BRAIN SCIENCE PODCAST

Dr. Ginger Campbell, MD

Episode #104

Seventh Annual Review

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INTRODUCTION

This is Episode 104 of the *Brain Science Podcast*, and I'm your host, Dr. Ginger Campbell. Today's episode is our Seventh Annual Review episode. If you're new to the *Brain Science Podcast*, you might want to skip ahead a few minutes to the meat of this episode.

I want to take a few moments to thank those of you who have supported my work over the last seven years. More than once I've been tempted to quit, but your feedback has kept me going. I especially want to thank those of you who have made donations, or supported the show by buying the *Brain Science Podcast* app for your mobile device or my book, *Are You Sure? The Unconscious Origins of Certainty*.

Please listen all the way to the end of today's episode, because I will be making an exciting announcement that I hope will help keep the *Brain Science Podcast* going for the foreseeable future.

A few months ago, the *Brain Science Podcast* not only celebrated Episode 100, but it also passed five million downloads. Of course, that milestone was made

possible by those of you who have shared the show with others. Since the *Brain Science Podcast* is produced independently of any organization or publication, I rely on your word-of-mouth to help the show grow.

So, let's get into our annual review.

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DISCUSSION

In 2013, the *Brain Science Podcast* hosted ten wonderful guests, including three who made return visits. My goal for today is to consider a few highlights from the past year, and to encourage you to go back and listen to any episodes you might have missed.

We started out the year with a topic that most of us would probably prefer to avoid thinking about, which is pain. In Episode 93, I interviewed Dr. Fernando Cervero, author of *Understanding Pain*. Dr. Cervero has been involved in pain research for nearly forty years, and at the time of our conversation he was serving as president of the International Association for the Study of Pain.

His focus is two-fold: understanding pain, and most importantly, using this understanding to reduce the suffering of those in pain—particularly those who suffer from chronic pain, because it is becoming increasingly clear that the mechanisms of chronic pain are different from those of acute pain.

The first key point of this episode was that pain is a brain function. It is not just a sensory process, it also has an emotional component, and this emotional component is what turns pain into suffering. There is also a cognitive component that is actually very difficult to separate from the emotional part. Obviously, the meaning of the pain is very important.

Historically there was a debate about whether or not pain was purely emotional. This dates actually back to Aristotle, who thought that any sensation could be painful if it was excessive. Although some scientists still debate the sensory nature of pain, the evidence for the existence of specific pain pathways is overwhelming. This matters because one's assumptions about pain will obviously influence how it is studied, what questions are asked, and how experiments are designed.

Historically in opposition to Aristotle's viewpoint there was the viewpoint of Descartes, who thought that pain was merely a reflex or a warning signal. The problem with this viewpoint is that it really only works for acute pain.

The bottom line is that pain is a mixture of components: sensory, emotional, and cognitive; which means it's not one single experience. Or, as Cervero said, we do not have one pain, we have many pains. And these different kinds of pains have different mechanisms.

The International Association for the Study of Pain defines pain as a "sensory and emotional experience associated with tissue damage or described in terms of such damage." For example, the pain of heartbreak doesn't actually damage the heart, but it can certainly feel like it will. We experience pain; when it comes to pain, it doesn't matter whether actual tissue damage exists or can be detected, because the person in pain experiences the sensation that something is wrong.

It doesn't make sense to tell anyone that pain is all in your head, since that's where all pain happens; it's a function of the brain. One problem with trying to study pain is the challenge of trying to measure a subjective experience. And while it might be theoretically possible to measure the output of the so-called nociceptors, which are the nerve cells that detect noxious stimuli, that doesn't really tell us what the person is actually experiencing.

I'll give you the analogy of vision. We can know which retinal cells have fired, but that doesn't really tell us whether the person saw an object. Just as vision is processed on the way to awareness, so is pain. I think this is worth emphasizing.

Again, thinking back to what we know about vision, we know that things like what we expect, our emotional state, and all these different top-down influences actually do influence what we see. And this is probably even more true for the experience of pain. In fact, if we think of pain as a sensory experience, it will help us to understand many of its qualities.

For example, we know that we can only see a limited spectrum of light. When it comes to pain, some things we can experience as pain, and other potentially dangerous or damaging things, we can't experience. So, this is a two-edged sword, because those things that we can't perceive as painful can harm us. A benign example would be sunburn. We have no perception of ultraviolet radiation, so we can get a sunburn without realizing it. A more dangerous example would be radiation poisoning.

The discovery of pain pathways also means that scientists can try to study how the signal goes from the so-called 'primary neuron' in the periphery via the spinal cord to the brain. In the past, a lot of focus was on trying to block the pain at the level of the spinal cord. But this turned out to be less effective than expected.

One problem is that pain doesn't seem to be handled the way other sensations are. With the five basic senses we see something called 'adaptation;' so, constant stimuli tend to disappear from our awareness. Whereas, pain is the opposite; with pain, we get something called 'sensitization', which means that even a mild pain like a blister can become progressively more unbearable. So, you stop smelling an unpleasant smell, but you don't stop feeling a pain.

While you can imagine how this could be important for survival from an acute

injury, it is probably an important mechanism for chronic pain. As Dr. Cervero noted, in chronic pain the whole pain experience takes over; sensitization appears to be occurring both centrally and peripherally, which is why blocking it at the spinal cord is of limited effectiveness.

One challenge to trying to block these processes is to try to find a way to do it without blocking normal functions. However, one thing Dr. Cervero emphasized was that, although our current understanding is relatively primitive, we can relieve pain with opiates, but in many parts of the world people are suffering because of lack of access. He encouraged listeners to explore the International Association for the Study of Pain website and to find their country's pain society to learn more.

During Dr. Cervero's interview we didn't really have time to talk about the different types of pain and their mechanisms; so, I talked about this in Episode 95. I also recommend Dr. Cervero's book, *Understanding Pain: Exploring the Perception of Pain*. I think it should be required reading for physicians. But since it was written for a general audience, it can be enjoyed by anyone who wants to learn more about this fascinating field. Just remember that the key points are that pain happens in the brain; it's a sensory experience with cognitive and emotional components.

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In Episode 94, we talked with Benjamin Bergen, who is the author of *Louder Than Words: The Science of How the Mind Makes Meaning*. Bergen is a linguist, but this book was explicitly written for non-scientists. In fact, at the start of the interview we talked quite a bit about the challenges of writing this sort of book, because it's so different from the kind of writing that scientists are trained to do.

In *Louder Than Words*, Bergen describes quite a bit of the experimental evidence, while demonstrating a unique ability to make the material both fun and understandable. Bergen is one of a new breed of linguists who are teaming up with neuroscientists to study how our brains generate and understand language. I was attracted to his work because he has been strongly influenced by the embodied cognition movement, which is something that I've talked about a lot in past shows.

The focus of *Louder Than Words* is the experimental evidence for a new hypothesis which he calls 'embodied simulation,' which basically says that when we hear or read language, we use our perceptual brain systems to simulate whatever is being described. Now, this might sound weird, but we already know that something similar happens when we remember or visualize an experience. We know that memory reactivates the same sensory and motor circuits that were involved in the original experience, and visualization is an effective method for practicing a wide range of skills, because it also activates sensory and motor pathways.

The embodied simulation hypothesis is offered as a replacement for older theories such as the idea that language meaning is innate, or that language is translated into something called 'mentalese,' which is called the 'language of thought hypothesis.' We didn't get into the experimental evidence in great detail, but I think you can see how the hypothesis fits with our current knowledge, including the fact that people's understanding of language is strongly influenced by their culture and their personal experience.

Louder Than Words is an unusually fun read. It's the sort of book you might give someone who thinks they don't like science. Just dare them to read the first twenty-five pages, and see what happens. I hope that this is the beginning of a long successful writing career for Benjamin Bergen, because we need more scientists who are able to share what they do in a way that is both effective and

entertaining.

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In Episode 96, we talked with Dr. Robert Burton, whose latest book is *A Skeptic's Guide to the Mind: What Neuroscience Can and Cannot Tell Us About Ourselves*. Dr. Burton is a retired neurologist, and we first talked—well, I first introduced his work back in Episode 42, when I discussed his book, *On Being Certain: Believing You Are Right Even When You're Not*. I also interviewed him for Episode 43.

Those two episodes inspired the short eBook that I published in 2012 entitled *Are You Sure? The Unconscious Origins of Certainty*. In *On Being Certain*, Burton described the evidence that the feeling of certainty—which is something we all experience—has its origins in brain processes that are both unconscious and inaccessible to consciousness.

In *A Skeptic's Guide to the Mind*, he extends these ideas to other mental sensations, such as our feeling of agency and our feeling of causation. Agency is the sense that we have done something ourselves. It's very much tied to the fact that our brain is constantly making predictions. If our hand ends up where we expected it to, we feel like we moved it. The fact that this feeling is generated outside of our conscious awareness is demonstrated by the fact that it can be manipulated in the lab, so that people feel that their hand, for instance, is moving without them wanting it to.

The sense of causation is a little bit more general, since it also applies to things outside of our control. It's highly dependent on timing. From an early age, we learn that things that occur near together are likely to be related; that if *A* came before *B*, it's likely that *A* caused *B*. The problem is we can be wrong.

It is interesting that people who are quick to see the connections between things

are also more likely to attribute causation. This can lead to tremendous insights, but it can also lead to totally wrong conclusions. For example, in South Africa there's a tree called the 'fever tree,' because back before the cause of malaria was discovered, people thought it caused malaria. It just happened to grow well in wet environments; which, of course, is what mosquitoes love.

We also experience our thoughts as occurring in a sequential causal order. But ironically, since working memory is fairly limited, there has to be a constant interchange between conscious and unconscious processes. We rely on the mental sensation of effort—the effort of thinking—but this can actually be very unreliable. So, we really can't tell what parts of our thoughts have started in the unconscious and which ones we generated at the conscious level—not reliably, anyway.

While about half of *A Skeptic's Guide to the Mind* considers the evidence that mental sensations originate unconsciously, the rest of the book focuses on the implications of this rather disturbing discovery. Dr. Burton observes that this imposes what he considers to be an insurmountable limitation on our understanding of the mind. He feels strongly that the mind is not the brain, because he argues that no one knows what a mind is.

But even if we decide to embrace some specific definition of the mind, we can't escape the fact that, as Burton says, there are certain limits to a mind generated by a brain. He argues that neuroscientists need to be aware of these limitations. For example, one's sense of causation is likely to strongly influence whether one sees a particular set of data as proof of a certain theory. The way our brains are wired means that we can never really be objective.

Burton argues that understanding how our brains really work ought to inspire humility. Realizing that people vary on how strongly they experience mental sensations like certainty and causation explains why one investigator's possible

correlation is another's absolute causation. Even if you aren't a scientist, you have probably experienced this phenomenon in any number of contexts, including conversations about religion, politics, or even in a debate about the events that have occurred during a replay of a sports play.

The mental sensations of certainty, agency, and causation are so strong that they can't be argued with. But that doesn't mean they're always right. That's why Burton wrote, "Hiring the mind as a consultant for understanding the mind is the metaphoric equivalent of asking a known con man for his self-appraisal and letter of reference."

This is not a problem that can be overcome by more or better technology; which is why Burton argues that the appropriate response is humility. He also feels that it's important that neuroscientists and the general public realize that studying the brain is not studying the mind. But we think it is, because the mind is the ultimate con man.

Burton feels that the mind is a first-person experience, whereas the mind as studied by neuroscientists and cognitive scientists is only a concept. He says, "All thoughts about and studies of the mind are guided by involuntary brain mechanisms that collectively generate an illusory sense of a personal unique self capable of willful, unbiased exploration of how a brain creates a mind."

He said that the most important message that he wanted to share was that the mind is not a specific organ, it's something we experience. While I'm not sure I agree with this conclusion—that the mind can't be studied scientifically—I agree with his larger message. Even though the theme of the *Brain Science Podcast* is to explore how new scientific discoveries are unravelling the mystery of how our brains make us human, I also realize that there are many other ways to explore what it means to be human.

Science is our best tool for understanding how the world works, including our brains; but it's not the only way to experience being human. I think *A Skeptic's Guide to the Mind: What Neuroscience Can and Cannot Tell Us About Ourselves* is a thought-provoking book that offers a needed counter-balance to the tendency to hype the promise of neuroscience as the ultimate source of knowledge about what it means to be human.

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I'm going to take a quick break here to mention that the *Brain Science Podcast* is sponsored by Audible.com. They have been sponsoring us since 2007, and lots of the books we talk about on the show are available via Audible.com. If you aren't already a member, you can get a free audiobook download by going to audiblepodcast.com/brainscience. They also have books in a wide variety of other genres.

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So, for Episode 97 we had two guests, Daniel Lende and Greg Downey, who wrote —I should say edited—*The Encultured Brain: An Introduction to Neuroanthropology*. Now, there's no shortage of fields calling themselves neuro-this and neuro-that, but what attracted me to this particular book was that it proposes a two-way collaboration in which anthropology and neuroscience enrich and inform each other.

Daniel describes neuroanthropology as "neuroplasticity meets human variation," because cultural anthropologists have long focused on human diversity, while the neuroscientific discovery of brain plasticity sheds light on why this diversity is possible. But you might ask what does anthropology have to offer neuroscience? Well, it offers a wealth of field data that can be used to test neuroscientific theories.

The goal of neuroanthropology is to facilitate interdisciplinary cooperation between cognitive science, neuroscience, and anthropology. They are looking for a way to create a synthesis of the whole 'nature vs nurture' debate. This does represent a move away from the traditional silo approach to doing science. But, as Downey observed, trying to pull biology and culture apart is not the way life works. He says that whole idea that you can separate things only works on dead things.

I have often talked with other guests about the importance of interdisciplinary approaches, but Downey also made another important point, which was that in order to do this, we have to respect each others' methods. In terms of neuroscientists learning to appreciate the value of field data—which means seeing it as more than just stories or anecdotes—he hopes that they can learn to see the field data as brains in the wild; which represents a chance to see if their theories hold up in the real world. An example we discussed was Lende's work with drug addicts in Columbia, which suggested that there was more to addiction than the models being proposed back in the '90s were taking into account.

Meanwhile, Downey has spent many years in Brazil studying a martial art called Capoeira, which involves spending most of one's time in a handstand. And his experience challenged the previously-held notion that the balance system was hardwired, since learning this skill requires mastering a totally different way of balancing. Not only is it different from our normal experience, but it's different from the way gymnasts learn to hold a handstand. That's another example of the fact that cultural context impacts brain plasticity.

We talked about a lot of other interesting issues, so I want to encourage you to go back and listen to that episode if you missed it. Their book will probably be mostly of interest to neuroscientists, anthropologists, and potential students. But our conversation will give you a good feel for what they're up to.

One more comment about brain plasticity. Downey commented that he feels we make two big mistakes in the West; one is believing in talent, and the other is thinking that we can only learn new skills when we're young. He thinks that the belief in talent is counterproductive because when children are young, they get the message that if they don't learn something really quickly, they never will; leading to a tendency to give up prematurely.

Of course, we have talked about plasticity often on the *Brain Science Podcast*, and he made the point that every day we choose how to use that plasticity, whether to get into a deeper rut by sticking to a familiar routine or by challenging ourselves to learn a new skill—maybe even one we thought that we could never master.

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The focus of the *Brain Science Podcast* is normal brain function, but over the years I have had many requests to discuss autism. So, when Temple Grandin's latest book came out, I decided to invite her on to the show. She was a little hard to reach, so I ended up devoting Episode 98 to a discussion of her new book, and then, on very short notice, I was able to get a follow-up interview, which became Episode 99.

The name of her book is *The Autistic Brain*. This book was written for a general audience, although her focus seems to be on parents and others with direct experience of the disorder. This book is unusual in that it combines scientific rigor with an accessible style, plus we get a glimpse of autism from the inside. Temple Grandin has a PhD in animal science, and is highly respected in that field. But she also has autism. She represents a great example of what happens when a person with autism gets extensive treatment and also has their particular strengths nurtured.

The Autistic Brain is an excellent introduction to autism, but it also provides a reasonable overview of the current scientific knowledge, as well as a history of the disorder. I want to mention a couple of key historical ideas. One is that it's a relatively new diagnosis; it was invented only in 1947. And there's no reason to think that the condition that we now call 'autism spectrum disorder' suddenly came into existence when psychiatrists gave it a name. In fact, as autism was originally described, it represented a subset of mental retardation with a specific set of communication and social deficits.

Once autism became part of the *DSM*—the *Diagnostic and Statistical Manual of Mental Disorders*—it also became a moving target; because for each edition, they changed the criteria. In *DSM-IV*, it was recognized that autism was a spectrum, which means it spans a wide range of function, and they added Asperger's, which could include a lot of really smart people who just lack social skills. But then *DSM-5* eliminates Asperger's and lumps everyone back together again. Which seems odd, given that the science is moving in the opposite direction, revealing more and more diversity among autistic individuals.

Temple, herself, demonstrates the fact that autism is a spectrum. She did not talk until she was four, but thanks to intensive speech therapy and social training she became a very high-functioning professional. On the other hand, some autistic people never acquire language, despite intensive therapy.

In our current scientific knowledge it is sobering to realize how little we know. For example, it was once hoped that a genetic cause could be found. This now appears unlikely, because none of the genetic links discovered so far can account for more than 1% of patients. But we do know that autistic brains are wired differently. Autism is definitely a neurological disorder.

There is a great deal of diversity between patients, but in general there seems to be a tendency toward over-connectivity at the local level and a lack of long-range

connections. Functionally this seems to put many people into a state of over-stimulation, although Grandin points out that, until now, the role of sensory problems has been neglected because of the focus on communication and social deficits. In fact, the main thing I learned from this book was the importance of the under-appreciated role of sensory problems—which, as I mentioned, tend to present as variations of over-stimulation.

If you stop to think about it, you can appreciate how sensory over-stimulation could lead to problems with communication and social skills. For example, Grandin describes, in her own case, how she had trouble learning language because the sounds were overwhelming and seemed to happen too quickly. She learned to talk because she had a therapist who realized she had to slow everything down.

Also, if one is being over-stimulated, there are at least two ways you could react. You could have complete withdrawal, or at the other end of the spectrum, go berserk. Traditionally it has been assumed that going berserk meant the person was seeking more stimulation, but Temple gave some real-life examples to show that this is not true—that the behavior doesn't necessarily tell you what's going on inside the person's head.

One interesting thing about the sensory problems that she describes is that it's likely that these affect many people outside the autism spectrum. So, it would make sense to devote more resources to understanding these problems, and more importantly, developing techniques to help people cope with them. If you're interested in learning more about this particular aspect, I really suggest you visit templegrandin.com. There's a link there to more information about the sensory problems.

The Autistic Brain has three main themes: the history, the science, and practical advice. When I interviewed Dr. Grandin, we focused on her practical advice. She

emphasized the importance of getting autistic kids out into the world, teaching them social skills and discovering and nurturing their strengths.

Ironically, the percentage of autistics who work has probably gone down. Obviously there are many reasons for this, but Temple points out that assuming they can't learn social skills is not in their best interest. Of course, she's referring to those who are relatively high-functioning. But I'd say if a kid can learn to play videogames, they can learn a skill and get a job someday—but only if they learn basic social skills like showing up at work on time and being dependable.

It's unfortunate that being autistic is often the key to access to educational and social resources. But until that changes, I think we need to heed her advice not to let any child or adult be defined by a *DSM* label. The evidence is strong that autistic brains are wired differently, but most autistic people also have strengths which can take some effort to uncover and nurture.

In the case of autism, early treatment is invaluable. But since we've learned that the human brain remains plastic throughout life, people of any age can be taught new skills. This is also true for people with autism spectrum disorder. Because they see the world differently than those of us who are neurotypical, people with autism have the potential to be valuable members of teams, even if they might do much of their work alone.

I definitely recommend *The Autistic Brain*, by Temple Grandin, to everyone. It's a great introduction to the topic, but if you're already familiar with autism, it will broaden your perspective. I especially recommend this book to all parents, because even if your children are normal, they probably have classmates labelled with autism. The practical advice in this book is truly priceless; and a lot of it can be applied to normal kids.

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So, one of the highlights of the year was the fact that we celebrated our 100th episode. So, I invited listeners to submit email and audio, and I did a special interview with one listener, Darryl Fergus. Even though I wasn't able to include everything, I want to thank everyone who submitted content. The main interview of this episode was with Alvaro Fernandez, co-author of *The SharpBrains Guide to Brain Fitness: How to Optimize Brain Health and Performance at Any Age*. This was actually the second edition of this book.

I interviewed the co-author, Elkhonon Goldberg, way back in Episode 18, so Alvaro and I have been in contact off and on for several years. *The SharpBrains Guide to Brain Fitness* is a practical guide to our current knowledge about brain plasticity. And although most of the material in this book was familiar to me, it did give me a new perspective on the subject of cognitive training.

Fernandez used the analogy to physical fitness, pointing out that 50 years ago, exercising for fitness was almost unheard of; but now, of course, we see this as an essential part of a healthy lifestyle. He sees brain fitness as being in its infancy, and he sees cognitive training as something similar to going to the gym, in the sense that it complements the rest of a healthy lifestyle.

While it's true that some people exercise only when they go to the gym, most of us go to the gym so that we can better enjoy other aspects of our lives, whether it be sports or just being able to keep up with children or grandchildren. Cognitive training is not meant to be a replacement for meaningful mental challenges like learning a new language or skill, rather it should be seen as a complement; something that will strengthen specific mental abilities that we can then use in real life.

I want to emphasize that the *SharpBrains* website doesn't sell any particular programs. Rather, they attempt to monitor and evaluate what's going on out there for scientific validity and effectiveness. It was interesting to note that the

book mentions two very affordable programs that are now available online: *BrainHQ* and *Lumosity*.

I've tried both of these, but I have to admit, I haven't used either one of them enough to have an opinion about which ones are best. There were actually a couple other programs that met several criteria that they set in the book, but those are more expensive, so I'm not mentioning them now. But you can find out about them in the book.

The *SharpBrains Guide to Brain Fitness: How to Optimize Brain Health and Performance at Any Age* is a highly readable overview of the current knowledge in this rather young field. It doesn't just talk about cognitive training, it also talks about things like nutrition, physical exercise, stress reduction—the whole gamut. It does an excellent job in explaining how to critically evaluate claims and how to develop a regimen that fits your needs and lifestyle.

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Episode 101 gave us a chance to talk with someone who is truly on the frontlines of basic research. I first talked with Seth Grant back in Episode 51, when he introduced us to his research about the evolution of the synapse. At that time, I was particularly struck by the fact that neurotransmitters like dopamine have been with us since the time of single cell platforms. But in reading Grant's latest papers, what really stands out is the surprising discovery that the vertebrate synapse is much more complex than the one present in invertebrates like *Aplysia* and *C. elegans*.

The focus of our discussion was not on the implications of this discovery for the use of invertebrates in neuroscience. Instead, we focused on Grant's recent work with mice. Because most of the complexity of the vertebrate synapse arose early on—it was made possible by two whole gene duplications—the synapses of mice

and humans are virtually identical. Which means that researchers can manipulate the mouse synapse and see what happens.

We talked about two experiments where this was done using particular synapse proteins that are known to affect human learning. I'm not going to get into the details here, because I want to focus on the big picture. One is that changing a single protein in the synapse can result in measurable changes in performance.

And secondly, while not all types of learning can be tested in mice, many types can, and this is valuable because there are numerous techniques for manipulating the mouse synapse by means of genetic engineering. So, when a genetic difference is discovered in humans, it is possible to create that same difference in the mouse and then measure what happens.

Seth Grant is one of those rare scientists who is really great at describing his work in a way that's not only understandable, but in a way that helps you see how basic science fits into the big picture. I highly recommend listening to this episode if you missed it.

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In Episode 102, we talked with Dr. Allen Frances, the author of *Saving Normal: An Insider's Revolt Against Out-of-Control Psychiatric Diagnosis, DSM-5, Big Pharma, and the Medicalization of Ordinary Life*. This episode was inspired by my conversation with Temple Grandin, because it made me realize that autism is just the tip of the iceberg when it comes to the problems with the *DSM* as it is currently being used.

For one thing, using diagnostic labels as the key to getting access to social and educational resources is contributing to the over-diagnosis of psychiatric conditions. I chose *Saving Normal* because Dr. Frances is highly respected, and he has extensive insider knowledge of how the *DSM* has evolved.

One point he made during his interview is that accurate psychiatric diagnosis requires more than the typical seven-minute visit that primary care doctors currently provide. Yet primary care doctors are providing 70-80% of all the psychoactive drugs in the United States. Dr. Frances and I are both concerned about the trend toward diagnostic creep and the overuse of medications that can actually have severe side effects.

I expected this episode to elicit some controversy, and although most of the feedback I got was positive, I did get an email from a child psychiatrist who actually said she hoped her patients never listened to the podcast. I wrote her back asking her to post her concerns publically, either on our Google+ or Facebook Fan Page—or better yet, in the Discussion Forum on Goodreads. What I wanted to do was to post a detailed response. But she did not reply to my email.

But I worry that she was not the only listener who missed the key points of our conversation. We were not saying that no one needs medications or that no one has the conditions we discussed. In fact, I would assume that, since she is a child psychiatrist, she sees a skewed sample of kids with severe problems.

In fact, Dr. Frances emphasized quite strongly that many people with severe mental illness are not getting treatment, but because most of the psychiatric care in the United States is currently being provided by primary care doctors, we have the ironic situation where the normal ups and downs of human existence are being labeled disease, while the severely ill can't get treatment.

Since I am board certified in family medicine, I want to emphasize that neither I nor Dr. Frances are pointing the blame at primary care doctors; it is ridiculous what patients and payers expect them to accomplish in seven minutes or less. I think it's important to acknowledge also that drug company advertising takes advantage of the human tendency to prefer easy answers. The idea that everything can be fixed with a pill is appealing, because it requires almost no

effort to take a pill.

This is not the sort of episode that will motivate you to become a mental health professional, but I think it provides information that everyone needs. If you live outside the United States, it will also give you a glimpse into how messed up our healthcare system is.

The problem of allowing drug companies to advertise certainly extends way beyond psychiatry. It also demonstrates that the drug companies have way too much influence, both on healthcare and in our politics. (I'd better stop now, before I get tempted to go on a rant about this.)

Saving Normal: An Insider's Revolt Against Out-of-Control Psychiatric Diagnosis, DSM-5, Big Pharma, and the Medicalization of Ordinary Life, by Allen Frances, is a compelling read. And in the show notes for this episode, I have included several other excellent books.

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After talking to Dr. Frances, it's something of a relief to return to the world of basic neuroscience research. So, in Episode 103, we talked with Olaf Sporns, author of *Discovering the Human Connectome*. I first spoke with Dr. Sporns back in Episode 74, so this was a chance for us to get an update on the Human Connectome Project.

The basic idea of The Human Connectome Project is to study the brain from a network perspective, because network theory provides valuable tools for studying complex systems. And the human brain is considered the most complex system known to man, because it has at least eighty billion neurons, and each of these nerve cells connects to around one to ten thousand other neurons.

In his new book, *Discovering the Human Connectome*, Sporns describes both the

progress that has been made, and the challenges researchers face. But the first question I asked him was why should people care. Simply put, he sees the human connectome as a fundamental building block to understanding how the brain works.

But it's important to acknowledge that it's not going to give us all the answers. In fact, it's likely to stimulate new questions that we haven't even yet imagined—sort of like with the human genome. Before the Human Genome Project was completed, there were high hopes that it would lead directly to all kinds of answers and cures. But it turned out that things were much more complex than that because, although we have less genes than we thought, there's a lot of stuff in the genome that's actually coding for turning things on and off, and all kinds of complicated things that weren't imagined ahead of time.

Right now, there are three obvious challenges that confront attempts to describe the human connectome. First of all, this is a multiscale problem; it extends from the level of the synapse, the real true wiring diagram, all the way up to the whole brain level and connections between regions. Then there's the issue of individual variability, because we are learning that everybody's brain is a little different. And sometimes there are significant differences. And third, there's brain plasticity; the brain is constantly changing, which means that if we did get a connectome it would, in a sense, represent a snapshot, not some kind of permanently existing state. *Discovering the Human Connectome* explores these challenges in detail.

I want to emphasize the importance of applying network theory in the context of neuroscience. Incredible amounts of data are now being generated by a wide variety of research techniques. Network theory is needed, not only to make sense of this data, but also to provide a way for researchers working at different scales to share their results with each other.

Another important point that Sporns made was that there is a need to develop theories that can be tested. Why is it important to have a theory? There are those that claim that future science will be totally data-driven, but I share the view of those who think this is ridiculous. Without a theory, data can only provide correlations, not meaning or understanding. Correlations can generate ideas for theories, but one key thing about a good theory is that it can predict findings that have not yet been observed; and this keeps us out of circular reasoning traps.

Consider this thought experiment: Say that you notice that neighborhoods with lots of crime have more cops or policemen. Suppose you're a scientist from outer space, and so you don't know what police are, so you hypothesize that the police are the cause of the crime. You could test this by seeing what happens if you remove the police. Of course, we all know that that would probably lead to the crime going up even further. But this would be an example of what Popper called 'falsification,' since our theory predicted the opposite.

I hope that most of you appreciate that the mainstream media and blogs are really bad about conflating correlation and causation. You're always seeing articles that say *X* causes *Y*, when all that's really been found is that there seems to be a correlation between the two things. And unfortunately, then later on, when scientists test the correlation and determine that there's no relationship, that doesn't get any press coverage.

Discovering the Human Connectome is aimed at students and working scientists, but I think this interview provides an excellent overview of a field that is likely to grow in importance in the near future.

[music]

So, that's the end of our brief—or not so brief—review. Looking back at this year's

topics which included pain, linguistics, philosophy of mind, neuroanthropology, autism, psychiatric diagnosis, and basic science ranging from the level of the synapse to brain networks, I was struck by two things: First, we just barely scratched the surface of the fascinating question of how our brains make us human. Second, even though we didn't have an episode devoted specifically to brain plasticity, it was the topic or principle that seemed to pop up most often.

Whether one is exploring the mechanisms of chronic pain or the diversity of human culture, brain plasticity seems to be a remarkable part of our human heritage. Every day I feel more strongly that basic neuroscience literacy is becoming as essential as understanding the basics of biology, chemistry, and physics. And brain plasticity may be the one discovery that has the greatest potential to change our lives, if only more people knew about it and applied it.

Of course, today's discussion doesn't do justice to the depth provided in the actual podcasts and interviews, so I want to encourage you to go back and listen to any episodes you missed. In the show notes, I will provide links to all eleven shows, along with a list of the books that I mentioned today. Every episode of the *Brain Science Podcast* has detailed show notes and a full episode transcript. You can find these at brainsciencepodcast.com; and you can send me feedback at brainsciencepodcast@gmail.com.

[music]

I hope you will listen just for a few more minutes so that I can make a few closing comments. I really enjoyed doing this annual review, although it's quite time-consuming to read the hundreds of pages of transcripts.

Which reminds me, I want to give a special shout out and thank you to Lori Wolfson, who does the episode transcripts, and also helps keep the website updated. Lori, your passion for this work helps keep me going.

Another shout out I would like to mention is to the Birmingham Alabama Johns Hopkins Alumni Group. Last month I had an opportunity to give a talk to this group, which I really enjoyed. And I wanted to thank you, and also mention to everyone else, that I do enjoy public speaking and I am available to talk to groups. If that interests you, you can contact me. Of course, depending on how far away you are compared to me in Alabama would influence how complicated that might be to arrange. But I also love to travel. So, just keep that in mind.

On the other hand, I regret to announce that the continuing education credits that we had available on the website disappeared a few months ago, because the company that had created them went out of business. And although I have the rights to some of those episodes, I don't have any method of dispensing them right now. I just don't have the resources to create continuing education materials, and I want to apologize to those of you who have written to me looking for those continuing education opportunities.

Now for the exciting announcement that I promised you at the top of the show. Over the years, many of you have wanted me to offer premium content. And I have tried a few methods that have not particularly succeeded. But for the most part, I have been trying to stick to an NPR-style model, which is largely reliant on listener donations. The problem is that, despite the generosity of many of you, most people never donate. So, I haven't been any closer to my goal, which is to retire from practicing emergency medicine and to do science journalism full-time.

Fortunately, it is now possible for me to combine my desire to continue to provide free content with my need to get paid for my work. Beginning on approximately January 1, 2014, there will be a new way for you to support the *Brain Science Podcast*.

New episodes of the *Brain Science Podcast* will continue to be free, but I will also

be offering a monthly Premium Subscription. Here's how it will work: The most recent twenty-five episodes will remain in iTunes and will also be freely available via the mobile app, on the web, and via all your usual podcasting clients such as Stitcher. Premium subscribers will have access to the entire one-hundred-plus episodes and to the episode transcripts.

If you sign up for the Premium Subscription, you will have access to all this content either via your mobile app or via a subscriber-only webpage. The *Brain Science Podcast* app will become free, and those of you who have purchased the app will be getting a special coupon code so that you can have a discount on the new Premium Subscription. But even if you don't subscribe, you will still get the new episodes in the app, just like you always have.

But what if you don't want to subscribe or you can't afford to (although it's not going to be very expensive), but you need access to one of the earlier episodes or to transcripts, it will now be possible to buy all back episodes and transcripts directly from the *Brain Science Podcast* website for $1.00 apiece. I want to emphasize that the twenty-five most-recent episodes will remain free to either stream or download. That represents about two years' worth of content. On the other hand, all the episode transcripts, including new ones, are now going to be $1.00 each for non-subscribers. I think this is a very reasonable compromise.

I also want to create additional premium content, and my pledge to you is that when we reach one thousand subscribers, I will begin creating premium content. Naturally, I want to encourage as many of you as possible to sign up for the Premium Subscription, so I'm trying to find a way to reward the first five hundred subscribers, but I'm still working with Libsyn on how to do this. But you will for sure at least get access to coupon codes.

I am hoping that many of you will become Premium subscribers, but I will continue to accept direct donations, and I also appreciate those of you who

purchase my eBook, *Are You Sure? The Unconscious Origins of Certainty*—which I should mention is available both directly from the website and from Amazon in Kindle format.

Other things that people have purchased that I appreciate include *Brain Science Podcast* logo gear. And, of course, I want to remind you that you can now purchase those individual mp3 files and episode transcripts directly from the website. I'm hoping to have those available on the website slightly before the premium content launches. The goal is to have everything ready to go at the end of the year.

I realize that moving toward premium content is going to impact my download numbers, at least at first. And since I rely on word-of-mouth for new listeners, I want to address the issue of sharing premium content. Many of you already have copies of everything I've ever done. And I have no objection to your sharing some of this content with others; all I ask is that you exercise common sense.

If you have a particular educational context in which you are using the show, I would like to work with you to create specific links that your students can use. You just need to contact me to work this out.

Now, looking forward to 2014, I'm not sure how long it's going to take to reach a thousand subscribers, so I don't know exactly when I'm going to start creating premium content. But my plan is to continue to produce the *Brain Science Podcast* on a monthly basis, with the new episodes being free for about two years.

My first guest in 2014 is probably going to be Dr. Michael Merzenich, who appeared back in Episode 54. We're going to be talking about his new book, *Soft-Wired: How the New Science of Brain Plasticity Can Change Your Life*. Since Dr. Merzenich is one of the pioneers of neuroplasticity, his book provides not only an inside look into how the field has grown, but more importantly, practical

suggestions about how we can apply these discoveries in our daily lives, whatever our age or circumstances.

I also hope to interview philosopher Paul Churchland. If you want to get a feel for what books I'm considering for 2014, please check out the Brain Science Podcast Group on Goodreads. That's also a great place to post your comments about any particular episode. But I try to add the books to the Goodreads site before I actually do the episodes—although I'm not as good at that as I ought to be.

My focus is going to continue to be on interviewing scientists who have written books that give us insights into the wide variety of questions that are being explored in neuroscience, cognitive science, and related fields. I welcome suggestions from listeners at brainsciencepodcast@gmail.com.

If you want to know whether a certain book or scientist has already been featured, please check the *Brain Science Podcast* website at brainsciencepodcast.com, where we have a list of all of our previous guests and a detailed bibliography of the books that have been covered. There's also an excellent Search function on the site, which I think is under-utilized.

If you want to get episode show notes automatically, please subscribe to the *Brain Science Podcast* newsletter. This is a great supplement to using the *Brain Science Podcast* mobile app or your podcasting client, because you won't miss any new episodes.

I guess the only last thing I want to mention is that if you are going to be a the New Media Expo, which is January 4th through 6th in Las Vegas, don't forget to drop me an email so that we can get together. That's when we'll also find out who wins the People's Choice Podcast Award. I'll be letting you know about that in January's episode.

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

[music]

[music]

The new theme music for the *Brain Science Podcast* is "Mind Fire" by Tony Cotraccia. You can find his work at syncopationnow.com.

[music]

Transcribed by Lori Wolfson
All errors or omissions responsibility of the transcriber.