

# POWER OF PREVENTION SEASON 2, EPISODE 3

## Making Sense of the Science: How Cannabis Use Impacts the Adolescent Brain

### **Christin D'Ovidio:**

Welcome to the Power of Prevention podcast. In each podcast, we will go deeper into the topic of prevention in New Hampshire. We'll share our best interviews with you of people who are working tirelessly for their professions, their families, and their communities to stop something unwanted from happening. In this case, substance misuse. This is a podcast for people who are looking for solutions and want to make New Hampshire a better place where we all have the opportunity to live, learn, and thrive. We are hoping to make your lives a little better with these inspirational stories about substance misuse prevention.

Today we sit down with Kristin Gilliland to discuss the crucial information caregivers need regarding the impact of cannabis use on the developing adolescent brain. It is not as harmless as some marketers would like us to think. We want to preface this conversation that we're going to touch on deeply sensitive subjects. One of them is losing a child to overdose, so please take care of yourself and skip this interview if that's necessary. Kristin Gilliland was focused on building her career and raising her twin sons and living in southern California with the California lifestyle when one of her sons began to increase his daily use of cannabis. The cannabis that was available to him was not the type of cannabis that many parents might be familiar with or young people might be familiar with, but rather it was this modified version and it's really designed to give a higher dose of THC with greater risk of dependency.

Over time, the frequent use of this high potency drug altered her young son's mood and mental health. Eventually, it resulted in the development of a permanent mood and substance use disorder. Despite professional treatment, his substance use disorder worsens and it led to a tragic, accidental and fatal overdose on opioids. As a mother and a scientist, Dr. Gilliland is going to talk with us today, and she's going to help us understand the rare but real, physical and psychiatric consequences of cannabis use really during this critical developmental phase. She is driven to share this honest and unbiased information to keep this generation of young people healthy and safe while their prefrontal cortex and executive functioning skills really get to fully develop. Dr. Gilliland is going to share with us the science and her lived experience to help us gain knowledge and compassion and some insight and some hope. I'd really like to say thank you so much and welcome. We are so excited to jump into our interview today.

### **Kristin Gilliland:**

Thank you so much for having me. I'm very honored to be here.

### **Christin D'Ovidio:**

I really would like to first acknowledge what fuels your passion to educate other people in this topic, which is the loss of your son and express how sorry we are that you've experienced this loss, but thank you again for coming today to talk to us about this.

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**Kristen Gilliland:**

Thank You.

**Christin D'Ovidio:**

Really, you talking about it's helping others because people sometimes are just facing this alone and they don't have the knowledge and guidance to move through it. Maybe let's start with a personal note at the beginning as a human and a mom, which you are, who's experienced this loss, how did you come to make sense of this and how did it change where you were and where you went with your goals?

**Kristen Gilliland:**

When I lost my son, it was the start of a new life for me. There was my life before and then after his death, and I knew that when I found out that my son had passed away from an accidental overdose, that I knew I had to do something because my son had suffered from anxiety and he had used cannabis in the beginning to try to relieve that anxiety. This is very common amongst a lot of adolescents. He slowly became dependent on the cannabis that he was using. At the time, I will say honestly, I didn't know the difference in potency. I didn't know how much it had changed over the decades, and of course as a parent, I did everything I could to tell him, "Do not use. This is not good for you." I could see where it was going.

He started to develop symptoms of schizophrenia where he was hearing voices and he was seeing things that weren't there when he was 17 years old. As much as going through therapy and then taking him to psychiatrists, he did not want to take the medication that at that time was prescribed for him and in particular the anti-psychotics because he was a very creative and talented, intelligent child and wanted to, he made music. He was very artistic, but when he took the anti-psychotics that were prescribed for him through the psychiatrist, he actually did not want to do those things anymore. The psychiatrist had mentioned that there is this correlation we're starting to see now where young people who have been exposed to cannabis have started to develop psychosis, and I just want to let you know that it has been in the scientific literature and this is where I started to really look at it.

My son, slowly, because he did not want to take the anti-psychotics, began to use other substances to try and escape the voices and delusions he was dealing with. He started using stimulants, cocaine and heroin, and he died from an accidental overdose. After he passed away, I knew it would take me a couple years. I mean, obviously it took me some time to just get up out of bed in the morning. My whole life had changed, but I knew that I had to do something and I always get emotional, but I had to do something to honor him because there are so many kids these days that think that cannabis is safe because of it becoming legalized everywhere. I thought I need to let parents know, I need to let kids know.

At the Warren Center for Neuroscience Drug Discovery where I work as part of Vanderbilt University, I started an outreach program that is used to educate children about their developing brain, about neuroplasticity, the ability to reorganize the connections in their brain. They have it so much greater than we do as adults during adolescence, and to teach them about just the impact of cannabis on the developing brain and to tell my son's story and so they can learn from it and hopefully, make an educated decision on avoiding cannabis during adolescence.

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### **Christin D'Ovidio:**

Kristin, thanks for sharing your very personal story. I'd like to ask if you could now delve into some of the science, which is really so important. As a researcher and a professor who teaches the neuroscience of substance use, could you start by explaining to our audience how cannabis use impacts the brains of adolescents? What changes occur with this repeated exposure to the cannabis?

### **Kristen Gilliland:**

I would love to talk about the endocannabinoid system, which involves where the compounds in cannabis interact, and in particular, I'm going to talk about the endocannabinoid system within the brain because this is something that a lot of people don't know about. They've heard about the psychosis, they've heard about addiction or substance use disorder or cannabis use disorder, but I think backing up a little bit and teaching people about the endocannabinoid system that, again, where the compounds in cannabis bind and interact within the brain is very important, and to realize what that system is responsible for. When we look at the endocannabinoid system, what it does is that it keeps the brain in check. In the brain, we'll have kind of an inhibitory system and we'll have an excitatory system. This happens all throughout the brain in different regions in the brain, inhibitory, excitatory.

What the endocannabinoid system does is it tries to keep those in check. For instance, if the brain has a gas pedal on in a certain region, it says, "Okay, wait, wait, wait. We need to slow that down a little bit. Let's put the brakes on," or the reverse. If the braking system is braking too much in a particular region of the brain, it says, "Okay, we need to let off the brake a little and let's turn up some gas." The endocannabinoid system is responsible for that. For that balance of braking and putting the gas pedal on in the brain, trying to keep it balanced all the time, the brain loves to be balanced or what we called being homeostasis. With the endocannabinoid system, we also need to now kind of put the microscope under it and look at what makes up that system.

To do that, I'm going to kind of go into a basic neurobiology and talk about a neuron. A neuron is a specialized cell that communicates messages to other neurons through chemical and electrical activity. If we were to look at a neuron talking to another neuron, there's a tiny space in between the two neurons, and we say the one neuron that's sending that message is that, we'll call it the sending neuron. The one receiving it is a receiving neuron. There's a tiny space called the synapse, and that is where the message is sent. Now, these messages come in the form of what are called neurotransmitters, so chemical messenger is called neurotransmitters, which a lot of people, if you say dopamine, you say serotonin. They've heard of this, neurotransmitters. When the sending cell is told we need to send this message, it spits out, we can kind of think about like a pitcher throwing baseballs out into the synapse.

Those baseballs are the chemical messengers that are stored in these vesicles are released into the synapse. The receiving cell has baseball gloves or catchers' mitts, and it catches those neurotransmitters and is told what to do. All right, so if we looked at it an excitatory system, it's saying, "Okay, we need to put on the gas pedal," so that neuron is sending these excitatory signals and basically, throwing all those balls out into the synapse. All the catcher glove are catching them and saying, "Okay, let's keep it going. Let's keep it going."

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Now, the endocannabinoid system, the actual balls are called endocannabinoids. They are made on demand, so they are synthesized on demand when they're needed, and their endocannabinoids are called, I'm going to call them AEA and IIAG because they stand for anandamide and arachidinoic glycerol, so we're going to call them AEA and IIAG.

Okay, these are the neurotransmitters or the chemical messengers. If that excitatory signal's being sent and all of a sudden it says, "Whoa, we need to slow this down," the endocannabinoids, like let's say AEA is made on demand, but not from synaptic vesicles that are holding it and shooting it out into the synapse. It's actually made from the receiving cell. It's made on demand when all of a sudden it says, "Okay, yeah, we need to stop this excitation. We need to let off the gas pedal." It's made on demand, and then it goes up to the sending cell and says, "Okay, turn off the excitatory signal. Let's turn it off right now. We don't need this to go any longer." Same thing holds true with an inhibitory system. It's made those endocannabinoids AEA or IIAG made on demand, basically go to the sending cell and say, "Okay, turn off the inhibitory signal. Now we need less braking, we need more gas."

The big point I want to make here is that they are made on demand. All right, so when the brain is trying to become balanced, they're made on demand. When we look at THC, the psychoactive ingredient in marijuana, that gives the high feeling, people who ingest that, and I mean anyway from vaping, from smoking it, from eating it through gummies, anything like that or rubbing it onto the skin, it gets into the brain very quickly. Especially when we have this higher potency THC, it floods the brain. We can think about it flooding the brain. Now, as far as those catcher mitts that we talked about, they're called cannabinoid receptors. The cannabinoid receptors are CB-I and CB-II, CB-I is the main one in the brain that we can think it's the most abundant in the brain. CB-II is mainly in other areas of the body.

THC, when it pulls in, and so let's talk about that endocannabinoid AEA versus THC. Imagine being at a busy mall during the holiday season. There's one parking spot left. THC versus AEA are facing off for that parking spot. THC wins every single time, and not only does it win, so it takes that parking spot, which is now that CB-I receptor, it parks in there, and when it does that, it tells that signal, whether it's excitatory or inhibitory. Let's stop. Let's stop. Okay, now this is happening when our body is not telling us to do that. The brain is not saying, "Okay, on demand, we need to stop this signal because things are not in check." THC is coming in from the outside and telling these neurons to stop doing what they're doing. What we get from that is complete chaos in the brain. The thing is that when people or kids are using this that you can imagine that just this influx of THC coming in and binding to that CB-I receptor and telling it to stop doing what it's doing, when in reality it probably should keep going, is going to result in some problems in development.

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### **Christin D'Ovidio:**

Adolescence is a uniquely vulnerable time with the brain going through enormous changes. Dr. Gilliland explains how cannabis use creates chaos and really physically changes the structure of teen brains.

### **Kristen Gilliland:**

This is where we see this because during adolescence, the brain is going under immense, immense changes. There's tons of neuroplasticity, which I said is just the ability for neurons, their connections basically to strengthen or to weaken based on how often those nerves are communicating. There's a phrase that we say, neurons that fire together wire together. What that just means is if a neuron is talking a lot to one another, then that communication says, "Hey, my person is using this a lot. Let's not get rid of that connection," but if a person is not using that connection, the brain says, "Okay, my person is not using this. Let's get rid of it." Now what else happens, and I know this is a long definition, but there's also synaptic pruning going on in the adolescent brain, and this is normal process that happens that in the adolescent brain there is a pruning back of the cortex, the area of the brain that is kind of your executive functioning emotion regulation.

This pruning is a normal process where the brain gets pruned back as far as, I shouldn't say that the cortex gets pruned back. The reason it does this, it's to look for what areas or what communication is being used a lot versus what communication between neurons is not being used. The communication that's not being used it says, "Let's clip that. Let's get rid of that." What we have seen, and I should say studies have seen from a scientist is that normally during adolescence, this pruning that is just like when a tree, when we prune dead or weak branches away, we're basically making it so that when we water, the water goes towards the healthy branches so the tree can grow and thrive. This is what the brain does to try and make the brain more efficient and to grow healthy connections so the brain can grow and thrive.

In normal adolescence, the pruning back of the cortex, prefrontal cortex is about 1% per year. What studies have shown, and it's Alba is a scientist measured the prefrontal cortex thickness of adolescents. About 700 or so adolescents from the age of 14 to 19, and they measured every year. They took adolescents who used cannabis versus adolescents who did not use cannabis. Those adolescents that use cannabis, it was anywhere from 10 to 50 times or more per year. What they found is that even though they all came in with the same thickness at 14 years old, that their prefrontal cortex had that same thickness when they used, those who used cannabis, their prefrontal cortex thinned 30% on average more than kids who did not use cannabis.

The pruning is happening, and they found it's also dose dependent. Kids who used more, their brains like 50 times or more during that time period. From the age from 14 to 19 38% thinning of the prefrontal cortex comparatively to kids who do not use. In a dose dependent manner, they saw thinning of the prefrontal cortex, which just means excessive pruning. We know that excessive pruning is also linked to depression.

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**Christin D'Ovidio:**

Dr. Gilliland explains how THC binds to cannabinoid receptors and it hijacking normal development causing functional impairment, including depression.

**Kristen Gilliland:**

We can't usually take children and say, "Hey, let's have you smoke a bunch of marijuana and see what happens to your brain." A lot of times we have to do these studies in adolescent rats and look at the impact on rats or look at what has happened after the fact of children using cannabis to look and see what happens. We do know that definitely with my son, when we think about what schizophrenia is, it is actually one of the theories is it's caused by an aberrant pruning, meaning that it's just random synaptic pruning that occurs. Schizophrenia, the age of onset is late teens to early twenties, which makes sense that if to me it makes sense, and I'm just going to say that if we think about aberrant pruning and this excessive pruning going on, and especially with these kids who have been using cannabis during that age period, during adolescence, that they are getting this thinning of the prefrontal cortex, which indicates excessive pruning, that there could be definitely a link between those two.

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**Christin D'Ovidio:**

Today's cannabis is being modified and synthesized to create a more powerful product, and they have dangerous implications. Our guest today is helping us understand these differences between the variations like Delta eight, Delta nine, and Delta 10.

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### **Kristen Gilliland:**

Delta nine is what is found in marijuana. Within the cannabis plant, when you talk about cannabis indica, cannabis sativa, those are the different species of plants and cannabis sativa, cannabis indica are, if we look at taking those cannabis species, cannabis sativa is a plant that has more THC than CBD, the kind of more relaxing feeling. When I say THC, when I'm talking about this, I'm speaking of Delta nine, okay? When we look at cannabis indica, it is a plant that normally has more CBD than THC. Cannabis indica would be kind of the more relaxing feeling. Cannabis sativa would be kind of the more I'm up and I'm going and more energizing. You can always think about cannabis indica because there's a term that people say, they say indi-couch. It means you're sitting down. Now those both have Delta nine in them.

Okay, so that's found there is Delta eight and Delta 10, and those are basically THC where there is, in chemistry, we call it a double bond. It's just where an atom has two bonds between it, so two atoms, they're sharing two bonds instead of one, and it just means that that double bond has moved a position. It looks exactly the same except for the position of that what's called a double bond. They both interact with Delta eight and Delta 10 both interact with the CB-1 receptor like Delta nine does, cause a little bit different effects though. Now, Delta eight and Delta 10, there's very small amounts within the cannabis plant, so very, very small amounts within the cannabis plant or the flower, which has the Delta nine, the major constituent. What people have done is that they have found out that marijuana is schedule one, trying to reschedule it to schedule three, but it says it has no medicinal value. It's illegal.

Now, Delta eight and Delta 10, because they are not, it's not marijuana because they look a little different than the Delta nine. They actually have fit into this loophole where they're legal, but there's not very much of it in the plant itself. They've found ways to actually make it from using hemp CBD and producing it by treating CBD with, when I say they, a lot of times they're kitchen chemists. They're people who get this protocol off the web. They'll take the CBD, heat it up with a solvent, and sometimes that solvent is toluene, which is model glue and also, acid they'll use as a catalyst to get the reaction going, and that makes more Delta eight and Delta 10, so that makes more of it. Now, the problem here is there's no federal regulation for checking Delta eight and Delta 10.

It's legal in most places if you're over 21, but we know kids can get, find ways to get it. There's no check. The only regulation on it is that it has less than 0.3% Delta nine, which is the component in marijuana. That's the only check that it has to prove that there's less than 0.3% Delta nine. As far as Delta-eight, Delta 10, is it pure? Is there solvent left in it? Is there any remaining acid in there? None of that is checked. What byproducts came from that reaction taking CBD and heating up? Not checked at all. Then this is frightening as a chemist. Frightening. I know when you do a reaction, I know you don't just get these pure products, so we really need to stand our ground on that and question the government why they're not. I mean, would we give our kids something that the FDA didn't approve and give them all the time, just say, "Hey, here you go. Just try this. This hasn't been approved by the FDA, but we're selling it, so it must be good for you."

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### **Christin D'Ovidio:**

Potency matters. Cannabis with higher levels of THC leads to greater risk of developing an addiction, depression, anxiety, and even psychosis. Dr. Gilliland makes a case for regulating the amount of THC in the products.

### **Kristen Gilliland:**

I don't know why we don't regulate the percent THC that's in marijuana. If we could regulate knowing that high-potency marijuana has increased the rates of addiction, it's increased the rates of psychosis, it's increased, we think about depression, anxiety, all of these, there are studies out on looking at high-potency marijuana and its effects on the brain, and particularly on the adolescent brain because it is in development. It's like so much is going on and just putting these substances in there is creating chaos in the brain. I mean, really just with what's trying to go on normally, and then you imagine just starting to put all this other stuff in there, the brain is like, "Wait, what is going on? I'm getting all these mixed signals."

Really, as parents trying to come together to talk to the government, talk to your representatives about finding ways to inform the public about the dangers of cannabis, particularly on the adolescent brain. That's what I mean, particularly on the adolescent brain. It's very, very crucial that kids know that they should not use marijuana. They could wait until they're 21 when their prefrontal cortex is mostly online then, and that's the legal age one they should use, like to have a say, don't use it at all, but if you're going to have a nuanced conversation with your child, you try to say, "Wait till you're 21," I think they'll listen to you more than if you say, "Do not use it at all." I did that with my son and it didn't work.

### **Christin D'Ovidio:**

As you may know, New Hampshire is the last state in our region to adopt a business model for the commercialization of cannabis. Given this, we have the opportunity to learn from other states and to consider science. Knowing what we know from neuroscience, what concerns do you have for our kids?

### **Kristen Gilliland:**

The one area that concerns me the most is the commercialization. There's no doubt that we see that weed is legal and then the commercialization of it gets out of control. It's like the wild west. One of the biggest concerns is, I think, especially for parents, is to really get a community on board of talking about how they market cannabis. There's so many marketing campaigns that are geared towards kids, and the one thing that we do know is that a child's brain during adolescence, as I said, is more plastic. This means also, that the reward system in their brain is more plastic. Again, remember as I talked about communication, when we look at communication between neurons, if we continue to stimulate or increase that communication, the brain says, "My human says this is important. I better keep this. I'm going to keep this communication."



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Well, this holds true with addiction. If you have a child whose brain is very plastic and can easily strengthen those communication networks, then they feel that reward is just going to be enhanced and it will continue to be strengthened, and they are more vulnerable to becoming dependent on cannabis. It's one thing I would say is that really as a community to stand up and really try to have some strong language in place to talk about how it's marketed. Do we have warning labels? Do we have all these things that are available for parents to see children to see?

### **Christin D'Ovidio:**

We talked a lot about the developing brain of young people. How does cannabis use impact adults?

### **Kristen Gilliland:**

As I said, those CB-1 receptors are found throughout the brain and can impact learning and memory, can impact definitely addiction. I would say it's a one place that whether you're an adolescent or you're an adult, you can become dependent on cannabis for sure. Also, we see what's called cannabis hyper-emesis syndrome. This is when people become heavy users of cannabis, all of a sudden develop this condition where they cannot stop vomiting and they come into the emergency departments. This has grown so much since the legalization and the commercialization of cannabis emergency department visits have grown with people coming in where they cannot stop vomiting. The pain is so immense that physicians have called it "scromiting," 'cause they're screaming and vomiting at the same time. The only way to get it to stop is one that they hot baths, super, super hot baths and putting capsaicin, that pepper on their abdomen has been away that people get it to stop. I know it's crazy, but it doesn't respond to the normal medicines that you would use to stop the vomiting from occurring. The only way that people can get better from this is by completely stopping using cannabis. This is happening to adults, it happens to teens as well, but it's with heavy use of cannabis, which I would assume would be cannabis use disorder.

### **Christin D'Ovidio:**

Well, that's very interesting. As you know, many people use cannabis during pregnancy to help with nausea. What are your thoughts on this?

### **Kristen Gilliland:**

My only hypothesis here, and I'm putting my neck out, but the vomiting reflex is found within the brainstem. My guess is just like with when someone becomes addicted to something, the reward center in your brain gets just flooded with dopamine so much that it finally says, "I can't do this anymore. I can't do this," and so it kind of stops. It starts pulling those baseball gloves in so that the dopamine can't hit it anymore. That's what causes those cravings and that wanting, because they're not getting that same feeling that they once had when they used the drug. I think if you think of using small amounts of cannabis to help with that vomiting reflex that it binds to it and quiets it, but now it's being flooded, so those receptors start to come back in or the gloves and now all of a sudden what used to help it doesn't help it anymore, and in fact, creates the opposite.

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**Christin D'Ovidio:**

We ask all our guests to share what their personal definition of prevention is. How do you think about prevention?

**Kristen Gilliland:**

I think of prevention in the terms of mental health and a lot of kids that use cannabis, when I go and talk to them and they tell me that it helps with their anxiety, and I'll ask them and I say, "Okay, if it's helping with your anxiety, do you have to keep using it to help?" They said, "Yes." I said, "Well, then it's really not helping. It's masking it. What are you trying to mask? What are you trying to numb yourself from?" Learn to be present, to learn what mindfulness is, and to learn to be in the present moment, about having your emotions and saying, "Okay, I feel sad right now, and that's okay," and learning to get through it. But as a society, we just constantly are distracted by doing other things instead of being present. Distraction can come from your phone, it can come from drugs, it can come from alcohol. If we could just be more present and learn how to sit with our emotions and work through them, I think we would all be in a better place and we would have a lot less substance use disorder.

**Christin D'Ovidio:**

Thank you so much for talking today and really sharing your personal story and all the lessons you've drawn from neuroscience. We truly appreciate the work that you are doing to safeguard our young people. Please check out the resources at the bottom of the webpage for this episode to find support. If you have a loved one facing challenges with substance use, you are not alone. We know that you need accurate and up-to-date information and answers to help you keep your kids safe and help them. While you're there, you can sign up for our notifications and you'll be the first to know when a new episode drops.