

## Transcript of [Cerebrum Podcast](#)—Remembering What We Learn

Guest: **Henry L. (Roddy) Roediger, III**, Ph.D., is the James S. McDonnell Distinguished University Professor at Washington University in St. Louis. Roediger received an undergraduate degree from Washington & Lee University and Ph.D. from Yale University. He joined the faculty at Purdue University in 1973. In 1988, he was appointed Lynette S. Autrey Professor of Psychology at Rice University, and in 1996 he moved to Washington University in St. Louis, where he became chair of the Department of Psychology. Roediger's research has concentrated on many aspects of human learning and memory, including memory illusions, collective memory, and methods of improving learning and memory. He is a member of the American Academy of Arts and Sciences and the National Academy of Sciences.

Host: [Bill Glovin](#) serves as editor of *Cerebrum* and the *Cerebrum Anthology: Emerging Issues in Brain Science*. He is also executive editor of the Dana Press and *Brain in the News*. Prior to joining the Dana Foundation, Mr. Glovin was senior editor of *Rutgers Magazine* and editor of *Rutgers Focus*. He has served as managing editor of *New Jersey Success*, editor of *New Jersey Business* magazine, and as a staff writer at *The Record* newspaper in Hackensack, NJ. Mr. Glovin has won 20 writing awards from the Society of Professional Journalists of New Jersey and the Council for Advancement and Support of Education. He has a B.A. in Journalism from George Washington University.

Bill Glovin: What makes you smarter than me? Do children learn better than adults? Do men and women learn and retain information differently? Hi, welcome to the *Cerebrum* podcast. I'm editor Bill Glovin and today on the phone we will be seeking answers to those questions from Roddy Roediger, a distinguished university professor at Washington University in St. Louis. Dr. Roediger is a co-author of our recent *Cerebrum* article, "[Remembering What We Learn.](#)" He's also a co-author of *Make It Stick, The Science of Successful Learning*. He has been conducting research on learning since joining the faculty at Purdue in 1973, and is considered one of the country's foremost experts on learning.

Roddy, welcome, and thank you for the article which you co-wrote with your wife, Kathleen McDermott, also a professor at Wash U. Besides the article, how closely do you work together?

Roddy Roediger: We do some projects together, but she is involved in cognitive neuroscience imaging of learning and memory. Although I know something about that, it's not my area of research, and so I use truly behavioral methods. And so, we have some interests we share and others that diverge, but in this case, we were able to collaborate nicely on the article we just wrote for *Cerebrum*.

Bill Glovin: Just to ask you to go back for a second to the beginning, what motivated you to pursue research and become an academic in the area of learning?

Roddy Roediger: Well, that's a long story. When I was a child my mother died when I was very young. I was five years old and it was the '50s and people didn't talk much about

death, and nobody knew how to talk to me about my mother dying very well, and so they didn't. And so, I decided as a child I discovered I could relive my memories of being with her, certain memories. And so, most every day I would just set aside time and do that from a very early age. I discovered it worked, and I still got some of those memories. And so, I'd always gotten interested in memory. How can we do that? How can we make this work?

And then later on, much to my surprise, there was a whole academic field that studied human learning and memory, and so I gravitated to it a bit in college. And then, I went to graduate school in psychology but not in learning and memory. And then, after my first year I had taken a course in learning and memory in graduate school, and decided I should just switch and make that my life's work. So I got interested in it as a child and just I had no idea until very late in graduate school that I actually wanted to study this problem for the rest of my life.

Bill Glovin: I guess one of the telltale signs that you've made it in this world is your own entry in Wikipedia. But I noticed in your entry the first thing it says is: "He rose to prominence for his work on the psychological aspects of false memories." Yet there's nothing about false memories in your article. Is that something you still do research on?

Roddy Roediger: Yeah. Wikipedia articles are written by other people of course, so when I read mine I kind of wonder who did it because I've done lots of research before that, and I have a feeling what the writer of the article meant was the first time they ever heard of me was about false memory research. But I have been doing work on implicit memory and other topics long before that. That was also highly cited. So yeah, I've got several different research interests. False or illusory memories, eye witness memory, something called collective memory, how groups of people remember together, like how we remember 9/11 for example, how Americans remember 9/11. And then how to improve learning and memory, which is what our recent Cerebrum article and also the book Make It Stick is about.

Bill Glovin: Let's start with something basic. What would make you smarter than me?

Roddy Roediger: Well, lots of things. There is believed to be an inherited part of that. Whenever people show you the intelligence and look at various ways of looking at genetic contributions there always turns out to be one. People argue about how great it is whether it accounts for 50 percent of the variance or higher, 50 percent is pretty much an accepted answer these days. But no matter what you're genetic inheritance there's things you can do to learn more information, then hence to make yourself smarter. There's great debate about this of course, but all of us can improve our ability to learn and remember by applying certain strategies and ways of thinking that help us acquire information better.

Bill Glovin: Yeah, I noticed in some of my research that students looking for tips on learning, there are sixth great tips in an article co-written by you, and I guess somebody

could find it by Googling "Make It Stick, Six Tips for Students in Psychology Today." That was quite interesting. But let's get back to some of the issues of learning. Are there any gender differences when it comes to learning?

Roddy Roediger: We have not found any. We haven't looked hard, I'll have to say, but no. There's differences of opinion. There are some people who believe that men do better at mathematics than women. If you look at the upper echelon of mathematics professors and prize winners, it's more men than women. But if you look at high school rates for example, women do better than men in math in high school typically. So it's a complicated thing. But generally speaking, we don't find gender differences in the kind of work I do. In fact, we stopped looking for them.

Bill Glovin: Why is someone better at learning numbers while others are better at language?

Roddy Roediger: There are, I mean for students who go into say art and architecture, they often do very well in spatial reasoning tests. People who are, say English majors, might be much better on verbal tests than they would on spatial reasoning tests. The exact reasons for those differences, I'm no expert in this, but I've never seen that we've had that pinned down. People point to possible neural differences, brain differences. Like there's a famous study of London taxi cab drivers before GPS where you really had to remember lots and lots of streets and to pass the taxi test you have to master this map of London. Once they showed that the people who became expert, really top taxi drivers who knew London, had larger hippocampus than other people who did not master that, so that suggested saying, "Yeah, there is a neural basis to some of this." But of course, we're in the early days of understanding those differences.

Bill Glovin: That's interesting. Are children's brains which are still developing more receptive to learning than an adult's brain?

Roddy Roediger: Well for certain things that's certainly true. Learning language for example, children, say from ages two to six, they seem to be biologically prepared to learn any language on earth. If you put the child in that language community, it will learn that language. As we now know, if they grew up in a bilingual or trilingual household they can just as easily learn two to three languages than they can one language. And so, at that age, we seem to have very plastic brains for picking up language. As we all know when we get older it gets much more difficult. So our second language, many of us knew as we were more monolingual, many of us don't even find that until we're in high school when we take a second language, and then we discover it's hard to pick up as when you're a three year old you have no trouble at all as long as people around you are speaking the language, you'll pick it up.

Bill Glovin: I've been playing songs on my guitar since I'm a teenager and I notice that I can still recall lyrics that I learned in my teens, but songs that I've learned in the last five years, for example, I can't seem to retain. Why is that?

Roddy Roediger: Well, one possibility is of course if you learn something long ago and you kept practicing it over the years, it was a favorite song where you practiced it much more than the recent ones, and maybe at the time you were a teen you had much more time to devote to this than you do now, where it's a hobby, you just do it, say an hour or two a week. So there might be a difference in simply the amount of practice. I imagine if you were a professional musician, and you had to learn new music all the time, and you were used to doing that, that you wouldn't have as much problem, so that's one possibility at least.

Bill Glovin: How does one distinguish between whether they are truly learning something or simply memorizing it? Or are they tied together?

Roddy Roediger: I think they're tied together. People often say, "Well memorization, that's just memorization," as though it's not important. Well to learn, you have to be able to keep the information, and so the idea of being able to learn something but not memorize, a lot of it has to be deliberate. One point that I try to make, in fact we make a little bit in the article in *Cerebrum* is that although we think of children as being natural learners, and they are, they learn all kinds of things about language, social behavior, the like, but many of the things we ask them to learn in school are in a sense unnatural to the human mind. It took the human race eons to learn some of these things.

There's no reason calculus should be intuitive. Until very late on, nobody knew about calculus. And so, the fact that some people discovered calculus and now students in college have to learn it. Well it didn't come naturally like language or else the ancient Greeks would have known about calculus and they didn't. This is something that had to be discovered, that had to be worked out, and it's really difficult. So yes, we can learn it, but we can't expect it to be easy as learning our native language because it's much more abstract and much harder to get hold of.

And so in general, the more abstract knowledge is, the more difficulty we have in learning it, and the more expertise we need to be able to learn. You have to have a good background of information in mathematics and arithmetic to be able to understand calculus, whereas understanding your native language you just have to have your family around you speaking it, and people in your neighborhood speaking it.

Bill Glovin: Has anything changed in education based on the research of cognitive psychologists?

Roddy Roediger: I've written an article claiming, not really, but that might be starting to change. There are many people who are trying to change that now, trying to improve teacher education with, what are some techniques that really work? The finding we have though, and we allude to this in the article, one strange thing about the human mind is that many techniques that help us learn and remember in the short-term are counterproductive in the long-term.

For example, let's take cramming. Students can repeatedly read something, say a chapter in a textbook. I'm going to have a test. I'll read the chapter two times, I can pass the test, I can do well on the test. But if you test me a week later if I've learned that way I won't do so well, or a month later.

On the other hand, there are better ways of learning. They're slower and more laborious, and they won't help you as much on that initial test, but you'll still remember the information better a month later, and because we can, we, as students, and we, as teachers, tend to see what works immediately, we don't realize that it might not work for the long-term. We kind of have this belief, and psychologists had this for a very long time that whatever promotes good learning initially that should lead to good retention later. It's a perfectly reasonable principle. I've probably believed it for years. But now I think at least in certain cases it's just untrue. These are cases where, as I say, something that leads to good learning in the short-term can turn out to be counterproductive in the long-term.

To give you one example that we talk about in the article. If you study something repeatedly, it feels like you're mastering it. You read, say the same thing over and over. If I want to learn the capitals of the states, well I just look at cards that say, "Iowa, Des Moines." I do that over and over. But the way to really be able to learn for later use is not just study the cards, but to use flash cards so it says Iowa on one side with a question mark, and you have to answer it before you look at the other side. There's something about the effort of trying to answer the question, and either getting it right, or even if you get it wrong you learn the information better if your mind has been posed with a question than if you're just presented with the information.

Bill Glovin: How important and useful is feedback?

Roddy Roediger: Feedback is critical. Whenever you quiz yourself you should get feedback because you can make a mistake. For example, let's say I look at Iowa, and I think Topeka, and I don't bother to check. Well, you learn from testing yourself. But if you learn something wrong, it's going to stick with you. And so, then you have to unlearn the Topeka-Iowa association and learn the Des Moines-Iowa association. So if you make an error, the only way you're going to be corrected is by giving yourself feedback and that's absolutely critical.

Bill Glovin: Does it matter if it's negative or positive feedback from other people?

Roddy Roediger: Well, correct answer feedback is what we ... It's not enough just to say, "No, you're wrong." That would be in a way negative feedback. You've got to give the person what the correct answer is, so the critical thing is correct answer feedback.

Bill Glovin: Yeah, but I guess I'm alluding to, let's say you're involved in some kind of trauma, so that has a huge impact on you emotionally. Are you going to be more receptive to learning from that experience?

Roddy Roediger: Well in trauma you have, one of the phenomena of post-traumatic stress disorder is having repeated flashbacks, that something that happened to you, something you saw is so horrifying and so vivid you can't get it out of your mind even if you try your best it just keeps coming back and terrorizing you. There are a number of psychologists in neuroscience working on that problem, how you avoid these kind of flashbacks, and often when you sleep they'll come to you in dreams, the same scene. And so, they create this vicious cycle. The more people think about them, the more they're likely to think about them in the future. And so, trying to break that cycle is critical for trying to recover from these sorts of traumas that produce these intrusive flashbacks.

The two ways of trying to do that are trying to divert attention from it, trying to block it somehow when it comes to mind by thinking of something else. And other people are trying to use measures coming from animal conditioning basically to extinguish the fear, so even if you think about it, it no longer arises. The fear arouses the fear response and you don't become terrorized about it. People have had moderate success in doing this.

Bill Glovin: You mentioned just briefly dreams, is there any connection or research been done in terms of dreams and retention or learning?

Roddy Roediger: Well, there's a lot of work on sleep, and learning, and dreaming is probably a part of that. There are, for example, some very clever studies that were pioneered by Dr. Ken Paller at Northwestern where he had people associate for example smells and words. Say you smelled the smell of popcorn and that's associated with the word glove. And then what he did was have people go to sleep, and say they had associated 30 smells with 30 different words, and what he did while they were sound asleep was measured by brain waves, he would present these smells, say of popcorn and 14 other things to their noses while they were asleep, didn't wake them up, but then later he would test for the words afterwards.

So 15 of them they had smelled the smell, and maybe that aroused the word in their subconscious brains while they were asleep, and for the other 15 he didn't. What he found later was that for the 15 that had been exposed during sleep people remembered those words better the next day than they did the 15 words that had been learned the same way, but then they had not been re-experienced during sleep, so it seemed to be a situation where having cues presented during sleep that were associated to the words did indeed help people remember those words later when they were awake.

And so there does seem to be some learning during sleep, and many people believe that certain memories consolidate, important memories consolidate during sleep, and perhaps another function of sleep is to kind of wash away the

unimportant memories, the stuff like what you had for lunch that you won't remember very long, those might be undone during sleep. And so this is a very hot area, I'm not doing this kind of work, I'm just telling you about what I read other people doing at this point. But sleep and memory, and dreaming and memory is a very hot topic at the moment.

Bill Glovin: Yeah. I noticed in your tips, "The Six Tips for Students," one of them is to get a good night's rest, and it will help you in your retention and your learning.

Roddy Roediger: Yeah, people pulling all-nighters and trying to study like that, I did that myself once or twice when I was a student, but in the long-run it doesn't seem to help. It seems you're better to study, and then get good night's sleep to help the information consolidate.

Bill Glovin: Getting back to education for a minute. Do essays rather than multiple choice do a better job of measuring learning? And, have teachers gone in the direction of essays over multiple choice?

Roddy Roediger: As far as measuring learning, just flat out measuring per se, there are arguments both ways. The argument for multiple choice is that the scoring is objective. For essays the problem is that when you give them to a variety of teachers, the variability in grading them is very high, so you don't even have a reliable measure, so it's hard to know if it would be valid. It almost can't be valid if it's not reliable whereas multiple choice tests can be scored objectively. I've talked to people when I was teaching Introductory Psychology, I would have a few essay questions, and mostly multiple choice 'cause there are lots of students, and it's hard to grade essays with so many students. But at the end of the semester when I performed correlations across students asking, "Well, did the students score high on multiple choice also score high on essays and vice versa?" The answer was always yes. The correlations were very high and reassuring. It was as though the tests were both assessing knowledge, but in somewhat different ways.

Now, one other thing though. There are some other differences that should be taken into account. Research dating back from the 1930s shows that when students think they have a multiple choice test they seem to study less and they study differently knowing they have an essay test facing them. So when you have a multiple choice test the argument goes, "Students tend to study more superficially in a way." They know, "Okay. I'm going to be given and asked to pick one fact from among others." They kind of look at the surface features, the kind of things 'cause it's easier to make multiple choice tests where you ask about dates, or names, or stuff. It's harder but not impossible to ask really deep multiple-choice questions where you have to think really hard, whereas essay questions you know you have to think.

And so, when you study for an essay test you study broad intervening themes. You're trying to think of, "What might they ask me about this material that would make me draw it together?" So they tend to study longer, and they tend

to study in a way, again, this is by mostly self-report that fosters bringing the information together because they know they might get a question that asks them to relate something from chapter six to something in chapter seven, whereas if they're being asked a multiple choice question, having to answer something using that kind of knowledge is unlikely.

I think one reason to use at least some of each type of question is you can get students to study both the details of the information and to study the general overarching themes of the information, so that's why I like to use both kinds of questions on tests.

Bill Glovin: We published an article a little while back called [“The Neuroscience of Narrative”](#) by Paul Zak, who wrote this book *The Moral Molecule*. In the article, he contends that when the brain is stimulated through storytelling the chemical called oxytocin is released and will stimulate pro-social behaviors like empathy. Has there been any tie to oxytocin and learning or retention?

Roddy Roediger: Not to my knowledge, although I'm not a neurobiologist of learning and memory. There could be. I like that. I mean what we do know is that narrative is a natural way for us to remember and learn. Telling stories, and having stories told to us is a very natural learning device. Historians use it a lot in teaching history. People debate that, whether it's a good thing or not. For example, I love to read historical novels. So where the facts of the novel are all fact-based, but of course they've made up a story to go along with it, and I find those very enjoyable to read, and I'm learning history but I'm kind of doing it while I'm reading a good story.

Now it's easier to do that for some fields like history than say mathematics, and you can do it to some degree in psychology but it's more difficult. I do think narrative is ... that there's a whole lot of humans who study narratives as a form. Aristotle laid out rules for good narratives thousands of years ago, and good stories still have a beginning, middle, and end. We like to have a resolution. We like for there to be a complication. We like for it to be resolved. So I think he might really be on to something. I hadn't heard about that research, but it makes sense to me.

Bill Glovin: This might be a better question to ask to your wife, but we can now depict individual differences in the brain through imaging. Can we determine anything about retention and memory from imaging?

Roddy Roediger: Well, she's certainly trying in her work and so are other people. I think the study we report in our article in *Cerebrum* where she showed, this is an article in which she's senior author. Basically, the people who learned and remembered better were the ones who were able to deactivate what's called the default mode network of the brain. The default mode network is a network of brain regions and it's very active when we are basically not doing anything. So you're just lying in the bed yet you're thinking about what you'll do later, you're thinking about yourself usually, you'll think about what you are doing there,

what you did in the past, what you will do in the future, you're just daydreaming or mind-wandering, and that is very active. The default mode network is very active. And then, suddenly you're asked to learn and remember something.

What she found was that the people who can deactivate the default mode, who can turn it off and pay attention to the information coming in, and not daydream, and not mind-wander, those were the people who learned fastest and remembered better later on. I think there's a good case of where brain imagining can tell us something about learning and remembering that would not be obvious just from watching people do the task.

Bill Glovin: What are you looking into now? And, what research still needs to be done?

Roddy Roediger: I feel like for all of these topics we've learned a lot. I mean if you go back and look at what people thought even 25 years ago, we've made good progress. But then, when I look at all the problems facing us, say just go back to improving learning and memory and getting into the educational system. Well, we're trying to do that, but education especially in the US is a very distributed system, and every state has its own education regime. Every community is given great latitude. Every school district is given latitude. And within limits, every teacher is given a lot latitude in their own classrooms. And so, the idea that you can do something that will affect the educational system as a whole, that's just a very difficult thing to pull off.

Now, in many other countries it's very centralized. You say, "Look, we're going to pick this textbook." The whole country picks the textbook. Or, "We will use some new educational practice," and you can be pretty sure everybody will do it.

But in the U.S., it's a very distributed 'cause we like to have local control of schools, and that's in many ways a good thing 'cause you can adapt to local situations. If we did discover suddenly, "Here's the best way possible to learn and remember." It would take years to get it out into our schools.

And also, most of the things we study assume a very motivated learner, and yet when I talk to teachers in the schools, which I do frequently, one of the big problems is motivation, that the kids they're great learners, they're learners at video games, they're learners at sports, but studying mathematics, or geography, or history might not be what their idea of a good time is, and they're not very motivated at it. And so, one of the key challenges I think in education is motivating students, that some students just come in naturally very motivated. They want to learn everything, and others come in, and they might be really interested in one or two topics but not care that much about the others. And so, trying to motivate them to learn better is a hard job. Frankly, we just haven't made much progress on that to my knowledge.

Bill Glovin: I think one of the big topics in education is sort of passive versus active approach which obviously is somebody just lecturing at a student rather than opening the discussion up to the group, and then having kind of everyone participate and become more engaged. I think there's been a movement towards doing that over the years.

Roddy Roediger: There certainly has. I think it's a good movement. I do think you need both. Just to give you a personal anecdote, I teach a freshman seminar most every year, but when I first started doing it, I gave them readings to do. The idea was to get them talking, to get them engaged. And so, I gave them readings. I would come in, and just talk for five minutes to set the stage, and then I would pose questions to them, and they would talk, and I would kind of sit back. If they got way off track, I would try to pull the conversation back to the topic at hand. And so, that's how the course went. At the end when I got the reviews, to my surprise, most students said, "I wish the professor had talked more. I wish there had been some lectures. I felt like I was sitting in this class listening to the opinions of other freshmen who didn't know anything more than I did, and here's somebody who's an expert on the topic sitting quietly on the sidelines for the most part."

And so, now what I try to do is do a mixture of trying to get people to think about it. But if they're floundering a bit, I'll hop in and try to lead them on the path, and not just sit back as much as I used to when I first started teaching a freshman seminar. So I think it's good to have a mixture of both, that there is a reason the message developed, that when we learn something we should find somebody who's a master in it, and that master helps them parse that information to the ones who aren't masters. And so, it's kind of an apprentice model.

But I do think by introducing the discussion you can get motivation up because now the students are thinking, "Oh, this is really interesting. What do I think about this?" They see what they think is different from some of their neighbors, and then I could come in and say, "Well, here's what the research shows about this topic." And then, talk about the research; that maybe they didn't read about in their readings and help bring the discussion to some closure instead of just letting it wander all over the place, which is what happens if students just have the conversation themselves.

Bill Glovin: Well that sounds really sensible, I must say. Well, I think that's a great place to end. I can't thank you enough for the article, and please thank your wife for me.

Roddy Roediger: I will.

Bill Glovin: And that's our *Cerebrum* podcast. If you'd like to see the [article](#), you can access the article at [dana.org](http://dana.org) at the Dana Foundation website.