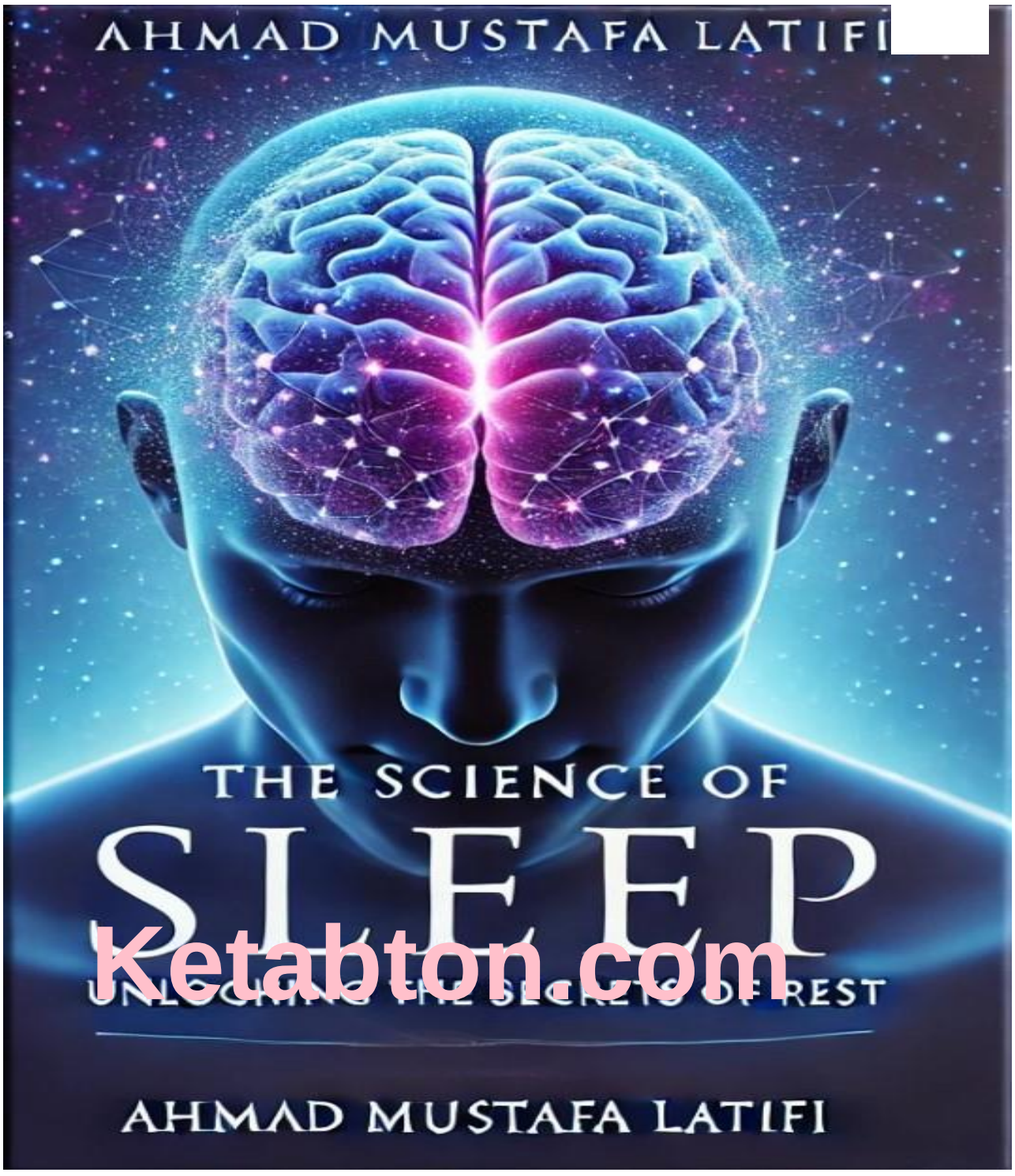

Preface

Sleep is one of the most fascinating and essential aspects of human life. Yet, for much of history, it was misunderstood—considered a passive, almost useless state. Today, thanks to decades of scientific research, we understand that sleep is not just a period of rest, but a critical function that impacts every organ and process in the body. From cognitive performance and emotional regulation to immune function and longevity, sleep plays a central role in our overall well-being.

As a person driven by both a passion for science and a deep instinct to help others, I have always sought ways to use knowledge to improve lives. This book is a result of that pursuit. I chose sleep as my focus because, despite its undeniable importance, many people neglect its role in their health and productivity. By exploring sleep, we gain the power to enhance not only our nights but every waking moment of our lives.

In this book, we will journey through the science of sleep—its mechanisms, its impact on mental and physical health, and the consequences of poor sleep. We will examine how sleep affects learning, memory, and emotions, as well as the disorders that can disrupt it. Additionally, we will delve into sleep hygiene, the art of cultivating healthy sleep habits, and the intriguing world of dreams and nightmares. Through this exploration, I aim to equip you with the knowledge and practical strategies necessary to transform your sleep and, ultimately, your life.

The information in this book is backed by extensive scientific research and the dedicated work of thousands of experts in the field. By understanding and improving your sleep, you unlock the potential for a healthier, more fulfilling life. Let’s embark on this journey together—toward better sleep, better health, and a better future.

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Sleep Introduction

Sleep is one of two phases of our life. It is probably the single most important thing to reset your brain and body health. It is an incredibly complex process. Although we might dream, twitch or etc. It is an incredible period of our life within which we are only in relation with activities within our body. Sleep is very different from wakefulness and cannot be replaced by any state of wakefulness. Outside sensory experiences mostly cannot impact us. sleep is the foundation for mental health, physical health, and performance of all kind cognitive performance, physical performance etc. it also controls things like our immune system, wound healing, our skin health, our appearance, whether we think clearly or not, and whether we live longer or not. we cannot talk about wakefulness, focus, motivation, mood, well-being, without thinking about sleep, but we cannot speak about sleep too without speaking about wakefulness because they are related to each other do intricately. What we do in wakefulness determines when we fall asleep whiter we stay asleep or not, how long it takes to fall asleep, and how we feel the next day and etc. We are going to talk a lot about sleep. through this book We dive deeper in almost every aspect of sleep.

Why we sleep?

Whatever sleep is doing, it should be non-negotiable life supportive. in what way it should be life supportive? First, if someone is not getting enough sleep like sleeping for five hours for five days, they will have a level of testosterone which is similar to someone who is 10 years older than them. So a lack of sleep will age you by ten years in just 5 days. If you limit yourself for the same amount of sleep and for the same period, your blood sugar will be so impaired that your doctor will consider you as pre-diabetic. Let me move on to immune system. Scientists took healthy individuals and limit them to 4 hours of sleep just for one night, then he measured the levels of critical anti-cancer fighting immune cells called natural killer cells. They found one night of that match deprivation could deprive you of 70 percent natural killer cells activity. That is a striking state of immune deficiency. To give people an idea of natural killer cells, think about them as secret service agents of your immune system. These natural killer cells are very good in identifying dangerous unwanted elements in your body like cancer going after them and destroying them. You want enough of them in your body. if you don't sleep enough that would not be the case. If you are getting 6 or less than 6 hours of sleep, you are almost three times more likely to develop the common cool. We also know that it is also your cardiovascular system that suffers when you are not getting enough sleep like heart attack. the other study, global like experiment that is performed on about 1.65 billion people around 70 countries twice a year, showed that in the spring, when we lose an hour of sleep, what scientists observed in that paper was 24 percent relative increased heart attack risk. In the fall when you gain an hour of sleep, there was a 21 percent reduction in heart attack risk. There is also higher risk of car accidents, suicide, after that one-hour reduction. In other study scientists looked at two groups for one weak. In one group participants slept for 6 hours,

and in the other group they slept for 8 and half hours. then scientists looked at their gene activity profile. what they found two things. First, a sizeable and significant number of 711 genes were distorted in their activity cause by lack of sleep. second, half of those genes' activities increased and half of those genes' activities decreased. Those genes which were impaired by lack of sleep were associated with immune system. Those genes that were increased in their activity were genes that were associated with promotion of traumas, long term chronic inflammation, and cellular stress and as a consequence cardiovascular diseases. The amazing part is this that there is no aspect of your well-ness that seems to be able to retreat sign of sleep deprivation. Lack of sleep is almost like broken water pipe in your home.

How we transmit to sleep state

It turns out that there are two main forces which determines when you want to be asleep and when you want to be awake. The first force is a chemical force which is called adenosine. adenosine is a molecule in our nervous system and our body that builds up when we are awake, and it clears when we are asleep. When it is rising it will increase the volume on your sleep promoting regions while decreasing the volume on awake promoting regions. So if someone has slept deeply for 8 to 9 hours the adenosine level is going to be very low because he spent enough time to clear it out. If someone, however, have been awake for like 15 or 16 hours, adenosine level will be very high and it is enough to fall you asleep. adenosine derives sleep hunger. You can test the pressure of adenosine by staying awake longer like for 4 hours than normal time and you will feel an intense pressure which wants you to sleep. However, if you stay for much longer than normal like up until morning, you will start to feel alert and focus again. Well, you may say that the pressure should increase even more because there is more adenosine in our brain and body, but why we feel alert? Well, it turns out that there is a second force. The second force which govern when you should sleep, and when you should wake up is circadian force or circadian rhythm. Circadian means about 24 hours. It is 24 hours rhythm in all sorts of functions. It is the master cock in our brain which beats out rhythmic message of activity for us during the day and inactivity during night and goes every single day. inside our brain this is the clock which determines when we want to be asleep and when we want to be awake. These two forces know nothing about each other. they just work independently on their own.

Stages of sleep

As we get sleepy by forces that I mentioned, we tend to shut our eyes, and this is controlled by neurons in our brain. Then we transition into sleep. Regardless of how long we sleep, our total sleep is broken to average 90 minute cycles called Ultra-dian cycles. however, some people could have longer or shorter Ultra-dian cycles but 90 minutes is average. Men could have 15 to 20 minute longer cycle than women. Sleep have two different stages non-REM and REM sleep. the first stage, non-REM sleep is further divided into four separate stages. They are unimaginatively called stage one through four increasing in their depth of sleep. We

got stages one and two (light sleep stages), stages 3 and 4 (deep non-REM). The second stage is REM (rapid eye movement sleep) sleep. REM sleep is the principle stage in which we dream, and we are paralyzed during REM sleep. During each Ultra-dian cycle, we tend to have both of these stages of REM and non-REM sleep. At the start of the cycle we will have non-REM sleep and toward the end we will have REM sleep. What is interesting is that the ratio of non-REM and REM sleep in each Ultra-dian rhythm throughout the night is not same. Early in the night we tend to have large amount of non-REM sleep and less of REM sleep in Ultra-dian cycle. For every 90 minutes of sleep that we have we tend have more and more of REM sleep and less of non-REM sleep. This is true regardless of whether you wake in middle of the night briefly or your sleep is broken. The more you sleep the more you are going to have REM sleep. If someone, for example, is sleeping for 8 hours each night, but one day he wakes up 2 hours earlier due to something, you might say he lost 25% of his sleep, but that is not entirely true. According to total sleep it is correct, but due to this strange structure non-REM sleep first and REM sleep later, they may have lost 60 to 80 percent of their REM sleep. I only made this point for introducing the structure of sleep correctly. Non-REM sleep is characterized by a particular pattern of brain activity in which there are big sweeps of waves of brain activity that include a lot of the brain. As we start to fall in those lighter stages of non-REM sleep our brain activity waves slow down from 30 to 40Hz which is in wakefulness, to 4 to 8Hz in stage two non-REM. What I mean by Hz is that the waves are going up and down times per second in other words 30Hz means 30 up and down waves in a second. So a huge deceleration in brain wave activity happen. When we go to stage one non-REM sleep, for reasons that we don't know yet, our eyes start to roll in their sockets underneath your eyelids. you will also have mini dreams or dream lite. You are losing consciousness and proprioceptive sensation, which is knowing about the position of your body and sensing it. Then we go to deep non-REM sleep. In these stages the brain waves really slow down to 1 to 2Hz. It is incredibly slow. You might say by the waves of the brain that your brain is less active, but this is not the case, in fact, the size of waves are very big like 10x larger than wakefulness. you might say why does this happen? Let me give you an analogy. Imagine there is a football match between real madrid and Barcelona. Before the game starts, everybody has a conversation about a different thing and there is a big incoherent noise. it is your brain in wakefulness different regions doing different things in different moment of time, but when you go to deep non-REM sleep, for reasons that we don't know yet, they fire together and the silent together and that is what producing these large waves, so the analogy in the football stadium would be the match starts and real madrid is in winning moments and all of a sudden the real madrid crowd is singing Barcelona sucks. They would say that all at once, and then go silent together. They will repeat this again and again. Different stages of sleep do different things and are all important. Deep sleep is important for two things. First, it stimulates the restocking of the weaponry in your immune arsenal. So when you wake up the next day you are more immune robust individual. Second, it is very good in regulating your metabolic system and your ability to control blood sugar and blood glucose. If we deprive you of deep sleep alone your ability to control blood sugar will be

impaired very much. REM (rapid eye movement) sleep is associated with eye movements under eyelids during sleeping. It is beneficial for dream related tasks and etc.

Light

Our sleep tends to be condensed into one single block, something like 6 to 10 hours block. That block and when it falls within 24 hours is governed by number of different factors. The strongest of these factors is light and particularly sunlight. There is a very important relation between sleep and light. Most of the people tend to wake up sometime around sunrise. The reason we wake up is release of hormone by the name of cortisol from adrenal glands, and also a release of epinephrine/adrenaline from your adrenals and brain which make you feel awake. Some of you might say that cortisol is not good why should we have it? I would say that the release of cortisol early in the day is healthy and normal. It makes you feel alert, to move, go for work, exercise social relations and so many other tasks. These releases might come with alarm clock or you naturally waking. They alerts your body to increase heart rate, tense muscles and etc. It is very important that cortisol release come early in the day or at least early in your waking period. When you wake up in the morning that cortisol pulse takes off. Something else important also happens. A timer (circadian rhythm) is set in your brain that dictates when a different hormone called melatonin, which makes you sleepy in the night, will be secreted from a particular brain region. When you wake up in the morning, and you experience that rise in cortisol level, there is a timer (a cellular) that starts going and says to your brain and body that in about 12 to 14 hours a different hormone, melatonin, will release from your pineal gland. So there are two different mechanisms: a wakefulness signal and a sleepiness signal. The wakefulness signal triggers the onset of the timer for the sleepiness signal. The rhythm of cortisol and melatonin is what we call indigenous. it is happening in us all the time without any external input. in fact, if we were in complete darkness living in a cave with no artificial light whatsoever or if we were in complete brightness this rhythm of cortisol and melatonin would continue, but in these situations everyday your rhythm will be triggered later and later as your circadian rhythm is a bit longer than 24 hours. These indigenous systems of our body could be better governed by external things like light which determines when this rhythm should fall. In fact, if we control our rhythm by external things, our wake-sleep cycle would stay static in 24 hours of the day otherwise our sleep-wake cycle would drift throughout the 24 hours as our circadian rhythm is more than 24 hours, and we will wake up later every day and go to sleep later naturally. In normal circumstance when you wake up, you open your eyes. Then light comes in to your eyes. There are particular kinds of neurons in your eyes that perceives a particular kinds of light and communicate that to the clock that resides right above of the roof of your mouth Called the master clock. That central clock has connection with each cell in your body. It is vitally important that we get light communicated to the central clock in order to time cortisol and melatonin properly. If we don't get that cortisol and melatonin rhythm right, there are tremendous bad effects on cardio vascular health, metabolic effects, learning, depression, dementia and etc. So when we wake up our eyes open. If we are in a dark

room, there wouldn't be enough light to trigger this rhythm. So you should go outside get enough sunlight and trigger the rhythm. Well, you might ask why won't any kind of light do it? It turns out that our eye neurons are less sensitive during morning and it needs lots of light. This is supported by dozens of studies. It turns out that these neurons in our eyes that set the circadian clock responses best to a particular quality of light and amount of light, and those are the quality of light and amount of light which comes particularly from sunlight. These neurons really look for the lower solar angle sunlight. These neurons don't know anything about sunrise, but they respond best to the quality of light which comes from lower solar angle sunlight. You might ask if we look at our phone or laptop screen will they activate it? The answer is sort of, they will be activated but not in optimal way. What you have to do is take sunlight as close to waking as possible. If you can get the sunlight when sun is rising, it is the best. However, you can also get sunlight if you get up few hours later than sunrise. You don't need sunlight beam right in your eyes. There are lots of sun light energy photons scattered, and you can take them. The key is get that sunlight into your eyes. It is critically important that you get outside to get that light. Dr. jimmy seitzer, from department of psychiatry and behavioral science at Stanford university and a world expert, said that it is 50 times less effective to get the light from window, car windshield, or side window of a car than it is to go outside with no glasses and view light. Off course you can use prescribed lenses and glasses. They won't filter out the necessary light. Never compromise prescribed things because of these information, there are some illness which is very bad to get sunlight for longer period. If you measure the light outside and it is, for example, 10000 lux and you should see that for 10 minutes and you then you measure the light from window inside your house, and it is 5000 lux. you should not think that you should see the light just 2 times more. It doesn't work like that you should see the light for much more longer. You can see this light up to two hours after sunrise but sun should be in low solar angle. Once the sun is over head the quality of light shifts and you miss to time the rhythm. You really want to time cortisol rhythm properly. If the cortisol increase happens later like 8 or 9 am, it causes many kinds of anxiety. Well how long should you see the light? It varies tremendously. Some people live in very bright areas with clean sky without clouds and it takes them 30 to 60 seconds to trigger the rhythm. However, if someone live in Scandinavia, sometimes there will not be enough light to trigger your cortisol rhythm, so the solution is, you can go for longer outside in order to trigger the rhythm. In normal days when sky is clear about 5 minute light would be enough to trigger your rhythm. It might vary due to circumstances. When it is cloudy you could get about 10 minutes of light or even more if the sky was so much cloudy. If one day you miss seeing light for next day try to have twice as much light exposure. Even if the sky is cloudy there will be light about 10000 to 50000 lux (lux is a measure for light) which is sufficient for triggering the rhythm. if you cannot get sunlight, you can opt to artificial light. However, in that time, it is better to use device to simulate sun light or blue light. Do this regularly. You don't have to do it exactly at sunrise. It should be done within 90 minutes after waking. The close it is to waking the better it is. Try to do it exactly at the same time every day.

Let's talk about time when you should avoid light because light is not supposed to arrive to us at any time. Nowadays we have access to light due to artificial light that normally we wouldn't. The longer you have been awake, the more sensitive these neurons in your eyes are to light. So if you are awake for 12 to 14 hours these neurons are so sensitive to light that even very little light from a device is going to trigger your central clock and make you stay awake for longer, and disrupt your sleep. So let's put it this way you need as more light in start of the day as safely possible. However, you need as little light after 8 pm. You don't want to have bright light exposure to your eyes between 11 pm and 4 am. A paper from cell journal showed that light between 11 pm and 4 am suppresses the release of dopamine which is the neuromodulator which makes us feel good, motivated, and inhibit learning and other detrimental effects. Also, light late in the night could also have bad effects on melatonin which helps for sleep. One of the good way to enhance our mood, focus, learning, emotional health and other is to control bright light exposure. Let's talk about the location of light at night. The neurons which signal our central clock mostly reside at the bottom of our retina and due to optical lenses in front of retina. These neurons absorb light from over your head. These cell were may essentially designed to take light from overhead. To prevent absorption of light during evening, possession the light low in physical environment. Let's talk about moon light, very dim light, fire places and their role in setting the circadian rhythm. It turns out that moon light, candle light, very dim light, and fire place light cannot set the rhythm and trick your brain that it is morning. even though, they may look bright they are not enough, and your brain is also not adjusted to trigger the rhythm by seeing that kinds of light. During the night you could use your phone flash or candle if you needed light which is much better than other kinds of light. Some people might that flash of phone is quite bright. Yes, but it is normally faced downward.

The other thing which is helpful for this rhythm is the sunset, when sun is again in low solar angle close to the horizon. It is very beneficial. By viewing sunlight at that time of the day, evening, the neurons signal the central circadian clock that it is the end of the day. There was a study that showed that seeing the sunlight in that time of the days prevent some bad effects of light on your melatonin that you see later in the night. How to do that? Go out in the late afternoon or evening and see the light for 2 to 10 minutes. It will be good without glasses because it will take 100 to 1000 times longer to get the benefit with glasses.

How do we know that we get enough light? Your rhythm will fall in some degrees of normalcy. You will wake at the somewhat same time each day you will fall asleep easily. It is going to take 2 to 3 days for the rhythm to start.

If you want, you can wake up early by turning on the bright lights or providing light by other ways 45 minutes to 1 hour before you wake up. Well, certainly you cannot do that yourself someone else should that for you. Once you do that light will reach the neurons even though your eyelids are closed. but you should not be under the cover. After doing that for few days that increases your total sleep time and shifts forward the time which you feel sleepy, and makes you want to go to sleep earlier each night. It is Remarkable that light could even

penetrate the eyelids activate those neurons and trigger your central clock. We humans have capacity for phase advances and phase delays. If you see light late in the day particularly late in the night your brain and body for reasons that you now understand will think that is morning light, even though it is not sunlight, it will delay your clock so next day you will wake later in the morning and will go to sleep later. That is called phase delay. The opposite is also true if you get up earlier than normal and see bright light, you are going to sleep and wake up early this is called phase advance.

Light through other orifices. Some people say that light through ears, nose and mouth could be beneficial for setting circadian rhythm. It is not so at least not directly. It might have some placebo effect or temperature effects, but it certainly doesn't affect circadian rhythm directly.

During the day, take about 30 to 40 minutes of natural light you could do that by just setting close to a window working or studying there.

If you wake up early in the morning when sun is not risen, you should use as many as possible artificial light to trigger your rhythm, but when sun is up go outside and see sun light as well.

Don't look at very bright light. What is bright light? The one which is painful to look at.

What about blind and low vision people? They still have the neurons to perceive the light to set the rhythm. So viewing light early in the day ideally sun light is key for establishing healthy wake-sleep rhythm and for allowing to get asleep easily at night. It is not going to assure it happens every single time, but it is foundation for proper sleep and circadian health. It controls metabolism and many other things which are supposed to be in 24-hour rhythm. There are other things too which could set the rhythm but light is the main and major one light because it is the direct output to the clock and it is beneficial sometime thousands times more than other factors. One of reasons why people have challenges with focus, mood, anxiety and others is not controlling their cortisol rhythm. If you somehow make your rhythm regular, you are going be surprised by the positive effects of it.

Temperature

Temperature is super interesting as it relates to circadian rhythm, wakefulness, and sleep. First, let's look at what happens to our body temperature across 24 hours. In general, our temperature is lowest at 90 to 120 minutes before waking. For example, if we are waking around 6 am every day, 4 or 4:30 am would be the time when our temperature is lowest. It starts creeping up around 6 am, 8 am and so on. It peaks sometimes between 4 pm and 6 pm. It is interesting that even in the absence of light cues and meal cues, we would continue to have this rhythm in our temperature. Our temperature will increase and decrease back. The way that temperature rhythm gets anchored to the pattern I described before is by way of entrainment or matching to some external cues which is almost always going to be light and

sometimes exercise. We have talked before about how light enters the eyes trigger activation of the master clock, and then that master clock put each of your cell in cohesive rhythm. However, I didn't talk about how does it do that. It does it in two ways. One is it secrets a peptide, a protein that flows the blood streams and signals to the cell. The other way is, it synchronizes the temperature under which those cells exist. So temperature is actually the effector of the circadian rhythm. Now this is really important because changes in temperature by way of exercise, cold shower, and ice bath can shift our circadian rhythm pretty dramatically. let's go to an extreme example. Nowadays there is some interest in cold shower, and ice bath. It is good because you will have a rebound in thermogenesis.
As the temperature increases It will shift your circadian rhythm. In which direction it shifts your circadian rhythm will depend on whether you are doing that during the day time or late in the day. If you do it after 8 pm, it is going to make your day longer, because your body and your central clock are used to temperature going up early in the day and throughout the day, peaking in the afternoon, and coming down again. If you then increase that further or increase it over its base line at 8 pm even by half degree or couple degrees, you will push further or delay your clock. You are convincing your clock that the day is still going. As a result, you will naturally want to stay up latter and wake up latter. If you do ice bath early in the day, you will experience a more rapped rise your body temperature that will phase advance your clock and make it easier to get up early the following day. Light and temperature are really effective in shifting your circadian rhythm and sleepiness and wakefulness time. We tend to fall asleep when our temperature is lowering, and we tend to wake up when our temperature is rising. It is wise to increase your temperature at the start of the day. One way is to get in cold water of some sort. This could be a cold shower from 1 to 3 minutes, ice bath, cold tub, or etc. This will really wake you up because there will be a release of adrenaline or nor epinephrine. It will also increase your core body temperature. Your brain and body work as a bit of thermostat system where you put something cold on the surface of your body, your brain will increase your core body temperature. People might think that getting into cold water should decrease your core body temperature. Indeed, it will do that if you stay for longer. If you stay for 1 to 3 minutes, your core body temperature will increase. So when get out of those water, your body temperature increases at a slop, which is steeper than it would be otherwise. Consequently, you will feel more alert. Beside adrenaline, it also increases dopamine, which is associated with so many good things that I mentioned. One of the best way to increase your temperature early in the morning is exercise. You should get sun light, cold water, and if you don't want cold water, you could have some movements early in the morning. Probably you could walk while getting sun light. So increase your core body temperature early in the morning by cold water and or exercise. It doesn't have to be your whole workout if you are exercising properly. We should take care of our core body temperature also in the evening or late in the day. The way we leverage temperature in the evening is exact opposite of how we leverage temperature early in the day. In the evening, we should have a nice hot bath or a sauna. You might again think it would rise your temperature. Indeed, if you stay for longer. However, if we do that and do not stay for more than 20 or 30 minutes, get out and take a cool shower or warm shower,

then it will decrease your temperature and make you fall asleep easier. You should also make your sleep area pretty cool if not cold. It doesn't mean that you should be cold while you are asleep. You could use as many blanket as you need. You should drop the temperature of environment by at least 3 degrees. People will decrease their bedroom temperature by variety of ways depended on their situation. Lay under blanket as needed to stay asleep, but if is too warm, get one of your foot or hand outside the blanket. The reason for that is pretty logical. It is because you have special portals, a way of passing heat in and out of your body, primarily through the palms of your hands, upper head and the bottoms of your feat. However, if the environment is too warm, then you have to put your hands through cold water or something. That is not so practical. You better maintain your sleeping environment cooler. Don't wear socks while sleeping unless you have a condition because it covers the bottom of your feet and prevent your body from cooling down. Cooling down makes you fall asleep and stay asleep. Do not exercise close to sleep time. It will push further your day. You need to drop your core body temperature by 2 to 3 degree Fahrenheit or 1 degree Celsius to transfer to sleep.

One of the most important things about setting your circadian rhythm properly is that your temperature will start to fall in regular rhythm. Temperature has a very strong effect on things like metabolism, and when you will feel most interested in exercise. Typically, the willingness to exercise and engage in any kind of activity mental or physical is when that rise in temperature is steepest. That is why 30 minutes, 3 hours and generally 11 hours after waking is a best time for doing any kind of physical and mental activity.

Caffeine

Caffeine is the most widely used drug around the world. More than 90% adults around the world use caffeinated beverages. Caffeine is a very important compound to think about. Caffeine could be both good and bad for us. we should use caffeine in particular way in order to benefit from it. Caffeine for most people, it makes them more alert. Some people are so sensitive to caffeine that they even feel jittery if they use it even in little amount while other people could use it in large amount and not feel jittery at all. Caffeine works as adenosine antagonist. What that means when you consume caffeine whether its caffeine, soda or tea? it binds to adenosine receptors, sort of parks there. Just as a car when it parks in parking slot. Therefore, adenosine cannot park over there. When caffeine park in adenosine slot, it blocks the sleepiness receptor. It blocks the sleepy signal, but the adenosine still builds up. This is why when that caffeine goes off adenosine will bind to that receptor with greater affinity and that is what we call caffeine crush, so you feel the intense sleepiness. When caffeine blocks the receptor, it doesn't activate or deactivate the adenosine receptor. it just blocks that from receiving adenosine. The adenosine is still circulating in the brain but cannot communicate to your brain. The caffeine has half-life and after some time your leaver will remove them. Caffeine tend to increase dopamine and make you feel energetic and motivated.

When should you drink caffeine? Everyone should delay their caffeine intake by 90 to 120 minutes after waking. However, painful it maybe to arrive those 90 to 120 minutes. After waking you want, and I encourage you to clear out whatever residual adenosine is circulating in your system in that first 90 to 120 minutes of the day. Get that sunlight exposure get some movement to wake up then start to consuming caffeine. If you delay early caffeine, you will avoid the so-called afternoon crush. Although you will get some dip in afternoon energy, but it will not be massive crush. For people who shift drinking caffeine immediately after waking from 90 to 120 minutes, that gives them a much longer arc of energy during the day. They don't feel to drink more caffeine in the afternoon. I want to say that drink caffeine but stop around 10 to 8 hours before your sleep time. The reason is that for those people who drink up until the evening at the best chance, they might fall asleep and stay asleep, but the depth of the sleep is no deep anymore. you are going to experience very shallow sleep and easy to wake up then it will be hard for you to fall back asleep. There are two consequences for that. The first, you could age by 20 to 22 years or you could do that by using caffeine up until evening. The second, you will not feel restored by your sleep the next day you wake up, so you will increase using caffeine to feel better consequently its deleterious effects will increase by time. Some people say that we drink coffee late in the day, and we don't have trouble sleeping. What they actually mean by that they don't have trouble falling asleep, but if we measure their sleep, they have reduction in their non-REM sleep. It could reduce non-REM by 20 to 50%, and that have bad consequences which I mentioned above.

Time and dose make the poison. Be mindful of your caffeine. probably 2 to 3 cups of coffee are enough. Early day caffeine is ok, but late night it is detrimental. The dose should be as follow, for every kilogram weight that you have you can consume from 1 to 3 mg of caffeine. If you are, for example, 100 kg (220 pounds) you can use up to 300 mg caffeine. The peak of alertness come within 30 minutes and last for 60 minutes.

Alcohol

Alcohol is in the class of drugs that are called sedative. It is probably one of the most misunderstood sleep aid. It is often used as a sleep aid for people who are struggling with sleep. Alcohol is anything but sleep aid. Most people use them to fall asleep. It will knock out your cortex. It will sedate your cortex. Sedation is not sleep. In truth you are losing your consciousness quicker, but you are not naturalistically falling asleep. It fragments your sleep. You will wake up many more times through the night. Your sleep will be far less continues. Some of those awakenings will be of conscious recollection, and you will remember them next day but many of them won't be. So when you wake up next day you will not feel restored. The next thing is that alcohol is quite potent in blocking your REM sleep. REM sleep is critical for a variety of cognitive functions, some aspects of learning and memory, and it seems to be critical for mental and emotional health as well. Even little bit of alcohol could disrupt your sleep. One study looked at one cup of alcohol in evening with dinner. It has a bad effect and we could measure that. In REM sleep we tend have many beneficial things including growth hormone.

One study showed that by consuming alcohol to the amount of standard illegal we could have up to 50% reduction in growth hormone release. Growth hormone is vital for metabolism, repair of tissues, and etc. A study from Harvard looked at different stages of sleep and life span. They found that REM sleep is stronger predictor of your longevity, and the relation was linear, which means the less REM sleep you get the more mortality risk. The sleep architecture with alcohol is suboptimal compared to sleep without alcohol. Even if you drink alcohol in the afternoon you will see some compromises. So there is no way skip the bad effects of alcohol.

QQRT

What is a good sleep? People may have some subjective ideas about quality of sleep, but science use a singular rubric for good sleep which is called QQRT. The first Q stands for quantity. A 7 to 9 hours of sleep is considered good sleep for the average adult. It is accepted by world health organization too. The second Q stands for quality. The first measure of quality is continuity. Was your sleep continuous or you had some awakenings throughout the night? If you wake few times throughout the night like 2 to 3 times, it is fine, but if it is highly fragmented then you have poor quality sleep. The second is the ratio of time we spend in bed to the time we sleep. For example, if you were in bed for 9 hours but slept for 7 hours that is very low quality of sleep although you slept for 7 hours, but you were awake for the rest 2 hours. If you were in bed for 8 hours and slept for 6 hours, your sleep's quality is 75 percent. 85 percent and above is considered a healthy sleep. Quality of sleep is as important as quantity. The R stands for regularity. The regularity in sleep mean when you fall asleep and when you wake up. If you keep that consistent that is the 3rd macro. What I mean by that is, you have to go to sleep and wake up from sleep at the same time consistently. You could have a 30 minutes room in changing that, but try to be as consistent as possible. Regularity really is very important. There was a great study in which they looked over 60000 people. Scientists divided those participants to four different groups. Two of the groups were most regular and least regular. they checked participants' regularity in sleep then they looked over the group which was most regular vs the group which was least regular. They tracked participants over years. They looked at their mortality risk, and what were they dying of if they passed away. Those people who had most regular sleep had 49 percent reduced risk of mortality relative to people who had most irregular sleep. Of those general decrease in mortality risks, when you split it apart, there was a 35 percent decrease in cancer mortality specifically and almost 60 percent decrease in cardiovascular mortality risk. Last but not least, the T stands for timing. How is regularity different from timing. What I mean by timing is your chronotype. Chronotype is the time of sleep which your genes have designated for you. We have 5 types of chronotype. First, extreme morning type, these people would like to go to sleep at 8 pm and wake easily by 4 or 4:30 am. Second, morning type, these people would go to sleep 9:30pm and wake up 5:30 or 6 am. Third, neutral type, this group would like to go to sleep 11 pm and wake up around 7:30 am. Fourth, evening type, this group would like to go to sleep by 12:30 or 1 am and wake up around 9 or 9:30 am. Fifth, extreme evening type, this group would like to go to sleep 2:30 or 3

am and wake up and wake up around 11 am. Chronotype is related to your genetic, there are 22 different genes which determine your chronotype. You can find your chronotype easily by searching chronotype MEQ in internet. It takes 3 or 4 minutes to fill out the form, and the result will tell you about your chronotype. If you miss your chronotype, sleep in a time other than your chronotype, you may get insomnia. You will either not be able to fall asleep or you will fall asleep but couldn't stay asleep and wake up at the middle of the night.

Sleep according to phases

There are three types of sleep according to phases. Monophasic, Biphasic, and poly phasic. These three types of sleep differ according to life span. Monophasic mean single phase and that means we will have a single bout of sleep through 24 hours. Biphasic means 2 bouts of sleep through 24 hours. Poly phasic obviously means many bouts of sleep which is normally associated with infants. How these phases change during the life span? When we are infants, we are incredibly poly phasic within our first year. We will probably go through wake-sleep cycles every 2 hours. Why do we do that? Why could not we be normal from the beginning? There are two reasons for that. First, an infant needs to feed every two hours. That energy requirements dictates that we couldn't sleep for longer. The second reason is our master clock hasn't developed completely yet. By age one, we are going to decrease those phases. However, we are still going to be highly poly phasic. Sleep is getting consolidated. We are going to sleep for longer during night and have few bouts during the day. Then by the time perhaps we are in kindergarten, we may have two bouts of sleep. We will be biphasic. We will have long bout of sleep at night and short naps during day. By age of 5 or 6, We are starting to see fully monophasic sleep. Children sleep at that age have long bout during night and could sustain wakefulness during day. From that you will keep monophasic sleep through out adulthood. So that is how sleep change phases during life span.

If we dive even deeper and look at different stages of sleep during different phases, that is fascinating. In utero, we for the most part are in a sleep like state. That sleep like state seems to be like REM sleep but not completely like REM sleep. Then during the first six months of life, we will sleep between 14 to 17 hours per day. At that time, we cannot distinguish between different kinds of non-REM sleep, but we see deep non-REM sleep and REM sleep. Almost 50 percent of our sleep is going to be REM sleep. It is amazing because as an adult our sleep consists of REM sleep just 20 percent.

When we are first born, you are still going throw brain maturation, and the recipe for that exploding synapses, all of these connections between your brain cells. What we discovered that REM sleep acts as an electrical fertilizer to stimulate the growth of these connections within the brain. If we deprive the kids from that sleep their behavior will be abnormal as their brain will not be matured. Then when we move from first 6 months, across next 18 months something odd happens. The total sleep tends to decrease, and REM sleep starts to decrease too, but non-REM sleep increases even though total time is decreasing. By about age of 5 or 6,

now the 80 percent of your sleep will be non-REM and 20 percent would be REM sleep. That is how different stages of sleep changes through life span. As I said as we become adult, we become monophasic. Yes, to a degree. There are some reasons which make you biphasic again. Then you tend to have a longer bout at night and a short nap throughout the day.

Ok, until now, we have talked about poly phasic sleep but in its natural way, but some people use poly phasic sleep even in adulthood, and they think it is good. There are different schedules for poly phasic sleep, which they use. Scientists have looked at their claims and found that there is no benefit like alertness, productivity or anything else to poly phasic sleep. They also found that poly phasic sleep in adulthood is very detrimental. It is deleterious for metabolic health, quality of sleep, and it decreases the REM sleep which is very important for our health. So try not to have unnatural poly phasic sleep in adulthood.

Body position

When your body is horizontal, you tend to feel sleepy. That all has to do with temperature. The distribution of how your body is able to move blood around the different regions decrease our core body temperature, meaning it could push blood, warm blood, out of the core of your body to the surface areas, and we push it out to the surface areas you release that heat. When our core body temperature decreases, we tend to be sleepy.

Naps

Lots of scientists have done studies about naps. Naps can have really great benefits. It is beneficial for cardiovascular health, blood pressure, levels of cortisol, learning and memory and also emotional regulation. In one study there were participants assigned to one of two groups. In midday they learned a whole list of knew things. Then one group took 90 minutes sleep opportunity while and the other just lied on the bed and watched nature documentary. Then, five hours litter, they had another learning session. Across the group who didn't nap, their learning capacity declined. The nap group, However, they were able to sustain learning capacity and improve it. The difference of those groups was 20 percent. In another study scientists looked at emotional brain. They showed people different types of emotional expressions and having them to rate them. They did that before and after a nap for one group, and in the same times to another group without nap. The group that didn't nap by about 4 pm they were starting to rate fearful and angry faces as much more fearful and much angrier. On the other hand, the group that napped, they lessened the response to fear and anger. They also boosted to rate happy faces. Your focus, concentration, and energy, and even decision making will improve by way of naps. Very short naps could have some potent effects on learning. NASA experimented this with their astronauts back in 1990s. What they found was as little as 26 minutes of nap could improve mission performance by 34 percent and improve day time alertness by 50 percent.

There is also a dark side to naps. It comes back to adenosine and sleep pressure. The longer we are awake the more adenosine pressure we build up. When we sleep the brain get the chance to clear out the adenosine. The reason that nap could be potentially dangerous is that when we sleep, we decrease the amount of adenosine pressure in our brain, and some of it is lost after naps. For some people, who has problems with sleeping at night, naps will worsen the situation for them. So people with insomnia shouldn't nap. If you nap regularly and don't have problems sleeping at night, then nap is totally fine for you. Try not to nap in afternoon. Naps could take sleep appetite from you. Avoid naps to at least 7 to 8 hours before sleep. If you nap for late in the day, probably your sleep in the midnight would be fragile. It will make you wake up in the middle of the night and it will compromise the speed with which you will fall asleep back. Try to limit your naps to 20 to 25 minutes. The maximum of nap could be for 90 minutes because longer naps will disrupt your night sleep by clearing out so much adenosine. Make sure to use alarm so that you don't go further than what you intend.

What is the optimal amount of nap?
It really depends on what you want from sleep. Most people nap so they could concentrate and focus better. For that purpose, you could nap for 20 minutes. The benefit of 20 minutes nap is that you don't get groggy after it. Some people say that we nap for 40 to 50 minutes, but we feel worse after that. There is something called sleep inertia. When you sleep for longer like 50 minutes you go deeper in to the cycle so that when you wake up at its middle you feel groggy. Now it is not like that longer naps are not good. When we nap for longer, its benefits are more, great in magnitude, and sustain for longer period of time.

Should we nap if we are not natural nappers?
No, we shouldn't force ourselves to nap if we are not natural nappers as long as we get the sleep we need at night, and feel refresh and restored during the day. If you want to try to nap, you should mimic night time as best as you can. Wherever you are, shut off the light, develop an eye mask procedure to avoid light, take your shoes off, and make sure to get under a blanket like thing. These things could increase the probability of your nap if you are not natural napper.

Are there individuals who should avoid napping?
Yes. People who have insomnia should really avoid napping. For older adults above 65 years old nap is not good. Napping in older adults predict worse health and is deleterious. It also predicts likelihood of early mortality. It is not that nap is bad but nap reflects a problem with night sleep of them.

What is caffeine nap or napichino?
When we nap for 20 or 25 minutes and then wake up we feel little grogginess. When you drink a cup of coffee or any other source of caffeine, it takes about 12 to 17 minutes to start its effects. So if you take a cup of coffee then take a 20 minutes nap you won't feel grogginess due to the coffee, and you will combine the benefits of both nap and caffeine. You will be so much alert. That is called caffeine nap.

Other types of naps. There is a kind of nap in which you should wash your hand and face immediately after waking. When your temperature is rising you become more alert. When you are using cold water for washing your face and hands your temperature rise, and you become more alert. With nap that benefit will double. The other kind of nap is seeing bright light immediately after getting up from nap.

Sleep and learning

We need sleep in three stages for learning. First, we need sleep before learning to prepare our brain for initial imprint of those memories' traces down. Then we need sleep after learning to take those fresh memories, save them, and cement them in to the brain, so that we don't lose them. The third domain is that sleep will then take those memories that we have been learning, and it will start to collide them with all of those back catalog of information that you have already got stored in your brain. This way, it updates the operating system of our informational system, so that then we come the next day, and we have a better ability to better understand how the world works. The difference between second and third stages is that in the second stage we just consolidate the information in our brain, but the third stage help us really learn what it means if we put this information together. I will expand each of these categories and science behind them.

Sleep before learning. Scientists took individuals into two different groups, the one which sleep and the other which are deprived of sleep. Then they put participants in brain scanner and had them to try learn a whole list of new facts as scientists were taking snapshot of brain activity. Afterward, the scientists tested them to see how effective that learning session had been. When they looked at the group which had a full night of sleep, they observed incredibly efficient learning capacity. However, When they looked at sleep deprived group, they observed 40% less learning capacity after deprivation. So exactly what is it about sleep which control our learning capacity? Scientists decided to do another study. In this study instead of manipulating sleep by dialing down, they dialed it up by way of a day time nap. They had again two groups. The groups should have learned new information again and again. The scientists, then, gave them 6 hour break. After the break scientists brought them back and have them learn new information again. One of the groups spend that 6 hours break just doing relaxing activities while the other group was able to take a 90 minutes nap and have a full cycle of sleep. The group which stayed awake had a declined in their learning capacity. However, the nap group seemed to restore the learning capacity. They didn't get the decline in fact they had a boost. The difference between two groups was 20 percent. Now we can see that sleep does something to our learning ability. So scientists unpacked the physiology of sleep in different stages of sleep. What they found was that non-REM sleep seem to predict how good your learning capacity is. The brain structure which is responsible for receiving information and holding to it is hippocampus. Its shape is like long cigar. You have two of them one on right and one on left side of your brain. When you sleep and then learn something, it becomes very active during learning. However, if you don't sleep and learn you can't find any signal of

activation from that region. Think of hippocampus as a USB stick. it is very good during the day. It is grabbing new information files. However, it has limited storage capacity. What sleep is doing to new information is that it is shifting the new information from hippocampus to above cortex, which you can think of as your hard drive with much bigger capacity. So after sleep you have a clear USB to collect new data. This could show as how and why sleep is important before learning.

What if something disrupts our sleep before learning or we don't sleep for a reason? Is there something to compensate?

There are two things which could help you to a degree. Frist is caffeine. Caffeine could enhance the activity of hippocampus. The second thing is circadian rhythm. If you are getting up from sleep 7 or 7:30 am your peak of alertness would come in 12 or 1 pm. You could now understand your peak of alertness from the back sentence. You could time your learning period to that peak of alertness time. Scientists in Harvard discovered that you also have another short peak in your alertness just before you get to sleep. You might say why do we become alert in a time that we have to lose consciousness?

The reason is our Ancestors. After foraging for food during the day, they needed final alertness to get them home safely. That habit still exists in us and we could use it for whatever we want.

Sleep after learning. As I said previously, you need sleep after learning too, but for different reason. Before learning you sleep in order to lay down those new memory traces. Sleep after learning then take those fresh memories and strengthen them almost like clicking save button on those memories. Sleep after learning future proofing that information so that you don't forget. Two researchers did a landmark study. They had participants in two sessions learning a whole bunch of syllables. Then they started to test them across 8 hours period. They tested them 2 hours later, 4 hours later, 6 hours later, and 8 hours later. The difference was that in one of those sessions the tests were during day. In other session they did same thing learning new information but then the participants slept and woke up 2 hours, 4 hours, 6 hours, and 8 hours later. They tested participants after awakenings. What they found in those people who stayed awake after learning there was catastrophic forgetting. The amount of information just declined through pass of time. In sleeping group, however, the information declined, but after 2 to 3 hours sleep fixated those memories. Then those memories would not decay any further. This study has replicated time and time again. The study demonstrates that there is something special about sleep that it is concretizing the new information. How does the brain do this fantastic thing?

We now have two mechanisms for that. I should note that sleep after learning runs in two different narratives. One is sleep after learning for fact based memory another is sleep after learning for motor memory. The above studies and these two mechanisms are for fact based memories. First is called memory translocation. It is deep non-REM sleep for fact memories. There are these big waves which work as file transform mechanism. It moves and shifts memories from a short term vulnerable reservoir, the hippocampus, to the more permanent long term storage sight, cortex. The second mechanism is called memory replay. This was

discovered back in 1990s when scientists were looking at rats and how they learn a maze. They had electrodes on rats hippocampus region. They were listening to individual firing patterns of the memory's cells in the hippocampus as they were running around the maze and sure enough as they run around the maze statistically you would build up what would look like signature pattern of learning. So think about those neurons that they each had a special tone to them. As the rat is running around the maze we can hear the signature of learning pa pa pa pam, pa pa pa pam. Then they, scientists, did something clever When the rats went to sleep after learning, they kept listening, they heard that same signature replay, pa pa pa pam. However it wasn't replayed in the same speed, it was 10 to 20 times faster. You are strengthening those memory circuits. What was also fascinating is that it is during non-REM sleep that you do all off this memory replay.

Sleep and motor learning. What I have talked about so far is that you need sleep after learning for that text book like memory, and that is one type of memory that resides within your brain. There is another type of memory which many realize is not memory, and that is what we call non-declaretive or procedural skills memory. We use this for sports, surgical processes, flying plans, musical performances and so many other places. So is sleep after motor learning beneficial like fact learning? In a study two groups learned a motor skill task. It was very much like piano, they learned a sequence of movements. Scientists have the participants repeat that action over and over again for periods of 30 seconds and rest for 30 seconds. They did twelve of those trails. Sure enough practice seems to get them better. Then scientists bring those participants back twelve hours letter and retested them. One group spend that twelve hours awake while other group had a 8 hours night of sleep in those 12 hours. In the first group who didn't sleep, they retained the memory. They were no worse and no better. However, in the second group who slept, they had improved their performance output speed by 20%, and they improved accuracy by almost 37%. It is not time that you need to produce perfection, it was time with sleep. we have heard that practice makes perfect, but it is practice plus night of sleep that makes perfect. Scientists then bring the first group after twelve more hours with a sleep, and they also showed the benefit. What is it about sleep that makes that beneficial? Scientists looked at the physiology. What they found were two interesting components. First, it seems to be related to stage 2 of non-REM sleep. I told you that text book memories need deep stages (stages 3 and 4). However, motor memory is more dependent on stage two. Scientists then wanted to ask, is this effect simply something to do with night time because that is the other potential hypothesis, it is not really about sleep, it is just something about night time. In all of the studies I described so far, they are all happening at night and at night they were sleeping, so it is really night time or specifically sleep. so then scientists did a nap study with motor skill learning. They repeated that and sure enough even though the time period was across the day not during night, they showed this beautiful motor skill benefit. In that nap study, they were learning that sequence with the right non-dominant hand, and the participants were typing 41324, 41324… that wright hand is controlled by left motor cortex. So in the nap study when scientists recorded the sleep they used very high density EEG. So lots of sensors on the top of

the head So they could map with high fidelity resolution the surface of the brain. on the right hand activity that invoked activation in the motor cortex, that left motor cortex and specifically hand region showed a local increase in its activity while other parts didn't. it seems to be sleep that do the job. Stage one of non-REM sleep is transitional stage. The stage two is certainly related to motor skill. In fact, stage two is fascinating, we used to think of it just the stage that you have to go in to get to deep sleep and the stage that you have to get back through to get to REM sleep. It had never made sense, because stage two is about 40 to 50 percent of your night. Why would we spend 40 to 50 percent of our time asleep, when it is just simply the gate to get to something better. You should spend more time in better stages. Stage two is distributed throughout the night, but spindles in stage two are not evenly distributed throughout the night. You get some of them in the first quarter, more of them in the second quarter, certainly more in the third quarter, but you get a lot more of those sleep spindles in the last quarter of the night. In fact, when scientists looked at overnight study, participants learned in evening and tested next day, they recorded sleep in between. Yes, sleep spindles predicted and stage two predicted how much better they were in the next day. But that was specially stage two in the last quarter of the night. There was also a study done in Stanford about this. Scientists asked basketball team to spend additional two hours in the bed. Indeed, there was significant improvement in their free through percentage and other basketball related skills. Exercise during the day could enhance sleep at night and sleep enhances your athletic performance the following day. If you limit sleep to less than 6 hours, the data demonstrates that your peak muscle performance is decreased, your peak vertical jump height decreases, your time to exhaustion decreases; in some studies, it was up to 30 percent. it decreases the brain motivation to exercise and there is significant increase in injury risk.

Creativity

Sleep before learning makes us ready for absorbing new memories. Sleep after learning consolidates the new memories. Data has started to emerge that sleep is much more intelligent than scientists used to think when it comes to information processing. Sleep doesn't just simply strengthen individual memories. Sleep after learning is almost a form of informational alchemy. Sleep will take the new memories, and it will start to interconnect them and crosslink them with the back catalog of the all of our past auto-biographical memory systems, so that you wake up the next day, you have a revised mind wide web of associations. This is how creativity happens. A good example of this, scientists did a study which looked at creative insights. It was a lovely study. They performed something called numeric number reduction test, which is one of those studies psychologists love to administer and participants hate to perform. Participants are shown a whole string of numbers. They are given a certain set of rules, and they have to work through those number problems and come out with the final answer. They are told that they are going to be judged simply on how many correct final answers they get. Participants worked through hundreds of these problems. What scientists didn't tell them in the instruction, however, is that there is a hidden rule embedded in all of

those sequences. There was one common rule which binds all different sequences together. Another words, all they had to do was work up to the first 10% of every problem. They could just shortcut the rest of it, and they just wrote down the number. So they trained participants on these sort of numeric number reduction at trails. Then they brought them back after 12 hours of being awake, and no one seemed to have that light bulb moment of ok I got the hidden rule. But then they did the same thing. They trained participants in the evening and gave them 8 hours of sleep and came back the next morning. There was a three folded increase in creative insight problem solving ability. Another words, participants were coming back the next morning with that moment, a-ha I got it. Then scientists did something clever they said is that really sleep or circadian rhythm That is to say is it just something going through the night that gives you this kind of creative benefits or is it sleep. So they took another group, they taught them the information in the evening and then tested them next morning just like first study, but they kept them up all night. So participants went through night time and showed no benefit in problem solving. What I also found interesting about sleep and creativity log is that there are innumerable instances that people had sleep inspired insights. It is almost as though when you wake up the next morning having had that revised set of web connections in your brain, you can divine solutions to previously impenetrable problems. There is a great example, I think Demitri Mendeleev who at the time was trying to answer one of the most epic questions in human history. How do all of the known elements in the universe fit together in a logical order? He was failing to answer. He was so obsessed with this problem that he created plan cards with all of the different elements of the universe and their atomic weights and their electrons. he would go on these long train rides, shuffle the cards and deal the cards on the table. He was desperate to see what the pattern was. The story goes and its written, one night he fallen asleep, and he dreamed, he started to see all of the cards dancing around his eyes and then the snap together in this logical grade based on electron weight and different electron properties. He wrote it down on the back of envelope. That was basics for what we call elements periodic table which revolutionized human history. There are many other examples like making groundbreaking discoveries like benzene cycle by August Kekule and making good songs by other artists. Albert Einstein was famous for his short naps for creative insights.

Yawning

There are 4 competing theories about why does yawning happen. The first one was about tiredness. This theory says that yawning is sign of tiredness. It turns out that it is not true because many could yawn when they are bored. They were not tired but well rested. The next one was that yawning is about rebalancing your blood gases and specifically the oxygen and carbon di oxide. When you yawn you inhale a great amount of oxygen. It seems what you are trying to do is pumping back oxygen to your blood stream and maybe it is about exhaling more carbon di oxide. It turns out that this is not the case because in experiments they manipulated the amount of oxygen and carbon di oxide. They expected greater frequency of yawning but it didn't happen. The third theory was about contagion. Yawning has a contagious element to it.

If someone yawn the chances increases for the person to yawn who is watching him. The final theory and the most logical one is when you inhale oxygen from the outside, it is usually cooler than your core body and brain temperature. When we inhale there is a modest drop in brain temperature, and when the brain temperature starts to rise that is when we see yawning frequency beginning to increase. So it is about cooling the brain. Next time you see a person yawning probably his brain is warm.

Measuring enough sleep

One of the biggest problem with sleep deprivation is this that you don't know that you are sleep deprived. We know this because when we are tracking your performance objectively it is going down and down, but when I am asking you about your performance subjectively you say it is fine.

What are some easy tests to measure your sleep? The first test I would offer is if your alarm clock didn't go off tomorrow morning would you sleep past your alarm clock, if the answer is yes and for many people will be then you are not getting enough sleep. no other species artificially terminate their sleep but human. You could have alarm clock, but make sure you sleep enough. In fact, you could have two alarm clock to bed alarm clock and to wake alarm clock. The other metric is not incredibly specific. Have you ever been driving day after day after day and sometimes you think I don't know if that light was red or green that I just went through. I make this point because you could have lapses of attention and these lapses of attention are caused by micro sleeps. Micro sleeps happen when the brain just very briefly drops down and have a quick sample of micro sleep. Scientists can measure it in your eyelids. Your eyes start to have a partial closure or it closes fully shut. Even if your eyes are half open, your brain is essentially offline. It is in sleep like state, scientists can measure it. So this is the second matric of measuring sleep. are you having these lapses? Another metric would be that you won't feel restored although you might sleep for 7 and half hours. So the question is that can you operate without needing caffeine, have good mood, and good cognition before 11 am? If the answer is no, you might self-medicating your state of insufficient sleep with caffeine. That comes to the second Q of QQRT which is quality. Doctors my find deficiency in quality of your sleep. So these are the tools for measuring enough sleep.

Sleep and emotions

Scientists have been interested and researched in the field of sleep and emotions for around 20 years. I would say that probably the most striking statement to offer is the following. In that 20 years of research, scientists have not been able to discover a single psychiatric condition in which sleep is normal. It shows us very intimate relationship between sleep and mental health. I am not going to talk only about psychiatric disorders but also about the benefits of sleep that could provide when you get it. So let's explore this relation- sleep, our basic emotional regulation, and our emotional stability. I am sure everyone has seen the example or had the example as a parent of the parent holding a child, and the child is crying. They look at you, and they say, well the child didn't just sleep well last night. As if they have miraculous parental knowledge that bad sleep the night before equals bad mood and emotional regulation the next day. Some years ago from now, scientists were fascinated by this, but they couldn't really unearth basic science that would help them explain what was going on and why was that so clearly the case. So they did an initial study where they took a group of healthy people no sign of psychiatric illness or emotional instability, and they give the participants a full night of sleep or sleep deprived them. Then the next day they put them inside of a brain scanner. They should participants a whole range of emotional images ranging from neutral all the way up to quite unpleasant and negative. Then, they looked at how the brain reacting to those emotional experiences with vs without sleep. The structure that scientists initially focused on was a structure that called amygdala. We actually have one on the left and one on the right side of our brain. The amygdala is the center piece region for generation of emotional reactions both positive and negative, but here we are focusing on negative aspect. When they looked at the structure in people who were sleep deprived what they saw relative to people who would had a full night of sleep was a sixty percent increase in amygdala responsivity under condition of sleep deprivation. That is quite a striking amplification. In fact, scientists to that date with all of their studies on sleep and sleep lose had not quite seen an effect size within the brain which was that big. Then, the question came why is the amygdala so reactive and uncontrolled when you are sleep deprived. They did another analysis. There is a structure in frontal-lob, the frontal-lob just sets directly above your eyes, and it was a particular part of our frontal-lob the middle part that sets right between your eyes, something that is called medial prefrontal cortex, and what they found was with a night of sleep the medial prefrontal cortex was strongly connected to amygdala. Why is that important? It is because that part of your frontal-lob is very good at acting like a control rational mechanism on your deep emotional brain centers. However, without sleep scientists found that connection had been severed. It was almost as though without sleep you become all emotional gas pedal and too little regulatory control break. So you couldn't modulate those emotions anywhere as effectively. Some people may say that was a total night deprivation, and that is not relevant for us. I am usually getting five to six hours of sleep is that really relevant. So scientists started doing another study. They wanted to say let's do what they call ecological study more of a real world sleep restriction rather that total deprivation. They were letting participants sleep less than 6 hours for five nights. Sure enough, they got the same response.

Scientists did a study on emotional memory. Here, they decided to add a second ingredient in to the equation. Not just simply looking at your emotional reactivity, but they wanted to look at emotional memory. Emotional memory is very different. If I were to ask you, cast your mind back to some of your earliest childhood memories or teen memories. My guess is that almost all of the memories that you recall are memories of an emotional nature, positive or negative. Why is that? It is because one of the functions of emotions when it comes to memory is to red flag and prioritize that experience as being salient. That instructs the brain that this information in particular is very relevant to us as an organism. Why? Because the rest of the brain shouting at me this is emotional. So, there is something very privileged and very special about an emotional memory that a red flag tags it for priority in the brain. What happens to emotional memories over time?

If I were to ask you recall an emotional memory just try to remember it. My guess is that now at the time of recollection, much later on, you are not having the same regurgitation of the same visceral emotional reaction that you had at the time of the experience. Somewhere in between initial experience and the later recollection of that emotional memory, it has done a very clever trick. It has divorced the emotion from the memory. So now when you come to recollect that emotional memory, let's say days later or months later, in some ways it is a memory of an emotional event but is no longer as powerfully emotional as it was at the time of experience. Scientists started to wander. is that time or time and sleep?

So they did a study. They had people experience and make emotional memories. They were doing it inside of a scanner. Then they, scientists, gave them a night of sleep or even a nap. Afterward, they brought them back or they just had participants learn those emotional memories in the morning and then brought them back after identical amount of time to try to soften those emotional memories but without sleep. Then they, scientists, put them back in the scanner. They were able to see when you come back later in that second session, is the emotional reactivity at that second session any different to the first session and is that different if that time elapse has contained a full night of sleep vs just awake. What they found was in those people who remained awake across the day having had those emotional memories, the amygdala was just as responsive as they were recalling those emotional memories. However, in those people who had same amount of time to process the memories, but have had a full night of sleep, scientists saw an incredible emotional amygdala depotentiation. What that taught us was that the sleeping brain was able to almost detox the emotional memory. So that then when you come back the next day again, it is now a memory of an emotional event, but it is no longer triggering that strong visceral reaction. Scientists describe this overnight forgetting. You both sleep to forget and sleep to remember respectively. Which is that you sleep to remember the information the memory of the experience, and you sleep to reduce its emotional load. From there scientists build a biological model of exactly how this works. Because when they looked at sleep group who would had that full 8-hour opportunity. They asked the question, what is it about sleep that provide this overnight therapy? What they found was REM sleep. REM sleep is associated with dreaming,

and the greater the amount of REM sleep the greater the amount of emotional de potentiation.

One of the fascinating things that I haven't quite mentioned yet is something utterly unique happens during REM sleep. levels of a brain chemical called nor-adrenaline are completely shut off. It is the only time during 24-hour period when you see the complete cessation of nor-adrenaline in the brain. Off course, nor-adrenaline is associated with many different functions. It is associated with emotional responsivity, focus, and that emotional energy. Nor-adrenaline and nor-epinephrine is the same thing with different names. So the stress related hormone is shut off during REM sleep. However, if you look at other parts of the brain, the memory related centers of the brain such us the hippocampus and the amygdala are very active during REM sleep. So scientists made up this biological model that is beautiful that the REM sleep is the perfect condition for emotional overnight therapy, where you can reactivate and re-experience those emotional memories but in neuro-chemically safe environment. This allows you to strip away the emotion from the memory. Then it becomes the memory that no longer trigger the emotional reaction. In some ways that is what you want. I told you one of the functions of emotions is to red flag and prioritize the memory at the time of learning to say that it is important. That is very adaptive process. It helps us prioritize which thing we should really be focusing on and remembering, but it is not adaptive to hold on to that emotion for long term once you have stored it. There is some wonderful research by a gentle man named William DeMent. He wondered what the consequences will be if we selectively deprive people of REM sleep. He brought individuals to his laboratory. Every time they would go in to REM sleep, he would go in to the room to wake them up having them to do some mathematical problems for two or three minutes. Then put them back asleep. They would go into non-REM, REM and wake up again. The first night he would wake them up 6 or 7 times. However, by 5^{th} or 6^{th} day he would go 17 or 18 times. Why? Because the people were building up this growing REM sleep death and the brain had such a hunger for it that by night 5 of no REM sleep all it wanted to do was rocket in to REM sleep and start devouring it with high volume. The interesting part is the consequences to these subjects. They were all healthy individual at first. However, by about day three of selective REM sleep deprivation, they started to show signs of paranoia. They started to believe people were out after them. They had hallucination and delusions, and by day five they were bordering on having aspects of quite severe psychosis. What all of this research has taught us in some ways is that it is almost as though REM sleep is the difference between sanity and insanity.

So now that you know REM sleep is important, how to improve REM sleep? I would say the single best way, and cheapest you can enhance your REM sleep is to just sleep an extra 15 or 20 minutes later in to the morning. The later you are sleeping in to the morning the more you would have of it.

Sleep and anxiety

Anxiety disorder seems one of if not the most common of all psychiatric conditions. It is a kind of mental pressure. Some people have conceptualized anxiety as being different to depression based on some ways in memory, which is that when you think about anxiety, people consider that a disorder of the future. We are consistently worried about what is coming up in the future like I am fearful to see someone tomorrow or fearful of flight tomorrow or next week. It seems to be so much about prospective future. Whereas people suggested depression is the opposite. It is about the rumination of the past. One could be stuck in past. Like I went through this event, or I had this painful divorce. Just can't get over my past. The relation between sleep and anxiety is pretty bidirectional. If you have anxiety, it is very difficult to sleep. If you have difficulty sleeping, it is very likely that you will increase anxiety. Scientists had a study, they took a group of people. They, scientists, were very careful to make sure that participants had completely normal level of anxiety. They, participants, showed no sign of anxiety related disorder. Then scientists had the participants have a full night of sleep or they sleep deprived them. The next day they were measuring participants' anxiety. In those people who were sleep deprived, they were measuring anxiety level every hour, so they could get almost this time laps photography of what happened to their anxiety state as it unfolded across the sleep deprivation period. The response was not linear. The more and more hours that they were awake beyond 16, the more exponential the rise in level of anxiety become. In fact, by the next morning compared to when you have a full night of sleep those individuals were so anxious that almost 50% of participants in that group who had no signs of anxiety before had a level of anxiety that was so strong that they reached the diagnostic threshold for having an anxiety disorder, and that was by the way of absence of sleep. Scientists did a slightly different study. Here what they did was they tracked individuals essentially in the wild. They had different sleep tracking monitors on them. So they were tracking sleep from one night to the next to the next… and from one day to the next to the next… they were tacking their level of anxiety. What they found here was that even small change in their sleep from one night to the next to the next… accurately predicted the increase or decrease of anxiety from one day to the next to… what was the critical ingredient here? Well, in the first experiment, scientists would essentially manipulate both quantity and quality the two QQ, but when they looked at the second study, it wasn't quantity that was the best predictor. It was quality. The worse the quality was the worse their anxiety became. So that led them to start to think, what is it regarding quality of sleep that seems to offer what I would call as anxiolytic benefit another word it is lessoning anxiety when it is present. What in sleep is anxiolytic? Scientists started with the hypothesis that was profoundly incorrect. They thought well for emotions it seems REM sleep to be the principle ingredient, wouldn't that be for the mood states like anxiety.

Well, here with the anxiety, it wasn't REM sleep. It was deep non-REM sleep, and we couldn't get away from it. So what they found when they looked at the sleep in laboratory and asked what was predictive from the night before, so they measure your anxiety the night before and then they measure it the next morning and basically they calculate a change, was that electrical quality of your deep non-REM sleep was very much predictive of dissipation of anxiety overnight. What is that deep non-REM sleep doing to help dissipate anxiety? Here again was a commonality with emotion. What they found was the greater the amount of deep non-REM sleep, the greater the re-engagement of your frontal-lob was the next day, and that was predicting the dissipation of your anxiety the next morning. So they really started to understand this critical bidirectional relationship, but it was really a complex one. Yes, anxiety could disrupt your sleep, and yes disrupted sleep could predict your next day anxiety, but it isn't the same stage of sleep that we thought before. It was the opposite. it was the deep non-REM sleep. what we have come to realize is that deep non-REM sleep in part seems to be almost shifting us from that sympathetic state over to the parasympathetic state. It seems to engage that nice rest and digest, reduce your heart rate, drop levels of cortisol, and we think that perhaps is the resetting embodied mechanism by way of deep non-REM sleep helping us just relieve that anxiety pressure. Yes, if we change any of your QQRT we could change your anxiety, but it is mainly quality.

So what we can do to improve our deep non-REM sleep?
The first thing I would tell you is that regularity is going to be key here. When you are giving your brain the signal of regularity, it understands exactly how to instigate that deep sleep, and that is one of the two qualitative measures of sleep that I spoke about. So QQRT, the quality the second Q, that I spoke about regarding the continuity of your sleep and electrical quality of your sleep. regularity is probably best for the continuity of your sleep. If you are really irregular with the timing of your sleep your sleep could really become confused. When you give it regularity, sleep starts to become more stable. More stable means it will be less littered with awakenings, meaning that is better quality of sleep. In terms of electrical quality of sleep, exercise seems to be one of those things that is very good at improving your deep sleep quality. Try to make sure that you are physically active to a degree. Temperature is beneficial too. Keeping your room cool seems to improve deep sleep.

At the end, I want to say that good sleep is one of the least painful available option for us as a not cost to try to stabilize our mental health. Moreover, control of light intake could improve our sleep and as a result our mental.

Dreams

Last night you and I and everyone else as long as they slept became flagrantly psychotic. Before you reject my diagnoses of your nightly psychosis, I will give five good reasons. First, when we started to dream, we saw things which are not there, so we hallucinated. Second, we believed things that couldn't be possibly true, so we were delusional. Third, we got confused

about time, place and person, so we were suffering from disorientation. Fourth, we had these wildly fluctuating emotions, something that psychiatrists called being affectively labile. Last but not least, how wonderful, we woke up this morning, and we forgot most of that dream at least if not all, so we were suffering from amnesia. If we were to experience any one of those five symptoms while you are awake, we would be seeking psychiatric treatment. But for reasons that we don't fully understand, dreams seem to be a normal biological and psychological absolutely life support perhaps necessary set of experiences to go through. So that is the peculiarity of dreaming, but how do we define it?
One of the definition is a dream is any report of mental activity upon awakening. So I will come into laboratory. I will wake you up. I will say what was going through your mind, and if you say nothing really then we note that down as no dream report. If you were to say, I was actually thinking about the next time you are going to come in and wake me up then we would report that as a dream. However, that is not really what you mean when you say I had this strange dream. What you are referring to is dreaming that takes place during the stage of sleep call REM. During REM sleep we have these bizarre hallucinagenic, these vivid, these narrative this emotion felt story experiences. These are the types of reports that we get principlly from REM sleep. Think about those light non-REM sleep, deep non-REM sleep and REM sleep. when does dreaming occur? Well, if I wake you up during stage two non-REM sleep, that is one of the lighter form of non-REM, you typically will report a dream maybe with fifty percent probability, fifty percent of time I wake you up from that stage no report the other half yes. If I wake you out of deep non-REM sleep, stages 3 and 4, we are about 0 to 20 percent chance that you will report a dream, so it is very unlikely. If I wake you up out of REM sleep something about 80 to 90 percent probability that you are going to report a dream. There is nuance in that REM sleep story by the way. REM sleep actually is defined by those rapid eye movements. when you are in that stage of sleep, you are not always going to have those eye movements. There come in these strange phases when your eyes are doting back and forth and times when your eyes are not. When those eyes are moving, scientists call that phasic REM sleep, and when they are not moving, they call that tonic REM sleep. By the way, don't worry about the terminology. When I wake you up out of tonic REM sleep, when the eyes are not moving, it is around that 80% probability. However, if I wake you up out of phasic REM sleep, when your eyes are doting back and forth, there is 95 to 100 percent probability that you are going to report a dream. Some people in the past have said if that is the case then presumably those eye movements are tracking something in the dream. If we do careful analysis that doesn't seem to hold up.
That is a little bit of definition of what dreaming is, and when does it occur.

Now I have to clarify something when I am saying REM I am going to infer that it is dreaming. I should probably note the way that we human beings seem to be special in our REM sleep dreaming amounts. A scientist looked at the proportion of REM sleep across different mammals. What he found was that we human being are a complete anomaly when it comes to relative amount of REM sleep. He has found that across most other primates REM sleep was averaging about 9% of their sleep period. However, we human beings on average including

when we are young will have a REM sleep proportion of about 20%. We don't fully understand why it is that we have such an exceptional amount REM sleep.

REM sleep seems to be quite fundamental and fundamental from a life necessary perspective. There were some studies done back in 1980s. They are studies that haven't been replicated and I understand why, because ethically you don't have the right for that. They took rats, and they deprived them of sleep totally. What they found was rats on average will die somewhere between about 13 to 17 days after total sleep deprivation. Another word rats will die from sleep deprivation as quickly as they will do from food deprivation. It is that essential. But then they did something different about the different stages of sleep. They selectively deprived them of either non-REM sleep and REM sleep. when they deprived them of non-REM sleep they took longer to die about 60 days. When they deprived them of REM sleep, dream sleep, they died after forty days. So it seems that REM sleep is more important than non-REM to supporting life.

Sleep talking. when people say things in their dreams how faithfully that reports what is in the dream? Well, it doesn't at all. The reason is because when we are sleep talking, or sleep walking, or even sleep eating, we are not dreaming. because we are not in dream sleep. This is one of the fallacies when we say during sleep walking or sleep talking stop dreaming wake up. We are waking someone from very depths of deep non-REM sleep. These different things sleep walking, talking, eating are what scientists call parasomnia. Para means around and somnia means sleep. So these are things that happen around sleep but not in sleep. because when we have those, we are lunched from deep non-REM sleep to wakefulness, but you don't make it all the way to wakefulness. So they are not faithful to dream. If I wake you from sleep when you are talking and tell you what was happening, you will say nothing.

What is the function of dreaming?
The functions of dreaming come back to some of the functions of REM sleep. One function of REM sleep seems to be creativity. Associating memories together, so that we can come up with these wonderfully divine solutions to these problems that we couldn't answer when we are awake. The second is emotional and mental wellness. REM sleep is a form of overnight therapy. I would say that these are the two leading theories about benefits of REM sleep and associating dreaming. But perhaps I didn't give you the full story here. There is a twist in both of those stories. I told you that when we are in REM sleep, and we are dreaming, the next day we are better able to assimilate and associate memories and come up with creative insight solutions. It turns out that sleep is necessary for that and not just sleep but dream related sleep, REM sleep. However, it is not sufficient. You not only have to be asleep and dreaming to get those benefits. you also have to be dreaming of the very things that you are trying to solve the next day. There is a great study by a scientist called Robert stickgolden. He had a whole group of individuals learn a virtual maze, and they were dropped in different locations of the maze. They had to try to get out of the maze and gradually. when they were dropped in different locations, they started to make this mental map of the maze. Then he lit one half of

those participants to take a 90 minutes naps, and the other half remained awake. Some hours later, he tested them on the maze and measured how quickly would they be able to navigate to get out of the maze. That was the outcome measure. Sure enough those people who slept vs those who didn't, they were better able to navigate the maze. But then they went back and they separated those individuals who were napping in to two classes. Because as they were napping they were waking them up intermittently and getting dream reports from them. What they found was that those people who slept and still had dream reports, but those dreams were not related to the maze, they didn't show any improvement. However, those individuals who slept and who dreamed, and also dreamed of the specific maze elements themselves, they were the only subset of people who showed the benefit. That is a beautiful demonstration that yes you need to sleep to get creative benefits. In fact, dream sleep is necessary but you also need to be dreaming about specific things.

Is this rule true for the second function of REM sleep, this overnight therapy benefit?

Yes, it does seem to be true. There was a great study by a scientist. She was looking at different patients' populations who would undergone really painful difficult emotional experiences. For example, a very painful divorce. At the time that those individuals were going through this difficult challenge, she would be recording their sleep, looking at the different stages of sleep, and she was collecting dream reports from them. Then she would track them and their progression clinically over the next year. What she found was that some of those participants, about 50%, ended up getting clinical remission from their depression that was instigated by the painful experience they have gone through. The other half didn't get the clinical remission from that depression. They remained depressed. Then she used those two classes to go back and have a look at the sleep and their dream reports. What she found was some differences in REM sleep. More interestingly were the differences in their dreams. Both of those sets of individuals were dreaming at the time of those difficult emotional experiences. Some of them would, however, dreaming of that challenging experience, others were not. Those who dreamed but also dreamed of the problematic experience where the ones who went on to get clinical resolution from their depression. Those who dreamed but didn't dreamed of those events seem to be the ones who didn't get clinical remission from that depression. In other words, here once again is this new rule that when it comes to dreaming, it is not just about sleep, and it is no just about dreaming, it is about dreaming of the specific things that you are trying to get the functional benefit from whither that is creativity and insights or wither it is emotional resolution and overnight therapy. Both of them seem to depend very much on expression of dreaming of specific things itself.

Nightmares

How do we define a nightmare in science clinically? It is a little bit tricky, but the way we usually define it is, it is strongly unpleasant dream that causes sometimes of day time displeasure. Another word, some kind of day distress. Everyone could have a bad dream, but when we go up to our waking life and our waking day, it doesn't seem to bother us too much,

and maybe we will just say it was bad dream. When it really becomes a nightmare is when we must think of it as though we wake up and that blanket of strong nightmare emotion is still wrapped around us, and we can feel it. We could just know our emotional state is still heavy, and we know exactly where it came from: from that nightmare. Throughout the day we don't seem to be able to derope ourselves from that affect of nightmare. It drenches us almost. That is when it starts to become unpleasant.

What are nightmares doing if anything at all?
There are at least two theories. The first is that it is simply the system failing: system gone wrong, and we are not processing what we have to. Therefore, nightmares could be maladaptive. They are not warranted. They are not normative.
The other theory is that they are adaptive and they are meaningful. it is us really trying to go to a very specific pain point, and we continue to process it over and over perhaps to the point where we get resolution, but sometimes we just don't so it keeps cropping up. we don't have data to disambiguate those two right now, so both of the theories remain open. Even when we get the answer in some ways, it doesn't change the fact that it still leaves the patient with nightmares.

We actually have a clinical category called nightmare disorder. The way we particularly define that is the same thing as I said of very unpleasant dream that causes some type of daytime distress, and it is happening at least once a week. At that point we start to move it in to this category of nightmare disorder. Is there any treatment for people out there if they are under this distress? Is there hope? For long there wasn't hope at all, we just had to go through it, but recently there was a method that was developed. It is very effective. It is called IRT which stands for image rehearsal therapy. Its basis comes back to something called memory reconsolidation. As I said before, there are two main steps of memory. First you have to imprint and learn the memory, but then that memory is fragile vulnerable to being over written, and for us to hold on to that memory, we have to go through a second step called memory consolidation very slow process. That always struck scientists as a strange model, because it is the equivalent of opening a word document, we type all of the information in to it, and then we hit the save button. So I have encoded, imprinted the information then I hit save and saved it and then I close that file. Then the next day I come back or some days later, and I double click on that file again because I want to edit it. I either want to add to it or I want to revise it and change it. However, according to that model, it has been locked in place, and we could never edit that word document. That seems, it is profoundly useless way to store information. What we learned is that every time in subsequent days, when we reactivate which is to say when we recollect the memory that has been consolidated, it opens that memory file back up to once again being plastic and malleable so we can go in and update the information in that memory store. Then the next night we consolidate it again. So it is memory updating. There is a very clear mechanism in the human brain that allows us do this memory updating iteratively time and time again. This comes back to nightmare disorders. This therapy or IRT will have us set with a therapist, at first we will describe that nightmare that we are going

through and write that narrative down. Then working with a therapist, we will agree to think about a more neutral ending to that nightmare. So let say that I was involved in a very difficult car crush just horrific and every night since that I would say at least once a week I just continue to have the nightmare of the car crush. I know that I am traveling towards the junction. I apply the brakes. The brakes fail. I am just looking around. I am trying to maneuver. Nothing is going to change this. I go through the red light, and someone sideswipes me and that is the end. I relive that time and time again. It is awful. So we with the therapist would then start to say what about the alternative scenario. I depress the brake, and the brake don't work, but gradually I think well I am just going to reach over to handbrake, and I am going to gradually apply the handbrake. That slowly is going to bring the car back to a nice safe stop. Then I am going to call the emergency services, and the car is going to get toad. I don't go through the junction. I survive. Everything is fine. So we rehearse this alternate ending, and we keep going through that rehearsing. Then we go to sleep the next night. We would probably have a high chance of that nightmare again. If we keep doing that once, we got that alternative ending, essentially what we are trying to do is, every time we reactivate the memory the trauma car crash, and then we rehearse this alternate ending. It is like me going in to the word document and editing the section that was really horrific, bad, and replacing it with something neutral or even positive. Over time then I sleep, and I will consolidate that memory, comeback the next day and do some more editing and more updating and time after time after time. Gradually, we would dissipate the narrative that is fixed inside of the brain and the nightmare frequency decreases in proportion. Now it is not effective for a 100% of patients. If we look at the data on average, it is about 2 out of every 3 people. So about 66% of people will benefit. If you look at some medical treatments that is a great treatment. That is still very effective. There are very recent studies from some scientists in university of Geneva that did an even more ingenious study. They were able to nudge the effectiveness of that treatment from 66% up to 92%. They used an additional memory related research tool scientists have come up with in sleep science called TMR or targeted memory reactivation. Here is how it goes. I am having you to learn a set of associations. Have you ever played that card game which is called memory, where we get a deck of cards, and it has two of the same items two houses, two cars, two fire engines, two cattle… Then we shuffle the cards and put them face down in a big square. Overtime we have to turn over one card and it is a cattle and then we just randomly pick another card and it is a fire engine. But gradually we start to learn where of pairs are located. So what is clever about that is, we would do that type of what is called paired association memory test. We learn these paired associations and then we are tested after a night of sleep and we are better. However, if as you are turning those items over, I play a congruent sound so let say you turn over the fire engine, and then when you turn over the other fire engine, I am going to stop playing fire engine noise in the background. So I am bonding the association of the memory card pairs with this congruent sound. Then a cattle, I turn over a cattle. I turn over the other cattle, and I start whistling. Then we are let to sleep that night. If we start replaying those same tones at the sub awakening threshold, So we are not waking up, and we come back tomorrow. let say we only do those sound reactivations for half of the memories that we have done, and for the other

half, we leave untouched. So within an individual, we have a unique within individual control. We are tested on the things we didn't reactivate at night and those that we did. It is almost like creating a bespoke playlist at night where we say look, I lend all of this information during the day, and here is the stuff that I really think personally to me. I want to Remember them well. It turns out I have been tagging that with particular music and then at night I replay that music, and then the next day it turns out that those things I reactivated are much more strongly consolidated by way of sleep than those things I didn't. So that is the basic method of TMR. What they did was something very clever. They had them go through this process of IRT. They were rehearsing the ending, and about every ten seconds, they were playing them this very pleasing piano chord in the background. They were just bonding the association of the new outcome ending to the nightmare with this pleasant piano chord. Then sure enough in the subsequent weeks afterwards not only was that person day after day doing the diligent therapy practice of rehearsing the memory while the piano tune was playing, but also at night they would wait until they went into REM sleep which is the state we think the emotional therapy begins, and they would start to replay that same piano chord over and over again. Sure enough, those people who had IRT standard, they improved by about sixty percent in their nightmare frequency reduction. Those people who did that plus the memory reactivation at night, it drove them from 66% to 92%. So now modern day neuroscience with its techniques is starting to overlap with classical clinical psychology, and scientists are developing these next forefront of methods that really harness and fine-tune the brain's ability to undergo effective therapy.

Unconventional tools

1. If you are struggling with sleep, and you have had a bad night of sleep, the first recommendation is, do nothing. What I mean by that is if you have had a bad night of sleep, do not sleep in any later into the morning. Do not go to bed any earlier. Do not increase your caffeine intake to try to offset it, and do not nap during the day. Why am I telling you these things? If you wake up later that following morning, your adenosine clock is going to start latter in the day, so when it comes time for you to sleep the next night at your normal time, you are not going to feel sleepy. why? Because you woke up that much later. You would not have sufficient adenosine, and you are setting yourself for failure again. Equally don't go to bed any earlier the next night. If you have become accustomed to going to bed at a certain time, and hopefully you are doing it regularly, then getting into bed 2 or 3 hours early has a danger of you getting into bed and thinking well, I know I had a bad night of sleep last night, but I still can't fall asleep straight away. So now you are spending another 90 minutes at the beginning causes you have gone to bed 90 minutes earlier thinking it is a good idea to compensate. Don't do that either. Hold out, even if you do feel tired, for as long as you can, as close to your natural sleep time as possible. Then go to sleep and you will give yourself a high chance of success. Try not to compensate with a nap why? Because that nap as it happens is going to remove some of that sleepiness, adenosine, and once again, you get into bed, and you are not as sleepy as you

would naturally be. So you again go through a bad night of sleep because you are struggling to sleep or you wake up in the middle of the night, and you can't get back because you got less weight of sleepiness on your shoulders due to the nap. I know it is hard, but I would say when the alarm goes off after a bad night, you would want to sleep more. I don't want to bother you, but it is a short term gain, and a potentially long term loss because you might then get into this vicious cycle.

2. Try to limit your time in bed if you are struggling with sleep. This is something that is used in probably the most well validated psychological intervention for insomnia, and it is called cognitive behavioral therapy for insomnia or CBTI. What happens is that you work with the clinician, they interview you. Then they asses all of the reasons that you may not be sleeping, and then they create from that tool box of many options prescription for your treatment. If you look at those studies of that collection of different tools in the CBTI box for the intervention of insomnia, and you ask off all of those, which seems to carry the greatest impact on insomnia has the greatest gravitas? It seems to be this thing that we all call bed time rescheduling. It used to be known as sleep restriction therapy, but obviously, if you come to me and say look I am not sleeping very well. I have got insomnia. I say I understand. I have got a treatment for you, and it is called sleep restriction therapy. You would say no no no. You didn't understand. I am not getting enough sleep. It is not quit that. Here is how it works. If you are spending so much time in bed, you are not forcing your brain to be efficient. By way of constraining your sleep window even to let say five hours a night to begin with, I brought force of ruthless efficiency from your sleeping brain after several days. So another analogy would be that to say you are trying to make a nice thin crust of pizza base. You put the dough on the table and you start rolling it out. If you rule it too thin, it starts to get gaps and holes in it. Why? Because you have spread it out too far and you have started to create these absences. That is the same thing that happens with sleep, and it is very natural as an insomnia patient. You would say, I am not getting enough sleep, so I am starting to spend more time in bed. This is very worst idea. Another way would be to say, I go to the gym, and I spend an hour and half working. However, if I video tape you, a lot of the people are doing the texting and are busy with their smartphones. If you look they are only working for about 45 minutes and the rest is wasted. So what if you come to the gym next day, and there is a big bouncer guy in the door. You are only allowed to work for 40 minutes, and then he is going to eject you. On the first day, you go back and do the same thing. Then you notice that you have only gone through 30% of your workout. So you get botted. The next day you come and botted again. After about five or six days, you will build up such a strong desire and hunger to get your workout in. As you walk in, you put your phone on to the silent. You put it on the corner, and you just get to exercise. That is the same thing we are trying to do with sleep restriction therapy. You have to be a little careful. Do it under supervision. Specially, if you are driving or operating heavy machinery because it could be dangerous. We just want to keep an eye. It is not necessarily a big concern. We would say ok, you are spending almost total about 8 or 7 and half hours in bed. Tonight, I am going to restrict you down to 5 hours a night, and we are going to do this for the next week. The way we

normally do it is, I don't change your wake up time. I change your to bed time. Why? It is easy to stay awake longer than is to wake up earlier. So I put it to the front end. At first day things don't change, but after maybe 4 days going through this, I build up enough of short term dead in your system that your system all of a sudden think that I can't be as lazy anymore. I can't do this thing, waking in the middle of the night and spending an hour and half awake. There is so much physiological buildup and pressure for this this. Gradually, what happens is that you sleep longer. You don't wake up as much, and after about two weeks of doing this all of a sudden you go to bed at that late time you are out like a light and then the next thing you remember your alarm goes off saying sorry, you have got to wake up. What happens by way of that reset is that we will gradually back it off by 15 or 30 minutes each time. If there is any sign of you not sleeping well, we will zip it back again. The goal of this is to reset your sleep. Your brain will relearn that you are a good sleeper. Now you control your sleep. The hard part is that it is not easy to go through, so you must motivate yourself.

3. Do not count sheep. Some people count sheep to fall asleep. It doesn't make you fall asleep faster. It makes you to stay awake for longer to fall asleep. Here is a good method for this purpose. If you are not into meditation or something like it, try to take yourself on a mental walk. It has to be a walk that you know very well. So let's tell you that you walk your dog every day, and you know couple of walks. Do it in hyper details. So close your eyes, you go to the front door, walkout, go down the steps, out to the drive way then you take a right, but you always crossover and look to the right and left because that is the way traffic always come… That fidelity of hyper detail walk allows you to do what we said earlier, which is get your mind off itself. When you do that again, typically you fall asleep faster.

FAQs

1. what are best practices for managing rumination and negative thought when trying to fall asleep. Meaning if somebody is ruminating and have negative thoughts when they are trying to fall asleep what should they do in order to get pass that and fall asleep?
Short circuit. You need to short circuit that situation. The way that you can do that is through a variety of methods. There are multiple methods for short circuiting rumination. The first I would recommend is meditation. All of these I would describe are about getting your mind off itself. That is the biggest problem regarding anxiety and sleep onset insomnia, which is what this question is describing. It is either guided and you are speaking about what you should be doing breathing or relaxation guided meditations. All of those stop your mind from being able to play on itself and go through that rolodex of anxiety. You can do breathing techniques. You can listen to sleep stories. You can do your own type of body scan. Anything that you can do. Something I have described just seems to be a quite beneficial method. It is taking yourself on a mental walk. Close your eyes and a walk the way that you know intensely well with vivid 4K detail. I left foot on the first step down the steps, take a right out the drive way, I go walk up the hill, looked at the bay. It is 5 pm. The sun is starting to set, that level of detail. The next

thing that you would remember would be that you waking up in the morning because you were able to short circuit.

2. what is the best body position to sleep in?
Best body position is probably the absence of the worst, which would be on your back. It is ill advised mostly for people who snore. When you are on your back, the likelihood of you snoring, the air way collapse entirely, and you having what is called hypoxic event where you stop breathing entirely is significantly higher than if you sleep on your side or on your front. So I would say for most people if you know that you don't snore, or if your partner says I don't hear you snoring that is partial confirmation that you don't snore. If you are curious and every one should be as to whether you snore, I would say download an app by the name of snore lab. I have no affiliation with this app by any way. By the way it is not a free app but very cheap. Once you installed that you start recording. Place your phone face down, and it listens to you all night. It records your breathing and nothing more. Then it will show your snoring distribution throughout the night. It categorizes that snoring from quit no snoring to mild snoring to moderate to epic. If you see a confirmation by way of that snore lab go and visit your doctor. That is the best advice. 80% percent of people who have sleep apnea or that snoring are undiagnosed right now. It will take years of your life, and when you get treated, it is transformational. Patients declared when they got treated, they felt 10 years younger. So if you think you are snoring stay away from back sleeping. Even if you don't suspect you are a snorer, just download the app. Just check it for couple of nights consistently.

3. why does my body wakes up at a certain time no matter what time I go to sleep?
So to that question, my first response is how do you know it is that certain time? Their response is, I look at the clock. That is the first problem. Take all clocks' faces away from your sight when you are sleeping. It is only going to reinforce it.
The second, people wake up at very specific times quite reliably, so part of that is because they are going through very reliably timed sleep cycles. Every time we finish a REM sleep period, we wake up. However, it is normally very brief and the reason is that we have been in paralysis and the body needs to move, so we wake up. We make a postural shift. We move in our bed slightly, and then we go back to sleep. It happens to us all. For some of us, we will wake up, and then we will stay awake. That is why it seems religiously timed to certain specific moments in our night. However, this other individual mention, no matter what time I go to bed. I seem to always wake up there. That to me smells of a suggestion of reinforced learning that you have woken up a couple of times, and you checked the clock. Now you have taught your brain very quickly that I always wake up at certain time every night. lo and behold what is happening. You start to do that more frequently. The more frequently it happens, and the more you check, the stronger that memory association becomes. The more likely it is to happen again. The advice would be remove the clock face from the room, and don't check the clock at the middle of the night when you wake up.

4. Can we bank sleep or catch up on lost sleep?
It is a great question. You can and cannot bank sleep. It is directional. So what we found is that for certain things such as an immune vaccination or learning and memory you cannot catch up on lost sleep. If you are sleep deprived the night after learning a specific task, which is critical for consolidating and saving those memories, I don't test you in the way I would normally do. Instead, I give you a full recovery night sleep well maybe I will give you two recovery nights of sleep. Then, I test you. Do you show any memory consolidation benefit? The answer is no. You don't. Another word, if you don't sleep the first night after learning, you lose the chance to consolidate those memories. So there, sleep is all or nothing phenomenon.
What happens when you go into a debt, and you try to pay it back to with later credit? It fails. You can't seem to do that with later sleep. So sleep is not in the bank in that direction. You can't accumulate debt. That is to say the weekend after short sleeping during the week see if you can pay off that debt at some later point in time. It doesn't work like that. For example, if I deprive you of sleep tonight, let's say it is an 8-hour opportunity, and then tomorrow I give you all of the recovery sleep that you want. Then, on second night, third night, fourth night, do you sleep longer those nights? Yes, you do. In fact, if you look at the data, it is usually less. It is usually around two hours. So only about 25% of the eight hours that you lost. So you will always be running a debt. If that is the case, if you can't truly pay back your sleep debt, and you are constantly running that short sleep cycle, it is like compounding interest on a loan. It just escalates dramatically, and that is why I think we see that short sleep really just predict ill health outcomes and earlier mortality the later and later in life that you go. However, there is a different form of sleep banking. Before, I told you that you are trying to pay it off with credit later. What if you had the inverse. Let's say that you are a doctor, a nurse or working in the emergency services. You know that you have two nights where you are on nights, and you are going to be probably very busy. You are not going to be sleeping well for those two nights, and that is going to be Monday and Tuesday. You are currently on Wednesday in the week prior. There is something that has demonstrated benefits called sleep banking, which is where I know I am going to go into debt. So I sleep longer. I create credit to begin with, and I spend that credit as going into debt. That seems to lessen the impact of that debt. However, it doesn't remove the impact entirely, but it does lessen it. So here it is the inverse. I am not going into debt and then trying to pay it off later. I build a credit and then I can spend that credit with debt. So there is a form of sleep banking that seems to be present, but it is not the sleep banking that most people think about it. In this case we could have a kind of sleep banking.

5. What are some of the best practices for getting back to sleep after waking in the middle of the night?
There I would say there are several things. First don't try too hard because trying to get back to sleep and become frustrated is very much like remembering someone's name. The harder you try the further you push it away, and as soon as you stop, all of a sudden that names pops back in your head. It is the same way with sleep. Previously I said you don't want to spend a lot time

awake in bed because you learn the association that your bed is the place of wakefulness, and every time you come in at night you are always wide awake. You don't know why despite having falling asleep watching TV 20 minutes earlier. The other suggestion is, however, the most people don't long to get out of bed: it is dark, it is cold, I get it. I understand it. The other thing to do in this situation is enjoy the concept of rest. So wouldn't it be wonderful if in the middle of your work in day someone say look just come away from your desk now, here is beautiful calm bedroom, it smells very nice, nice dim lights, I would like you to lie down, no need to fall asleep, don't fall asleep, just lie down on the bed or on the couch, and just rest for the next 30 or 40 minutes. That sounds lovely. If you are struggling to fall back asleep, and you have red this book, you could start to restress, gosh sleeping doing this and this and now it is 20 minutes, and I can't fall back, you just get more and more stressed. Instead take a different approach in that time, say to yourself don't worry tonight is not my night and it is ok, yes it really is ok. Tomorrow night is going to be a better night. Tonight rather to inforce myself to sleep, I am just going to lie here maybe with my eyes open. I am just going to rest. I am just going to enjoy rest in my bed. Once again the next thing that happens is that the sun has emerged. It is bright in your room, and your alarm is going off. As soon as you relax out of state of trying, sleep comes back.

6. I used to be a good sleeper, but as I got older, 65 years old currently, I find that I wake up much earlier than I did previously. It is difficult for me to get more than 6 hours of sleep. What do you think is going on, and what are some remedies?
The first question I would want to ask is how do you feel on 6 hours of sleep? If you are impaired and struggling during the day, and this person seems as though they are unhappy with that 6 hours, then we can start to have a conversation. What that conversation would look like? I want to understand perhaps the reason that you can't get back asleep, and we begin these techniques that we have spoken about for trying to get back to sleep. let say that you have gone to bed at 10 pm, and you normally would like to wake up at 6 am, but you are always waking up at 4 am. There is just nothing you can do in that stage. You just don't feel sleepiness over you. No method could help you. You just have to get up. We see this a lot in older adults. Sleep late in the night is very fragile. Much greater probability of them waking up in the second half of the night and in last quarter. It is because most older adults' circadian rhythm shifts earlier. I told you, as we go through teen years our circadian rhythm shifts to the future, and we like to go to bed much later and wake up much latter. In older adults, it goes back to place when we were children. We want to stay up late, but we can't. We go to bed early and wake up early. Some regression happens as we get older. So how do we deal with that. One way is that you can use one of the four macros of good sleep QQRT. However, I would see if you can delay your bed time as best you can. If your bed time is 10 and normally wake up at 6, but you consistently waking up at 4, start going to bed at 11 pm. Push push push as harder as you can until you are so sleepy. Then it will take a couple of days to build up that debt. That to begin with, you will go to bed now 11 p.m. and wake up at 4 am, so things are even worse, but after a while you will build up this pressure to sleep. All of a sudden, you are going to bed again at 11

pm. What does your brain think? I had four nights of 5 hours of sleep. I am not doing this anymore. I will sleep through until five. You can keep moving your schedule later. When older adults wake up at 4 and they can't get back, it is also miserable because the rest of the world is asleep: the people they want to engage with, have a social life, speak with grand kids. They can't do any of that. So it is very difficult situation. If these things don't work, you can speak to a board certified sleep medicine clinician.

7. What does it mean if I can Remember my dreams. Conversely, what does it mean if I can't Remember? Does this have any reflection on my sleep quality?
If you don't Remember your dreams, many of you will ask me then does that mean I don't get REM sleep? No absolutely no. There seems to be no correlation between how much sleep that you are getting, and whether or not you remember your dreams. That is point number one. Point number two, there doesn't seem to be a strong correlation between you remembering your dreams, and the quality of the waking day that ensues as a consequence of that dream remembered sleep from the night before vs dream non-remembered sleep. The only time that we have some data is about lucidity. In lucid dreams, there might be some negative effects. By the way, if you don't remember your dreams, it doesn't mean that you are also not storing those dreams and being influenced by them. There is something called implicit memory. It was long held these versions of studies where you go into a movie theater, and for very brief periods of time(milliseconds) you show images of a certain soda cans. Then during the intermission, you track people's purchasing of soda, and sure enough they will buy more of that certain soda if they get flashed. So we can actually embed implicit information into people, and it changes their behavior. They have no recollection of the memory, but it is clearly there, and it is clearly influencing their behavior. What does this have to do with dreaming? There is a theory: most of us forget our dreams, and most of us think when we forget dreams, they are evaporated from brain. What if it is not the case. Have you ever had the experience where you are waking up, and you know you were dreaming, and you just cannot capture it. You think it is gone. Then two days later in the shower looking at the shampoo bottle and labels, all of a sudden unlocks the memory of the dream, and it comes back. It is in existence but unavailable. There is a difference between availability and accessibility. The memory was available, but you had lost the IP address to go and retrieve it.

8. If you could get one tip for better sleep what would that be?
Regularity. Just keep things regular. If you get regular sleep, a lot of things will start to take care of themselves. After that if they don't, we use the other three macros and protocols, but start with regularity. You should find your chronotype and get regular with it. If you do those two things, and you are regular weekdays and weekends, you will get a long way to getting better sleep.

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