

Brains On (APM) | Brains On! Dreams: The science of a sleeping brain 01G39B57Q7E1YYRFBNAW53KTD3

TESSA: You're listening to *Brains On*.

ANDREW: Where we're serious about being curious.

TESSA: *Brains On* is supported in part by a grant from the National Science Foundation.

MOLLY BLOOM: You're listening to *Brains On* from American Public Media. I'm Molly Bloom, and my co-hosts today are Tessa and Andrew.

TESSA: Hi, Molly.

ANDREW: Hello.

MOLLY BLOOM: Well, we are really excited to have you here today to talk about dreams.

SANDEN Hey, Molly, am I interrupting?

TOTTEN:

MOLLY BLOOM: Not at all, Sanden.

SANDEN Because there's totally popcorn falling from the sky right now.

TOTTEN:

TESSA: What?

SANDEN Look out the window.

TOTTEN:

ANDREW: Cool.

MOLLY BLOOM: Wow, that's amazing. Now, Tessa and Andrew, what's your favorite kind of popcorn?

ANDREW: I like mine with ketchup.

MARC Did you say ketchup? I happen to have some in my pocket.

SANCHEZ:

ANDREW: Thanks, Marc. I'll put it on the popcorn I have in my pocket.

MARC High fives.

SANCHEZ:

TESSA: What is going on here?

SANDEN Look, now it's raining jellyfish.

TOTTEN:

ANDREW: Run!

TESSA: Wait, how did we get outside?

ANDREW: Tessa, didn't you hear? Run.

SANDEN It's raining jellyfish.

TOTTEN:

TESSA: OK.

MARC Good thing I have this umbrella in my pocket.

SANCHEZ:

TESSA: Where's my umbrella? Why can't I run faster? What is going on?

ANDREW: Tessa?

TESSA: What?

ANDREW: Tessa?

TESSA: Huh?

ANDREW: Tessa, wake up. We have to get ready to go to the *Brains On* headquarters for the taping.

TESSA: But the jellyfish. Didn't we already--

ANDREW: Come on, we're running late.

TESSA: Do you like ketchup on your popcorn?

ANDREW: Ew, no. Why?

TESSA: Never mind.

SANDEN OK, up and at them. Let's go.

TOTTEN:

TESSA: I should probably bring my umbrella just in case.

[QUIRKY MUSIC]

MOLLY BLOOM: You're listening to *Brains On* from American Public Media. I'm Molly Bloom, and I have two co-hosts here with me today, brother and sister Andrew and Tessa from Toronto. Hello.

TESSA: Hi.

ANDREW: Hi.

MOLLY BLOOM: This episode was partly inspired by one of your questions, Tessa. You wrote to us saying that you have very vivid dreams. So, Tessa, how often do you remember your dreams?

TESSA: I don't know. Whenever I dream, they feel like they're real. But whenever I don't dream, it doesn't feel like anything at all.

MOLLY BLOOM: So which kinds of dreams do you remember? What's usually happening in them?

TESSA: Well, it's usually me and my friends doing something or me and my family doing something. There was this one dream where, me and Andrew, we want to go to school. And then we brought a dollhouse and dolls. And then we played. And then it turned out the dolls were broken. And then for this reason, school got dismissed early. So then, we just went home. And then our mom was making lunch. And then our dad was at work. And we took animals and we pretended they were our dad because we wanted to play with someone.

MOLLY BLOOM: Wow, that is an amazing dream. And you remember it so well. It's very impressive. And how about you, Andrew? Do you-- are you able to remember your dreams?

ANDREW: Yeah, pretty much. The most realistic dreams, I tend to remember them.

MOLLY BLOOM: So how do you-- how are you able to tell a difference between those very realistic dreams and then real life?

ANDREW: I just wake up in bed. And for one second, you feel like, oh, say you got, I don't know, a new computer. It's like, oh, I'm going to go downstairs to check out my new computer. Then you realize you're in bed.

MOLLY BLOOM: Yes, I know that feeling.

ANDREW: And you wonder why you're in bed.

MOLLY BLOOM: Would you say you like when you have dreams, or would you prefer not to remember them?

ANDREW: I think I like it when I have dreams, just because it's like sometimes they might have a message in it, like in the future, don't do that or do this. When I have homework and I-- and I realize, oh, I have homework, those dreams help me because, say, I'm in French class and the teacher asks me, where's my homework? Then I'll wake up and go, oh, I have to get my homework done.

MOLLY BLOOM: Yeah, so it's sort of like something goes wrong in the dream, but then you can actually get it right in real life.

TESSA: Like a warning.

ANDREW: Yeah, like a warning.

MOLLY BLOOM: Your brain's warning you. Good job, brain. Today, we're going to get into the reality of dreams.

TESSA: We dream every night, about four to six times. But we usually forget most of them.

ANDREW: They start about an hour and a half after you doze off. And the first dreams last about 10 minutes.

MOLLY BLOOM: Then you stop dreaming but keep sleeping. About an hour and a half later, you start up again.

TESSA: It's a cycle. And your dreams get longer and longer each time.

ANDREW: By the end of the night, you might be dreaming for almost half an hour straight.

MOLLY BLOOM: Those are the basics. Now, let's get to some of your questions.

[QUIRKY MUSIC]

TESSA: Hi, Molly. I wonder what happens when you dream.

ANDREW: And my question is, where do dreams come from?

CHILD 1: Why do people dream? Do all people dream? Do animals dream? And what do dreams mean?

CHILD 2: My question is, how are dreams created?

[QUIRKY MUSIC]

SANDEN Tickets. Tickets, please. Tickets. Anyone?

TOTTEN:

MOLLY BLOOM: Sanden? Sanden, what are you doing? Is that a roller-coaster carriage?

SANDEN Yeah, I wanted to help answer those questions we just heard. So I took an old theme-park ride, and I turned it

TOTTEN: into a dream-park ride. It's a trip through the sleeping brain. Your brain is actually pretty active while you dream.

It's just active in different ways. Anyway, hop on or the ride will start without us.

MOLLY BLOOM: OK, then.

ANDREW: I call dibs on the front seat.

TESSA: Wait, is this a dream, too?

MOLLY BLOOM: No, this is just normal *Brains On* weirdness. Don't worry.

TESSA: Whew.

SANDEN OK, all strapped in. Let's go. So we dream during part of the sleep cycle called rapid eye movement sleep or REM

TOTTEN: sleep. During this time, your eyes look like they're kind of darting back and forth behind the lids. That's how it got the name rapid eye movement sleep.

TESSA: We're going really high up.

SANDEN Well, sure. We have to fall asleep first.

TOTTEN:

MOLLY BLOOM: Fall?

ANDREW: Are you absolutely sure this thing is safe?

SANDEN Absolutely not. OK, here we go.

TOTTEN:

[SCREAMING]

Whoa. [CLEARs THROAT] Excuse me. Well, is everybody still here?

ANDREW: Barely.

TESSA: I'm fine, but I think Molly passed out.

SANDEN Hmm. Molly? Hey, hey, Molly?

TOTTEN:

- Yes, Miss

Pewterschmidt?

No, aliens ate my
homework.

SANDEN Ah. I think she's in a dream trance. It's fine. She'll just dream her way through the ride. Now, a lot of the brain is
TOTTEN: resting during REM sleep. But some areas are actually more active at night than they are when awake.

[QUIRKY MUSIC]

ANDREW: Whoa, where are we?

MAN: Far out, man. Trippy colors, dude. Like whoa, whoa, what a sight.

[QUIRKY MUSIC]

SANDEN This is the secondary visual cortex. It gets lit when we dream.

TOTTEN:

MAN: Hey, has anyone seen my rainbow rhinoceros?

WOMAN: It's over there by cuddly Frankenstein.

MAN: Me love puppies. Must snuggle all puppies.

SANDEN Your primary visual cortex is where you process the information from your eyes. It helps you see the world. But
TOTTEN: this, this is the secondary visual cortex. It's where our brains create the images in our imagination. So if I say Hot
Cheetos forest--

TESSA: Whoa, those trees are made of bright red Cheetos.

SANDEN Yeah, your secondary visual cortex is super busy when you dream. That's why our sleep is full of these weird and
TOTTEN: wonderful images.

ANDREW: Let me try. Oh, oh, how about LeBron James Brown?

LEBRON JAMES Pow!

BROWN:

(SINGING) I feel good like how you should.

[BIRD SQUAWKS]

MOLLY BLOOM: Hey, guys, this is my new pet, parakeet Pete.

PETE: Parakeet Pete.

TESSA: Molly, where'd you get that neon orange bird?

SANDEN She dreamed it up in her secondary visual cortex. Hang on to Pete, Molly. We're moving on.

TOTTEN:

MARC OK, walk and jump. Looking good. And now fly. All right. Now, let's all run like we're being chased by a cuddly

SANCHEZ: Frankenstein.

FRANKENSTEIN: Come back. Me want to hug you to pieces.

MARC Great stuff, everybody. Now, run and run and fly and fly. Now, fall and fall. Looking good. Keep it up. Keep going.

SANCHEZ: You've got this. Come on now.

ANDREW: Where are we now?

SANDEN This is the motor cortex. It helps with our movement. It's also very active in REM sleep. That's why we're often on

TOTTEN: the go in our dreams. Luckily, there's another area, part of this section of the brain called the pons. It stops us from actually acting out our dreams.

MOLLY BLOOM: Oh, no, come back here, Pete. Stop flying away. I can't catch up to you.

PETE: Gotta go. Pete is a cracker. Bye.

TESSA: You're not moving, Molly.

SANDEN Yeah, but she thinks she is. Her motor cortex is busy running, chasing, grabbing. But her pons keeps her pretty

TOTTEN: still.

MOLLY BLOOM: Whew, I finally got to you. Boy, you are pesky, Pete. It's a good thing I have a deep, undying love for you. I'd be nothing without you, Parakeet Pete.

PETE: Pete loves crackers and Molly.

TESSA: Whoa, she's bonkers for that bird.

SANDEN Yeah, part of the brain involved with emotions is also busy when you dream. That's why you can have these

TOTTEN: strong feelings that seem to come out of nowhere. OK, hold on, everyone. We've got more to see.

TESSA: Wait, this is just a big, dark room.

ANDREW: This is a lot less exciting than the last two stops.

SANDEN Yeah, this is the prefrontal cortex. When you're awake, this part of the brain is busier than Times Square. It helps

TOTTEN: you with planning, decision making, making sense of the world. Safe to say, it's super important. But when we dream, it's pretty quiet.

ANDREW: Echo, echo.

SANDEN The language center of the brain is also pretty inactive during dreams. That's why it can be hard to talk or read

TOTTEN: sometimes.

MOLLY BLOOM: Has anyone seen my brother, Parakeet Pete?

ANDREW: Wait, the bird is her brother?

MOLLY BLOOM: Oh, there you are, Pete the pair of paisley socks.

ANDREW: OK, where did those socks come from and what's going on?

SANDEN
TOTTEN: The socks came from her dream. See, when you're dreaming, your brain is getting all kinds of messages, like weird images from the secondary visual cortex, strong emotions, movement from the motor cortex, bits of memory and experiences. They don't really make sense together. But your brain kind of strings it all into a story. It's just not a logical story. And normally, this part of the brain we're in right now, the prefrontal cortex, would look at all this mixed up information and say, hey, this is nonsense.

TESSA: But since it's less active during dreams, Molly is just going with it?

SANDEN
TOTTEN: Exactly. Our dreams are a mishmash of various parts of the brain just doing their thing. And since our prefrontal cortex has taken a break, we don't wig out when things suddenly change or if something makes zero sense. We just kind of ride it out. And speaking of which, this ride is over. You all survived, just like I totally expected you would. Ha.

MOLLY BLOOM: Woo. Hey, guys, did I fall asleep?

TESSA: Like instantly.

ANDREW: And you befriended a bird who was also your brother and then randomly socks.

MOLLY BLOOM: What are you talking about?

SANDEN
TOTTEN: Oh, yeah. So I should have told you guys, another part of the brain that pretty much shuts down during dreams is the part responsible for long-term memory storage. When you're awake, this part of the brain files away important stuff so you can access it later. But in sleep, stuff just kind of comes and goes. You only remember your dreams if you think about them as soon as you wake up once your long-term memory storage systems are back online.

MOLLY BLOOM: I have no idea what you are talking about. But weirdly, I am craving Hot Cheetos, and I want to give Frankenstein a hug.

SANDEN
TOTTEN: Cool. Well, I'm going for another spin, so I'll see you guys later.

ALL: Bye.

(SINGING) Ba ba ba ba ba ba ba ba ba ba *Brains On.*

MOLLY BLOOM: So now we know a little more about what's happening when we dream. But we still haven't answered the big question.

TESSA: Why do we dream?

ANDREW: There are a lot of theories.

MOLLY BLOOM: To help us explore some of them, we spoke with dream researcher Deirdre Barrett.

**DEIRDRE
BARRETT:** I'm an assistant professor at Harvard Medical School.

ANDREW: Deirdre says an early theory comes from a guy named Francis Crick.

TESSA: We're calling it the garbage disposal theory. You'll see why.

**DEIRDRE
BARRETT:** He published a theory. He had one co-author with him. And they theorized that dreams were getting rid of memories and information that were not useful, that it was the way our brains kept from being cluttered up was to throw out unnecessary stuff every night and that we were sort of watching the unnecessary stuff go by.

MOLLY BLOOM: Hence, the garbage disposal nickname.

**DEIRDRE
BARRETT:** And he even proposed that paying attention to dreams and trying to remember them might be bad for you because it was exactly what you were supposed to be forgetting. All evidence shows that, if anything, dreams contain some of the things that we are trying to remember and help us consolidate useful memories. So the garbage disposal theory has been pretty much disposed of.

TESSA: So onto another theory. This one is called the threat simulation theory.

**DEIRDRE
BARRETT:** This is a group in Finland that believed that all dreams are getting us ready for threats, that we're practicing things we could do in the face of danger. Then we do better when we encounter a real threat.

ANDREW: So when you're running from a jaguar in a dream or showing up unprepared for a test, that's just your brain practicing in case these things happen when you're awake.

MOLLY BLOOM: Your brain is simulating threats.

**DEIRDRE
BARRETT:** The biggest problem with the threat simulation theory is that most dreams don't have a big threat in them. Many dreams are happy, and people are doing things they enjoy. And they're just really doesn't seem to be a threat there.

TESSA: It's sort of the opposite of another theory proposed by a guy named Sigmund Freud.

MOLLY BLOOM: Freud believed all dreams were wish fulfillment. He thought we were doing stuff we wanted to do but couldn't act out in real life.

**DEIRDRE
BARRETT:** And he had the same problem, that some dreams are happy and do look like wishes are being fulfilled, but some dreams fit the threat simulation. Scary things are happening, and you're trying to figure out what to do with them. So neither of those theories seems to really account for most dreams, or, at least, they have to account for them in very convoluted things of saying, well, a threat is really so scary that it's showing up as a wish instead or vice versa.

MOLLY BLOOM: Deirdre says no one theory seems to fit all dreams. But then again, maybe we don't need a theory.

DEIRDRE I mean, I personally think that even asking the question, what are dreams for, is not something we ask about waking thought, or at least we wouldn't expect one simple answer. If you say, what is thinking for, it's kind of for everything. It's fulfilling your wishes. It's contemplating threats and figuring out what to do if you're in a scary situation. You're thinking about your personal relationships. You're thinking about work if you're an adult and school if you're a kid. So I think that dreams are probably for just as broad an array of things as our waking thought is. But there are many theories that try to say dreams have this one function.

MOLLY BLOOM: So, Tessa and Andrew, do you have a theory about why we might dream?

ANDREW: So you know how people are always trying to find something to do, whether that might be fun or not so fun? But you have to have something to do or it's really boring. So I think that your brain dreams because it needs something to do while half of it is shutting down.

MOLLY BLOOM: Nice. I like that idea. Tessa, do you have any thoughts about why we might dream?

TESSA: I don't know, maybe your brain just maybe wants to give you a message or a warning about what happened in earlier on or something like that.

MOLLY BLOOM: Oh, I like that idea, too. You guys have some really good ideas.

[QUIRKY MUSIC]

Are you guys feeling alert and awake?

ANDREW: Totally.

TESSA: Yeah.

MOLLY BLOOM: Well, you're going to need your wits because here comes the mystery sound.

[MUSICAL TONES]

TESSA: Mystery sound.

MOLLY BLOOM: Here it is.

[RATTLING]

You'll hear it again because it's a really short one.

[RATTLING]

Any thoughts on what that might be?

TESSA: Maybe something falling into-- money falling into a glass jar.

MOLLY BLOOM: Excellent guess. Andrew, do you have a guess?

ANDREW: I think it might be like when you put the dishes in the sink, and you have a utensil and a bowl. The utensil will jump around if you put it in.

MOLLY BLOOM: Yeah. Those are both really, really good guesses. Well, we're going to be back with the answer a little later in the show.

[QUIRKY MUSIC]

ANDREW: Do you have a mystery sound you want to share with us?

TESSA: Maybe a drawing or a question?

MOLLY BLOOM: Yeah, like maybe you want to draw a picture of us on the dream coaster with Parakeet Pete, or maybe you want to draw a picture of jellyfish raining from the sky. That would be awesome. That would make me very happy. Well, you can send those all to us at brainson.org/contact or we also accept physical mail. You can find our mailing address at brainson.org.

And here's something else we want you to send to us at brainson.org/contact. We're working on an episode all about things that are the most-- the fastest, strongest, the oldest, stuff like that. If you were going to give a mosty award, what would you give it to? Maybe it's the funniest joke, the tastiest food, the most stylish color.

Truly, whatever category you can dream up, we'd like to hear your winner. I think I'd give the mosty award for the most comforting lunch to noodles and cottage cheese. You really can't beat it. Send your mosty awards idea to us at brainson.org/contact. That's where Jahan sent us this question.

JAHAN: I am Jahan. And my question is, how do octopuses make ink?

ANDREW: We'll answer that question during our moment of um at the end of the show.

MOLLY BLOOM: You can find lots more moment of ums by searching for moment of um wherever you listen to *Brains On*. The moment of um podcast has daily answers to your wonderful questions.

TESSA: And we'll read the most recent list of names to be added to the brain's honor roll.

[QUIRKY MUSIC]

MOLLY BLOOM: You are listening to *Brains On*. I'm Molly.

ANDREW: I'm Andrew.

TESSA: And I'm Tessa.

MOLLY BLOOM: And today, we're deep in dreamland. But before we get too much sleep, let's go back and listen to that mystery sound one more time.

[RATTLING]

Any new thoughts?

ANDREW: I still think it's a hard object hitting glass but not breaking it, bouncing inside of something.

MOLLY BLOOM: Really good.

TESSA: Yeah, me, too.

ANDREW: Or porcelain.

TESSA: Yeah, but I changed my mind about the coin because I feel like maybe something not too clinky that would-- so maybe something light, like a button or something like that.

MOLLY BLOOM: Very good guess. Here with the answer is producer Marc Sanchez.

MARC SANCHEZ: That was the sound of a key dropping out of my hand and onto an overturned plate. So you guys were really close. And that totally makes sense with this dreaming episode. So see you later, bye.

ANDREW: It's so random, though--

MOLLY BLOOM: I know.

ANDREW: --the key.

MOLLY BLOOM: But wait a second, Marc. That doesn't really make sense. I don't think we're just hanging around dropping keys on plates. I mean, I don't.

MARC SANCHEZ: Well, maybe you don't, but surrealist painter Salvador Dali did.

MOLLY BLOOM: OK, so he used to do that. But why did he do that?

MARC SANCHEZ: Well, first, you have to understand the word "realism." If you're a realist painter, you're trying to make exact drawings and paintings of the world around you. But a surrealist painter takes what we see in the world and changes them. For example, Dali's most famous painting is called *Persistence of Memory*. And it kind of looks like a desert scene with these big, giant, melting clocks scattered around, kind of like something you'd see in a dream.

MOLLY BLOOM: OK, so what about this key and plate?

MARC SANCHEZ: Right, the key and the plate. Dali would get all cozy in an armchair and get ready to take a nap. Then he would place a heavy key between his thumb and forefinger, and just when he started drifting off to sleep, that key would fall out of his hand and onto a plate he'd placed on the ground underneath him. The noise would wake him up, and he would immediately try to paint what was in his mind.

Researchers call this state hypnagogia. It's that state of mind where you're kind of half dreaming and just starting to let go of reality. Inventor Thomas Edison and physicist Albert Einstein were also known to take these hypnagogic micronaps, too. Einstein's most famous discovery, the theory of relativity, $E = mc^2$, that theory also has its beginnings in a dream.

When Einstein was a teenager, he dreamt about a herd of cows next to an electric fence. Typical dream. Then he sees a farmer turn on the electric fence, and the cows all jump back at the same time. The farmer in his dream, however, tells Einstein that he saw the cows jump back one at a time. And this gave Einstein the idea that people experience things differently depending on their perspective.

Einstein's theory of relativity has a similar point of view. Where you are in the universe, you can experience time differently. There's evidence of people using parts of their dreams as inspiration all over the place. Maybe you've heard of a little band called The Beatles.

[MUSIC - THE BEATLES, "LET IT BE"]

(SINGING) When I find myself in times of trouble, Mother Mary comes to me. Speaking words of wisdom, let it be.

Singer Paul McCartney said he was inspired to write the song *Let It Be* when he dreamed of his mother. She died when McCartney was a teenager. But he says she visited him in his dream to let him know that everything was going to be OK.

[MUSIC - THE BEATLES, "LET IT BE"]

(SINGING) Let it be. Let it be. Let it be. Let it be. Whisper words of wisdom, let it be.

And before you start to think that all these inspiring dreams happen way back in the past, take a listen to this.

[MUSIC - TAYLOR SWIFT, "ALL YOU HAD TO DO WAS STAY"]

(SINGING) People like you always want back the love they gave away.

The average under 20-something knows the cool sounds of Taylor Swift. Can I call her Tay-Tay?

[BUZZER]

No, I am being told I am too old to call her Tay-Tay. Well, listen to what Ms. Swift said in this *GQ* magazine interview about her song, *All You Had to Do Was Stay*.

[MUSIC - TAYLOR SWIFT, "ALL YOU HAD TO DO WAS STAY"]

(SINGING) All you had to do was stay.

TAYLOR SWIFT: I had a dream that my ex showed up at my door, knocked on the door, and I opened it up. And I was about ready to launch into the perfect thing to say. And instead, all that would come out of my mouth was that high-pitched chorus of people singing, stay. And I-- and then you're like-- and then you go to say something else, and it's just like, stay, stay, stay. And I woke up. I was like, oh, that was mortifying. But that's kind of a cool vocal part.

[MUSIC - TAYLOR SWIFT, "ALL YOU HAD TO DO WAS STAY"]

(SINGING) All you had to do was stay.

MARC SANCHEZ: Tessa, Andrew, and Molly, I planned to say a lot more to you. But for some reason, the only thing I can think to say is stay.

[BUZZER]

So I guess I'll leave.

[KIDS SHOUTING "BRAINS ON"]

MOLLY BLOOM: Tessa and Andrew, we asked you to do a little experiment for us before the taping. We wanted to see if you could control your dreams. So, Andrew, can you tell us what we asked you to do?

ANDREW: You guys asked us to repeat a line. I think it was, I will remember what my dream is. I will dream of blank. And see if we could remember our dreams. And we would repeat it 10 times.

TESSA: We were also supposed to see if we could control our dreams, to dream what we wanted to dream. And then you asked us to keep a paper beside our bed and write down what we remember about it.

MOLLY BLOOM: So what did you find? Were you able to control your dreams?

TESSA: I was not able to control my dreams.

ANDREW: I remember one dream. I dreamed of dogs or puppies. And I ended up dreaming of myself being the pet and the puppy being the owner. But it's relatable.

MOLLY BLOOM: Whoa.

TESSA: Opposite day.

[LAUGHTER]

MOLLY BLOOM: Awesome. And I have a question for you. Have either of you ever been dreaming but you actually know that you're dreaming while you're in it?

TESSA: No.

ANDREW: Not that I recall. I mean, I probably would have forgot it.

MOLLY BLOOM: When you're dreaming and actually know that you're dreaming, that's called lucid dreaming. So you're in a dream and you say, wait a minute, I'm dreaming. And then you stay in the dream. It's kind of like the best virtual reality simulator.

MARTIN DRESSLER: Typically, a lucid dream is really a very impressive experience. And therefore, you remember it quite well. And indeed, if you have a lucid dream, then you really realize that you do have one.

MOLLY BLOOM: That's neuroscientist Martin Dressler, and he studies dreams. Now, only about half of us have ever had a lucid dream. And for those who have had lucid dreams, it happens pretty rarely. But kids have lucid dreams much more commonly than adults do. And remember what Sanden said about the prefrontal cortex not being very active during dreams? That's not the case for lucid dreams.

MARTIN DRESSLER: During lucid dreaming, we find that these areas get reactivated again. So they show almost awake activity patterns. We see, indeed, that people who have a lot of lucid dreams show in these very same brain regions that they show more gray matter. So their brain-- brains are sort of bigger in these regions. There are also other associations, for example, mindfulness. So people who meditate a lot typically tend to have also more lucid dreams.

MOLLY BLOOM: Even if you've never had a lucid dream, you can train yourself to do this. And it's actually kind of easy.

MARTIN DRESSLER: There are a couple of tricks and strategies to do that. Most and foremost, just think more about your dreams. So during daytime, just think about the dream of the last night. And in particular, think about what was strange in that dream and think about these strange things. So if that really becomes a habit, that you think about your dreams, that you think about dream topics, and particular, think about strange things that are happening in dreams, then the chance is high that the next time when you are dreaming, and in particular when you are dreaming about strange things, that then you also start with that reflection and start thinking about your dream. And that, actually, is a lucid dream already.

MOLLY BLOOM: Keeping a dream journal like we had guys do also helps a lot and telling yourself before you go to sleep, I will realize I'm dreaming, often leads to lucid dreaming. It's amazing how powerful our minds are. So do you think it would be fun to be able to lucid dream?

ANDREW: Yeah.

TESSA: Yeah.

ANDREW: Because it would feel like you're actually in somewhere. But then it would be easy to snap out of it, I guess.

MOLLY BLOOM: Yeah, it sounds fun.

MARTIN DRESSLER: Most people who try to get lucid or train lucid dreaming just do it out of fun since it's really-- it's just an action movie where you are in control. But lucid dreaming, indeed, has some practical applications.

MOLLY BLOOM: Martin says lucid dreaming can be really powerful nightmare therapy. If you're having a nightmare, you can train yourself to realize it and change it into a good dream. It's also helped people with anxiety. And it can help you get better at the stuff you do in real life.

MARTIN DRESSLER: Lucid dreaming has been shown to increase motor learning. For example, if you train certain motor skills during lucid dreaming, typically on the next day, you are better in these skills. And there are surveys among professional athletes showing that, indeed, a couple of professional athletes use lucid dreaming for training during the night.

MOLLY BLOOM: So it can make you better at shooting baskets and also better at, say, writing.

MARTIN DRESSLER: There are some studies pointing towards an association between creativity and lucid dreaming. But in particular, lucid dreaming might help insofar as all the normal characteristics of dreaming that might be associated to creativity, in particular the hypersassociativity so that you associate very abnormal and unusual things with each other that is present in lucid dreaming. However, still, you have control and can reflect on that.

MOLLY BLOOM: So, Tessa and Andrew, do you think you're going to keep trying to control your dreams?

ANDREW: Maybe if I'm having a streak of nightmares because you can just snap out of the nightmare.

MOLLY BLOOM: Exactly.

TESSA: Yeah, I agree with Andrew.

[QUIRKY MUSIC]

People have four to six dreams a night, even if you can't remember them.

ANDREW: When you dream, your long-term memory storage is shut off, but other parts, like the secondary visual cortex and motor cortex, are super busy.

MOLLY BLOOM: And since your prefrontal cortex isn't very active, your brain takes all the random images, emotions, and storylines and just kind of goes with it.

TESSA: We're not really sure the purpose of dreams, but it likely helps us with a variety of things.

ANDREW: Thanks to your brain hyperassociating in your sleep, it can be a time of great creativity.

MOLLY BLOOM: And lucid dreaming can help you control the power of dreams to make your dreams and your waking life even better.

TESSA: That's it for this episode of *Brains On*.

ANDREW: *Brains On* is produced by Marc Sanchez, Sanden Totten, and Molly Bloom.

MOLLY BLOOM: We had production help today from Ned Lee Brookstriker and Taylor Freyney. We had engineering help from Veronica Rodriguez, Billy Heaton, and Corey Schreppel. Special thanks to Teresa Chung, Winston Young, Denzel Beeland, Eric Ringham, Christine Hutchins, Michael Olsen, and Curtis Gilbert.

TESSA: *Brains On* is a nonprofit public radio podcast.

ANDREW: Your donations keep the show going.

MOLLY BLOOM: To support the show and see our cool thank-you gifts, head to brainson.org/donate.

[QUIRKY MUSIC]

TESSA: Now, before we go, it's time for the moment of um.

- Um, um, um,
um.

JAHAN: How do octopuses make ink?

BECKY DUCHILD: Hey, my name is Becky Duchild. I am an aquarist, which is basically a zookeeper for fish, here at the Minnesota Zoo. Octopuses make ink through an organ they have inside of their mantle called the ink sac. And there are specific cells that attach to the ink sac and create the ink. The octopuses use the ink in situations where they think something's going to try to eat them. They're going to use the ink, squirt it out of the siphon tubes from their mantle, and kind of confuse predators in order for them to escape away from the situation.

The ink is made by the animal. There are cells that make it, and it's pumped into the ink sac. And then the ink sac empties into the intestine. Now, all of these organs are inside of the mantle, which is kind of like the big, bulbous part of the octopus. It's almost like a big bag. And everything empties out of either the top, which is right next to their head, or the siphon tube that kind of comes out underneath their heads.

The only reason that an octopus is going to ink is when it's in fear for its safety or even its life. Usually, that's in the form of a predator, something that's trying to eat it. They will squirt this ink out, and it basically distracts the predator. It kind of allows the octopus a chance to escape away from the predator.

[QUIRKY MUSIC]

- Um, um, um.

MOLLY BLOOM: The ink is dry on this list. It's time for the brain's honor roll. This is where we read the names of the listeners who have shared questions, ideas, mystery sounds, and drawings with us. They make this show what it is.

[LISTING HONOR ROLL]

(SINGING) *Brains On.*

We'll be back soon with more answers to your questions.

ALL: Thanks for listening.