

## Brains On (APM) | Brains On! Why is it so hard to break a habit? 01EV9VG76CA39HAT4KS4F3RQ0V

MOLLY BLOOM: Hello, friends. Happy New Year. We're so happy to be back in your ears with a new episode. But before we jump in, we wanted to let you know about a cool thing coming up next month. We're going to be sending some super awesome *BrainsOn* temporary tattoos in the mail to our fan club members in February.

If you want to get the mailing, make sure you sign up for the fan club by January 31. It's totally free to join. It's just our way of saying thanks for being a fan. You can sign up at [brainson.org/fanclub](http://brainson.org/fanclub). And if you're already a part of the fan club and want to make sure you get the mailing, you can go to the same site, [brainson.org/fanclub](http://brainson.org/fanclub) and make sure that we have your mailing address. Or if you've moved or you can't remember if you've given us your mailing address before, just head to that same website, [brainson.org/fanclub](http://brainson.org/fanclub) and fill out the form. Then keep an eye out for that mailing in February. Temporary tattoos coming to your mailbox. OK, now, onto the show.

**CHILD:** You're listening to *Brains On*, where we're serious about being curious.

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

[GROANING]

**MIRIAM:** Hey, Gungador! What are you doing?

**GUNGADOR:** Trying to put finger in my nose. Finger won't fit.

**MOLLY BLOOM:** You're trying to pick your nose?

**GUNGADOR:** Fingers in nose has name?

[BEEPS]

Picking?

**MIRIAM:** Yeah.

**GUNGADOR:** Well, then yeah, trying to pick nose. Want to stop twirling fur on my chin.

[BEEPING]

**MOLLY BLOOM:** You do tend to do that when you're thinking. I always thought it made you look smart.

**GUNGADOR:** Thanks, Molly. Problem is anything on my hand becomes on my chin, cookie dough, tie dye, grass clippings.

**MIRIAM:** That does seem like a good habit to break.

**GUNGADOR:** Have tried so many things. Tried chili oil on chin so fingers would slide off, but that just made fingers taste spicy. Gungador likes spicy. Didn't work.

[BEEPING]

Wore wool ski mask, itchy. Had to pull chin hairs out of mouth hole, still twirl fur.

[BEEPING]

Do special sign. Made little helper face say no twirling fur. Still twirled fur.

[BEEPING]

**MIRIAM:** So now, you're trying to find something to do instead?

**GUNGADOR:** Right, and picking nose is better than twirling fur, right?

**MOLLY BLOOM:** Well, putting your fingers in your nose can bring germs into your body.

**MIRIAM:** You should probably try something else.

**GUNGADOR:** Really? Kind of a relief. My fingers way too big to go into nose anyway.

**MOLLY BLOOM:** Yeah, wow, you really couldn't pick your nose even if you wanted to.

**GUNGADOR:** OK, don't rub it in. Gungador doesn't even want to pick nose.

[MUSIC PLAYING]

**MOLLY BLOOM:** This is *Brains On* from American Public Media. I'm Molly Bloom, and I'm here today with Miriam from Austin, Texas. Hi, Miriam.

**MIRIAM:** Hi.

**MOLLY BLOOM:** Today, we're talking about habits, and Miriam, you sent us a great question all about habits.

**MIRIAM:** Why is it so hard to break a habit?

**MOLLY BLOOM:** Yeah, some habits are so hard to kick. So Miriam, I want to know. Did you have a specific habit in mind when you asked about this?

**MIRIAM:** Yes, I bite my nails and crack my knuckles.

**MOLLY BLOOM:** So when you're biting your nails, do you think about it at all or is it just something that kind of automatically happens?

**MIRIAM:** Sometimes, I think about it. Sometimes, I don't.

**MOLLY BLOOM:** So when you do think about it, what goes through your mind?

**MIRIAM:** Mostly, which nail I'm going to bite next.

[LAUGHS]

**MOLLY BLOOM:** How do you decide?

**MIRIAM:** I look at the ones that are the longest.

**MOLLY BLOOM:** Mm, and so is this something you do every day?

**MIRIAM:** Yes.

**MOLLY BLOOM:** Have you tried to break either of those habits before?

**MIRIAM:** I've tried to stop biting my nails, and it's really hard to stop cracking my knuckles though.

**MOLLY BLOOM:** So what have you tried to do to stop the nail biting?

**MIRIAM:** I've tried the icky nail polish that you can get at the stores.

**MOLLY BLOOM:** Did it work?

**MIRIAM:** Not really.

**MOLLY BLOOM:** Hmm, is it really gross, or is it really not that bad?

**MIRIAM:** Yes.

**MOLLY BLOOM:** It is gross?

**MIRIAM:** It's really gross.

**MOLLY BLOOM:** But you bit your nails anyway because you love biting your nails so much?

**MIRIAM:** Yeah.

**MOLLY BLOOM:** Gotcha. So have you noticed any habits that your family or friends have?

**MIRIAM:** Yeah, my brother bites his nails, and my other brother sucks his thumb.

**MOLLY BLOOM:** Are they trying to stop doing those?

**MIRIAM:** Yes. My mom says she bit her nails, too.

**MOLLY BLOOM:** Mm, it runs in the family.

**MIRIAM:** Mhm.

**MOLLY BLOOM:** How did she stop?

**MIRIAM:** She started using nail clippers and files to keep them short instead.

**MOLLY BLOOM:** Hmm, that might be something worth trying. If it worked for your mom, maybe it'll work for you.

[MUSIC PLAYING]

There are all kinds of habits like tapping your pencil on a desk, fidgeting, playing with your hair. All of these habits are behaviors, so things that you do. But you probably don't have to think much about them.

**MIRIAM:** You might do your habits without even realizing it.

**MOLLY BLOOM:** Some habits are good like brushing your teeth in the morning.

**MIRIAM:** Or looking both ways before crossing the street.

**MOLLY BLOOM:** But today, we're going to focus on bad habits and how to stop them.

**MIRIAM:** To start, we need to understand why habits form in the first place.

**MOLLY BLOOM:** Producer Menaka Wilhelm is here to help us with that.

**MENAKA** Hey, Miriam. Hey, Molly. Habits can be stickier than superglue on a kangaroo or superglue on anything really.

**WILHELM:** Like you might get so used to turning off the lights when you leave a room that sometimes, you turn the lights off even when someone else is still using them.

**MAN:** Hey, I'm reading here.

**MENAKA** Oops, sorry. Anyway, doing a habit without realizing it is one sign that a habit is pretty stuck because it's really

**WILHELM:** tough to stop doing something if you're doing that thing almost automatically without even thinking about it. But actually, doing something while you think about something else entirely is really helpful.

**KENNY AMAYA:** It frees up your mind to be able to do other things.

**MENAKA** That's Kenny Amaya. He studies brains and habits at Dartmouth College, and he told me that the stuff we do

**WILHELM:** without thinking about it like our habits has helped us survive. If our ancestors had to stop and think about every single move they made, they wouldn't have lasted long.

[MUSIC PLAYING]

**KENNY AMAYA:** So if you could imagine back a long time ago, someone running from a saber tooth tiger. They, for some reason, had like an itch on their face.

**PERSON FROM** Ah, face itch!

**PAST:**

**KENNY AMAYA:** But then they couldn't do two things at once because they couldn't automatically do it, and they had to stop running and itch their face.

[SCRATCHES]

**PERSON FROM** Ah, that felt great!

**PAST:**

**KENNY AMAYA:** Then they get eaten by the saber tooth tiger. Whoops.

[GROWLS]

**PERSON FROM** Oh, yeah.

**PAST:**

[GROWLS]

Still worth it though!

[CHOMP]

**MENAKA** Yikes! To avoid that our brain makes some actions like scratching automatic. You don't have to stop and think

**WILHELM:** about it. You just do it because doing multiple things at once is so incredibly useful. Still, habits take time to sink in, especially the ones that get super stuck.

**KENNY AMAYA:** In order to get a habit, you have to do something a lot.

**MENAKA** And chances are if you do something enough to form a habit, the action that you're doing is rewarding. You get  
**WILHELM:** something out of it. Lots of habits are kind of about grooming yourself like picking at scabs or running your fingers through your hair or biting your nails. And you might not think about it this way, but things like this can be kind of calming. Do you think biting your nails is sort of calming for you at all, Miriam?

**MIRIAM:** Sometimes it is. But mostly, I do it when I'm bored.

**MENAKA** Ah, so it's more of a boredom busting habit. So in your case, the reward might just be feeling a little bit less  
**WILHELM:** bored. That's still a good reward. So you'll keep doing it, and your brain will set you up to do that habit all the time so that it becomes automatic. That way, you get that reward of feeling less bored or more calm without even thinking about doing the action. Kenny said there's three parts of the brain that are super involved in this kind of habit making. So we need a little brain parts roll call. First up, the prefrontal cortex.

**PREFRONTAL** Here. Not to brag, but I'm a brainy type. I keep tabs on your surroundings and help your brain decide stuff.  
**CORTEX:**

**KENNY AMAYA:** Next, the striatum.

**STRIATUM:** Here, and Prefrontal Cortex, all of us are brainy types. I, the striatum, turn decisions and observation into actions, which is also brainy, duh.

**MENAKA** Last, the motor cortex.  
**WILHELM:**

**MOTOR** Here and brainy as well. I make your body move.  
**CORTEX:**

**MENAKA** Great, so these are three brain areas that really matter for habits.  
**WILHELM:**

**KENNY AMAYA:** And these brain areas are constantly talking with one another.

**MENAKA** They talk to each other with brain chemicals. One's called dopamine. There's another scientists call GABA, which  
**WILHELM:** is short for gamma aminobutyric acid. So let's walk through picking up a habit like clicking a pen. If you're sitting at your desk and trying to pay attention, but you realize you've got a clicky pen, your prefrontal cortex might say something like this--

[MUSIC PLAYING]

**PREFRONTAL** Ooh, a clicky pen. Hmm, should we click it? I think yes. Striatum?  
**CORTEX:**

**STRIATUM:** Definitely. Let's tell the fingers to click that pen. I'll get that to the motor cortex.

**MOTOR** On it!  
**CORTEX:**

[CLICKS]

**PREFRONTAL CORTEX:** Oh, wow, that click was exciting. It made a noise. It was satisfying. Wow! That was awesome! Do that again.

[CLICKS]

**MENAKA WILHELM:** So at this point, pen clicking is a fun activity not a true habit. If you pick up a pen, you're still thinking about whether or not to click the pen. It's not super wired in, and you could probably stop without trying too hard. But you do get a reward from the clicky sound. Maybe, it wakes you up a little or you just like the springy feeling of clicking, so you'll probably click a lot of the pens you pick up.

**PREFRONTAL CORTEX:** Can I get a pen click?

**STRIATUM:** Definitely.

**MOTOR CORTEX:** Clicks away!

[CLICKS]

**MENAKA WILHELM:** And each time you hear that satisfying click, your brain bits will get faster and better at doing that action whenever you see a pen. After enough of that, the conversation between your brain bits starts to sound more like this.

[MUSIC PLAYING]

**PREFRONTAL CORTEX:** A clicky pen! I, the Prefrontal Cortex, will decide--

**STRIATUM:** Oh no, Striatum here. And me and the Motor Cortex, we got this. You can do other stuff.

**MOTOR CORTEX:** Yep, clicking handled.

[CLICKS]

**PREFRONTAL CORTEX:** Wait. You guys don't need me to decide about clicking the pen?

**STRIATUM:** No way. We're all set.

**PREFRONTAL CORTEX:** You know what? That's great. I've been meaning to decide if I should have a quesadilla or tacos for lunch. I'll think about that instead.

**STRIATUM:** Have a great time.

[CLICKS]

**MENAKA WILHELM:** So over time, picking up a pen and immediately clicking it becomes a shortcut in your brain. And that shortcut frees up your brain to think about other things.

**KENNY AMAYA:** Habits are stuck in your brain because your brain is actually designed to have them stuck in your brain.

**MENAKA**  
**WILHELM:** But like we've mentioned, not all habits are good and not all stuck habits need to stay that way because here's something sneaky about habits. Eventually, the reward for a habit might fade away. If it's pen clicking, you might not even notice the click anymore. But your brain can still hang on to the habit, even after the reward goes away. In your case, Miriam, you said you bite your nails when you're bored. Do you feel like biting your nails actually makes you feel less bored?

**MIRIAM:** No, I think it's really just impulsive.

**MENAKA**  
**WILHELM:** That's the tricky part. Habits can just become something you do just because you do them. But luckily, we can break habits, and we've got tips about that coming up.

**MIRIAM:** Thanks, Menaka.

**MENAKA**  
**WILHELM:** Oh, of course.

**MEN:** (SINGING) Ba ba ba ba ba ba ba ba ba ba ba brains on.

**MOLLY BLOOM:** Miriam, are you ready for a sound that'll definitely be rewarding?

**MIRIAM:** Kind of.

**MOLLY BLOOM:** OK. Well, it's time for the--

[MUSIC PLAYING]

**CHILD:** (WHISPERS) Mystery sound.

**MOLLY BLOOM:** Here it is.

[MYSTERY SOUND]

OK, Miriam, what did you hear there? What are your thoughts?

**MIRIAM:** It sounded kind of like the footsteps of an animal? Like maybe on dry leaves?

**MOLLY BLOOM:** I love that guess.

**MIRIAM:** Or shallow water or something.

**MOLLY BLOOM:** Very good ears. We're going to hear it again and give you another chance to guess a little bit later in the show.

[MUSIC PLAYING]

**MIRIAM:** *Brains On* is making an episode all about bananas.

**MOLLY BLOOM:** And you know what we're putting in that episode? Banana jokes from listeners, jokes like this. Hey, Miriam, what's a sheep's favorite fruit?

**MIRIAM:** I don't know. What is a sheep's favorite fruit, Molly?

**MOLLY BLOOM:** It's a baa-nana. Get it? Yeah, OK. Well, Miriam, what's your favorite banana joke?

**MIRIAM:** Knock, knock.

**MOLLY BLOOM:** Who's there?

**MIRIAM:** Banana.

**MOLLY BLOOM:** Banana who?

**MIRIAM:** Knock, knock.

**MOLLY BLOOM:** Who's there?

**MIRIAM:** Banana.

**MOLLY BLOOM:** Banana who?

**MIRIAM:** Knock, knock.

**MOLLY BLOOM:** Who's there?

**MIRIAM:** Banana.

**MOLLY BLOOM:** (LAUGHING) Banana who?

**MIRIAM:** Knock, knock.

**MOLLY BLOOM:** Who's there?

**MIRIAM:** Orange.

**MOLLY BLOOM:** Orange who?

**MIRIAM:** Orange you glad I didn't say banana?

**MOLLY BLOOM:** Yes, yes, I am. That's a good one. I bet *Brains On* listeners have a bunch of great banana jokes to share. We want all kinds, knock knock jokes, zingers, puns.

**MIRIAM:** Send them in at [brainson.org/contact](http://brainson.org/contact).

**MOLLY BLOOM:** And you might hear your joke on the show.

**MIRIAM:** That's where this question came from.

**OLEC:** Hi, my name is Olec. My question is, how do 3D glasses work?

**MOLLY BLOOM:** The answer to that is coming up in our Moment of Um at the end of the show. We'll also read the latest group of listeners to join the Brains Honor Roll.

**MIRIAM:** So keep listening.

[MUSIC PLAYING]



**MOLLY BLOOM:** You're listening to *Brains On* from American Public Media. I'm Molly.

**MIRIAM:** And I'm Miriam.

**GUNGADOR:** Yeah. Hi. I Gungador.

**MOLLY BLOOM:** Nice to see you again, Gungador.

**GUNGADOR:** Normally, you too, Molly. Not today. Gunga here with new habit problem.

**MIRIAM:** Another habit you want to break?

**GUNGADOR:** No, habit I liked, drinking plenty of water!

[BEEPING]

**MOLLY BLOOM:** Oh, that is a good habit.

**GUNGADOR:** Yeah. Gungador drink 1, 2, 3. Ugh, well, more than one water glass for 13 days straight! Then forgot. Broke habit. Not fair.

**MOLLY BLOOM:** Well, take it easy on yourself, Gungador. Habits are different for each of us, and some habits stick with us more than others.

**GUNGADOR:** Thanks, Molly. Today, Gungador woke up depleted and dehydrated. So Gungador ready to jump back in game like Gungador jump into burning lava to defeat laser fang!

[BEEPING]

See? Here's Gungador's 11 water glasses.

[SLURPING]

**MOLLY BLOOM:** Oh, good for you. But hey, I have an idea that might make it easier. Instead of carrying 11 water glasses around at once, maybe you could have one glass that you refill?

**GUNGADOR:** Why no Gungador think of that? Maybe get one of those backpacks with water straw! Then Gungador can do dropkicks and drink water at same time!

[MUSIC PLAYING]

**MOLLY BLOOM:** Yeah, that would totally help.

**MIRIAM:** A habit will stick more the more times you do it, whether it's good or bad.

**MOLLY BLOOM:** But it also depends on you and how rewarding the action of the habit is for you, how much you like that habit.

**GUNGADOR:** Still learning to like taste of plain water, but new water backpack will make Gungador supreme master water drinker!

[BEEPS]

OK, got to go. So much water! Gungador have to pee.

**CHILDREN:** Brains on!

**MOLLY BLOOM:** So Miriam, are there any good habits that you're proud that you've formed?

**MIRIAM:** I'm really good about getting my homework done in school.

**MOLLY BLOOM:** That's really great. That's super important. How did you become so consistent about doing your homework all the time?

**MIRIAM:** Well, if you focus on one problem at a time and not how many you have to do, then you can get it done faster because you're not rushing.

**MOLLY BLOOM:** Mm, so staying in the moment, focusing on that one task is more helpful than thinking like, oh, I have this huge pile of homework to do.

**MIRIAM:** Yeah.

**MOLLY BLOOM:** That's a really good advice, I think, for grownups, too.

[ROBOT SOUNDS]

**ROBOT:** Brains, brains, brains on.

**MOLLY BLOOM:** Let's get back to those pesky, bad habits. Our pal Ava Kian is here with some bad habit busting tips. She used to bite her nails, too.

**AVA KIAN:** That's right. I bit my nails a lot when I was younger. High five, Miriam. I grew out of it though. What are yours looking like right now?

**MIRIAM:** Well, they're really short. They're getting really hard to bite even.

**AVA KIAN:** Well, nail biting can feel satisfying and harmless sometimes, but it's kind of a bad habit. We've got so many germs on our fingers, and sometimes, we'll bite too much and our nails end up hurting.

**MIRIAM:** I hear what you're saying. But I can't stop it. My nails are just there, and it always happens.

**AVA KIAN:** What if I told you, you could change it?

[MUSIC PLAYING]

**MIRIAM:** I'm listening.

[MUSIC PLAYING]

**AVA KIAN:** If you think about it, tons of stuff we do every day are habits like how we wash our hands after using the bathroom or fall asleep at the same time every night. And just like we form some habits, we can also change them.

**MIRIAM:** You're saying I could stop biting my nails?

**AVA KIAN:** Exactamundo. Brace yourself though, it's not exactly easy to do as you might know. These good and bad habits work the same way, and there's really only one difference between the two.

[MUSIC PLAYING]

**WENDY WOOD:** In one case, good habits, they're consistent with our goals. In the other case, bad habits, they're inconsistent. They challenge our goals.

**AVA KIAN:** That's Wendy Wood, a social psychologist at University of Southern California. She's the author of the book *Good Habits, Bad Habits*. Wendy spent the last 30 years doing research on habits, trying to understand what they are and why they're so difficult to break.

**WENDY WOOD:** Probably the best way to break a habit is to change the context.

**AVA KIAN:** Context means things like where you are, who you're with, what time of day it is, what you're feeling, stuff like that. That's all context. Changing the context means changing those things. So Miriam, when do you catch yourself biting your nails?

**MIRIAM:** A lot of the time it's during class when I'm bored or even sometimes, when I'm falling asleep or in the car.

**AVA KIAN:** So in your case, your context is when you're bored and don't have other stuff to do. That's what triggers you to bite your nails.

**MOLLY BLOOM:** So if Miriam changes those things, will she be able to break the habit?

**AVA KIAN:** Well, kind of, if you could find a way to change that context, maybe by having other things to distract you with like noticing things around you in the car like colors or smells or even bringing a book or game to play wherever you go. So that'll make you less bored, but it's also important to stop and think about your habit, too. That might make it so every time you're about to automatically bite your nails, you'd stop and think first.

[MUSIC PLAYING]

Remember the three habit making parts of the brain? The prefrontal cortex, the striatum, and the motor cortex? Well, when you have to stop and think, it's like you're inviting the prefrontal back into the mix.

**PREFRONTAL CORTEX:** Remember me? The Striatum and Motor Cortex asked me to butt out when we were clicking pens? They didn't need me as much anymore because clicking became a habit. But now, with some new context, my skills are needed in the squad again.

**STRIATUM:** Welcome back, buddy.

**MOTOR CORTEX:** I missed you, smarty.

**AVA KIAN:** And with your prefrontal cortex doing the thinking again, you can catch yourself and focus on the things around you. But it won't be easy. Bad habits stick around because our habit memory is sometimes stronger than our thoughts about how bad that habit is. So we can know we want to quit and still have trouble doing it. So if you're still having a hard time, there's one more trick that scientists have discovered.

**PEOPLE:** Ooh.

**AVA KIAN:** You might want to try this special thing called creating friction.

[DING]

Friction here means that you purposely make it harder to do your habit.

**WENDY WOOD:** When people want to quit using their cell phones so much, one way to do that is to actually put the phone away, so maybe in your backpack or in your purse, in a pocket that's not easy to get to. So it adds some friction, some effort, some time before you access the phone.

**AVA KIAN:** Friction is really helpful in breaking habits. To stop biting your fingernails, you could put on mittens or even sit on your hands. Have you tried anything like that in the past?

**MIRIAM:** No, not really.

**AVA KIAN:** When I was having trouble with biting my nails, I would sit on my hands, and it really helped

[MUSIC PLAYING]

In the end, your goal is to stop triggering that bad habit and make it more difficult to do. Following Wendy's advice, you can experiment with changing the things around you and make it harder to do that habit. So maybe treat yourself to some new gloves.

[MUSIC PLAYING]

**MIRIAM:** Thanks, Ava.

**AVA KIAN:** You're welcome. See ya.

**OPERA SINGER:** (SINGING) Brains on!

[CLEARS THROAT]

**MOLLY BLOOM:** All right, Miriam, are you ready to get back to that mystery sound?

**MIRIAM:** Yeah.

**MOLLY BLOOM:** All right, here it is again.

[MYSTERY SOUND]

What are your new thoughts? Last time you heard like leaves and animals.

**MIRIAM:** Maybe somebody scraping a whisk on the edge of a bowl while they're mixing?

**MOLLY BLOOM:** Ooh, excellent guess. Yeah, that kind of rhythmic whisking sound.

**MIRIAM:** Yeah, it also sounded a little like a keyboard.

**MOLLY BLOOM:** Hmm. This is a very versatile sound. Are you ready for the answer?

**MIRIAM:** Yeah.

**MOLLY BLOOM:** Here it is.

**CALISTA:** My name is Calista.

**HOLDEN:** And my name's Holden. We're from Pasadena, California.

**CALISTA:** That was the sound of our three bunnies chomping on lettuce. That sound makes us feel happy because our bunnies are having a yummy meal.

**MOLLY BLOOM:** Oh, cute little bunnies eating their dinner. Do you have any pets?

**MIRIAM:** Yes.

**MOLLY BLOOM:** What kind of pets do you have?

**MIRIAM:** We have a cat, a dog, and a lizard.

**MOLLY BLOOM:** What's the lizard's name?

**MIRIAM:** George.

**MOLLY BLOOM:** George, the lizard. Does he ever eat lettuce like the bunnies?

**MIRIAM:** Yes.

**MOLLY BLOOM:** Ah, I wonder if they ever meet in the produce aisle of the grocery store.

[MUSIC PLAYING]

**MIRIAM:** When an action is rewarding and you do it over and over, it can become a habit.

**MOLLY BLOOM:** You might do habits without even realizing it. They're almost like automatic actions.

**MIRIAM:** So thinking about your habit is the first step to kicking it.

**MOLLY BLOOM:** If you can change your environment a little or make your habit a little harder to do, you'll have more luck avoiding it.

**MIRIAM:** Breaking bad habits is possible.

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

**MIRIAM:** It was produced by Marc Sanchez, Menaka Wilhelm, Sanden Totten, and Molly Bloom.

**MOLLY BLOOM:** We had production help from Ava Kian and Christina Lopez, engineering help from Johnny Vince Evans and editing from Phyllis Fletcher. Special thanks to Christy Wilkins, Emily Dugdale, David [? Ja, ?] Emily Guerin, and John Miller.

**MIRIAM:** Now, before we go, it's time for our Moment of Um.

[SAYING UM]

**OLEC:** How do 3D glasses work?

[MUSIC PLAYING]

**PUPA GILBERT:** Hi, I'm Pupa Gilbert. I'm a Professor of physics at the University of Wisconsin-Madison. The first thing to know about 3D glasses is that they have one red lens and one cyan lens. Cyan is a color that is also called turquoise or if you look at a cell phone screen or a computer monitor, it's usually generated by the mixture of blue and green.

Red and cyan are two complementary colors. They're as different from each other as two colors could ever be. Other couples of complementary colors are yellow and blue or magenta and green. But in this case, we use the most common, which are cyan and red. Why are they used and why do they generate a 3D image?

Because two separate images have been acquired beforehand with two cameras, one with the red filter and one with the cyan filter, from two different angles, just like the two eyes on my face look at an object, let's say, a cube from two slightly different angles, because they are at two slightly different positions, they have slightly different images of the same cube.

Now, imagine one of my eyes or one camera is taking this image in red and one of them is taking it in cyan. Then these two images, red and cyan, are actually combined with the computer. And then when you wear glasses and look at this computer combined image, you reconstruct the 3D image in your brain as if you were seeing it in three dimensions.

[MUSIC PLAYING]

[SAYING UM]

**MOLLY BLOOM:** This list occupies every dimension of my heart. It's the Brains Honor Roll. These are the amazing listeners who send us their questions, ideas, mystery sounds, drawings, and high fives.

[LISTING HONOR ROLL]

**ROBOT:** (SINGING) Brains Honor Roll.

**MOLLY BLOOM:** *Brains On* will be back soon with more answers to your questions.

**MIRIAM:** Thanks for listening.