# Insight Into the Teenage Brain: Adriana Galván at TEDxYouth@Caltech

Hi, thank you. I love, love, love your enthusiasm. Your energy and excitement is really what makes me love my job, and my job is to study the adolescent brain.

I'm a scientist at UCLA, as Jake said. So scientists have studied the brain for centuries, but it's only been in the last 15 years or so that we've discovered one of the most fascinating things, and that is that your brain changes every single day.

As you sit in this room, your brain is changing in response to my voice, in response to the person next to you, and your experiences and the people you affiliate with shape the way your brain ultimately develops.

We also know that the brain matures and continues to do so past childhood and into the teenage years and well into your mid-20s. So most of you in this room today, as middle and high school students, don't yet have a fully mature brain.

But this is actually really beneficial, if we think about one of the functions of adolescence, which is to establish your independence from a caregiver, because your brain as an adolescent is built to help you do that.

Compared to children and adults, the teenage brain is really good at seeking out new experiences enjoying thrills and seeking out risks. It's also really good at recognizing social or being sensitive to social and emotional information.

And so for that reason, the teenage brain is really responsive to rewards and emotions when making decisions. And in my laboratory at UCLA, and in laboratories all around the world, we're interested in uncovering that very question: How does a teenage brain make decisions? One of the first discoveries relevant to this topic was made when we discovered that the part of your brain in the very front, called the prefrontal cortex, which is the last brain region to develop, because your brain develops from the back to the front, continues to change up until the mid-20s.

And the reason this is relevant is because the prefrontal cortex is a part of your brain that helps you think about the consequences or potential consequences of your actions before you do them. It helps you regulate your behavior and your emotions.

And so it makes sense that if this part of the brain isn't fully available until well past adolescence, then teenagers may make more impulsive decisions with less regard for the potential future consequences.

But we now know that the stories are far more interesting and complicated than that. And in fact, what we really need to do is think about how brain regions that are not at the surface of your brain, but in the deeper layers, how they change.

And one region we focus on is called the striatum. And the striatum is the key component of the reward system. So when you receive something that you find rewarding, your striatum is very responsive and it releases something called dopamine.

And this is the case not just in humans, but in kids, in mice, in rats, in monkeys. All of these organisms respond really with a lot of excitement in their brain when they get something they like. So in my lab, we study this reward system across development, especially in teenagers. And we do that by asking people to come to the laboratory and perform what is called a Functional Magnetic Resonance Imaging Scan, or fMRI And the beauty of fMRI is that you can take a snapshot of the brain in motion.

So while you are experiencing something you like, or while you are making a decision, we capture how your brain is responding to that, how your brain is active. And so, to study the reward system, what we did is not simply show people pictures of reward, which is what mostly happens in brain imaging studies, but instead what we did is we actually gave someone a reward and what's something that people find rewarding? Sugar.

So what we did is we asked people to come to the lab, we asked a group of teenagers and a group of adults, and, while they were in the MRI, we hooked them up to a straw and we fed them squirts of sugar water ever so often.

And first we asked them whether they liked it. Maybe they weren't going to like the sugar as much as we thought. But they actually did. This is the rating scale asking them, "How much do you like the sugar?" And the average response is in red for the teenage group and the adults is

shown in white, and you can see that everybody liked it, but it's the teenage group that showed this exaggerated sensitivity.

They really liked it. So we started to wonder whether there was something neurobiological that represented this difference. So, instead of focusing on the prefrontal cortex, which is what a lot of brain scientists who study adolescents do, we looked at the deeper layers of the brain.

So in this image, which is actually a real human brain image averaged together among all our participants, we saw that, in the deeper layers, here represented with this yellow activation, the striatum was really excited to the sugar water, and this was across all age groups.

But the really cool thing was observed when we looked at the differences between the teenagers and the adults. Here again I'm showing you the magnitude of activation, that is, how excitable the brain was, in the teenagers compared to the adults, to this very simple reward of sugar.

And you can see that the teenagers were much more excited to the same exact stimulus, and in the same exact region of the brain, it's the teenage brain that was going crazy. It was really excited to get it.

And when we associated that with their ratings of the sugar, it was only in the teenage group where we saw that people who showed greater activation in the brain in response to the sugar also told us they liked it more.

So that means that, in real time, at that very moment your brain gets something that it likes, it will make you think that it's better. And you can think or imagine that, in future circumstances, your brain will encode that information and remember that you liked it, so it will bias your decisions toward getting more rewards, and that's what happens during adolescence.

But to ensure that this wasn't just specific to something as simple as sugar, we gave people something else that everybody likes and we did this while they were in the MRI. And what's something else that everyone loves to get?

(Audience) Money!
AG: Money.

Right? Everybody likes money. So, we brought in a whole separate group of teenagers and adults, and this time we threw a group of kids in there, who were between about 7 and 10, and we found that, again, the part of the brain that was most responsive was the striatum, shown here on the left.

This is a brain scan showing the average activation. But what you can see really clearly is that not only were the teenagers more reactive to the money than the adults, which you might argue is because maybe they have less of it, they like it more, but that's not the case, because the kids probably have even less than the teenagers, and the teens still showed this exaggerated response.

So this is telling us that there's something really special about the teenage brain. There's a sharp increase in sensitivity to rewards and novel information from childhood to adolescence, but then there's a sharp decrease from adolescence to adulthood.
And that probably has something to do with the fact that the prefrontal cortex is starting to come online, as people transition into adulthood, and regulating the emotional response to the rewarding information.

So what does this all mean for behavior and for your everyday life? Well, there are a few things. From my perspective, this is a really exciting time to study the teenage brain. Although scientists have made significant progress in understanding what makes the teenage brain unique, we still have a lot to learn.

For instance, we're just now starting to appreciate that this sensitivity in the brain to rewards and to emotions might lead teenagers to make poor choices sometimes, but it also presents an excellent opportunity to seek out new adventures, to meet new people and to confront interesting challenges in ways that people don't typically do later in life.
And I predict that, as we continue to conduct more of this research, we will learn to take advantage of the sensitivity of the brain during adolescence to generate new ideas and to promote creative thinking.

There's a lot that we can and will learn from the adolescent brain and from adolescence in general in the coming decade. And perhaps we'll learn that taking risks and seeking out rewards are really adaptive behaviors in many contexts that actually lead to really good decisions, and that help individuals navigate the often challenging and intimidating transition from childhood to adulthood.

So with that, I encourage you to savor the excitability of your teenage brain and to enjoy all the new people you meet and all the adventures you take. Thank you.