So this is sort of like warming up your body to exercise. When the dorsolateral striatum is engaged, your body and you brain are primed to execute a habit

00:37:08 States of Mind, Not Scheduling Time Predicts Habit Strength

and that you get to consciously insert which habit you want to perform. So in order to

leverage the neural mechanisms of task-bracketing, in order to increase the likelihood that you're going to perform a particular habit, I have to break it to you that one thing that you've probably heard over and over about habit formation is not true. And what I'm referring to is this idea that if you're very specific about exactly when you're going to perform a particular habit, that you're more likely to perform that habit. And while that is true in the short term, it is not true in the long term. And the reason for that is that our nervous system tends to generate particular kinds of behavior based not on time, but on our state. Meaning what level of activation is taking place in our brain and body. How much focus we happen to have, how fatigued we are, how energized we are. So while schedules are important, it's not the particular time of day per se that's going to allow you to get into a habit, and form that habit, and consolidate that habit.

00:38:16 Tool 3: Phase-Based Habit Plan: Phase 1

Rather, it's the state that your brain and body are in that's important to anchor yourself to. So now I'm going to offer you a tool. It's actually an entire program by which you can insert particular habits and activities at particular phases of the day, not times of day, but phases of the day, because it turns out that particular phases of the day are associated with particular biological underpinnings, chemicals and neural circuits and so forth, and in doing so it will make it far more likely that you will be able to regularly engage in these habits and activities over a long period of time. And whether or not that will move you from somebody who ordinarily would take 200 days to form a habit to one of those 18 days to habit people in that earlier study I mentioned, I don't know. But I am certain that will have a significant shift on allowing you to engage in particular habits more easily and to consolidate those habits more quickly. So the program I am about to describe, I formulated for you based on the neuroscience literature, and the psychology literature of learning, and this concepts of task-bracketing. It involves the 24 hour days into what I call three phases. The first is phase one, which is 0 to 8 hours after waking up, approximately. Okay, you can put a plus or minus 30 minutes on this for yourself. The second phase is the 9 to 14, maybe 15 hours after you wake up. And the third phase is 16 to 24 hours after waking up. So we've taken the 24 hour cycle, we've carved it up into three phases, phase one, phase two, and phase three. Now, everything I'm describing, or at least the way I'm going to describe it, is based on what I would call a typical schedule, diurnal schedule. You've heard of nocturnal? Well, we are diurnal. Most of us

are asleep at night and awake during the day. I do realize that a number of people have shift work or they have newborns or other reasons why they have to be up in the middle of the night and sleeping during the day. If that's the case, please listen to the episode we did on jet-lag and shift work because that has a lot of tools specifically for that population. But most people go to sleep somewhere around 10:00 PM, plus or minus two hours, and wake up some time around 7:00 AM, plus or minus two hours. So today, I'm going to use the to bed at 10:00 PM and a wake up time of 7:00 AM as the framework for this, but you could adopt it easily to your particular schedule. Phase one, which again, is 0 to 8 hours after waking, has a particular neurochemical signature. Regardless of what you do, the neuromodulators norepinephrine as well as epinephrine, so that's noradrenaline and adrenaline, as well as the neuromodulator dopamine tend to be elevated during that first 0 to 8 hours after waking. There are a number of reasons for this related to the fact that also cortisol is higher in our brain and bloodstream, it's a healthy level of cortisol upon waking, body temperature is increased, et cetera. And there's several things that perhaps we should all be doing, I've talked about many of these on the podcast before, that in addition to those chemicals, further support an alert and focused state. And I'll just list those off. I've done many podcasts on each of these if you'd like to access those podcasts you can find them in the menu of podcasts on YouTube, Apple, Spotify, et cetera. They involve, for instance, viewing sunlight or bright artificial light if you can't access sunlight, within the first 30 minutes of waking. Physical exercise of some kind in this phase of the day, 0 to 8 hours of the day, ideally pretty early in that phase, but, you know, if it has to be at the 7 to 8 hour transition point that's fine too. Cold exposure in the form of cold showers or ice baths or outside with minimal clothing, appropriate yet minimal clothing. Caffeine ingestion. Fasting, for instance, not ingesting calories, also will lend itself to increased norepinephrine and dopamine, et cetera. If you are going to consume foods, foods that are rich in things like tyrosine, which is a precursor for dopamine. You can look up foods that are high in tyrosine. And for those of you that are interested in supplementation and like to use those routes, things like alpha GPC or phenylethylamine, think, or L-tyrosine, if that's in keeping with what you're able to do. Of course, consult your doctor if you're going to rely on supplementation. What's this all about? Well, the already elevated norepinephrine and dopamine, the sunlight, exercise, cold exposure, caffeine, tyrosine, et cetera, all of those place the brain and body into a state in which you are better able, or I would say, more easily able, to engage in activities that have a high degree limbic friction and where you

need to override that limbic friction. Right? We've heard that the morning is kind of sacred, conquer the hardest things first thing in the morning, and that's been discussed in the pop psychology literature and in the habit formation literature merely from the perspective of get it out of the way so you can feel good about having done it. But what I'm referring to is quite different. What I'm referring to is a particular phase of day that after rising, after waking up, that is, for 0 to 8 hours, right, in that first phase, your whole system is action and focus oriented. And we know that when you're action and focus oriented and because of the neurochemicals that are naturally released in your brain and body that you will be more likely to overcome any limbic friction that stands in the way of performing particular habits. So, as you list out or think about the various habits that you'd like to adopt in your life, take the habits for which you know there's the highest degree of limbic friction, they are the hardest for you to engage in, they require the most activation energy, and put those in this 0 to 8 hours after waking. This will greatly facilitate your performance of those new habits. I'm certain of that. And in addition to that, by doing them in this particular phase of the day, not necessarily the same time, I mean, if you want to be very habitual, and you want to do, you know, the exercise, or the sunlight viewing always at the same time, or you want to do, you want to drink your caffeine always at the exact same time, that's fine, but by placing them in this broader window of 0 to 8 hours after waking, what you're doing is you're creating task-bracketing. You're making it such that your nervous system will predict when you are going to lean in against limbic friction in order to perform particular types of habits. And this is very different than saying, "I'm always going to run" or, "I'm always going to study from 10 to 12 AM every morning." That's great, and if you can do that, terrific. But the literature indicates that people who do that, who are very rigid about when they do things tend, because of context dependence, to not necessarily stick to those habits over time. Some people do, but many, many people don't. So think about the hardest habits to form and the habits that you most want to form that are hardest for you to adopt and to maintain and I highly suggest placing those somewhere within this phase one of 0 to 8 hours after waking. Now of course, some of the things I listed out, sunlight viewing, exercise, cold exposure, caffeine, fasting, those might be the actual habits themselves, but here I realize, or rather I want to acknowledge that many people, including myself, are doing some or all of these things already and many people, including myself, are trying to adopt new habits that don't fall into the category of just trying to set your overall state. Again, norepinephrine, dopamine, and all these neural systems will be greatly elevated

in this 0 to 8 hours after waking. However, the other things I mentioned, sunlight exposure, exercise, cold exposure, caffeine, fasting, if that's for you, or if you're eating during that phase, eating things that contain some or elevated levels of tyrosine, maybe supplementing alpha GPC or L-tyrosine, et cetera. All of those things further facilitate the neurochemistry and therefore the state of mind that's going to be ideal for leaning into limbic friction and overriding that limbic friction so that you can regularly perform that habit. What we're really talking about here is leveraging neural systems in order to help you make it more likely

00:46:29 Tool 3: Phase-Based Habit Plan: Phase 2

that you're going to be able to engage and maintain a particular habit. So what I'm referring to as phase one of each day is useful for acquiring certain habits, but there are other phases of the day, and those turn out to be useful for acquiring other types of habits. Phase two, as I mentioned, is about, again these aren't specifics, but about 9 to 14 or 15 hours after waking. During this phase of the day, because of the circadian shifts in our biology, the amount of dopamine and norepinephrine that's circulating in our brain and bloodstream tends to start to come down and levels of cortisol tend to start to come down. That's the ideal circumstance. In fact, you don't really want elevated cortisol late in the day. That's actually a signature of depression and anxiety and a number of other unfortunate things. So, 9 to 14 hours after waking dopamine and norepinephrine and cortisol are starting to taper down, just naturally. And a different neuromodulator, serotonin, is starting to rise. Serotonin is definitely going to be highest in this second half of the day and tends to lend itself to a more relaxed state of being. Now of course, I do realize that some people are less of morning people and do find that they really come alive and awake in the afternoon, but most people don't fall into that category. Most people feel more alert early in the day, even anxious early in the day, and then, as the afternoon progresses, they tend to be a bit more sleepy, a bit more relaxed, a bit more calm. There's certain things that we all can and should do during this phase two of each day that lend themselves to a state of mind and a state of body that is going to be beneficial for the generation and consolidation of certain types of habits. What are those things? First of all, as the day goes on, you should try if you can to start tapering the amount of light that you're viewing. Now, this doesn't mean putting yourself into dim light at 3 o'clock 4 o'clock in the afternoon. That's certainly not the case. Simply that you want

to start tapering off the amount of really bright light that you're getting, unless it's sunlight. Talked about this before on the podcast, but if you haven't heard, viewing the sun as it's at what we call low solar angle so it's headed toward the horizon, you don't necessarily have to watch the sunset, although that can be nice. But getting some sun light in your eyes in the second half of the day can also be beneficial for a number of brain systems and psychological systems so you can get some some light in your eyes, you can certainly have artificial lights on, but you want to start dimming those lights and bringing them actually physically lower in the room because the neurons in your eye that view the upper visual field they actually trigger this alertness mechanism in the brain and body. And in the second half of the day, even if you're humming around and doing work at 3 or 4 or 5 or even 7 PM, you are probably headed toward sleep a few hours later, so things like limiting the total amount of light if you can, things like NSDR, non-sleep deep rest, another thing that I've talked about on this podcast. If you haven't heard about this before, non-sleep deep rest is an umbrella term for things like meditation, for Yoga Nidra, a very powerful science supported tool for teaching you how to relax, things like self-hypnosis which might sound a little kooky to some of you, but actually is a clinically based tool for which there's a lot of scientific literature. If you're interested in that there's a great free resource called Reverie, [REVERIE .com](http://REVERIE.com). There's a app for both Apple and Android. This is an app that was developed by colleagues of mine and researchers at Stanford School of Medicine. You can do these short 15 self hypnosis script, as they're called. They can teach you how to relax yourself, there's even one for focus, for sleep, for chronic pain, Again, all very strongly supported by quality peer-reviewed literature. So things like Reverie, meditation, things like heat and sauna, hot baths, hot showers. Those are terrific things to do in the second half of the day, they tend to support this serotonergic, or high serotonin like state and lend themselves to more calm and relaxation. For those that are interested in supplementation, there's always ashwagandha, which reduces cortisol, again peaks in cortisol late in the afternoon and evening are associated with depression, anxiety, and so forth. Ashwagandha has a pretty potent cortisol inhibiting tool. I personally don't use it very often and I caution people about using it for longer than two-week periods of time without taking some breaks. You can look up more about ashwagandha on examine.com. There's a lot of traffic literature with links to studies there. But basically this phase two of the day is one in which you're alert, you are present you are working, you are engaging socially, you're cooking dinner probably, paying attention to a number of things, but you should really be

trying to taper off your stress level. So how do you leverage phase two of the day for habit formation? Well, given what we know about the neurochemistry of learning and memory, given what we know about task formation and its reliance on certain forms of neuroplasticity, the second half of the day is a terrific time to take on habits and things that you're already doing that require very little override of limbic friction. So these might be things that categorize in common terms as kind of mellower activities. It might be journaling, it might be that you already are performing music or I should say, practicing music regularly, but there's a particular type of music that is hard for you or that you're working on a particular piece of music, or you're trying to learn a language. Something that's a little bit challenging, but doesn't require a ton of energy in order to override that limbic friction. The second half of the day is a much better time to do that. Less resistance, as we might say. But of course, resistance has a neural substrate and the reason for doing those things in the second part of the day, the so-called phase two, as I've called it, part of the day is because your ability to override resistance is really diminished in this second phase of the day. Some of you might say, "Whoa wait," "I like to exercise in the second half of the day." "That's actually when I have the most energy." "That's when I feel warmer" "I'm not a morning exerciser." That's absolutely fine, but what I'm referring to is the acquisition of new behaviors and placing those consistently at the second half of the day in order to engage these task-bracketing mechanisms that I talked about before. One of the hallmark features of those basal ganglia circuits for go and no-go is that they are associated with certain neurochemicals, dopamine and serotonin, acetylcholine, and other neurochemicals. And by placing particular habits at particular phases of the day, those neurochemical states start to be associated with the leaning in and the process of beginning, and as I mentioned, ending those particular habits. And in doing so they shift the whole nervous system toward being able to predict that certain things are going to happen at particular times a day, that you're going to be leaning very hard against limbic friction early in the day in phase one, and that you're going to be doing things that require less conscious override of limbic friction in phase two. And in doing so, set up task-bracketing system so that the individual habits that you're learning or that you're trying to learn have a much greater probability of being executed and consolidated, meaning that pretty soon that they will just naturally become reflexive. And as with phase one, many of the things that I mentioned that support this, what I'm calling a serotonergic state or more relaxed state in phase two, things like seeing sunlight in the afternoon, but not a lot of bright light from artificial sources, things

like NSDR, things like heat and sauna, hot baths et cetera, ashwagandha, again all of those things themselves could be habits that you're trying to adopt, right? In that case, do those if you'd like to explore them. They are quite beneficial for a number of reasons, not just related to execution of particular habits in phase two of the day, but also for improving quality of sleep and consolidating any learning that you might have triggered earlier in the day. I've talked about that before, but just briefly, as a relevant aside, neuroplasticity involves triggering the neural plasticity, setting it in motion, but the actual rewiring of the brain and the reconfiguration of neurons that will allow that learning to be reflexive, that actually occurs during states of deep rest, like an NSDR and like deep sleep. And I should just mention, for those of you that can only exercise or prefer to exercise in phase two of the day, right, 9 to 14 hours or 15 hours after waking, that's absolutely fine. However, because of the importance of sleep and in particular deep sleep throughout the night for not just neuroplasticity, but recovery of muscle and other tissues that are taxed during physical exercise, if you do train in phase two, I highly recommend, highly recommend that you start doing some NSDR activity after you train, within an hour or two, because that will allow you to taper down and relax

00:55:24 Tool 3: Phase-Based Habit Plan: Phase 3

so that you can get into the next phase we're going to talk about, which is phase three. Phase three of the 24-hour schedule runs from about 16 to 24 hours after waking. During that period of time, there are few things that are going to support being in a state of mind, state of body that are going to allow neuroplasticity to occur, that are going to allow the rewiring that you've triggered during the waking part of the day to actually take place. Those things are very low to no light, meaning keeping your environment very dark or very, very dim. I don't think it's necessary to sleep in a room that's complete blackness. I think that's a little bit overkill, but for most people keeping the room dark and keeping the room temperature low is very beneficial for getting and staying in deep sleep. The body has to drop by about 1 to 3 degrees in order to get into sleep and stay asleep, so low light, low temperature environment, you can always pile on blankets of course if you don't want to be cold at night, you want to be warm enough, but you want your environment to be cold. Typically people aren't eating in the middle of the night, although one thing that can be useful is to make sure that you're at least well-fed enough when you head into this third phase of every 24-hour day that you're not awake because

you're hungry. A lot of people recommend putting a gap between your final bite of food and when you got to sleep at night. Some people say that gap should be 4 hours, other people say 2 hours, if you're me, I generally have something, I don't know, within 2 hours or 90 minutes of going to sleep, but it's not a big meal, but that's just me, and I fall asleep and stay asleep fine with that. You have to experiment for yourself. I've talked about supplements that can support sleep in previous episode of the podcast, things like magnesium threonate, or magnesium bisglycinate, things like theanine, apigenin. If you'd like to read more about those, we actually have a newsletter that I'll just quickly refer you to this is the Huberman Lab Neural Network Newsletter, you can sign up for it by going to hubermanlab.com, it's very easy to find, but even if you don't sign up, you can go to the toolkit for sleep that's listed there and that tool kit is not just supplements, that tool kit is a number of different things, both behavioral and supplement-based and nutrition-based, et cetera, that can allow you to get in to sleep and to stay asleep more readily. It's totally zero cost, you can find that again at hubermanlab.com. So things like low light, low temperature, the supplements I mentioned, adjusting your eating schedule appropriately, obviously not drinking caffeine in the middle of the night or too close to bed, that's going to be critical. In fact, ideally you wouldn't ingest any caffeine in phase two of the day, so that you could get into this deeper state of rest in which habit formation and neural plasticity can occur. What if you wake up? The way I've cast phase three is that you're supposed to be in this deep slumber, you're not supposed to wake up at all, you're supposed to be in low light and your brain is rewiring and those habits are getting consolidated, et cetera. Well, if you're like me, you probably get up once in the middle of the night. Maybe go use the restroom. Perfectly normal, perfectly normal, but a lot of people have trouble falling back asleep. Very important if you get up in the middle of the night to use a minimum of light in order to navigate your surroundings, just as much as you need in order to safely do so, because light inhibits hormone melatonin, can make it very hard to fall back to sleep if you inhibit melatonin. The effects of light inhibiting melatonin are actually very potent. It happens very, very quickly, so try and keep the lights low. And you have trouble falling back asleep, that's when you might also want to use something like a Reverie app, they have a sleep script there that can hopefully help you get back to sleep. Or something like NSDR, you can find NSDR scripts on YouTube. These are zero cost. You can look up one that I particularly like is NSDR Made for. It's a company I'm associated with, but the NSDR is completely zero cost, and there are other things, like Yoga Nidra, which you can find scripts for

elsewhere. Again, all of these habits or these behaviors, these do's and don'ts around phase three, themselves might be habits that you're trying to create for yourself. But again, phase three is really about making sure that whatever limbic friction you've been able to override in phase one and trigger some new habit, right? Forcing yourself to write or forcing yourself to study or forcing yourself to exercise during that high limbic friction state. And then whatever things you've been doing in phase two, which are habits that hopefully have moved a little bit further along the continuum of newly-formed versus all the way to reflexive, or things that take less limbic friction in order to do. Phase three is when all of that gets really locked into the nervous system through those Hebbian mechanisms, like NMDA receptors, et cetera, that I talked about before. Again, neuroplasticity is the basis of habit formation and neuroplasticity and the rewiring of neural circuits happens in these states of deep sleep. So if you're not obeying this phase three, if you're not giving phase three the material it needs, and you're and you're not avoiding the certain things, like caffeine and bright light and stress during phase 3, you're simply not going to be able to build those habits that you've been working so hard to trigger in phase one and phase two of the day. Again, these are things that I've talked about previous episodes of the podcast and elsewhere, but really this is about habit formation. And the whole reason for placing particular types of behaviors at particular phases of the day is to set a framework for that task-bracketing. Again, task-bracketing and the circuits of the basal ganglia indicate that it's not just the neural circuits that are engaged by the task itself, but the neural circuits that are engaged before and after that task execution. That's what gets consolidated. So when you do things that particular phases of the day, under particular conditions of neurochemistry, what you're doing is you're giving the brain a very predictable set of sequences that during sleep it can start to put into your hard drive, if you will. It can really program it into your nervous system, so that within a short period of time, hopefully within 18 or maybe even 6 days or who knows? Maybe even fewer days, you'll find that executing those behaviors is very, very straightforward for you

01:01:34 Habit Flexibility

and that you won't have to feel so much limbic friction or override so much limbic friction. Some of you are probably asking, okay, if I perform a particular habit during phase one, and then I do other habits during phase two, and I eventually get to the point where I'm

engaging in those habits in a pretty effortless way, do I keep them in the same phase of the day? And the good news is, the literature says it doesn't matter. And in fact, moving that particular habit around somewhat randomly can actually be beneficial to you because actually moving it from one time a day to the other is that context independence that we really are seeking. By being able to do the same thing that we want to do regardless of time of day or circumstances that's how we know that we've achieved a real habit formation, that's how we know that the habit has been moved into certain components of our neural circuitry that just allow us to do it what seems like reflexively. Although earlier I pointed out that these aren't reflexes in the traditional sense. The reason for that is that this brain area, the hippocampus, that many of you know is associated with learning and memory, is not actually where memories are stored. The hippocampus is where memories are formed, it's where procedures, like we talked about before, procedural memory of how you're going to execute a particular sequence, where that's maintained. So like if we use the recipe model, that's where the recipe is maintained until you know how to cook that dish and then the procedural memory literally migrates off into a different set of neural circuits, which are the neural circuits of the neocortex where we have maps of sensory experience, maps of all kinds experiences, including motor maps of how to execute things. So we use one part of the brain to learn something, but then that information, in the form of the electrical activity of neurons, is passed off to a different brain area. Now, the neurons themselves don't move from the hippocampus to the cortex, that doesn't happen. What happens is the signals, the sequence of electrical firing, much like a script for a movie or the notes on a sheet of paper for a particular musical piece is transferred off to a different brain area. So, that whole process of really leaning into something that's hard, and then it becoming easier, and then eventually that things becoming more or less reflexive involves a migration of the information in the brain. And once it's migrated out to a different location in the brain, at that point it's achieved context-independence. It doesn't have to be bracketed by, you know, your caffeine and your lunch. It doesn't have to occur immediately after your afternoon NSDR, but before your four O'clock meeting on Zoom, or something of that sort. So all this is to say that once something has become reflexive, you should play with it a little bit about time of day. If you want to keep it in the same phase of day, great. But if you one day decide you're going to exercise in the afternoon, the next day you decide you're going to exercise in the morning, and that's the habit that you're concerned with, that's terrific. If you're able to do that, that means that it's truly achieved context-

independence. It means that you have officially formed that habit. And as I mentioned earlier, much earlier at the beginning of the episode, the strength of a habit is dictated by how much limbic friction, that was one, and how much context dependence there is. So when it doesn't take much activation energy to get into the execution of that habit

01:04:57 Should We Reward Ourselves? How? When? When NOT to.

and you can do it in any context, well, then you have formed a habit. We really can't have a discussion about learning anything, habits or otherwise, unless we talk about reward prediction error. Reward prediction error is associated with the molecule dopamine, although I should say there are other neurochemicals in our brain and body that are also related to reward prediction error. But reward prediction error is a very good system, or I should say, a lens through which to think about, whether or not we should reward ourselves for performing a given habit. And this is a much larger discussion that actually relates to things like parenting and self-regulation. You know, should we reward kids just for effort? Should we reward ourselves just for effort? What should we reward? How much should we reward ourselves? When should we withdraw reward? Should we use punishment? These kinds of things. This is a vast literature. We don't have time to go into all the details, but the notion of reward prediction error is so powerful that it can predict most if not all forms of learning, including habit formation. And you can deploy or use particular features of reward prediction error if you would like to reinforce or accelerate the formation of certain habits. So, reward prediction error, quite simply, is if you expect a reward and the reward comes, a particular behavior that was associated with generating that reward is more likely to occur again. That's pretty straight forward. However, the amount of reward, in the form of this molecule dopamine, that you will experience is even greater if a reward arrives that's unexpected. Okay. So let me repeat that again. If I think that something's coming that's going to be great, let's say I lean into a habit, I manage to override my limbic friction, and I'm doing my 45 minutes of writing in the morning with no phone and no internet and I'm getting toward the end, and I'm anticipating how I'm actually doing this, this is great, I did it, I'm feeling really, really good. I finish, I definitely will receive a dopamine reward, I'll make my own dopamine reward, that's where it comes from. Remember, this is all internal. However, I will also receive a dopamine reward if unexpectedly something positive happens. And typically if something unexpected but positive happens, the amount of dopamine reward that we

get is actually much greater than in any other conditions. However, it's hard to surprise yourself about a behavior that you're deliberately engaging in. So that becomes a bit of a tricky one. Reward prediction error also says that if we expect a reward and the reward doesn't come that the pattern of dopamine release will follow a particular contour and that contour is very important. Here's how it goes. Let's say that I'm writing and I'm about 30 or 45 minutes in, I'm thinking, "Ah, this is great." "I'm actually, I managed to do this" "I'm succeeding in executing the behaviors" "that I need to in order to perform this habit." "I'm overriding limbic friction." Just that series of thoughts will start to generate the dopamine release within my brain and body. However, if at the 15 minute mark the phone rings and I pick up the phone or I break my own protocol, I break my own self-discipline and I go on and check social media or I do something that takes me out of that, what's going to happen is that my level of dopamine is actually going to drop below the baseline, meaning below the level of dopamine I had before I even started the habit execution. Okay? So what this is, is this system that predicts whether or not rewards are going to come. When we think a reward is going to come, it starts to actually arrive earlier in the form of dopamine release. This is the feeling that we experience as positive anticipation. You tell a kid, "Hey, we're going to go to the amusement park." Or "We're going to go get ice cream." They haven't had the ice cream yet, they're not at the amusement park, but they're excited, the dopamine release comes earlier. Okay? They get to the amusement park or they get the ice cream, they will also have some dopamine release associated with that. But most of it, believe it or not, came in the form of the anticipation. And dopamine has some qualities that make the actual ice cream and the actual amusement park experience more pleasurable than it would be had that dopamine release not happened. Now of course, the other way to do is to surprise a kid. You tell them, "Listen, we're going to the class that you absolutely hate." Or "We're going to go see the person" "that you absolutely despise." And then you drive them to the amusement park that's the big release of dopamine. But reward prediction error also says that if you tell the kid, or yourself, "Okay, we're headed to the amusement park." "We're going to get some ice cream." They're really, really excited. And then you get there and it's closed, or they're not letting any more people in, well then the dopamine level drops way below what it was before you told them that you were headed there. Okay? I've given a number of different examples that hopefully make this clear. Reward prediction error governs virtually all aspects of effort and all aspects of learning. Why? Because when dopamine is released in the brain and body, the neural circuits of our

brain and body change. There's a state change. Our over level, excuse me, our overall level of energy, but also the sorts of sensory events that we're paying attention to changes when there's a lot of dopamine in our system.

01:10:30 Tool 4: "Dopamine Spotlighting" & Task Bracketing

Now you can leverage this for habit formation. Think back to task bracketing. Think back to limbic friction. If you are considering adopting a new habit or if you are trying to break a habit, something we haven't talked too much about, but we will in a moment, it's very useful to think not just about the procedural aspects of what you're going to do, but also think about the events that precede and follow that particular habit, and the execution, or at least the effort to execute that habit. What you're doing is you're casting a kind of a spotlight around a bin of time, or a set of events, for which dopamine can be associated. What does this look like in the practical sense? Well again, I'll just try and use very simple concrete examples, but this could carry over to anything. Let's say I were somebody who has a hard time getting in that 30 to 60 minutes of zone II cardiovascular exercise mid-morning. This is actually an issue for me. I much prefer to do resistance exercise than cardiovascular exercise, although once I do it, I always feel much better that I've done it. What I should do is positively anticipate the onset and the offset of that session. Right? So thinking about leaning into the effort, going out and doing that zone II cardio session, and I should think about how I'm going to feel after. So, not just thinking about how great I'm going to feel after, but also thinking about how hard it's going to be at the beginning, and then trying to reward myself subjectively for the entire experience. In other words, start rewarding task-bracketing in addition to rewarding the execution of the habit itself. Now some of you might be saying, "Well, wait this is all self-talk." "This is just positive self-talk." But it's not positive self-talk, it's not saying, you know, "I feel so great about doing something" "that I actually hate." You can't lie to yourself, or you're welcome to lie to yourself, but the neuroscience literature, the literature of growth mindset, all the literature basically of mindset speaks to the fact that when you lie to yourself, you know you're lying, and you actually set up the opposite of a reward system. So, you have to be brutally honest with yourself that, for instance, "I don't like initiating this cardiovascular exercise" "but I do like the fact that I've done it" "after I've done it." So what you are doing is you are applying reward prediction error to the entire sequence of things that's involved in getting into the habit execution, getting through the habit

execution, and getting out of the habit of execution. How do you do this? Well, I take us back to our procedural memory visualization exercises we talked about earlier. When I talked about it in that context, I talked about walking through mentally the series of steps that's required to perform a particular habit. So in the case of the zone II cardio thing it would be, "Okay up and put on my shoes," "then I'm going to head out the door," "then I'm going to drive up the road." There is a particular canyon near here that, if I'm going to run, I happen to like running, or I don't hate running enough that I tend to do it. Going through that, heading back, et cetera, et cetera. That's great, but even better would be to broaden the time bin and start to positively anticipate the period headed into the habit, so even before you put on your shoes. The fact that you are successfully placing the habit in, in this case, phase one of the day and that afterwards I'm going to feel a particular set of positive benefits, elevated mood, et cetera. I like being hungry and quickly after I exercise I'm hungry, so I like being hungry because I like eating, so there's a whole set of things that link up with one another. So I'm not just thinking about habit execution as this isolated little set of events, or this little time bin, but rather, I'm drawing a larger envelope around it and starting to positively associate dopamine reward with that larger envelope. And for those of you that are thinking, "Well, this is just a psychological trick." You know, you're kind of like, "This is sort of like lying to yourself." It's not because you're not actually contradicting the fact that some of this is unpleasant. What you're doing is you're taking this entire series of events, what I'm calling this kind of time envelope, and you're associating it with a particular reward that comes later, which for me would be the feeling that, you know, that I've completed this. Right? Because for me that's usually a good feeling. So reward prediction error is beautiful, not just because it's a sort of math of anticipation and reward, or a math of anticipation and disappointment, it's beautiful because you can stretch out or make more narrow the time bins in which reward prediction error works. Reward prediction error is the way in which people navigate four year degrees. Right? I mean, you go, sure, final exam to final exam, et cetera. But ultimately, there's a big payoff at the end and it's all basically for that big payoff. And of course, I understand that it's the journey, not the destination, but let's face it, for a lot of us goals and habits are about achieving some sort of destination. In the case of zone II cardio, for me it's about trying to stay alive for as long as I can, as long as I can with vitality, that is. And it's also the fact that if I'm doing that, I get to eat the foods that I like. I tend to be able to eat more, which I happen to really enjoy eating, so much so that I'd like it just as an activity. So basically what you're trying to do is not

restrict your thinking to just the habit that you're trying to form, but rather, to grab ahold of the timing before and after that particular habit and start to positively associate reward mechanisms in your brain with that entire time bin. This is a very useful and very powerful tool in order to form habits. And I should say that it's not something that comes naturally to most people. In fact, even as I describe it, you might find it's still a little bit abstract, but what I encourage you to do, if you are finding it to be a little bit vague, would be to pick the habit that you want to form, write down or think about very concretely what is the sequence of steps involved in the execution of that habit, and then write down or think about what is the sequence of events that need to precede that habit, maybe the immediate 10 or 15 minutes before, as well as the immediate sequence of events and/or feelings that will occur after that habit, and then call the whole thing a habit execution. The whole thing an effort to engage in that particular habit. And in doing that, and in positively associating with the idea that you're going to complete that entire sequence, you will engage reward prediction error in the proper way that the dopamine surge can lend itself towards motivation. Because ultimately, dopamine is not about feeling good, it's about feeling motivated. This is something that I've talked about numerous times before, but dopamine, contrary to popular belief, is not a reward molecule, so much as it is a molecule of motivation and drive. And the natural consequence of doing the exercise I just described, of writing things out that precede, are involved in the immediate execution of the habit, and follow the habit, will allow you to experience an increase in energy and thereby an increase in likelihood that you're going to engage in that entire sequence of events. And the reason for that is that dopamine gives us energy, and the reason for that is that the molecule epinephrine, adrenaline, is actually manufactured from dopamine. Biochemically, it comes from dopamine. So, dopamine is powerful and you can access more dopamine around even habits that you haven't yet formed by taking this broader time envelope and task-bracketing that specific task execution or habit execution. Way back at the beginning of the episode, I promised you that I would deliver two programs that are geared towards habit formation. And I promised that I would give you ways in which you could gauge whether or not certain habits had moved from high effort, what I call high limbic friction, to reflexive. And we talked about a number of ways to gauge that. In researching this episode, I found a tremendous number of different systems for habit formation. It's really amazing how much is out there. There, one says 60 days to this, or 21 days to that, or 18 days to this. I mean,

01:18:22 Tool 5: The 21-Day Habit Installation & Testing System

it's just rampant in the popular psychology literature and in the self-help literature. I want to spell out a particular system that I think could be very useful to most if not all people that's rooted in the biology of habit formation, rooted in the psychology of habit formation, and that is entirely compatible with that phase one, phase two, phase three type program that I talked about earlier, but encompasses a bit of a longer time scale and really arrives at a kind of a system, if you will, for how to build in habits and then to test whether or not those habits have really stuck and whether or not they're likely to stick going forward. And so this, at least for the sake of this example, a 21 day system. I picked 21 days because that seems to be the average or most typical system for engaging neuroplasticity as it relates to the formation of new habits. This 21 day system, actually, is one that someone I know very well uses and has used for a very long time. They actually, their kids use it as well. And it has a certain elegance to it and I think as I describe it that elegance will begin to reveal itself. So basically what this involves is you set out to perform 6 new habits per day across the course of 21 days. Why 6 and why 21? Well, we'll talk about that in a moment. But the idea is, you write down 6 things that you would like to do every day for 21 days. What phase of the day those things fall into? Well, that will depend on what they are and how they relate to those earlier phase one, phase two, phase three, but for now, 21 days, 6 things per day. However, the expectation is that you'll only complete 4 to 5 of those each day. Okay? So built into this is a kind of permission to fail, but it's not failure, because it turns out that this approach to forming habits is based not so much on the specific habits that you're trying to form, but the habit of performing habits. Right? It's the habit of doing a certain number of things per day. So, you set out to perform 6. Now, another reason for not necessarily performing all 6 is that some activities probably shouldn't be performed each day. For instance, in my case, if I were to weight train or even run every day, I'm of the sort, or my biology is of the sort that I don't recover so well. So I wouldn't want to do resistance training every day, but I might want to do it 4 days a week, for instance. So by having 6 things in that list, you could shuffle out that particular activity on particular days of the week, and simply do 4 or 5 other activities. So 21 days, you list out 4 to 5 things. So it might be zone II cardio, resistance training, sunlight viewing, writing could be journaling, it could be learning a language, mathematics. Again this is going to vary depending on

your particular goal and the habits that you're trying to create. But no more than six and the expectation is that you're not going to perform more than 4 to 5. If you miss a day, meaning you don't perform 4 to 5 things, there is no punishment. And in fact it's important that you don't actually try and do what, in the literature, is called a habit slip compensation, which is just fancy psychological language for if you screw up and you don't get all 4 or 5 in one day, you don't do 8 the next day in order to compensate. This actually brings me back to an example I had from graduate school. I remember when I started graduate school feeling very excited, but a little bit overwhelmed by the amount of things that I had to do because I had to both do research, I was doing coursework, at the time graduate students stipends, and still now unfortunately, were depressingly low so it was financially stressful. There were a number of things happening and I remember a neurologist, this was at UC Berkeley, he was a really fantastic scientist and person, his name was Bob Knight, some of you may know him. I remember he, I went to him and I asked, you know, "What is the process by which someone" "actually navigates graduate school successfully?" And he said, "Listen, you don't want to do anything" "or engage in a routine in any way" "that you can't keep up consistently" "for at least five and ideally 6 days per week." I thought, "Oh, that's pretty good." And he said, "Every 4 or 5 years" "you might have to update that," "but you need to decide what you can do consistently," "what you can do every day or at least six days a week," "or 5 days a week." And that was very very useful to me and it fits well with this notion of habit slips, that if you happen to screw up and not be able to engage in whatever habits you're trying to learn for whatever reason, that the next day, you just get right back on on the on the horse, so to speak. However, there's a really interesting feature from the neuroscience literature and from the psychology that says that chunking this 21 days into 2 day bins can be very, very useful. While it is true that the unit of the day that our cells use is a circadian one, a 24-hour clock, there does seem to be something powerful about engaging in particular habits, in a particular sequence, for two days in a row, and then resetting, so thinking, "Okay I can do this for a day" "and if I can do it for a day," "I can probably do it for 2 days." And then resetting. So every 2 days you're resetting. So you're kind of chunking 21 days into a series of 2 day bins, in which you are trying to perform 4 to 5 new habits and then completing that 21 days. Now, everything I've described about this 21-day program with 6 things that you're trying to do with new habits and only performing 4 to 5 and not compensating, et cetera. There's nothing neuroscientifically unique about it, except for the fact that it's not just 21 days, broken up into two day chunks. After 21

days, you stop engaging in this 21-day deliberate 4 to 5 things per day, tight schedule, and you simply go into autopilot. You ask yourself how many of those particular habits that I was deliberately trying to learn in the previous 21 days are automatically incorporated into my schedule? How many of them am I naturally doing? In other words, every 21 days you don't update and start adding new habits. You simply try and maintain the ones that you built in that first 21 days. And this I think is extremely important because in all the habit literature that I could find, sure, there was a lot of psychological data and neuroscience data, behavioral science data around here's how you form a habit, here's how you break a habit. There was even some kind of test for whether or not a habit had really achieved context independence, whether or not it was a strongly formed habit. But there wasn't a lot of information, at least by my search, of what to do once you've formed a habit, and how to evaluate whether or not that habit is likely to persist long into the future. So here's the idea, you set out these 6 things that you would like to learn, or that you would like to acquire in your life, these habits, you only expect that you're going to perform 4 or 5 each day, you do that for 21 days. Again, if you miss a day, you just hop right back on the next day. However, you should think about the functional units within this 21 day period as 2 days. You can try and nail 4 to 5 of these things for 2 days. If you happen to get all 6, great, but that's not necessarily required. So you can do it for 2 days then reset 2 days, then reset 2 days, and then in the next 21 days, you're not trying to acquire any new habits, you're not going to throw in 6 more habits that you want to learn, you're simply going to assess how well, how deeply, you rewired your nervous system to be able to perform those 6 habits of the previous 21 days. And this is extremely useful, I believe, because it will allow you to assess whether or not you can indeed make room, if you even have room, I should say, for more habits. Many people are trying to cram so many new behaviors into their nervous system, that they don't stand a chance of learning all those behaviors. What you may find, is that you kept up 2 of those things very consistently throughout the 21 days. And perhaps there was one of them that you did sporadically, and that there were 3 others that, frankly, you didn't manage to execute. You may also be one of these people, one of these mutants, that sets out to do 6 new things per day for 21 days and performs every single one of them. Terrific. More power to you. In that case, for the following 21 days, let's see whether or not you can continue to perform those very same 6 things every day for 21 days, and then, and only then, would you want to add more habits in. So you could repeat this 21 day process, you know, 21 days of new habit, 21 days of testing those

new habits as to whether or not they're reflexive or not. You could do that forever, if you wanted. But the idea is that this isn't something that you're doing all year long. It's that you're perhaps starting the new year or regardless of when you're listening to this, you set out to make that 21 day really the stimulus period in which the habits get wired in and then the following month, and maybe even the following months, or periods of 21 days, are really the kind of thermometer or the test bed of how well you've embedded those particular habits. And if indeed you want to continue to add new habits or you find that certain habits that you weren't able to embed in your nervous system and make reflexive, you want to then bring those in, fantastic. But it's only once you've achieved all those 6 habits as reflexive, that you would move forward. And I think this sort of system, while it could have been replaced with many other different systems. Again, there's nothing holy about this system. But this particular system has a number of features, the lack of compensation for missed days, the fact that it's a fairly high intensity program for 21 days, but then you test yourself, a kind of competition test with yourself, if you will. Those features and the fact that habit slips, missing of particular habits and not doing all 6 is kind of built into the system, I think makes it a very reasonable one. It's very adaptable to the real world. And I think it's one that, provided you obey the phase one, phase two, phase three type system that we talked about earlier, you collapse these two programs with one another, which hopefully will be easy, based on the descriptions I've given. Well, if you do that, and I think there's a very high probability that the habits that you try and form will achieve this context dependence

01:28:26 Breaking Habits: Long-Term (Synaptic) Depression

and that it will take progressively less limbic friction to try and perform them. Thus far, we've almost exclusively been discussing how to form habits. But what about breaking habits? Certainly many people out there would like to break habits that they feel don't serve them well. One of the challenges in breaking habits is that many habits occur very, very quickly and so there isn't an opportunity to intervene until the habit has already been initiated and in some cases completed. Well, there are a couple of tools that neuroscience and psychology tell us can be very beneficial. Some of those things are somewhat intuitive and relate to what I call foundation practices. Meaning things that set the overall tone in your body and brain, such that you would be less likely to engage in a particular habit or that would raise your level of awareness, both of your situation and to

how you feel inside. So things like stress reduction. Things like getting good sleep. Things like quality nutrition. Things like having positive routines arranged throughout your day. All of those, of course, will support you in trying to break particular habits. And while that can be very useful, it's admittedly very generic advice. It doesn't point to any one specific protocol. In order to identify a specific protocol that one could apply in order to break habits, we have to look at the mirror image of the sort of neuroplasticity that we talked about at the beginning of the episode. At the beginning of the episode, we talked about a form of neuroplasticity called long term potentiation, involving the NMDA receptor. Just to refresh your memory a little bit, it says that if a set of neurons is very electrically active it's likely that those neurons will communicate with themselves more easily because of changes in things like NMDA receptor activity, the recruitment of additional receptors, et cetera. It's essentially a cellular and molecular explanation for how something goes from unlearned, to learned, to reflexive. Now, in order to break synapses, or to break apart neural connections that are serving a habit that you don't want to engage in, we need to engage the process called long term depression. And long term depression has nothing to do with a state of mental depression or a reduction in mood. So I really want to be clear that when I say depression in this context it has nothing to do with psychological depression, it has nothing to do with mood. It's simply called long term depression because just as long term potentiation says if neuron A triggers the firing of neuron B, and it does so very robustly over and over and over again, then neuron A will not have to fire as intensely, or as frequently, in order to activate neuron B in the future because they become potentiated. Right? The threshold for co-activation has been reduced. There's a much higher probability that they will be activated together at low levels of intensity. That's essentially what long term potentiation is. Long term depression says that if neuron A is active and neuron B is not active within a particular time window, then the connection between neuron A and B will weaken over time, even if they started off very strongly connected. Okay? So, I'm going to repeat that because this is a pretty detailed neurobiological mechanism whereby if neuron A, and neuron B is active, but at a different time or outside a particular, what we call, temporal window, meaning outside a particular time window, then through long term depression, the connection between neuron A and neuron B will weaken. And just as a point of interest, the NMDA receptor is also involved in long term depression, although there are other molecular components involved as well. So how do you take two neurons that underlie a habit out of synchrony? How do you get them to fire asynchronously? This is

pretty interesting with respect to the cellular and molecular biology, but at the behavioral level, it's especially interesting. The way that one would do this is, let's say for instance, you have a habit of picking up your phone mid work session. Okay? That's a reflexive habit I think that most people have experienced. And we often hear the idea that, oh, the phone is so filled with access to dopamine and incredible things that we're just drawn to it. But if you noticed what's happened with phone use over time, most people, including myself sometimes I admit, find ourselves just looking at our phone, or find ourselves in a particular app without actually having engaged in the conscious set of steps of, "Oh I'm really curious" "what's going on in this particular app." "I'm really curious" "what's going on in this particular website." And you just kind of "find yourself", in air quotes, for those of you listening, I'm making air quotes. You just sort of find yourself doing it because the behavior of picking up your phone is sort of reflexive, or has become fully reflexive. You see this a lot at meals where multiple people are there and no one's looking at their phone and then all of a sudden someone takes out their phone and you'll notice that other people just naturally take out their phone. It's this kind of observation induced reflex. And I would wager that most people aren't consciously aware of the immediate steps involved. So the literature says there are a number of ways to break these sorts of habitual behaviors, or reflexive behaviors. Most of those approaches involve establishing some sort of reward for not performing the activity or some sort of punishment for forming the activity. I've heard of some basic things that some people will do, like they'll even put like a rubber band on their wrist, and every time they complain, or every time they do some behavior, like pick up their phone, they'll give themselves a snap on the wrist. And yeah, the rationale there is that you're trying to create a somatic, a very physical representation of something that makes it very real and harder to overlook. Other people will just do a tick mark on a piece of paper. This sort of, "What gets measured is what gets managed" kind of mindset, where if every time you do something, you take away the judgment, this is very new age-y, I realize, but this is what you find out there, if you search the literature. Even on PubMed, peer-reviewed articles, that every time you engage in a behavior, you just measure the fact that you did that behavior, you just mark it down. At the end of the day, people are supposed to look at that and say, "Oh my goodness!" "I can't believe that I spent, you know, 3 hours." Or, "I did it 46 times." And in fact, a lot of apps, social media apps, will start to give you warnings now, if you opt in, that you've been on the app for an hour, would you like to leave? Most people just click right past it and go back in. I think very few people say, "Oh

my goodness!" "It's been an hour and therefore you're right," "I absolutely shouldn't engage in this any more." It's just far too easy to just blow past those reminders. Well, the literature on habit formation and habit reduction, breaking habits, has been analyzed. There's a beautiful meta-analysis, which involves looking at a number of different studies all together, comparing the statistical strength of each of those studies, looking in different conditions what sorts of habits were trying to be made or broken. The first author on this review is Fritz, F R I T Z. I'll certainly put a link to this. It's Heather Fritz and it's "Intervention to modify habits: a scoping review." And it is indeed a very broad scale review. It's from the Journal of Occupation Participation and Health. It's published in 2020. It's a really nice article. A couple of things I learned from this article

01:35:49 Notifications Don't Work

and then I'll get into the specific tool for breaking habits. Perhaps the most interesting thing that I took from this review was the finding that notifications to either engage in habits or to not engage in habits actually were not very effective over time. They were effective in the immediate period when people started using these notifications, as were little sticky notes, like, "Don't go into the refrigerator" "between the hours of whatever and whatever." Or just visual reminders, physical reminders or electronic reminders were effective in the immediate term, but in the long term, did not predict whether or not people would effectively stick to habits they were trying to stick to, or break habits that they were trying to break. So sadly, that doesn't seem to work very well. And perhaps they just need to come up with more robust reminders. I don't know, mild electric shock or something like that because what we do know, only sort of kidding about mild electric shock, but what we do know from both human and animal studies is that things like electric shock, things like monetary penalties, right? Having to pay out every time you engage in a particular behavior. Those are pretty effective ways to break habits. The problem is when people are not being monitored for habit use, for instance, you can imagine a situation where you say, "I'm not going to pick up my phone" "for the 4 hours in the early part of the day" "so I can get, you know, real dedicated focused work done." Unless someone's monitoring them, then people don't tend to monitor themselves completely enough that they punish themselves completely enough, that they break the behavior. In other words, the punishment isn't bad enough, in order to break the habit, which just speaks to how powerful these habits are once they become reflexive. They're

just very, very hard to override. So it turns out that the key to generating long term depression in these pathways is actually to take the period immediately following the bad habit execution, meaning, let's say you tell yourself you're not going to pick up your phone, you're not going to bite your nails, you're not going to reflexively walk to the refrigerator at a particular time or day,

01:37:50 Tool 6: Break Bad Habits with Post-Bad-Habit "Positive Cargo"

but you find yourself doing it anyway, and what actually has to happen is bringing conscious awareness to the period immediately afterwards, which I think most people recognize, they realize "Ugh I just did it again. I just did it again." And in that moment, capture the sequence of events, not that led to the bad habit execution, but actually to take advantage of the fact that the neurons that were responsible for generating that bad habit were active a moment ago, and to actually engage in a replacement behavior immediately afterward. Now, this is really interesting and I think powerful because I would have thought that you have to engage in a replacement behavior that truly replaces the bad habit behavior, right? That you would have to be able to identify your state of mind or the sequence of events leading into the bad habit, but rather, the stage or the period immediately after the bad habit execution, is a unique opportunity to insert a different type of, what we would call adaptive behavior, but that could be any behavior that's not in line with the bad behavior, so let's give it an example. Let's say you find yourself, you're trying to do focused work, you pick up your phone, you're disappointed in yourself for picking up your phone, you could of course just put it down, and re-engage in the work behavior, but if you were good at that, then you probably wouldn't have done it in the first place. And so, what turns out to be very effective, is to go engage in some other positive habit. Now, this has two major effects. The first one is you start to link in time the execution of a bad behavior to this other good behavior. And in doing so, you start to recruit other neural circuits, other neurons, that can start to somewhat dismantle sequence of firing associated with the bad behavior. In other words, you start to create a kind of a double habit that starts with a bad habit, and then ends with a good habit. And that seems to create enough of a temporal mismatch so that then recognizing when you're heading toward to bad habit becomes more apparent to you. So again, I want to make this very, very concrete. Let's say that the behavior is reflexively picking up one's phone. You do that, you think, "Ugh, goodness, I did it

again." Here's what I'm going to do, you would set that down and then you would engage in some other positive behavior, that you've deemed positive. And here, it's very subjective, so it's hard for me to give an example that will necessarily make sense to everybody, but perhaps you're working on hydration, so maybe you go have a glass of water. Maybe you're trying to do breath work or something. Maybe you're trying to enhance your language speaking skills so you go and you spend 5 minutes doing a particular type of language learning. You literally exit whatever you were doing and perform that other new positive habit in the immediate period right after that, even for a short period of time. It's a little bit counterintuitive, but what this does it creates kind of a cognitive and a temporal mismatch between the initial bad behavior, which before is what we would call sort of a closed loop, and the engineers out there will know what I'm talking about. But in a closed loop, so one behavior, one set of neural firings, leads to another, leads to another, and then just kind of sets the same thing in motion. It can be kind of a self-perpetuating system. By changing the number of features that are in that loop, it disrupts the closed nature of that loop, it creates what we call an open loop, and in an open loop, you are better able to intervene. So, as I mentioned before, this might seem counterintuitive, you might think, "Why would I want to reward the execution of a bad habit" "with a good habit." "I don't want to reward myself for the bad habit." But really what you're trying to do is you're trying to change the nature of the neural circuits that are firing so that you can rewrite the script for that bad habit. A different way to put it would be, imagine that the bad habit is like a chord on the piano that you play, or a chord notes, or a sequence of notes that you would play, and it comes very easily. You can play it every single time. But, let's say, as you're trying to learn a new piece of music, you're just constantly inserting that at the inappropriate time. That was, you know, I think it was a decent enough analogy for a bad habit because it involves some motor execution. You just find yourself doing it. Rather than trying to prevent yourself from doing it, the next time you do it, add in a new chord or sequence that you're trying to learn. What this does then is it changes the whole nature of the sequence of neurons that are firing from bad habit through to the end of this newly applied good habit. So, this is the way in which you start to dismantle or, when I say dismantle, really weaken the likelihood that if neuron A fires, neuron B will fire. Because, as you're starting off in the mode of very reflexively performing a bad habit, those neurons are firing together without you consciously being aware of it. It's almost impossible for you to intervene in yourself without a number of other features, like severe punishment, severe consequence type

outcomes. Rather, tacking on some additional sequences, like if neuron A, neuron B fires, and then you're saying, "Okay well, if neuron B fires," "I'm going to start inserting neuron C, D, E, F to fire." Right? That's the, C, D, E, F being the positive behavior that you're going to insert. And in doing so, you create a chain of neuronal activation that then is very easy to dismantle. And so, when people have applied this kind of approach, it removes the need to have constant conscious awareness of one's own behavior prior to that behavior, which is very, very difficult to achieve. Rather, what they find is that they are able to engage in re-mapping of neural circuits associated with bad habits in ways that are very, very straightforward. Right? Because you can always identify when you've done the thing you don't want to do and then tack on to that something additional that's positive. Now, the nature of that positive thing is important. You don't want it to be something that's very hard to execute. You want it to be something that's positive and fairly easy to execute, so that you're not struggling all the time to insert this on top of this bad behavior, whatever that bad behavior might happen to be. But again, this is rooted in the biology of long term depression, it maps very well to the behavioral change literature that I was able to glean that really shows that rather than just get reminders, rather than try and instill punishment, rather than setting up reward for breaking bad habits, that perhaps the simplest way to approach this is to tack on additional behaviors to the bad habits, make sure those behaviors are good behaviors, or behaviors that are adaptive for you, and in doing so, you will soon find that the initiation of the bad habit

01:44:26 Addictions as Habits: <https://hubermanlab.com/dr-anna-lembke-understanding-and-treating-addiction/>

takes on a whole new form or that you're not even inspired to do it at all. And of course, I want to acknowledge that breaking bad habits is really hard. We had an episode all about addiction with Dr. Anna Lembke from Stanford Medical School. She's a colleague of mine who runs the Dual-Diagnosis Addiction Clinic at Stanford. And in that episode, we talked a lot about how addicts for drugs, alcohol, people have addictions to certain types of behaviors, or avoidance behaviors even, that in the case of addiction, there has to be a tremendous kind of full-scale campaign for them to be able to intervene in their behavior. So, for those of you that are thinking about bad habit breaking in the context of addictive type behaviors, definitely check out that episode. Addiction does employ some of these principles around habit making and habit breaking, as it were, but of course,

because the consequences of certain habits in addiction can be so severe, there's other sets of protocols and there's a kind of a psychological backdrop to it that's very important. It also relates to the biology of dopamine,

01:45:28 Conclusion & Synthesis

and you can find all of that in the episode with Dr. Anna Lembke. So today we've covered a lot about the biology and the psychology of habit formation and habit breaking. We talked about why certain habits are so hard to wire in, why certain habits are so hard to break down and eliminate, and how we can determine which habits are going to be easier for us to access and which habits are going to be harder for us to access and break. We talked a lot about this notion of limbic friction and we talked about context dependence. And we talked about a number of different things as it relates to neural circuits and the formation of new connections in the brain, and strengthening and weakening of connections in the brain. We also discussed two programs. Programs designed specifically for you on the basis of the neurobiology literature and the literature on the psychology of habit formation and habit breaking. Just to briefly recap, one program involves dividing the 24 hour day into three phases, phase one, phase two, phase three, and to try and tackle specific habits at particular phases of the 24 hour cycle. The second program involved a 21 day process of engaging approximately 6 new habits per day, although the expectation, as I mentioned earlier, is that you're not going to perform all 6 of those. And an assessment in the following 21 days as to whether or not you have indeed formed those new habits or not. And there were a number of other features that I mentioned that were related to those two general programs. Phase one, phase two, phase three, and the 21 day program, and how those could be meshed together. So, I'm guessing some of you will probably have questions about those programs and how to apply them, but hopefully they were clear enough for you to get started. This is a good opportunity for me to mention that the Huberman Lab Podcast has something called the Neural Network Newsletter that is sent out approximately once a month. For the next newsletter, I will release a on-paper version of these two systems and how they mesh together for habit formation and habit breaking, and if you'd like to access that, you can go to hubermanlab.com, you go to the menu, you can sign up for the newsletter. First of all, it's zero cost. Second of all, we have our privacy policy there, but I can tell you right now, we don't share your email with any vendors or with any other

sources. Those emails stay internal to us. And if you'd like to see what the sort of flavor of those newsletters is, the previous newsletters, for instance, one on tools for sleep, that I mentioned earlier, or tools for neuroplasticity, in the classroom and outside the classroom as well, for teachers and for students of various kinds, those are also posted there so you can access any of the previous newsletters. My hope is that today you've learned both the biological mechanisms and the practical tools by which you can start to establish habits that, for you, you deem adaptive, healthy, and that are going to support you in your goals. And that you can start to dismantle some of the habits

01:48:27 Zero-Cost Support, Sponsors, Patreon, Supplements, Instagram, Twitter

that you find to be unhealthy or maladaptive for you and for your goals. If you're learning from and/or enjoying this podcast, please subscribe to our YouTube channel. That's a terrific way to support us. In addition, on YouTube you can leave us feedback in the comment section. You can also leave us suggestions for future guests that you'd like us to host on the Huberman Lab Podcast. And please also subscribe to the podcast on Apple and/or Spotify. On Apple, you can leave us up to a 5 star review. And now Spotify has a feature by which you can also leave us review feedback. Please also check out the sponsors mentioned at the beginning of this podcast episode. That's perhaps the best way to support our podcast. In addition, we have a Patreon. It's patreon.com/andrewhuberman, and there you can support the podcast at any level that you like. During today's podcast and in many previous episodes of the Huberman Lab Podcast, I mentioned supplements. While supplements aren't necessary for everybody, many people derive tremendous benefit from supplements. Supplements for sleep, supplements for focus, supplements for various other things related to mental and physical health and performance. One key issue any time there's a discussion about supplements, you have to be sure that the supplements you are taking are of the very highest quality. And for that reason, we've partnered with Thorne, because Thorne has the very highest stringency, with respect to the quality of the ingredients they include, and the precision of the amounts of the ingredients that they include in their supplements. If you'd like to see the supplements that I take, and get 20% off any of those supplements, you can go to Thorne, thorne.com/u/huberman and, in addition to being able 20% off any of those supplements, if you navigate deeper into the Thorne site through that web portal, thorne.com/u/huberman, you can also get 20% off any of the

other supplements that Thorne makes. If you're not already following us on Instagram and Twitter, please feel free to do so. There, I teach neuroscience and neuroscience related tools in short format. Some of that material overlaps with what you hear on the podcast, some of it is unique and different from what's on the podcast. And once again, I want to thank you for going on this journey of exploring the neuroscience and the psychology of habit formation and habit breaking. I hope it supports you in your goals. And last but certainly not least, thank you for your interest in science. [mellow music]