BRAIN SCIENCE PODCAST

With Ginger Campbell, MD

Episode #15

Interview with Dr. Read Montague, Author of *Why Choose This Book? How We Make Decisions*

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INTRODUCTION

Hi. I'm Dr. Ginger Campbell, and this is the *Brain Science Podcast* – the podcast for everyone who has a brain. In this podcast we explore how recent discoveries in neuroscience are unraveling the mysteries of how our brains make us who we are.

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Welcome back to *Brain Science Podcast*. This is Episode 15. Today we are going to be talking with Dr. Read Montague about his book, *Why Choose This Book? How We Make Decisions*. This is a continuation of the discussion we started in Episode 13, which was about how we make decisions.

However, compared to the book, *Blink*, which was a somewhat superficial consideration of the topic, Dr. Montague's book examines the question of decision making at a much deeper level; which is where the whole idea of the computational model of the mind comes in. Don't let that title intimidate you. As you will see in the interview he does a great job of explaining the ideas of his book.

But first, let me make a few brief announcements. Over the last several weeks I have had some problems with my podcast feeds, and some of you may have had trouble receiving episodes or perhaps received them a couple of weeks after they were already posted. Hopefully all this has been resolved.

Because of the problems I have been having with the feed my intention to get the new Brain Science Podcast Forum up by the end of June has had to be pushed back. However, I do have a new web host and I am working on getting the Forum up and running, and hope that it will be up within the next couple of weeks. If it gets up before the next podcast I will post a notice on the website.

I am hoping that there will be a lot of discussion on the Forum once we get it going. It will offer an opportunity for those of you who have been sharing your very interesting ideas with me by email to share them with other listeners and to have some interaction.

Let me just remind you before I get into the interview that you can send me feedback at docartemis@gmail.com. The podcast website is at brainsciencepodcast.com. And also, don't forget that if you use Flickr we have a Brain Science Podcast Community Group on Flickr. I have been enjoying getting pictures from around the world, and I hope that you will add your pictures to the Group. If you need help with how to do this just send me email at docartemis@gmail.com.

So, let's get into the interview.

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INTERVIEW

GC: I want to welcome Dr. Read Montague to the *Brain Science Podcast*. Today we're going to talk about his book, *Why Choose This Book? How We Make Decisions*. Dr. Montague, thank you for coming on my podcast.

RM: Thanks for having me.

GC: The first thing I thought we might do is let you tell us a little bit about your background and how you came to write a book about the computational model of the mind.

RM: Early on all my training really was in mathematics and physics, with a specialization in biophysics. I got interested in neuroscience—and actually science—quite late. I was an English major in college. The interest in computational neuroscience—that is, the idea that the brain is an evolutionarily adapted computing device; it's not made out of silicone and circuits, it's made out of goopy stuff, but nevertheless it computes—that was a natural fit for my background. And I have extensive postdoctoral training in that from people that specialized in computational neuroscience.

After that my work has largely segued from making computational models to neuroimaging experiments and using computational models to gain insights in the neuroimaging experiments. That is, I put people in imaging devices and eavesdrop on their brains while they do something cognitively interesting. So, my book doesn't start at the point of view of the psychologist and sort of go down; my book starts at a very low level with the idea of a machine needing energy.

The fundamental way in which your brain is different than a computer—the one beside your desk—is that it is designed to go get its own energy. It has behavioral algorithms built into it that allow it to adaptively go around and recharge its own batteries. And although that seems like a small difference between the thing beside your desk that has a wall plug and the thing between your ears which has to go get its food, and digest it, and ship the energy out and what not, that makes all the difference in the style of computing that goes on in your brain. So, that's the quick summary.

GC: I thought you did a really good job of making that point. And I'm going to come back to it in a few minutes. You introduce the field of computational neuroscience in the book. Can you tell us briefly what that is and how it has emerged?

RM: Yes. The idea of computation emerged in the 20th century and really started with a man called Alan Turing. And the idea was this. What Turing realized was that any sequence of steps that you could spell out—like a recipe; add 3 cups of water, add 2 cups of sugar, add 1 cup of flour, mix, cook for an hour and you have a cake—any algorithm like that, that you could precisely specify, could be cast as a computation: a series of steps in which numbers were transformed from one form to another.

In that particular example the recipe is a bunch of words whose meaning we know and the steps that we take are directed by the verbs and nouns in those sentences. Well, those kinds of directives could be translated into numbers. And that's what Turing realized. And he further realized that you could build machines that could run those kinds of things very fast.

That point of view about what computation is has been transported to the brain and mind sciences. And the fundamental insight, which is powerful but incomplete, is that your mind is a pattern of information processing—just like a program on your computer—that runs on your brain, which is a special type of computer. So, it separates the idea of patterns of information processing, like a piece of software, from the hardware that implements it.

That has come under challenge. That's called the computational theory of your mind. It's that your mind isn't equivalent to your brain but it requires your brain to exist—that's why there's such a close tie between your mind and your brain—and that your mind can be depicted as a pattern of information processing.

Now, people who think about these issues deeply have challenged that to say, 'Well, that leaves out something. There's no meaning there. Some thoughts, some computations, have more meaning to us than others. The idea of my child is a more meaningful thought than the idea of a hotdog that I'm going to eat today at 12:00.'

And I think that's correct—and I argue this in the book—I think that's a correct criticism that computational neuroscience on its own can't, without meaning, correctly depict what your mind does. However, I think that's not what even evolved. That's the wrong way to think about the computations that evolved in the brain. And let me give you an example of why I think that's true.

You see, your brain could never afford to represent symbols and do blind computations without knowing their value back to the organism. So, if you go to a single cell bacterium and it's running around in fluid and it's looking for food and it's trying to run away from bad chemicals, it has to decide which of its actions are more valuable than others. In other words, it has got to decide where to ship its energy. 'Do I ship my energy to sort of run to the right, or do I sit still, or whatever?' So, it knows how to value its computations.

And so, in the book I argue that the idea that your brain ever evolved the capacity to do meaningless symbol manipulation, like a computer does, was wrong. There are no brains like that around. That's not the kind of computer your brain is. Your brain transforms meaningful strings of symbols into other meaningful strings of symbols. And so, I think the argument about the computational theory of mind—that it left meaning out—was correct, but it was also not a correct model of what evolved between our ears.

GC: That's great. You sort of almost stole my next question, because I was going to ask what you meant when you said in your book, "Choice is not about choice, it's about value." And you just answered what you meant by that right there.

RM: Let's put it this way. If you were a creature and you had this magic wall socket available to you, and you could just plug into it whenever you felt like it, you would never have to make a choice at all—ever—because it wouldn't matter. If you never died you wouldn't have to make a choice at all.

It's the fact that you have limited energy available to you as an organism and the fact that you need it that forces you to make choices. If you're going to make choices then you have to value the options available to you. And the animals that value them accurately relative to what they actually yield for them are more efficient and more successful than the animals that don't.

GC: The other thing that you said that I bet you've been challenged on was that we are fundamentally computational creatures but we aren't mindless automatons because we possess the capacity to choose. Is that an accurate representation of what you said?

RM: That's right.

GC: I've talked about this to at least one of my friends who couldn't seem to get their mind around how, if we're computing, we still have choice. Can you address that objection?

RM: The idea that choice is only available if there's sort of free choice; or the number of choices isn't limited? Is that what you mean?

GC: I think that people sometimes have trouble with the fact that the more we learn about how our brains work, the more we learn that so many of the choices are happening beyond our conscious control.

RM: Oh, that's absolutely true. The fact is your consciousness is a pretty impoverished machine. I mean how many of us can think more than one thought per second? You would hate to sit around and have to monitor the pH of your blood, the rate of your heartbeat, the amount of acetylcholine dumping out on your pacemaker node in your heart, whether or not your digestion was moving at the right rate, or whether you needed to secrete more things out of your pancreas.

You can't monitor all that. Our conscious minds are low bandwidths. They can't deal with all that. So, 99.9% of every decision that your body and brain have to make is made underneath consciousness, and only some of that information bleeds into consciousness.

Now, it's an interesting question to ask what kind of information is available consciously and why is it this information and not some other? And that's kind of an active area of interest for people interested in these issues.

GC: Do you think that it's going to come down to what's happening in the prefrontal lobes?

RM: It's an integrated system. I think what we're going to see, and what even experiments in my lab have shown, is that abstract ideas—ideas that can veto our biological instincts—they gain control of regions of our brain that are evolutionarily old and that we share with creatures that don't even have prefrontal cortices; systems in our brain that are there to help us harvest rewards and to chase sex and food appropriately so that we can propagate. The idea with the prefrontal cortex is that it is able to abstractly frame problems, but these abstract ideas have behavioral punch.

I mean you can actually veto your instinct to eat if you have this idea that you don't look good in a mirror. That's a very abstract notion—being overweight. Animals don't look at their reflection in a pond and think they should cut back on their next meal. That kind of power is gained by the prefrontal cortex, because it gets to talk to the midbrain and the striatum and low level structures that we share with creatures that don't even have prefrontal cortices.

GC: That's what you talk about in that great chapter in your book called, "Sharks Don't Go On Hunger Strikes." I think that title just captures the idea beautifully.

RM: Right. Sharks don't go on hunger strikes. It is easy to see their behavior is instinctual. People, on the other hand, for a political idea—a good one, or a bad one, or even a crazy one—can go on a hunger strike to the point where they can kill themselves over bad ideas. There's no creature on the planet that I know of that will take its own life—that has the capacity to choose with such power that it literally overrides every biological instinct it has to survive—except for humans.

GC: I think you're right. I know you don't have very much time, but on some of my podcasts in the past I've talked a lot about things like neurotransmitters. And you talk about in your book the dopamine gating hypothesis. I was wondering, you also talk about some mathematical modeling and how it turns out that the dopamine system seems to match one of the mathematical models. Is it one of the mathematical models that it actually matches?

RM: That's right. It looks like it's a system exactly like systems in control theory and computer science that optimize decision making over a whole series of decisions. It's remarkable how the activity in the dopamine system corresponds to that in certain circumstances. Now, the dopamine system has a lot more jobs to do than just that. But that's the piece of the activity in the dopamine system that we've really come to understand mathematically quite well.

GC: One of the key points I think you made is that when we get a surge of dopamine, that does not simply equal a reward signal. It's more complicated than that, right?

RM: Right. What we think is that it's very clear that increased dopamine doesn't equal increased pleasure. That's just not true. There is experiment after experiment that says that's not the way to think about the information being conferred by dopamine.

However, it is true that you will chase things that cause dopamine squirts in your brain. The question is why do you do that and what kind of information does the dopamine represent? And this piece of the activity of the dopamine system that I described, for which we have models, the idea is that dopamine neurons are a control signal.

In neuroscience you call it a learning signal. That is, it reports whether or not things are getting better than expected or whether or not things are getting worse than expected, and tells the system to adjust. 'Oh, that was much worse than expected, back off of that, don't go that direction. Don't take that choice, go this other way.'

GC: And it seems like we get the biggest surges from things that are better than we expect, right?

RM: We get surges from things that are better than we expect and we get diminishment over baseline levels for things that are worse than expected. There are dopamine receptors in cells located throughout your brain that respond to that—that tell the interior of the cells, 'Uh oh, things got worse than expected; uh oh, things got better than expected.'

GC: Do you think that's why we always tend to be disappointed when we get what we expected?

RM: Well, the system doesn't even react. In other words, I can tell you when people do very precise experiments—they stick microwires on dopamine neurons in animals' brains and they give the animal sort of a training paradigm where a cue like a light or a bell predicts the delivery of a rewarding substance like food or water or something—if the animal gets just what the light has formerly predicted, then the neurons don't change their activity at all. It's only when it's up or down from what was expected.

What it does is it lets the system report changes to you. It lets the system deliver information about the most important things, which are the things you didn't know about. If you can expect it, then you already know how to deal with it. It's the things that are off-beam, that are outliers that your brain should pay attention to.

GC: Just like we don't notice our clothes because we ignore those signals.

RM: Right. Or the hair on your head.

GC: I don't even think I can feel the hair on my head.

RM: Well, if you toss your head around, or if I talk to you about it a lot you'll start noticing it—especially if it's falling down on your forehead. And then eventually if you quit paying attention to it, it will go away. You'll habituate to it. You'll get used to it. Your system is always doing that.

GC: How do you think the work that you have done relates to the debate over whether or not people have free will?

RM: I think the debate about free will is a little bit of a red herring, the same way that the nature/nurture debate is a bit of a red herring. The nature/nurture question to me—and I'll start with that one—has always been a really bad way to cut the problem in two. There is a dichotomy of nature vs. nurture, right? But it doesn't mean it's a very useful one always.

For example, if I ask you, 'Do you weigh 200 pounds?'—I don't know what you weigh, but I'm going to guess that you don't weigh 200 pounds—I could categorize everyone in the world as the ones that weigh 200 pounds or the ones that don't weigh 200 pounds. Right? But that doesn't mean that's very useful. It's a very un-useful division of the world.

Nature and nurture is the same way. Your brain is designed by nature. It gets built automatically by things that govern themselves and monitor themselves in the womb, to come out and to be nurtured by the environment and by caretakers and by all that kind of stuff. In other words, these things have never been very cleanly separated. And so, the nature/nurture separation certainly in the function and the structure and the sustenance of the nervous system has never been a very fruitful way to cut the problem in two.

Babies that come out that are not touched, that receive impoverished sensory stimulation, that receive impoverished nurturing of various types that they would get from parents—they die. The structure of their brain is different. The cortex of their brain is thinner. They don't have as many connections. It goes on and on. And so, these things have always been intrinsically sort of married to one another.

The free will question is also sort of weird. First of all, I think people carry this notion that it would be free will if you had an infinite number of choices available to you. But you know if you actually had an infinite number of choices available to you –

GC: You'd be frozen.

RM: Yes; you couldn't choose. I've noticed something: Infinity is a really big number. It's really hard to flip through a book with infinity number of pages. And so, it's never been the case that you had an infinite number of choices. And the reason is you've got a finite amount of energy and mass in you. You could never have an infinite number of choices.

The other thing is you could have a finite number of choices but which was so functionally large that for all intents and purposes you might have choices available to you that allowed whatever mechanisms were in your head to sort of choose freely. But lastly, it would be really inefficient to give the system what you might think of as true free choice. That wouldn't be very adaptive.

If a wildebeest was dropped on the Serengeti and grew up making truly free choices it wouldn't be enough like the other wildebeests. It would just accidentally wander off and develop ideas and behavioral patterns with respect to the world, but it wouldn't be able to breed and hang out with the other wildebeests. It's the same thing with a human. So, the idea that we were ever free was built on a flawed idea of what it takes to build a human that's enough like other humans to interact with them appropriately.

GC: That's an interesting point of view. One of the things that surprised me—because this is a question that I get in emails—at least one of my listeners brought up the idea that free will implies something that's outside the brain. And I don't particularly think that's what it means.

RM: There may be something outside the brain, but there's nothing yet about the brain, nor what we know about it, nor how we think it chooses, nor what we know about evolution to warrant that. In other words, if there is something that we can't explain and we can't describe and it's actually influencing us, it's certainly not the object of science. It's just something I don't study.

GC: Right.

RM: That's not studying it. That's a claim. I mean the discussion ends. You just say, 'Well I believe that there's this God outside the brain that directs us.' And I say, 'OK.' And then we're done. Right? We go and have tea and crumpets at that point.

GC: And then those that are arguing that free will is an illusion because everything is brain-determined somehow seem to want to argue that that would take away our responsibility. I think one of the things I like about your book is that you really emphasize that we are still the ones that are choosing.

RM: We have a capacity to choose. I chronicle in the book sort of my low-level-up point of view of that. It's a very thin slice of a very big area—any book on this area would be. But the social institutions that we choose to build and that we choose to value, they're still our choice.

And let's face it, we all know if I damage a very specific part of your brain you lose a very specific part of your decision making apparatus. You may become hyperemotional. You may overeat without end. You can perturb very distinct pieces of your personality by changing pieces of your brain. So, I don't think that diminishes our experience in any way at all.

If I tell you all the things going on in your brain when you eat chocolate ice cream does it taste any worse? Does it all of a sudden start tasting bad to you? I don't think so. Does it change your concept of yourself? You bet it does. Just like understanding where babies came from changed our concept of ourselves. You can go back just to the 19th century and see books with pictures of sperm cells with little babies curled up in the head of the sperm cell.

We could entertain all kinds of weird ideas about the physical structure of people, how things were inherited, etc., until we discovered how it's actually done. And now we know a lot about it. It's changed the way we think about ourselves. Just think of the number of in vitro fertilization options available to people now. So, the knowledge about the brain is certainly going to change our knowledge of ourselves, but it's not going to remove responsibilities for building social institutions that we care about, and protecting them.

GC: Well, I agree with you completely. I really appreciate your taking the time to talk with me today. Is there anything else that you think would be important to share with my listeners?

RM: No, just tell them to go to Amazon and buy, *Why Choose This Book?*

GC: Right. And I will have a link on the website brainsciencepodcast.com.

RM: Great.

GC: Well, thanks a lot. When I get this up I will send you a link. I hope you will listen to it and give me your feedback.

RM: Will do. I enjoyed it.

GC: OK. Thanks again.

RM: Thanks a lot. Bye.

GC: Bye.

[music]

I wish Dr. Montague had had more time to talk with us. I hope that gives you a brief glimpse into the basic concepts of the computational theory of the mind. I am going to be coming back to this area in the future. But in the meantime if you're interested, the book is *Why Choose This Book?* by Read Montague, and there will be a link in the Show Notes at brainsciencepodcast.com if you're interested in getting the book.

The next episode is going to be our first discussion of the role of the prefrontal lobes. We've been talking so much about how much goes on in our brain at lower levels that we do not have conscious awareness of, so I thought it was time that we go to the prefrontal lobes and explore how they integrate the information from other parts of the brain and how important they are in our decision making, planning, and the many aspects of what actually makes us human. I hope you will be with us in a couple of weeks when we do that episode.

As always I look forward to your feedback at docartemis@gmail.com. I hope you will visit the website at brainsciencepodcast.com. Also, I should be having a new episode of *Books and Ideas* up probably next week. If you are not subscribed to that podcast I hope that you will go to booksandideas.com and check that out. It will be a follow up on the subject of free will.

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One last thing that I forgot to mention earlier is, first, any of you that are new to the podcast, I really appreciate your listening. I hope you will subscribe. There are several ways to subscribe to the *Brain Science Podcast*.

Obviously via iTunes all you need to do is search under Ginger Campbell in iTunes and you can see both of my podcasts. At the website brainsciencepodcast.com there are links for subscribing via iTunes, via any RSS reader or podcatcher of your choice, and also via email subscription if that is your preference. I hope that you will subscribe, and I appreciate your listening.

Talk to you soon.

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Transcribed by Lori Wolfson
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