BRAIN SCIENCE PODCAST

With Ginger Campbell, MD

Episode #76

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Interview with Sian Beilock, PhD, Author of *Choke: What the Secrets of the Brain Reveal About Getting It Right When You Have To*

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INTRODUCTION

This is Episode 76 of the *Brain Science Podcast*, and I am your host, Dr. Ginger Campbell. This month's episode is an interview with Dr. Sian Beilock, author of *Choke: What the Secrets of the Brain Reveal About Getting It Right When You Have To*. In English, 'choking' refers to performing below one's ability under pressure. It can happen to an athlete during a big game, but it can also happen to any of us in a stressful situation. That's why I think this interview will provide practical information for everyone.

We will focus on the two main types of choking: the kind that involves failure to perform an intellectual task, such as taking the big test or blowing an interview; and the kind that occurs during sports, or performing a skilled task. We will examine what makes these two types of choking different, as well as what they have in common. Most importantly, we will consider some practical tips that can help you avoid choking.

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Before we jump into the interview, I just want to remind you to visit our website at brainsciencepodcast.com. There you will find detailed show notes and free transcripts for every episode of the *Brain Science Podcast*.

I will be back after the interview to review the key ideas, and to remind you how you can post feedback about this episode.

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INTERVIEW

Dr. Campbell: Sian Beilock is my guest today. Sian, thanks so much for taking the time to talk with me.

Dr. Beilock: No problem.

Dr. Campbell: Before we start talking about your work, would you tell us a little bit about yourself, and maybe about how you got interested in cognitive science?

Dr. Beilock: I am a psychology professor at the University of Chicago, and here at the university I run the Human Performance Lab, which, broadly speaking, allows me to ask questions about how people get good at what they do. We're particularly interested, not only in the building blocks of expertise, but why sometimes folks just aren't able to pull out their best performance when it matters the most. And that ranges from performance in academics, like taking a test, to giving a speech in front of others, to even hitting that three-foot golf putt when all your friends are watching.

Dr. Campbell: As I was going through your list of famous sports chokes in the book, I was thinking, *Well, after the World Cup, I guess we're going to have to add another one*—the Women's World Cup, that is.

Dr. Beilock: Yes, that was a hard one.

Dr. Campbell: Fortunately for me, my husband misread the score and turned off the recorder, so I didn't even see the penalty kick fiasco.

Dr. Beilock: Oh, no! You can probably see it online.

Dr. Campbell: Oh, I have. But, how about you personally; how did you get interested in this area?

Dr. Beilock: I got interested in cognitive science, and really understanding how people perform well in stressful situations and why they sometimes don't, because I, myself, am interested in performing at my best in all sorts of situations. Growing up, I was an athlete. I played soccer in the Olympic Development Program; I played lacrosse in college.

I was also really interested in doing well in academics, and I noticed some parallels behind what happened when I was sitting for an important test vs. up in front of everyone, trying to make that shot that would win the game. And I realized that there was lots of research documenting what happened in the brain and body as people got better and better at performing particular activities, but there wasn't a lot of work talking about how that went awry when there was stress or pressure to perform well. So, I was really interested in understanding what went wrong, and, hopefully, use that to determine how to fix it.

Dr. Campbell: I think over the years I've read an awful lot of books on peak performance, and getting in the flow, and that kind of stuff, but I don't remember ever seeing a book about choking before.

Dr. Beilock: Right. And that's where my research comes in. For the past decade or so, my lab and my work have been really focused on understanding this phenomenon that I think we all have experienced. We all talk about choking, or we see sports performances, or politicians, or even companies making poor decisions; we talk about choking in stressful situations. But I wanted to be able to define it scientifically, and operationalize it—meaning come up with a definition that we could all apply, so that we could really get under the hood and try and understand why it happens.

Dr. Campbell: That sounds like research that could be of practical importance to just about everyone.

Dr. Beilock: Yes. And I think that's one neat thing about the work we do in this lab is that we really are interested in basic science questions—so, how emotions and anxieties compromise the brain systems that would otherwise be used to perform well—that these basic science questions readily give rise to actually pretty simple techniques that folks can use to perform better in whatever endeavor they are interested in excelling in. So, it's fun, because we can do the basic research, but then we really do have something to say about how to provide people with tools, and tips, and techniques to perform their best.

Dr. Campbell: And I'm going to let you share just a couple of those as we go along; but could you tell me a little bit about the kind of research tools you use in your lab?

Dr. Beilock: My lab is, I think, an oddball, because we do lots of different things in our lab to try and get a poor performance. And so, we look at this across a lot of different activities. We have the standard psychology apparatuses that I think a lot of people use to look at humans thinking and performing, reasoning—test-taking types of activities. So, we have computers, we measure reaction time and accuracy. And we also take some physiological measures. We often take salivary cortisol. Cortisol is often known as the stress hormone. It's produced in times of stress, and so we can use this as a measure—an index—of people's physiological arousal at a particular point in time.

We do behavioral measures, we look at how people take tests, we measure cortisol. But we also do a couple of different things. We actually are very interested in sports performance, so we have a putting green as part of our lab, and we bring in really skilled golfers and they spend time putting. Then we put them under stress—we offer them money for peak performance, we sometimes bring in their teammates to have them watch, or tell them their teammates will be coming in—and we try and induce some of the types of responses that these athletes might have in a real do-or-die situation.

So, in addition to just looking at academic performance or public speaking, we really try and understand what happens in sports skills, as well, when the stress is on. And finally, we also use neuroimaging—functional neuroimaging, fMRI—to actually take a peek inside the head and look at how neural activity changes in different types of stressful situations.   So, we bring a whole toolbox together to try and get at how people excel and why they sometimes fail.

Dr. Campbell: I want to narrow in on the brain imaging just for a minute, because that's one that people are familiar with. Would you mind talking a little bit about the basic principles of how that works, and especially what the pitfalls are in drawing conclusions when you're using brain imaging?

Dr. Beilock: Yes, I think we often— especially when something comes through in the media—we portray neuroimaging as this sort of end-all, be-all; this very definitive way of understanding how the brain works. But one of the things I talk about in the book is that we should view data that we get from neuroimaging just like any other piece of data. And it's susceptible to the same types of misconceptions or wrong conclusions that are drawn by any piece of data—like how many items someone scores right on a test, and what we interpret that to mean. And so, oftentimes I think people put a lot of weight on this data that a particular area of the brain seems to be active when people are under stress or less active when it's not. And we think that tells us the whole story, but it turns out it's just one piece of the puzzle.

One of the things I talk about in the book is that people tend to ascribe more meaning to these pictures of brains—maybe because they think it has a more biological basis—and so, people will actually be willing to say that they think research is more credible if it's accompanied by a picture of a brain than if that research is not accompanied by a picture of the brain. So, you've got to be careful what the scientists are selling. Just because there's a picture of a brain there doesn't mean that it's telling the entire story. You have to approach it with a critical eye, just like you would any other piece of scientific data.

Dr. Campbell: Yes. I saw a piece of a video of a lecture by Cordelia Fine. Are you familiar with her work?

Dr. Beilock: Yes.

Dr. Campbell: She was talking about this, and how they will show two brain images and say that one means that this part of the brain is doing something in, say a male vs. a female, when all you're really looking at is the difference between the signals—not actually necessarily which brain areas are active, but that maybe one area is slightly more active, and that they are over-stretching in their conclusions[1].

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[1] Link to video of Cordelia Fine: http://www.articlesbase.com/videos/5min/516946145

Dr. Beilock: Yes. One of the popular methods for analyzing neuroimaging data is to take activations from two groups or from two conditions and you essentially subtract it away. So, if you're looking at males' and females' brains and you want to ask about differences, what you do is you say there's activation for males here and there's activation for females here, and you sort of take the difference. And this may tell you something about differences between them, but it doesn't mean that that area wasn't active for the other group; it just might mean it's incrementally more active.

And so, oftentimes we see these blank brains with just one dot on them. It doesn't mean the rest of the brain isn't working; it just means that that one dot is working somewhat differently with respect to some baseline condition. And people see these things, and they're often led to jump to conclusions that just aren't necessarily warranted by what the research has done. So, you just have to be a good sort of consumer of this work, just like you would be of any other work.

Dr. Campbell: OK; I know you don't want to spend a lot of time on that, but it's just something I think is important, because the average person doesn't really know how to tell whether the stuff they're being presented is being exaggerated, or what it really represents. The other problem, that we don't even have time to get into, is if the experiment is not well-designed.

Dr. Beilock: Yes, and that's a big problem here, because, as you had mentioned before, oftentimes what we're looking at are different scores, or subtractions from one condition to the other. And so, if I say the temporal lobe is active when people do some sort of face recognition task, you want to say active relative to what. Because there's a baseline that people are using to say that this area is active; they're subtracting something out. Maybe it's looking at a blank screen, or maybe it's looking at houses instead of faces, but it's really important what that baseline is. So, when you're talking about this area is active, you want to know active relative to what.

Dr. Campbell: Good point!

So, how much of your book is based on your lab's research?

Dr. Beilock: There's a good part of the book that draws on the work that I've been doing; but I also survey the field, because there's a lot of great work out there really trying to understand the phenomenon of choking under pressure, and how anxiety and stress gets the best of us. So, my goal is to take a lot of the research that's been done in cognitive science, and bring it to people who might not necessarily have PhDs in psychology or neuroscience, but people who are interested in understanding a little bit about some of the basic principles behind human performance, and bring it in a way that's accessible, so that they can actually take it for the basic science, but also learn something interesting about how to apply it in their own lives.

Dr. Campbell: So, I guess that's the reason why you wrote the book, was to reach that audience?

Dr. Beilock: Yes. I spend a lot of the time talking to the media after the work we do comes out, and oftentimes my ability to reach the broader audience is limited to a couple-of-minute interviews. So, I wanted to be able to take the time to really put all this work together to give a coherent picture of what we know and how people can use it.

Dr. Campbell: And I'm interested in your work because, doing the *Brain Science Podcast*, I'm very interested in bringing the research to regular people in a way that tells them why they should care—why it matters. And I think this is a perfect example of a practical application of basic research.

So, I guess we could get into some of the stuff that's in your book. Perhaps you should start by defining what is choking.

Dr. Beilock: Right. Choking is something, as I mentioned before, that we all talk about, but it's really important that we're all on the same page in terms of thinking about it. How I define it is, it's really suboptimal performance—poorer performance than you would have in a non-stressful situation. And it's really poor performance in response to the perceived stress of what's going on. So, someone else doesn't have to think the situation is stressful, but you have to think it's stressful, and because of that, you end up performing below your ability. And these stresses can come in many forms: it can be sitting for the SAT, or trying to make the Olympic team, which are, I think, classical examples of stressful situations—interviewing for a job.

These stresses can come in more covert ways. For example, parallel parking in front of your spouse can be a real stressful situation that could lead to worse performance than you would otherwise exert. Or even a minority student, answering a question as the rest of the class looks on, might show symptoms of choking, just because they're aware of stereotypes about how they should perform because they're a member of a group that may be stereotyped not to perform well in school. So, maybe this is women in a math situation, or African-Americans in many academic situations; just that knowledge of the stereotypes out there about how they should perform can lead to these choking effects.

Dr. Campbell: Is it true that the better you are at something, the more likely you are to choke?

Dr. Beilock: Well, there is some work suggesting that as you become better and better at performing a skill, and especially activities that become habitualized or automatic—we talk about it as 'proceduralized'—as you become better and better at performing these skills your need to attend to every detail of performance goes away. So, this might be giving a memorized speech, or hitting that three-foot putt, or that free throw. And one thing that we've shown is that these highly-skilled performers are really susceptible to poor performance, because one thing that happens in these stressful situations is that people become conscious of what they're doing; they start trying to control every step of their performance, in a way that actually disrupts it.

It's as if you were shuffling down the stairs to get to a meeting, and I asked you to think about how you were bending your knee as you did that; there's a good chance you'd fall on your face. And the reason is that you don't need to exert explicit control over every step of your movement. When you do, you slow down how your limbs are coordinated together, and you disrupt what you're doing. And we think that one thing that happens in these stressful situations, especially, for example, in the athletic domain, is that people start paying too much attention—they exert too much of their explicit attention to what they're doing; which actually disrupts their performance.

Dr. Campbell: Are there different types of choking?

Dr. Beilock: Yes. I mentioned that one thing that happens in these stressful situations is that people often become self-conscious about their behavior, which, in turn, causes them to focus on elements of what they're doing, that disrupts them. One of the ways I talk about choking, in general, is that we essentially have a malfunction of the prefrontal cortex. This is the front part of your brain that sits right over your eyes, and it's really the seat of our thinking and reasoning ability. And in these stressful situations, what we've shown is that people often have thoughts or worries about the situation and its consequences, and this essentially uses up important resources—our ability to think, attend on the fly—and essentially causes people to do a couple different things.

One is they don't have as much cognitive horsepower—I talk about it's something that's often talked about as working memory. This is our ability to attend to some information and ignore others. They don't have as much of this attention to devote to the task, and so, this can be really detrimental if people are performing an activity that requires lots of attentional control—say, doing a math problem, or responding to questions on the spot. But another thing that happens is that, because people are worried, they become really self-conscious; they want to have a perfect performance. And this leads them to focus really hard on elements of what they're doing that should just be left outside conscious awareness.

So, it's sort of this double whammy that occurs. You have less of this important cognitive horsepower you need to focus on tasks that require a lot of it, but you're also devoting some of these resources to sort of the step-by-step details of what you're doing, in a way that's really counterproductive.

Dr. Campbell: And then, I guess if you're comparing something like sports, where you might be using your frontal lobes when you shouldn't be, vs. taking a test, I guess the thing they both have in common is the role of stress.

Dr. Beilock: Yes. The interesting thing is that you can have the same sort of pressure situation, and the stress that you feel might not be any different whether you have a pencil or a golf club in your hand, but how it plays out in terms of disrupting your performance may be quite different. So, when you worry about the situation and its consequences, that eats up that working memory—that cognitive horsepower you need to take the test. So, right there you're in trouble.

But eating up that cognitive horsepower may not be so bad if you're trying to take that winning putt. In fact, it may be great, because it sort of keeps the frontal lobes out of what you're supposed to be doing. But what's problematic is that attention, that extra control you try and exert because you're trying to ensure that you have this optimal performance—thinking too much—is what ends up being detrimental in those proceduralized, habitual, automatic type tasks.

So, knowing that is really important, because then it gives you some tools for how to fix it. And it's not necessarily a one-size-fits-all; but knowing the science gives you actually some simple techniques that you could use when you step up to the plate in an athletic event vs. when you sit for that test.

Dr. Campbell: Let's look at the concrete example of test-taking for a minute. Why is it that it seems to be the good students that do bad when they take the big test?

Dr. Beilock: This is a finding that comes from work I've done for several years in my lab; and we were really interested in who was most likely to perform poorly in these high-stakes testing situations. And these high-stakes tests are becoming such a ubiquitous part of our educational system, that we really thought it was important to understand how just the pressured environment of taking the test might impact students' performance.

One study I talk about in the book is we brought students into our lab, and we measured their working memory before they did anything. As I mentioned before, you can think of working memory as a kind of mental scratchpad that helps you work with whatever information is held in consciousness. It helps you keep some things in and some things out; it allows us to focus our attention and ignore distracters. And it turns out that people who have higher working memory generally tend to do better in school. They're better able to focus on what's important and ignore everything else.

But we thought that having all of this cognitive horsepower at your disposal might actually be a detriment in stressful situations, because we know that worries tend to flood working memory when people are under stress, and we thought that it might impact those people who are relying heavily on this cognitive horsepower to begin with. And what we showed is that for students who have the highest working memory—so, students most capable of achieving—they were actually the ones who were most hurt by the pressure of the situation.

Students who had lower working memory—less cognitive horsepower—didn't show any performance drops under pressure. And one of the reasons that we've demonstrated this is the case is because the best students come in essentially solving problems in different ways than those poorer students. Those students high in cognitive horsepower—those students with a lot of working memory—tended to work through very difficult algorithms to get the answer. And when they had all the time in the world, when they weren't under pressure, this was a very accurate way to get to the answer, and they scored much higher on several different types of tests we've given them, than students lower in working memory.

But when they are under stress, now these students who are most capable all of a sudden don't have that same brainpower they normally rely on to succeed, and as a result their performance drops. In contrast, the students with less working memory tended not to use the complicated strategy to begin with. They used maybe some sort of heuristic or a reasoned guess, and so essentially they weren't really relying on that brainpower that was zapped by the stress to begin with, and so, they had nothing to lose.

Dr. Campbell: When I was reading that I found myself thinking about, way way back, 30 years ago, when I took the MCAT to get into medical school; and I remember—because I came from engineering—that the only prep I did (because back then it wasn't all this prep craziness) was learn how to do the physics things, without the differential equations. Because I knew that whatever physics was going to be on that test was going to be being done by biology majors, and they weren't really going to intend for me to solve it the hard way; and I wanted to make sure I relearned the easy way.

Dr. Beilock: Right. Sometimes solving it the hard way can be really detrimental in those situations, because it opens up the opportunity for error—for you to make mistakes that you might not otherwise make if you weren't in a time-pressured situation, for example. And that's one of the things that these test prep courses teach. They teach tricks of the trade—ways, often, to circumvent the complicated algorithm, to get the right answer to the problem without loading your working memory.

Dr. Campbell: When it comes to working memory, how important is genetics? Can we actually improve this with training?

Dr. Beilock: Yes. This is a really interesting question; and I talk about some of this in the book, as well. There is some work showing that there is a genetic component to working memory. So, some of this is inherited. However, there's also lots of really neat new work coming out showing that working memory can be trained: just like you can improve a muscle with weight training, you can train your cognitive horsepower.

There's some work showing, for example, that kids who have ADHD—and working memory tends to be a major deficit underlying ADHD—can improve the symptoms they have of this disorder with working memory training; both how they perform in the classroom, and actually their behavior. The idea is that training this executive function capability, training this cognitive horsepower allows you to exert control over what you attend to and what you don't. So, it diminishes, essentially, distractibility.

And this brain training seems to have some widespread effects. I blog[2] for *Psychology Today*, and I just wrote a blog last week about a new article that came out in the journal, *Psychological Science*, showing that working memory training actually led to decreased alcohol abuse in problem drinkers[3]. The idea is that one of the reasons people drink and abuse alcohol, even when they have intentions or

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[2] http://www.psychologytoday.com/blog/choke

[3] Houben, K., Wiers, R. W., & Jansen, A. (2011). Getting a Grip on Drinking Behavior : Training Working Memory to Reduce Alcohol Abuse. *Psychological Science*.

goals not to, is because they don't have the control, essentially—the self-control—to inhibit taking that drink.

By training this general inhibitory ability which is at the heart of working memory—to attend to some things and ignore and inhibit others—you essentially are able to improve performance in all facets of your life. There's even work I talk about in the book showing that mothers are less likely to be reactive to a tantrum thrown by a child, the higher their working memory is. Again, it's about controlling, inhibiting, regulating the emotions, so that you can respond in a reasoned way.

Dr. Campbell: And I noticed you also said in the book that we know that teenagers and adolescents, their frontal lobes aren't totally on line yet, and so they sometimes have impulse control issues. So, I got a kick out of the fact that you said sometimes adults, when they're under stress, basically their brain function goes back to that of an adolescent.

Dr. Beilock: Yes. The frontal lobes develop very slowly. They don't stop developing well into the 20's, and teenagers are often characterized by making poor decisions, poor impulse control, not able to keep their emotions at bay. And one of the big functions of the frontal lobes is to regulate and control some of the emotional areas of the brain, to control our emotional reactions. So, one of the reasons teenagers tend to be poor at this is because they don't essentially have the brain mechanisms yet to do it.

And, as I talked about before, under stress, when our working memory is zapped, we essentially don't have this control as adults. So, it's often like we revert back to our teenage brain. In essence, we often let our emotions get the best of us; we're not good at attending to what we want to and ignoring others, which can lead us to be distracted by worries on a test, and also start perseverating on what our wrist is doing when we're just trying to get the shot off in the important game.

Dr. Campbell: What about video games? Can they help?

Dr. Beilock: Yes. I think this is every parent's nightmare to hear that video games, there's some benefit. Maybe that's good, because then they feel better about their kids playing them. But there is work showing that playing video games can be a way of brain training. It can hone some of the visual, perceptual, and even working memory type skills that are so important.

Of course, it depends on what video game kids are playing, and for how long they play them. The work that's shown some of the benefits, it's often playing for 10 hours a week, or 10 hours over a long period of time. So, there's probably some diminishing returns if you're always stuck to your computer.

Dr. Campbell: Right. You also mentioned Torkel Klingberg. I almost interviewed him a couple of years ago, but we just couldn't get our schedules together. He's doing some computer training with helping people to improve their working memory[4].

Dr. Beilock: Yes. He uses a computer-based working memory training program. Actually, this alcohol study I just mentioned used something very similar to what the Klingberg lab uses. Essentially what happens in these studies is they bring people in—whether it's kids with ADHD, or alcohol abusers, in the context of the recent study I told you about—and they assign people randomly to working memory training on the computer several times a week for a month or so. They do a bunch of different tasks designed to give their working memories a workout.

As I talked about before, working memory is like this mental scratchpad that allows us to hold on to information in consciousness, and so, essentially learn to build your ability to hold this information in the face of distraction. And one of

[4] *The Overflowing Brain: Information Overload and the Limits of Working Memory* by Torkel Klingberg

the neat things about these studies is they assign some people to a training group, where they actually increase the amount of information they're having to hold in working memory. So, your working memory keeps on getting more of a workout across the training sessions.

But for the other group, they stay at the same place for the course of say, a month. And so, it's just like if you exercised and never pushed your body to work any harder, you wouldn't see improvements in either your cardiovascular fitness or your strength. The same thing goes for this working memory training. What they show is that that group that had the working memory workout, who was constantly pushed to hold more in mind, to keep more things out that were maybe distracting, showed increased working memory and increased ability to perform well in a variety of areas; where that group that just stayed at the stagnant level did not.

Dr. Campbell: So, I guess that's a good opening for me to ask you if you have any practical advice for dealing with situations that require using our working memory.

Dr. Beilock: Yes. In the book, as I mentioned, I talk a lot about the basic science behind poor performance, but I also give some tips to try and alleviate it. We just had a paper come out in the journal, *Science*, in January [5]—and I talk about some of this work in the book, as well—where we showed that one really great way to help free up working memory, especially when students are sitting for tests in stressful situations, is to do something rather counterintuitive.

It's actually to sit for about 10 minutes before you take an important test—or this can apply to giving a speech, a business meeting, or even getting ready for that sporting event—and to write about your thoughts and feelings about what's about

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[5] Writing About Testing Worries Boosts Exam Performance in the Classroom Gerardo Ramirez and Sian L. Beilock *Science* 14 January 2011: 211-213. (*Science* podcast interview)

to happen. There's research out there that we borrowed from clinical psychology literature, showing that getting people to write down their thoughts and worries serves as a download. It frees them from recursively ruminating on what they're thinking about. And, in essence, it's been shown to free up working memory.

So, we showed that students who wrote about their thoughts and feelings before they took a really important test—just for 10 minutes before they took the test—scored much higher than students who didn't write about their thoughts and feelings; maybe they wrote about something they did the day before, or even what they thought might not be on the test. The idea is that offloading your worries essentially frees up working memory, so that it's not distracted by these worries when you're actually taking the test.

Dr. Campbell: It also helps to practice under some simulated pressure, doesn't it?

Dr. Beilock: Yes. I mentioned before that one of the things these test prep courses do is teach tricks of the trade for maybe how to circumvent some of the demands on working memory when you're actually taking the test. But I think the biggest benefit of these courses is that they give students tons and tons of practice in real timed tests. One of the things I talk about in the book is that it's practice under pressure that makes perfect. Our ability to execute an activity or a skill when no one is watching is great, but when we want to really ace that exam, that speech, interview, or that game, when the stress is on, we have to get used to the stress that we're going to feel.

The great thing is that our brains and bodies are great at learning by analogy. There's research showing that just getting used to a little bit of simulated pressure gets us ready for that real do-or-die event. And this is very similar to what happens in the military; the FBI does it. They simulate the types of situations that their officers or soldiers are actually going to face when they get into the real important situation. Of course, you can't mimic it completely, but just getting used to a little bit of it adapts you in such a way that when the real stress comes you're ready to perform at your best.

Dr. Campbell: Yes. I work as an emergency room physician, so naturally, that's what we do. We practice cardiac arrest situations on a regular basis. But the other thing I've noticed is that, since I've been doing this work for about 20 years, when I go out on the tennis court I feel much more relaxed, because I always can say to myself, *Whatever shot I miss, or whatever, no one's going to die.*

Dr. Beilock: Yes, that can relax you, you're right; you're putting everything in perspective. But I'd be willing to bet just your experience performing in those stressful situations spills over to help you deal with the stress. Or maybe you know how to interpret a physiological response if you get sweaty palms or a beating heart. You know how to interpret that; you know that those responses before have led to success. And so, you can interpret that in a way that actually leads to a positive performance. And there's research I talk about in the book showing that how you interpret those reactions really matters, in terms of whether or not you're going to succeed or fail.

Dr. Campbell: Right.

Now, you spend a lot of time in the book talking about the various things that cause people to have problems when they're taking a test. And, to me, the most important one was what you called the 'stereotype threat.' Do you want to talk a little bit about that, and how it works?

Dr. Beilock: Yes. The stereotype threat is this phenomenon that social psychologists have discovered in the last decade or so. It turns out that just being aware that someone endorses a stereotype about how you should perform because of your membership in a gender group or a racial group, just being aware of those stereotypes can cause people to perform more poorly than they would otherwise. It can cause them to choke.

The really interesting thing about this phenomenon is that the person who's aware of the stereotype doesn't have to endorse the stereotype; they just have to know that someone else believes it. And so, it can be really problematic, because it turns out that just being aware that people hold stereotypes about how you should perform can lead you to fail, even if you don't endorse them.

Another interesting thing about this stereotype threat phenomenon is that it tends to affect those at the vanguard of their field. People who want to perform well, who are really most invested in performing well, are the ones most impacted, because they essentially have the most to lose. As an example, there's been work done with African-Americans at Stanford University. These are high-achieving African-Americans, who are invested in their intellect and performing well. And it's been shown that just making them aware of stereotypes about race and academic ability can lead them to underperform.

This awareness doesn't have to be in a very explicit form. There's work showing that just checking off your race, if you're African-American, before you take a standardized test like the SAT or GRE, leads to substantially worse performance than if you hadn't checked off your race beforehand. And the same thing happens for women in taking the quantitative section of the SAT. Just checking off their gender before they take this math portion of the SAT will lead them to perform worse than if they hadn't done that.

Dr. Campbell: That's something I just found really amazing. I know it's been replicated. It's hard to wrap your head around. But I guess you did point out a very simple solution in your book, which was just put that stuff at the end of the test, instead of at the beginning.

Dr. Beilock: Yes. And there have been pushes by psychologists and educators around the country to really put some pressure on ETS—the Educational Testing Service, for example; the makers of the SAT and the GRE—to do some of that. It's been implemented at more local levels. But the idea that you're putting all this information down that might stereotype you, or bring up stereotypes about how you should perform as a member of some minority group, for example, to the extent that it exists (and there's lots of work suggesting it does), it's a quick fix.

[music]

Dr. Campbell: One of the things I read with a great deal of interest was, of course, the stuff about women and math[6]. You answer this in the book, and I just want to make sure we bring it out: how is it that we really know there's not a significant genetic difference between men and women when it comes to aptitude for science and math?

Dr. Beilock: This issue has gotten so much attention in the media as of late—which is good—but especially sparked by remarks by Larry Summers, who, when he was president of Harvard, suggested that there were these general differences between men and women. I talk a lot in the book about this issue, just really to underscore this idea that expectations and exposure in your environment can have a big impact on whether you underperform or not—especially for girls in math. My goal is to just bring a lot of the research that's out there to the forefront, showing that there can be really significant differences in how girls and women perform, depending on whether they've been exposed to the same sorts of support and materials as boys, and whether they're operating in an environment where these stereotypes hang on their shoulders.

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[6] See also: *Delusions of Gender: How Our Minds, Society, and Neurosexism Create Difference* by Cordelia Fine

And there are some really powerful findings suggesting that a lot of what dictates whether a woman is going to succeed in math and in science depends on her environment; depends on these expectations that she and others around her hold for success. The research out there suggests that any differences that there may be early on don't seem to translate into complex math and science; where those differences really come from is in terms of opportunities, exposure, and attitudes.

Dr. Campbell: I was impressed by the point you made about the fact that the difference in scores doesn't come across in all countries. If you look at countries where these stereotypes don't exist, women test just as well as men.

Dr. Beilock: Right—which really drives home this idea that it's a lot about the climate these men and women live in that predicts how they're going to perform. And it goes right along with this phenomenon of stereotype threat. If I tell a woman, right before she takes a math test, that I'm looking at gender differences in math, this brings up this idea of this commonly-held stereotype, and can lead her to perform more poorly than if I hadn't made that remark before.

Dr. Campbell: So, I'm going to sort of shift gears now. While it seems intuitively obvious that stress can impair a performance, do we know anything about what's actually going on in the brain when this happens?

Dr. Beilock: I talked a little bit about the malfunctions of the prefrontal cortex; this idea that oftentimes our working memory is not working the way it should. And there are several studies I talk about in the brain, showing, for example, that the connections between the prefrontal cortex and other areas of the brain, when people are under stress maybe aren't as fluid as they might normally be.

There's a great study [7] with Cornell medical students who are getting ready for their Boards, I believe. What they did is they used functional neuroimaging to look at brain activity when these students did pretty simple tasks—reaction time tasks, maybe trying to figure out which of a sequence of shapes presented to them is not the same as the other ones; pretty simple tasks that really just get at your ability to attend, to perceive, to get rid of distractions. And they did these simple tasks two months before they were studying for their Boards—when they're in the heat of the stress—and then, a month after.

What they did is they looked at neural activity for these medical students, and compared it to activity of people who were matched for education, for age, but just weren't getting ready for their exams. And they showed that in these medical students, the frontal part of the brain (the prefrontal cortex; an area called dorsolateral prefrontal cortex, which is a really important part of our working memory system) just didn't seem to be communicating as well with other brain areas. They showed sort of a lack of connectivity between this prefrontal cortex and other important areas of the brain that we need to perform at our best.

Our brain, just like a symphony, works as a network in concert. And what they showed is when the stress was at a high level, there was a lack of, I guess you could talk about it as 'fluent connections,' compared to people who weren't under the same sort of stressful situation. But one interesting thing is that when they brought these medical students back a month after they took the Boards, they showed that this lack of connectivity had gone away. So, it really was being in the stress of the moment, under the stress of getting ready for this exam that changed how well the brain communicated to impact performance. And indeed, these students, when they were getting ready for the exams, didn't do as well on these tests of attention and working memory as they did once the exams were over.

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[7] C. Liston, B. S. MeEwen, and B. J. Casey, "Psychological stress reversibly disrupts prefrontal processing and attentional control." *Proceedings of the National Academy of Sciences*, USA, 106 (2009), 912-917. (Abstract)

Dr. Campbell: And I guess the sleep deprivation of being on-call would be a really good way to bring out these kinds of problems.

Dr. Beilock: Yes, there is definitely a lot of work showing that a lack of sleep can have important and significant effects on our ability to attend, reason, think, and function at our best.

Dr. Campbell: We used to joke, when I was a resident, that when we were tired it took two of us to have the brain of one person.

Dr. Beilock: Yes; and it's an important issue. There has been some work, for example, showing that one of the places where being in these sorts of situations (either sleep deprivation or stress) breaks down is when people are communicating with each other. And so, for example, as medical practitioners often have to do—transfer information about a patient from one person leaving a shift to the other person going on to the shift—oftentimes people tend to overestimate what the other person understands of them; and this seems to be especially true in times of stress, or in stressful situations. So, that important transfer of information from one to the other: it's not about the connections just within your own brain, but the connections across people, that can be really hurt in these times of stress.

Dr. Campbell: Yes. I have definitely experienced that.

So, is there anything that we can do to prevent choking on that big test?

Dr. Beilock: Yes. I talked about practicing under pressure. Writing down our worries is a really important one. In the book I talk a lot about other practices that people have used. For example, meditation has been shown to train our ability to perform at our best in stressful situations. There are a lot of other things that can be used in that moment. So, writing down the intermediate steps of a problem, not trying to do it all in your head, gives a break to your working memory, so that you aren't zapped in that stressful situation.

Or, if you are feeling stereotyped about how you should perform, or you're aware that there are these issues out there, taking a couple of minutes to write about all the things you're good at—to affirm yourself—can actually be enough to take you in a different direction, to give you a positive outlook that changes, essentially, how the brain is functioning to perform at one's best.

Dr. Campbell: You mentioned in your book a study that you did in your lab where you gave people 10 minutes of meditation instruction before testing, and it seemed to make a difference in their score that was significant. Has that study been replicated by anybody else?

Dr. Beilock: There's some work coming out now. I just heard an abstract the other day of a paper showing that this sort of meditative training can have an impact on how people process emotional words, and how they function in stressful situations. So, it wasn't the exact same study that we did, but very similar conclusions coming out.

Essentially one of the things that meditation does is it gives us a greater ability to let go of information—to not perseverate on it. And that's one of the things that you need to do in these testing situations, for example, is not perseverate on these worries, but essentially put them aside so you can focus your attention on the important information at hand. Meditation seems to help people bolster those abilities.

Dr. Campbell: There certainly is plenty of documentation that this actually changes the brain. I guess a lot of it is been done by Rich Davidson at Wisconsin. You mentioned his work in your book[8].

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[8] A. Lutz, H. A. Slagter, J. D. Dunne, and R. J. Davidsons, " Attention regulation and monitoring in meditation," *Trends in Cognitive Science*, 12 (2008), 163-169.

Dr. Beilock: Yes. Richie Davidson has some interesting and exciting work showing these brain changes as a function of meditative practices. And I think one of the neat things about some of the work he's done—and others—is that you don't have to be a Buddhist monk, or a Yogi who's practiced this for 30 years. Of course, they do look different in terms of how their brains respond to information than someone who doesn't meditate. But there's now work coming out showing that as little as 10 hours of meditative practice can change some of the wiring of the brain. And so, one of the neat things about this is it suggests that we can use it, even sparingly, to really improve our performance.

Dr. Campbell: I would definitely endorse that. I mean I've actually done a little bit of meditation, myself, and I think it does really allow you to learn that 'let-go-of-it' skill that some of us find hard to do.

[music]

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[music]

Dr. Campbell: So, we've been talking, Sian, about how stress causes people to choke on the big exam. Of course, when I hear the word, 'choke,' I usually first think of athletic performances. Do you want to talk a little bit about how choking on the field differs from that of taking a test?

Dr. Beilock: Right. I talked about this idea that in these stressful situations we worry—we worry about the consequences of the situation, about how others might look at us—and these worries flood the working memory that we would have otherwise to focus on an important exam. But these worries also cause us to start trying to control our performance, in order to ensure an optimal outcome. And this control is what can be detrimental when we're performing those habitual, automatic activities that often occur on the sports field.

The idea is that in these situations, that added attention to the details of our performance—and this has been shown with neuroimaging work showing increased activity in certain parts of the frontal lobe, that aren't there when people are not under stress—it tends to be almost too many cooks in the kitchen, if you will. It's too much control in terms of what we're doing. And we've shown that some pretty simple things can help.

For example, distracting yourself a little bit when you're taking that important shot essentially prevents the frontal cortex from monitoring in a way that's counterproductive: maybe it's singing a song; we've shown that counting backwards by three's, even thinking about your pinkie toe can sort of focus your attention, and prevent you from deconstructing your movements in a way that leads to a flubbed performance.

We've also shown that actually speeding up your performance slightly can be beneficial. This idea that 'haste makes waste' doesn't always seem to be true; because the idea is that attention, focusing on those steps of the performance, takes time to deploy, and if you speed yourself up a little bit, you prevent that from happening. So, we've shown that highly-skilled golfers actually putt better under stress when we push them to go just a little bit faster.

Dr. Campbell: Of course, athletes, I think many of them understand this intuitively. That's why teams use icing.

Dr. Beilock: Yes, calling the time-out right before a kicker steps up on say, the football field; there's definitely evidence out there that it does occur, and that in those pressure-filled situations when it will make or break a game, icing the kicker has been shown to significantly lead to poorer performance. Teams have this idea that it works, but what our research suggests is why; and one of the reasons is it gives the kicker time to think—to dwell on their performance—in a way that messes up what would otherwise be this fluent routine.

Dr. Campbell: So, what's the defense against icing?

Dr. Beilock: Again, it's taking your mind off the steps of what you're doing: singing a song before you get up there, so that you're not, essentially, deconstructing the kick in your head before you step up to the ball. Thinking about the outcome—where you want the ball to go—rather than how it's going to get there, makes it such that the well-practiced routine you have knows what to do, and knows to just run off on its own, in essence. There's work showing that if athletes just focus on the hole where they want to hit it, they get the rest for free. And the idea is that you spend so much time linking a behavior, an action to an outcome, focusing on the outcome actually primes or prompts that behavior to run off on its own.

Dr. Campbell: Trusting our body, or brain/body—that it knows how to do it, because we've practiced it so much—and getting out of the way, as they say.

Dr. Beilock: Exactly!

Dr. Campbell: Do you ever do any work with medium-skilled athletes? I mean ones that aren't like super-elite, but ones that have been playing sports—say, for example, recreational tennis players—a long time; people like me, who will take lessons, but don't have the time to practice hours and hours a day. Sometimes it's hard, when you get in a match, to make that transition to not doing that.

Dr. Beilock: To not doing what, exactly?

Dr. Campbell: To not thinking about what you think about while you're in your lesson, and go to thinking about the goal.

Dr. Beilock: Right. You bring up an important point: that there's a difference between what you're going to think about in practice (especially if you want to change something), and what you're going to think about when you're actually in that match. And oftentimes you have to think about particulars of your movement to change your stroke or change your footing when you're in practice. And so, the question is how do you stop that when you get into an actual match.

The answer is that you've got to practice what you're going to do in the match in practice. So, if you spend part of the time thinking about changing your footing or changing your stance, then you also have to spend part of practice not thinking about it—focusing on the outcome; playing for your performance, rather than just playing to improve. That's an important distinction; and you have to practice both if you want to go out in a match and not be overwhelmed by all the things that you have learned about in practice.

Dr. Campbell: Yes. I just find that to be a common problem of people at the level that I play. And the other one is people that get nervous when someone is watching. I guess the answer to that is pretty obvious: practice with someone watching!

Dr. Beilock: Yes. Or it can be something small, like videotaping yourself. If you play with a video camera in front of you, and you know that you might show that to a coach or a friend, just that awareness gets you used to the type of all-eyes-on-you that you might feel in the real situation. There is research I talk about in the book showing that actually, ironically, having family and friends as supportive audience tends to make people more self-conscious; more aware. So, if you plan to invite all your friends to the big match, I suggest you invite them to practice, too.

Dr. Campbell: I am the generation when parents didn't pay any attention to kids' sports; and, to me, it's just ridiculous that parents won't even let their kids practice without being constantly under their watchful eye. But I guess that could be the upside of those 'helicopter parents.'

Dr. Beilock: Yes. I guess that might be one upside; although I talk about some work in the book showing that kids who tend to have more recreational play, kids who have more opportunity for unstructured play tend to be the ones who are more likely to end up as professional athletes. The idea is that having more of those opportunities to play lots of different sports and experience things, and especially lots of informal play, hones a lot of those skills kids need to succeed at the later ages.

Dr. Campbell: Yes. I found that really interesting; and one of the things we don't have time to get into today.

So, you have a list of tips in your book for athletes and performers. Is there one that you think is the most important?

Dr. Beilock: I think they're all important. And some people might find some more useful than others; but I think this general idea that just knowing that one of the reasons that people perform poorly, especially when they're performing something they've practiced in the past—something that has become rather habitual—is that they start trying to deconstruct it in the moment.

So, applying techniques that prevent you from doing that, whether it's singing a song to yourself, or coming up with a one-word mantra that sort of encapsulates the whole movement you're about to do can really focus your prefrontal cortex in a way that is to your advantage, rather than letting it run amuck, essentially deconstructing what you're doing.

Dr. Campbell: Professional athletes do this all the time with their various little routines that they do.

Dr. Beilock: Yes. A lot of these pre-performance routines and the rituals, in my mind, are a way to sort of focus them on one point, and prevent them from starting to think too much about every step of what they're doing. This idea that athletes can't often tell us what they did, after the fact, is a true testament to this idea that performing well in these situations doesn't require a lot of explicit attention.

I've done work showing that highly-skilled athletes, especially when they're performing their best, have really poor memories for what they just did. And the idea is that if you're not attending to everything you're doing, you're not going to be able to remember it later.

Dr. Campbell: Is there anything else you want to share before we close?

Dr. Beilock: No. I mean I think really what I'm hoping to get across in my book is that by understanding a little bit of the science behind why we perform poorly, it gives us this great, great advantage in terms of finding tools that will work to perform at our best. And so, that's really what this book is about; it's designed to give people a bit of the science behind how people excel, and why they sometimes fail, and from that, to give them practical take-home tools that they can use to excel in whatever endeavor they want to perform.

Dr. Campbell: Do you have any advice for students who might be interested in learning more about the field of human performance?

Dr. Beilock: Well, they could start with my book, of course. But then, I think it's finding some of the research that people I talk about in my book are doing, and reading it, learning who's doing what; and if you're an undergraduate thinking about graduate school, then contacting those folks and seeing if they have room to take you under their wing.

Dr. Campbell: I really have enjoyed talking with you. I've always been interested in the peak performance, and, obviously, the choke is the other side of the coin. We've all experienced it, so this is some information that I think everyone can use. So, I appreciate you taking the time again.

Dr. Beilock: No problem.

[music]

I want to thank Sian for taking the time to talk with us. I hope this interview gave you a feel for the kind of practical information contained in her book, *Choke: What the Secrets of the Brain Reveal About Getting It Right When You Have To.*

If you want to perform better under stress, I think the first thing you should consider is what kind of task you will be performing. If it's one that involves the use of working memory, like taking a big test or performing a complex intellectual task, then one key is to reduce the load on your working memory as much as you can. This would include things you do beforehand to avoid having working memory sidetracked, such as journaling as a means of offloading your pretest worries.

But it also means saving your working memory for the essential tasks. For example, if you are solving a complex problem, don't be afraid to write things down as you go. A great example of this is the checklist that pilots use before takeoff. While preparing for takeoff isn't necessarily stressful, it is a place where distractions can easily occur. Those checklists help to make flying safer. In medicine, similar tools have proven effective, but there is often resistance to their use. Perhaps it would help if medical personnel were more aware that these failures of working memory are common under stress, and can happen to anyone.

Now, when it comes to performance of a practiced physical task, like hitting a tennis ball or playing a musical instrument, choking involves almost the exact opposite problem: too much thinking. We have to get out of our own way and trust all that practice we have done. But one thing that both sports and intellectual performance have in common is the value of practice. High-quality practice means simulating the actual situation as closely as possible, whether that means playing in front of an audience or taking a practice test with a time limit.

So, as I said in the introduction, I think that Sian's book contains practical information for everyone. If this area interests, you, I encourage you to read her book.

Before I close by telling you about next month's episode, I do want to make a few brief announcements. First, for those of you with iPads, I want to remind you that the *Brain Science Podcast* app is now iPad-compatible; which means it's now the perfect app for reading episode transcripts. The *Brain Science Podcast* app is also available for Android devices. And when you buy the app I get 35% of the cost.

Next, I want to suggest a relatively new podcast that you might not have heard yet. It's called *Triangulation*. It's from the TWiT network, and in it they interview a wide variety of interesting people, mostly from science and technology. One of the early episodes was an interview with Ray Kurzweil. The most recent episode, Episode 19,[9] is an interview with Miguel Nicolelis, who is the researcher at Duke who is best-known for his work demonstrating that

[9] I erroneously refer to this as Episode 12 twice. Thank to Lori Wolfson for correcting this error. VAC

monkeys with electrodes implanted in their brains can control a robot arm thousands of miles away.

This interview gets off to a slow start, but if you stick with it you won't be disappointed. Dr. Nicolelis makes some very interesting comments about why he doesn't think the singularity is near. He also has a new book out called *Beyond Boundaries*, which I am looking forward to reading. I will put a link to *Triangulation* Episode 19 in the show notes.

Don't forget to visit brainsciencepodcast.com for detailed show notes and episode transcripts. If you want to share your thoughts about this episode, or the *Brain Science Podcast*, in general, you can write to me at docartemis@gmail.com. You can also post comments on our new discussion forum at Goodreads, or on our Facebook Fan page. Links to all this, and more, can be found at brainsciencepodcast.com.

Next month I will be talking about a book by Fabrizio Benedetti called, *The Patient's Brain*. I will be focusing on what happens in the brain in response to placebos. I think you will be surprised by some of the research findings.

Until then, I hope you will remember to check out my other podcast, *Books and Ideas*.

Thanks again for listening. I look forward to talking with you again soon.

[music]

[music]

Transcribed by Lori Wolfson

All errors or omissions responsibility of the transcriber