BRAIN SCIENCE PODCAST

With Ginger Campbell, MD

Episode #50

Highlights from the 2008 Annual Meeting of the Society for Neuroscience

Aired November 22, 2008

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INTRODUCTION

This is the *Brain Science Podcast* – the podcast for everyone who has a brain – and I'm your host, Dr. Ginger Campbell. On the *Brain Science Podcast* we explore how recent discoveries in neuroscience are unraveling the mysteries of how our brains make us who we are. For more information including Show Notes, links to previous episodes, and information about how to subscribe please go to the website brainsciencepodcast.com. We also have a Discussion Forum at brainscienceforum.com, and you can send me email at docartemis@gmail.com.

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DISCUSSION

This is Episode 50 of the *Brain Science Podcast*, and I'm your host, Dr. Ginger Campbell. I would like to welcome any new listeners to the *Brain Science Podcast* and take a moment to tell you about the usual format for this show.

Usually I do either a discussion of a recent book about neuroscience—generally one aimed at a general audience—or I do an interview with a scientist or an author. Today's episode is unusual because it is a discussion of the recent Neuroscience 2008, the annual meeting of the Society for Neuroscience, which was held in Washington, D.C. in November of 2008.

This was my first opportunity to attend the conference. If you are someone who was there you will realize that the following discussion is incomplete, to say the least. If you are new to the show I would like to encourage you to consider listening to one of the more recent episodes, such as Episode 49, which was an interview with Dr. Brenda Milner, just to get a better feel for what the show is usually like. You will find a list of all the guests that have been on the *Brain Science Podcast* at our website at brainsciencepodcast.com, and you can subscribe to the show in iTunes or with any feed reader. And for those of you who are regular listeners, we will of course be returning to the normal format in the next episode.

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Before I talk about the annual meeting let me tell you just a little bit about the Society for Neuroscience. The Society for Neuroscience is the largest professional organization for neuroscientists in the world. It now has membership of almost 40,000. Its membership is estimated to have about one-third students and about one-third members from outside of North America. The annual meeting is a huge event that rotates between several major cities in the United States; and as I mentioned, this year it was in Washington, D.C. The attendance was about 31,000 people, and one of the things that impressed me was the fact that there were so many young people there.

One of the young people that I met there was actually a *Brain Science Podcast* listener, Mary Petrosko, from Dominican University. Now, I blogged about Mary

on the website. Since I know most of you don't read the blog I will just mention her briefly. Mary received one of the travel awards from the Faculty for Undergraduate Neuroscience. I will have a link to that on the website. But, at any rate, I enjoyed meeting Mary at the poster session and reception for the undergraduate students. And I was very impressed with her poster, which was actually one that regular listeners to this show I think would really appreciate. It was about exposing *Aplysia*—sea slugs—to Ginkgo to see whether or not it affected their learning. And what she saw was that it did not.

Now, this does not prove that Ginkgo is ineffective in people. However, it does support the evidence that generally suggests that Ginkgo is ineffective in promoting improved memory and learning in normal humans. And I think the day after I posted about her there was also a paper that came out showing that Ginkgo did not seem to be effective in helping Alzheimer's disease patients either. In the past when we have talked about memory on this show I have talked about the importance of the *Aplysia* as an animal model for studying some of the basic mechanisms of memory. And that's the reason why the fact that Ginkgo didn't work in *Aplysia* is actually quite significant.

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So, how is such a large meeting organized? Well, it has several different components like poster sessions where people present their work with posters and people come up and talk to them about their basic work. There were hundreds, if not thousands of posters, and also lots of technical talks and mini-symposiums. And a lot of this stuff was at the bench science level that I definitely don't have the expertise to appreciate. And then they also had main talks on broader themes. And I was able to attend some of those, and I am going to later in this episode describe just one of those talks so that I can give you sort of a feel for it.

One of the main talks was an historical lecture by Brenda Milner, which was really neat because I got to meet her in person. And since she just appeared on the last episode of the *Brain Science Podcast*, that was really special. I'm not going to give you a blow-by-blow description of who I met at the conference. I will mention that thanks to going to Neuroscience 2008 I hope to have several guests from the Society for Neuroscience on the show in 2009.

If you've been following the website you know that before the Society for Neuroscience conference got started I was invited to another conference by a listener, Kathleen Burke from USC. She took me to a poster session of the International Society for Developmental Psychobiology, which was actually held just before Neuroscience 2008 started. This organization is basically focused on how brain development affects behavior. I talked to several different researchers, and again, that should result in some interesting interviews in the future on this podcast.

In terms of Neuroscience 2008, one of the key themes was public outreach. There was a special reception celebrating Brain Awareness Week, which is something that the Society for Neuroscience does along with the Dana Alliance. This is a special program that's held in March that is aimed at sharing neuroscience with K-12 students. At the reception they announced that they are going to be launching a new website in early 2009. If you are a K-12 science teacher and would like to learn more, just go to the website and I will be linking to that for you. Or you can write to me if you want to be notified when their new website is up.

The other outreach thing that they talked about was something called the Neuroscience Core Concepts, and this is the idea that there are eight basic concepts that everybody should know about how the brain works. They've got pamphlets and a lot of educational material based on this approach, and I will put a link to this on the website. The incoming president of the Society for

Neuroscience, Dr. Tom Carew from the University of California at Irvine, seems to be really committed to the idea of public outreach and public education, so I'm hoping that in the coming year I will be able to work more closely with SFN in helping with public education, since that is also the focus of this podcast.

I had press credentials for this conference and so I was able to attend several press events. Here, also, the subject of public outreach was emphasized, and one of the ideas that was emphasized was the idea of helping people understand the importance of the continued use of animals in research. I will talk more about that in a little while.

There was also a press breakfast at which Eve Marder, the current president of the Society for Neuroscience, shared her thoughts about what were the key ideas going on at the conference. She said, "Understanding circuits is going to revolutionize our thinking." Obviously that's a topic that could use more discussion, and I am looking forward to having her as a guest in the future to really explore this idea of circuits. [Note: Dr. Marder was subsequently interviewed for Episode 56.]

She also talked about the importance of translating basic science into an understanding of human cognition. She argued that connecting brain science at the circuit level is going to be a key to understanding human cognition and behavior. She also feels that there is an important connection between basic science and addressing human disease. In this sense she was emphasizing something almost every scientist that talked to the press was very concerned about communicating, and that was the idea that basic science remains essential to making advances in treating diseases.

Another idea Dr. Marder talked about was the idea that plasticity should revolutionize our approach to treating various nervous system diseases. On the other hand she also mentioned that understanding brain development, and

especially the relationship between genetics and the environment, was another theme that she felt was very important.

The professional part of the conference was organized around main themes, and I'm not going to try to list all of those. As I mentioned there were several press events that I attended, and besides the basic idea of public outreach there was an emphasis on what they called translational research, and that is when the basic science is translated into some kind of practical application. An example of translational research would be using genetic research to develop gene therapies.

It was also interesting to me that one of the subjects that had its own area of focus was sleep. There seems to be an increasing body of research that shows how important sleep is for many aspects of mental health—learning, memory, and just general healthiness of the brain—and that unfortunately many people in modern culture are chronically sleep-deprived. According to an email that I recently received from someone living in Japan this problem is actually worse in some countries than it is in the United States.

Those of you who have been listening to the show for awhile remember that John Medina, the author of *Brain Rules*, talked a lot about the importance of getting enough sleep. As an American it seems like it's a little bit hard to get over that feeling of guilt that comes with getting more sleep. You know we have this ideal of Thomas Edison, who supposedly only needed three or four hours of sleep a night, and this sort of myth that somehow one is superior if they can get by on less sleep. The way this research is influencing me is that I am getting more sleep and feeling less guilty about it.

Another subject that came up in quite a few different talks was the importance of fruit flies. This was probably somewhat motivated by the recent comments during the United States presidential election by Sarah Palin when she implied

that studying fruit flies represented a frivolous use of taxpayer money, when nothing could be further from the truth.

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One of the things that struck me about the main lecture topics was how many of them seemed to resonate with topics that we have talked about on the *Brain Science Podcast*: things like memory, smell, and sleep. There was a really interesting lecture that I didn't get to attend that was about studying how songbirds learn to sing, in relationship to how we learn language. There was also a lecture by Giacomo Rizzolatti about mirror neurons, which I unfortunately didn't get to attend because it conflicted with a Women in Neuroscience luncheon that I attended. [Note: I discussed Rizzolatti's book *Mirrors in the Brain* was in Episode 35.]

So, I think it's fair to say that I saw a very, very small bit of what happened at this meeting. But the good news is I did meet a lot of interesting people and I made a lot of contacts, and I'm very hopeful that attendance at this meeting is going to help me to improve the content of the *Brain Science Podcast* in the coming year.

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For the last part of the podcast I am going to talk about one of the lectures that I attended. But first I would like to take a moment again to thank those of you who have been supporting the *Brain Science Podcast* with your donations. If you're interested in helping, there is more information at the website, brainsciencepodcast.com.

The most important way that the *Brain Science Podcast* can reach a larger audience is by word of mouth. So, even if you can't afford to support the show monetarily you can help by telling others about the show, and especially by linking to brainsciencepodcast.com. Every link to my website that you make

helps someone to find the podcast. Every day I get an email from someone who found the *Brain Science Podcast* thanks to one of your links. Thank you again to those of you who have been giving me the link love.

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So, like I mentioned, there were so many talks there was no way that any person could attend all of the wonderful lectures—not even all of the generally oriented lectures—that were held at Neuroscience 2008. So, I have picked one that I attended to share with you, and this was the lecture, "Anatomy and the Problem of Behavior" which was given by Dr. Michael Bate from Cambridge University. I picked this lecture because it is not only interesting, but it relates to several themes that I think are important. One is the idea of plasticity, which as those of you who are regular listeners know is one of my favorite themes. And then also it was a talk focused on some results from studying fruit flies. As I mentioned before, I think it's important to have an appreciation for why fruit flies may be the most valuable animal model in all of biology.

Now, one thing I need to say about Dr. Bate's lecture, what I'm going to tell you is just going to be an overview based on notes that I took during the lecture. There were strict non-recording policies in place at this conference, so I don't have a transcript or an abstract to work from, I am working from my notes. So, if I should make a mistake and you were there, please drop me an email at docartemis@gmail.com and let me know.

Dr. Bate entitled his lecture "Anatomy and the Problem of Behavior." He started out by saying that his key idea that he wanted to communicate was that activity-dependent tuning and adjustments occur in motor systems as well as sensory systems. Now, remember we already know that the sensory systems in animals are tuned by feedback. For example, if a young cat has its eyes sewn shut during the critical period it will not be able to see properly. He mentioned work done 40

years ago by Donald Wilson, who studied locust flight and showed that there were central circuits that coordinated output with sensory feedback. So, the main idea is that this level of control is existing in insects.

This brings us to the *Drosophila*, the lowly fruit fly. They make genetic mutations in these fruit flies, and one of the interesting things that they discovered is that crawling behavior still emerges even if they have mutations. So, this implies that there is a level of plasticity in the emergence of this crawling behavior. Now, in studying how movement emerges in a fruit fly there are three parts to consider. There are the component cells, how they're connected, and excitation.

The first thing that Dr. Bate mentioned was the fact that if you have genetically identical neurons they will end up with different patterns of branching. In other words they have different growth solutions, which implies that growth is exploratory rather than specific, and it also implies some kind of feedback. Other researchers have shown that similar principles apply with intrinsic excitability and conductivity.

Eve Marder, as I mentioned before, her work in lobsters has been aimed at elucidating the circuits that are going on in the invertebrate nervous system, and she has basically shown that the cells do explore alternatives but that they need feedback to set and maintain an acceptable level of excitability. It appears that the crucial functional characteristics are set as the cells move to achieve target values in the context of the circuits of which they are a part. And what that means is that at the beginning they don't have a particular set level, but once they have become part of a particular circuit that circuit determines what those target values are going to be.

This theory is considered under what's a sort of a homeostatic hypothesis. The idea is that the cells have a characteristic set point. If this is true, then there should be evidence of adjustment and tuning as the circuits begin to function. A

question is when do the cells receive their set points. Dr. Bate said his guess was that how the cells assign during development results from pattern activation of transcription proteins, and that's what leads the neurons to have specific properties.

One thing they do know is that if they use knock-outs—which are animals that have had certain genes knocked out—then by doing knock-outs they can reveal lost properties. For example, the cells might fail to cross the midline like they are supposed to. OK, well that sounds really good but the question is, is there any evidence for adjustment and tuning. And that was the purpose of the experiments that Dr. Bate conducted with his graduate student, Sarah Crisp.

The experiments were conducted in *Drosophila*—fruit flies—to test this hypothesis. The hypothesis is that the cell is assigned its role via patterned activation during development. So, they were studying *Drosophila* embryo movements. And what this means is when the fruit fly is still an embryo—it looks kind of like a larva in the video—it kind of inches along. So, that's the kind of movement that they are studying.

They had three questions that they wanted to answer. How does function begin? How good is the motor score—that is, how coordinated was the motor behavior? At the beginning it turns out it's poor. And the most important question was is there evidence for adjustment and tuning. They had a technique for tagging the muscles so that they could measure the movement. And I will have a link to the key paper about this in the Show Notes. He showed a video, and I'm hoping to be able to get a link to that video for you in the Show Notes but I haven't heard back from him yet.

Anyway, basically the embryo demonstrates kind of like a peristaltic wave going through it, and it starts out unilateral—that is, one side of the animal—and then it becomes a coordinated bilateral wave that goes through. Now, the interesting

thing is that fruit flies develop so quickly that it only takes 21 hours to develop their whole nervous system. But even before the neurons can transmit signals, spontaneous contractions of the muscles are observed. Dr. Bate said, "We want to understand the transition from the myogenic phase to coordinated movement."

So, what they did was they blocked synaptic transmission and that allowed them to just isolate the myogenic, or muscle, activity. They saw that the coordinated waves normally appeared at about 18.2 hours, but not if the nerve transmission was blocked. So, the neural inputs appear to be critical. Now, coordination means left and right firing together, and this appears gradually such that it appears that the performance is improving during bursting, which is at the beginning just spontaneous bursts of activity from the muscles and then it gradually becomes coordinated. So, there's a transition from isolated bursts to coordination. That could be evidence for adjustment and tuning, or it could just be that the circuit is completed.

So, the question is, is the nerve activity during this phase important or necessary. What they did was they did a test where they had mutants where they had temperature-sensitive synaptic blockade. And what this meant was that they could heat up the embryo to block synaptic transmission. So, when the embryo was at a normal temperature the synaptic transmission could occur, and then if it was heated it couldn't. Thus they could block the synaptic transmission during the critical periods to see what would happen. Now, they did have a control that showed that nothing happened if they raised the temperature early on—in other words, before the critical period. So, that showed that the heat itself didn't have an effect.

The results were interesting. First of all, if they blocked only the motor neurons then there wasn't any movement during the critical period but the first wave still occurred on schedule. If they blocked the entire network then the peristaltic

waves were delayed. So, this suggested that the synaptic transmission was necessary. Interestingly, when they removed the block then the bursting returned. So, it does seem to show that there is a window of development where the synaptic transmission is essential.

The next question was whether or not the transmission needed to be patterned, like it does in vision. So, for this part what they did was they used a technique that allowed them to activate all the motor neurons at once. They did this using something called Channelrhodopsin-2, which is sensitive to blue light, and so then basically they could shine the blue light on the embryo and all the motor neurons would be activated.

And what happened when they did this was that there was a worse delay in the emergence of coordinated movement than there was when they just did the simple temperature-sensitive synaptic blockade. This implies that there is also a window of adjustment in tuning. Basically what this experiment showed was that this coordinated peristaltic movement in the embryo of the *Drosophila* fruit fly was dependent upon neural signals going to the muscles and that these signals needed to be patterned.

So, the conclusion that Dr. Bate drew from this experiment was that there is a critical period that requires patterned activity, or patterned neuronal firing, in order to tune the target activity—the activity of the muscles. This brings us back to the original theme, which was the idea of tuning happening in motor function just as it does in sensory function. And like I said, for those of you who are interested in knowing more about the details of this particular experiment I am going to put a link to the original paper[1] in the Show Notes. And if I'm able to get a link to the video I will, because I think that will really help you to visualize exactly what kind of motion was being studied.

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[1] The development of motor coordination in Drosophila embryos by Sarah Crisp, Jan Felix Evers, André Fiala and Michael Bate; Development 135, 3707-3717 (2008)

The reason I picked this particular talk was because it was one that I found interesting, and it did emphasize the idea of plasticity, which is one we've talked about on many occasions. And it is a concrete example of how useful the *Drosophila* fruit fly is in doing research.

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I want to talk a little bit more about the importance of the fruit fly. Fruit flies are very important in genetic research for several reasons. First of all their genome was one of the first to be sequenced, and the techniques that were developed to sequence the fruit fly were actually used to help to sequence the human genome. And because their genetic structure is well understood it's possible to manipulate their genes. For example, it's possible to make fruit flies grow eyes on their legs. That's just a little bit odd, but something I read about recently in a book I'm reading about vision.

But again, this idea of changing the genetic structure and then observing various results, these techniques have been extended to other animals such as mice. One very useful feature of the fruit fly is its rapid reproduction. I mentioned before that it only takes 21 hours to get its entire nervous system. This means that scientists can breed thousands of generations in a very short time. Not only does this save money, but it allows scientists to examine questions that would be impractical to study in other animals, including examining theories about how evolution works.

Well, what does this have to do with neuroscience? Well, I think Dr. Bate's research provides an indirect answer to that question. There were lots of papers presented at Neuroscience 2008 that were based on *Drosophila* research. One which I missed, which I think would probably have been very interesting, had to do with studying sleep in *Drosophila*.

Researchers are able to manipulate the nervous system of the fruit fly, which is actually surprisingly complex even though they don't really have a brain per se. It's already been possible to develop some novel gene therapies in fruit flies that are now being tested in mice. And then there's the fact that since it's already been shown that fruit flies learn, they are an important tool for studying learning at a very basic level. I'm sure that many of you could think of some even better examples about why fruit flies are important.

Fruit flies are an incredibly valuable tool in many fields of biology. If you hear a politician or anyone else treating them as an object of scorn, it essentially tells you that that person is scientifically illiterate. And given the importance of science and technology in solving the problems that confront us in the 21st century, I think it is dangerous to have anyone like that in a leadership position.

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So, before I close I just want to share a few final thoughts about my experience with attending the annual meeting of the Society for Neuroscience in 2008. It was a somewhat overwhelming experience, but I think it did give me a new appreciation of the immense diversity of the field. And I think it will enrich the content of the *Brain Science Podcast*. I also hope that I'm going to be able to forge some connections with the Society for Neuroscience, since we are both committed to improving general understanding of neuroscience.

I want to give a quick personal shout out to the *Brain Science Podcast* listeners that I met at the meeting: Kathy, Jeremy, MA, Joe, Mary, and especially Ken Caldeira from Stanford who came downtown from Dulles on Tuesday just to have dinner with me.

In closing I'd like to remind you to please visit the website brainsciencepodcast.com. If you aren't already subscribed to the *Brain Science*

Podcast please consider subscribing either through iTunes or through your RSS reader. You can also subscribe to the RSS feed for the site and get the posts that go up in between episodes. I need everyone to help promote the *Brain Science Podcast* by word of mouth. If each one of you got one other person to listen to the show then the audience would double.

Also, don't forget to check out some of the other science podcasts at our website sciencepodcasters.org. Recently we've added a few new shows to that site, so if you haven't been there recently I hope you will check it out.

Finally, don't forget my other podcast *Books and Ideas*. My most recent episode is an interview with Nobel physicist Frank Wilczek, so if you want to know what the Large Hadron Collider is all about I hope you check that out. It's at booksandideas.com. And if you've already heard Dr. Wilczek's interview, I'm hoping to get a transcript up soon and I'm also hoping to get him on for a follow-up interview in the near future.

Lastly, remember that I'd love to hear from you. You can send me email at docartemis@gmail.com, or join in the Discussion Forum at brainscienceforum.com.

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

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Transcribed by Lori Wolfson
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