

BRAIN SCIENCE PODCAST

With Ginger Campbell, MD

[Episode #64](#)

Third Annual Review Episode

Aired December 9, 2009

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INTRODUCTION

This is [Episode 64](#) of the *Brain Science Podcast*, and I'm your host, Dr. Ginger Campbell. Today we are going to be doing our Third Annual Review Episode. In fact, the [first episode](#) of the *Brain Science Podcast* went online on December 15, 2006.

You can find show notes for all the episodes of the *Brain Science Podcast* at brainsciencepodcast.com. And as always you can send me email at docartemis@gmail.com. And don't forget my new voicemail number at 206-984-0358.

The goal of the *Brain Science Podcast* is to explore how recent discoveries in neuroscience are unraveling the mystery of how our brains make us who we are. In today's episode I am going to give you an overview of the topics that we discussed in the past year.

Then I'm going to have some announcements. Some of these will be to remind you what's on the website, and also how you can connect with other listeners and with me. This is mostly stuff that I try to remember to tell people in regular episodes; but I know a lot of you don't listen, so I try to put this all together also at the end.

Finally, I will be taking a look ahead to 2010, give you an idea of what to expect in next year's episodes, and also let you know a few new things that I'm hoping to launch in 2010.

So, if you're a new listener I think you'll get a lot out of the first part of the episode. Even if you're a regular listener, I think it will be a great review. And also, maybe if you've missed an episode it will remind you to go back and check that out.

One neat thing is that this year all the episodes are available as [transcripts](#), and these are currently free. So, if you don't have time to listen to an episode but want to see what it's about, you can also download the transcript to get a quick overview.

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DISCUSSION

This year, as always, I tried to have a balance of episodes that would be of interest to general listeners and those that would be of interest to those of you that have slightly more technical backgrounds, because the audience for the *Brain Science Podcast* is extremely diverse, ranging from people with no science background to those with PhDs—which, as you might imagine, I find to be an interesting and ongoing challenge.

This year there was a balance of episodes between philosophy of mind, basic sciences, and general interest episodes. We started out in [Episode 53](#) with a discussion of the book, [*Did My Neurons Make Me Do It?: Philosophical and Neurobiological Perspectives on Moral Responsibility and Free Will*](#), by [Nancey Murphy](#) and [Warren Brown](#).

This was the only episode I did this year that wasn't an interview, and it was really a challenging episode, both for me and for listeners. The goal of the book was to show that a [physicalist](#) account of the mind can be reconciled with our intuitive sense of ourselves as free agents. The argument rests on something called [non-reductive physicalism](#), which uses tools like [dynamic systems](#) and the idea of [top-down vs. bottom-up causation](#).

The bottom line is our ability to make choices—including those related to right and wrong—is built into our biology. It doesn't require another source, such as a non-physical soul. I will talk a little bit more about this later, when I get to my review of the follow-up interview with Warren Brown.

But for now I do want to mention that this book also touched on another one of my favorite themes, which is the importance of [embodiment](#). Brown and Murphy emphasized that it is the whole person who decides and acts, not just the brain. They quoted [Antonio Damasio](#) as saying, “The mind is embodied, not embrained.” Again, the overriding theme of this book and this episode was that reason, moral responsibility, and free will are naturally-emerging properties of human biology.

[Episode 54](#) was an interview with [Dr. Michael Merzenich](#), who is one of the pioneers in the field that we now call [neuroplasticity](#). I invited him because I wanted to talk with him about his career in this field; and I was a little surprised when some listeners were offended by the fact that I also asked him about the

commercial products that he has helped develop. In particular, our focus was on the science behind them.

One of the things that we talked about was the [cochlear implant](#), which led to some surprising discoveries that actually relate right back to neuroplasticity. When people got their cochlear implants, at first it just sounded like noise. But after four to six weeks, I think, they were able to understand most speech.

The thing about this that was surprising was the quality of the inputs was pretty poor compared to what you would get with normal hearing (Dr. Merzenich compared it to playing Chopin with your elbows), but the brain was able to adjust to the new inputs until the point where they were able to understand incredibly well.

Now Dr. Merzenich's work at [Posit Science](#) is focused on developing tools for helping people maintain their mental sharpness as they age. They have been doing animal experiments, and they have found that in the animal experiments most of the aspects of mental performance that deteriorate with age can be improved. This is pretty encouraging, I think.

I asked Dr. Merzenich for some practical advice, and he emphasized two things: One is the importance of remaining physically active; and the second is the importance of remaining engaged in challenging mental activities.

This means that we have to resist the temptation to take the easy way out and do things the same all the time, so that we're not challenged. He also emphasized that you have to pick something you really care about in order for it to be effective.

Another thing we talked about that I found fascinating was some of the surprising ways that hearing and vision are involved in the memory problems we associate with aging.

In [Episode 55](#) I talked with [Dr. Patricia Churchland](#), a philosopher from the [University of California at San Diego](#). She is the author of the well-respected book, [Neurophilosophy: Toward a Unified Science of the Mind-Brain](#). This was actually one of the year's most popular episodes. I think it had the most downloads of any episode I have ever recorded. We had an interesting discussion of the relationship between philosophy and neuroscience.

Dr. Churchland observed that early on many philosophers were resistant to the idea that the findings about the brain mattered. In fact, early on in her work she got more support from neuroscientists than she did from fellow philosophers. On the other hand, she also observed that science changes the questions that we ask.

I was hoping Dr. Churchland would give me some feedback about [Episode 53](#)—*Did My Neurons Make Me Do It?*—but she hadn't read the book. However, she did have an interesting take on the question of free will. She explained that [contra-causal free will](#), which is the kind of free will that an immaterial soul would possess, is a relatively new idea—it came from [Descartes](#). It would have been a foreign idea to the ancient Greeks, and it is totally unsupported by science.

But she thinks that [systems biology](#) supports the idea of emergence of moral responsibility. One of her interests is the precursors to moral thinking that can be observed in various mammals. Her current focus is on morality and the social brain. She makes some very interesting observations on these topics. I encourage you to go back and listen to this episode if you missed it.

[Episode 56](#) was our first real basic science type episode of the year. It was an interview with [Dr. Eve Marder](#), who is a neuroscientist at [Brandeis University](#), and recent president of the [Society for Neuroscience](#). Many listeners really enjoyed hearing Dr. Marder's story.

It included the fact that she was part of the sudden influx of women into science PhD programs back in the late '60s. She also entered neuroscience before it became a separate specialty. She has been working in her field for 35 years. Dr. Marder also talked to us about the goals and activities of the Society for Neuroscience, which has members all over the world.

Finally, we talked about her research, which is definitely on the basic science end of the spectrum. She has spent over 30 years studying the [stomatogastric ganglion](#) in crabs and lobsters. This ganglion has only 30 neurons, which means its wiring diagram has been thoroughly studied. It's of interest because it's what is called a [central pattern generator](#), which means that it can generate rhythmic motor signals without any external input. An example of that in us would be the thing that makes us breathe.

We talked about the specific value of this sort of research; but the thing that I found most interesting was some surprising discoveries that have implications beyond Dr. Marder's work. Her work has revealed that the wiring diagram alone is not enough to predict neuronal behavior, because the neurons and the synapses are subject to [neuromodulation](#).

This means that chemical substances—which are called neuromodulators—can change how sensitive they are to inputs, and that changes their outputs. So, the same circuit could have different outputs; which means you need more than the wiring diagram. This has significant implications for larger systems—like, for example, the idea that if you had the wiring diagram for a whole brain, you would be able to predict its behavior, or simulate it with a computer.

Another thing Dr. Marder is exploring that has wide-reaching implications is the importance of individual variation. Up until now it has been standard to do experiments where you repeat the same experiment as many times as possible, average the results, and ignore animal-to-animal variation.

But because each neuron in the stomatogastric ganglion is so well-characterized, they can start to look at variation at the single neuron level. And they have found surprising levels of variation. They started to look for this because it was predicted by their computer models. So, it may turn out that the amount of variation of individual animals is more important than previously realized.

In [Episode 57](#) I talked with [Chris Frith](#), a [neuropsychologist](#) from [University College London](#), and author of the book, [Making up the Mind: How the Brain Creates Our Mental World](#). This book's goal is to share what Dr. Frith has learned as a neuropsychologist working with [brain imaging](#).

Imaging has given psychologists a tool for studying subjective experience in an objective way, and it has revolutionized the field—hopefully putting the last nail in [behaviorism's](#) coffin. Because, remember, the behaviorists argued that nothing going on in the brain or the mind matters. Interestingly, a lot of the imaging experiments have confirmed many things that were already found by the experimental psychologists.

Those of you who have been listening for awhile may remember when we talked to [Dr. Edward Taub](#) back in [Episode 28](#) about his stroke rehab program, that he had for years had difficulty getting his work recognized because it was only based on clinical data, and his work was ignored until the imaging data was available. So, that's how it has been for the experimental psychologists, in a way—the imaging has brought new respect to their work.

Another focus of *Making up the Mind* was examining the relationship between the mind and the brain; because everything that happens in the mind is in a sense created by the brain. All we know about our bodies and the world comes to us from our brain; but the brain doesn't tell us everything. In fact, most information never reaches consciousness. Or, as Dr. Frith observed, "Our brain can know things that our mind doesn't know."

Significantly, we get our knowledge of ourselves the same way we get our knowledge about the external world. We have no direct knowledge of anything. The brain also creates our sense of separateness. And perception is not a passive process, because it depends on both sensory inputs and prior expectations, as well as our acting in the world. I'll be saying more about that in a few minutes.

The key theme of Dr. Frith's book is that the brain uses the same processes to inform us about the world outside as it does to tell us about our own bodies and thoughts. So, in a certain sense all our knowledge is indirect, because it is filtered through the brain.

I asked Dr. Frith about how his work had changed his definition of the mind, and he said the biggest change was that he had become more aware of how his mind depends on other people. He said, "The existence of culture and other people makes the mind something much bigger."

Which leads us into [Episode 58](#), which was an interview with [Alva Noë](#), a philosopher from the [University of California at Berkeley](#), and author of the book, [*Out of Our Heads: Why You Are Not Your Brain, and Other Lessons from the Biology of Consciousness*](#). As the title of Noë's book implies, he set out to challenge the notion that consciousness is something that happens inside our brains.

His view is that the brain is not the whole story, but he wants to explain the mind in a completely naturalistic way. He says, "The brain is only part of the machinery of what makes the mind possible."

Some listeners objected to Noë's arguments, but what I got out of his book and our conversation was that he is emphasizing the same thing many of my other guests have talked about: embodiment. As he says, "Your brain is part of you, but your body plays a role, and so does your environment."

In this regard he also emphasized the role of action and interaction with the world. We don't learn about the world by just passively taking in sensory information; we have to move and interact with the world. And there were several great examples in this interview, including the one that some of you are already familiar with, which is the fact that experiments have shown that cats who aren't allowed to move around do not develop normal vision.

This book, *Out Of Our Heads*, is a great example of the contribution philosophers can make when they are willing to engage with the emerging neuroscience. I highly recommend the book.

I would also like to mention that if you go back to listen to this episode and you find that there are some problems with the levels (Dr. Noë's voice is difficult to hear), I haven't had a chance to get that fixed yet. So, you might want to consider downloading the transcript as an alternative way of getting this episode; and you'll find that in the show notes at brainsciencepodcast.com.

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I want to take a moment to thank Audible.com for their ongoing sponsorship of the *Brain Science Podcast*. Many of the books that are covered on the *Brain Science Podcast* are available from Audible.com. New Audible users get one free audiobook download. Just go to audiblepodcast.com/brainscience.

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[Episode 59](#) is an interview with [Dr. Guy Caldwell](#), a molecular biologist from the [University of Alabama](#). In our conversation we talked about why [molecular biology](#) is such a valuable tool for neuroscience, and we also learned a little about the tiny worm, *C. elegans*. This was the first animal whose complete [genome](#) was sequenced; which is extremely valuable because of the fact that they have already

determined its complete developmental lineage for all of its 959 cells, and they already have the complete wiring diagram for its 302 neurons.

And if that wasn't good enough, it's also transparent, so you can label things inside of it with [fluorescent labeling](#), and then study them. So, in the case of Dr. Caldwell, he is studying the eight [dopamine neurons](#) that the *C. elegans* has; and his goal is to help to cure [Parkinson's disease](#), which is a disease of dopamine neurons.

Every scientist I have talked to has had obvious passion for his or her work; but I think this interview is particularly special in this regard. This is the episode I would copy and share if I knew a young person who was interested in a career in science.

[Episode 60](#) is an interview with [Stuart Brown](#), the author of [Play: How It Shapes the Brain, Opens the Imagination, and Invigorates the Soul](#). Dr. Brown is a retired psychiatrist who has devoted his retirement to trying to get the word out that play matters, and it's not just for kids. We discussed the importance of play from two directions.

First, children need play—including rough-and-tumble play and free play—to develop normally. Rough-and-tumble play not only defuses excess energy, but it is important for learning how to get along with others. And when children are alone together they learn valuable social skills. Play that nurtures imagination is important for being able to problem-solve and imagine solutions. Unfortunately our culture is suppressing the kind of play that children really need.

The second aspect of the episode was talking about the fact that adults need play: it keeps our brains agile. [George Bernard Shaw](#) was quoted as saying, “We don't stop playing because we grow old; we grow old because we stop playing.” Dr. Brown also emphasized the fact that the opposite of play is depression.

This book, *Play: How It Shapes the Brain, Opens the Imagination, and Invigorates the Soul*, is aimed at general readers. I would like to encourage you to read it and, as Dr. Brown said in the interview, to share it with your school board.

[Episode 61](#) is an interview with [Dr. Allan Jones](#) from the [Allen Institute for Brain Science](#). This was a direct result of several listener requests. Dr. Jones is the Chief Science Officer at the Allen Brain Institute, and from him we learned about how the Allen Institute has created a [map of the adult mouse brain](#) that serves as a free database for researchers around the world.

This map shows what genes are active in any given location in the brain. Surprisingly, 70-80% of the genome is active in the mouse brain; and they think this will be similar in the human brain. They hope to complete a similar type map for the human cortex in 2010.

This is an episode that will be of particular interest to those of you who are interested in the nuts and bolts of how science is done. Dr. Jones talked candidly about how this sort of science represents a different kind of career path, since it involves being part of a large team rather than pursuing a specific hypothesis.

We also talked about how the data generated by a project like this does not generate any kind of proof of theories. It just generates clues that then can be tested by those that are working on the theories and hypothesis testing. It does not replace the need for hypotheses and theories.

Finally, in [Episode 62](#), I got [Warren Brown](#)—one of the authors of *Did My Neurons Make Me Do It?*—onto the podcast. Dr. Brown is an [experimental psychologist](#) who teaches at the [Fuller Theological Seminary](#). We tried to clarify some of the misunderstandings that seemed to have arisen from my attempts to present the key ideas of his book.

One thing Dr. Brown said that struck me as something Alva Noë would have agreed with was, “Mind is basically a verb.” Just like Noë, Brown and Murphy (his co-author) challenge our tendency to think of mental processes as something passive. He said, “First we act in the world, and then our sensory systems give us feedback.”

I asked him to talk about the idea of [top-down causation](#)—since this is a phrase that makes many people uncomfortable. First, remember that we’re talking within the context of a [physicalist](#) description of the mind. The main idea is that in a complex system, the whole constrains, or influences, the parts. But even though the nervous system is hierarchical, the levels are so tightly coupled that what happens in the cortex has no meaning without its tight coupling to the other parts of the brain and to the body.

When I went back and reviewed the transcripts for these episodes I was struck by the large amount of overlap between Noë and Murphy and Brown. I point this out because some listeners seem convinced that Brown and Murphy have a religious agenda; which is clearly not the case for Noë.

I think they are both arguing that if we take a different view of mind and consciousness—one that goes beyond the brain—then there is a chance to solve some of the long-standing dilemmas in [philosophy of mind](#). And they both agree that incorporating the findings of neuroscience is absolutely essential to unraveling the mystery of consciousness.

Last month’s episode—[Episode 63](#)—was an interview with [Dr. David Bainbridge](#) about his book, [Teenagers: A Natural History](#). Dr. Bainbridge teaches veterinary anatomy and reproductive biology at [Cambridge University](#). He also wrote, [Beyond the Zonules of Zinn: A Fantastic Journey Through Your Brain](#), which I discussed back in [Episode 32](#).

The major thesis of *Teenagers* is that the changes that happen in the teenage brain are unique to humans, and are essential. In other words, teenagers make us human. We talked about how the brain changes during the teenage years: There is [pruning](#), and [myelinization](#), and maturing of the pathways to the [prefrontal lobes](#).

We also talked about addiction and why teens might be more susceptible to addiction. I mentioned during the episode that I have teenage nieces; and I am proud that one of my nieces listened to the episode, and actually told her boyfriend that it was good.

Now, obviously, I've only touched the surface of the issues that we've talked about over the last year. I would like to encourage you to either go back and listen to the episodes that you missed, or get the transcripts—since transcripts are now available for all episodes.

Some of you may be wondering why I have spent quite a few episodes this year on philosophy of mind—which includes the ongoing effort to define consciousness and the mind. Well, I think it is of obvious importance to the whole issue of how our brains make us who we are. Another thing is that one important question I think we are going to be facing in the future is what is the significance of neuroscience to questions of ethics and moral responsibility?

These questions are going to become more and more pertinent as neuroscience progresses, so it is important to keep an eye on the intersection between philosophy and neuroscience. Also, I think good philosophers of the mind know that it's important to understand not just how the brain works, but how it is embodied—which means being embedded in a world that includes culture and other people.

On the basic science front this year we talked to Dr. Eve Marder, who has spent 35 years studying a single circuit in the crab and lobster, and we talked to Dr. Guy Caldwell, who is a young molecular biologist working with *C. elegans*. We also talked to Dr. Allan Jones from the Allen Brain Institute, who went from being a bench scientist to running a huge project that represents a new way of doing science.

These three scientists give you a glimpse of the wide variety of career paths available in neuroscience, as well as emphasizing the importance of a wide variety of disciplines. I emphasize this because I often get emails asking me for career advice, and that's one reason why I always ask working scientists to share their insights in this area.

And I think two themes emerged during the year from talking to these scientists who are at various points in their careers. One was that you should start from where you are, because almost every field has something it can offer to the field of neuroscience. And the second one is to follow your passion. This is something both Dr. Caldwell and Dr. Marder were very eloquent about.

I guess I didn't get to do as many general interest episodes this year, with cutting back to only one episode a month. However, the books by Chris Frith, Alva Noë, Stuart Brown, and David Bainbridge are all excellent books for general readers, and you can find links to those in the show notes. The episode about play was probably the most important episode in terms of practical information that we can all use; but I think the episode about teenagers will also be helpful.

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Now for a few announcements and reminders—or an overview of what's available on the web for those who want to become more involved.

First, if you want to have one place to go to find everything that I'm doing, the best place to go is virginiacampbellmd.com. There you will find, in addition to the *Brain Science Podcast*, a link to my other podcast, [*Books and Ideas*](#), and a link to sciencepodcasters.org, which is the site I do with a bunch of other science podcasters just to promote science podcasting.

Also, if you go to the *Brain Science Podcast* website at brainsciencepodcast.com you will find links to everything that I talk about today.

The new thing that we started this year was the [Facebook Fan Page](#), which takes the place of the Facebook Brain Science Podcast Group. I'd like to encourage you to join that if you haven't joined it yet.

We also still have our Discussion Forum going at brainscienceforum.com. And you can also find a Flickr Group which is called [The Brain Science Podcast Community Group](#).

In the year 2009 we got all the episodes of the *Brain Science Podcast* transcribed, so those are [available on the website](#). And they are also available via the new [iPhone application](#) which just launched in November of 2009.

Another new thing in 2009 was that it became possible for those of you who donate to the show to donate directly via mail. That has been very useful for people who don't want to use PayPal. You can find that at brainsciencepodcast.com by clicking on the [Donations and Subscriptions](#) link at the top of the page.

Now I want to take a few minutes to talk about next year—2010. First of all, I plan to continue the monthly format, and most episodes will be coming out on the second Wednesday of the month. I may have to vary that from time to time, but I intend to put out one episode a month; although I may occasionally add

episodes of [Books and Ideas](#) into the feed. By cutting back from twice a month to once a month I have managed to make the workload a little bit more manageable.

One of the things we're going to do in 2010 is return to some of the basic themes like memory and emotions. I've got an interesting episode on memory and an interesting episode on emotions already lined up. And I am hoping that we will be able to have an interview with philosopher, [Thomas Metzinger](#) about his book, [The Ego Tunnel](#).

As always, I'd like you to continue to send me your suggestions. My focus will continue to be on new books, so feel free to send me books that you think would be good. If you want to do that, you can just go to brainsciencepodcast.com and look at the [contact information](#). I've got a mailing address there for that. I also should be getting a link to my Amazon Wish List up on the website sometime early in 2010; so that will be another way you can do that.

As the *Brain Science Podcast* enters its fourth year I am planning some major changes—not in content so much, as the fact that I am planning to make it a goal to make some money in the year 2010. The reason for this is that my long-term goal is to retire from emergency medicine.

As I mentioned before, cutting back to one episode a month has made things manageable, but I'm still putting out two podcasts a month (since I put out [Books and Ideas](#) once a month also), and to tell the truth, back in the summer I came very close to ending the *Brain Science Podcast* at the end of 2009.

So, what I'm planning to do, and hoping to do, is to create some products that will allow you to support my work, and also hopefully reach a larger audience. These will be rolled out on a gradual basis in the coming months.

The first thing I'm planning to do is launch some newsletters as a tool that will allow me to communicate better with regular listeners—because I know it's easy

to get behind in listening to episodes, and I also know that some of you always skip my announcements. If you sign up you will be able to choose what sort of information you want to receive. And I won't share your email with anyone else.

I've got some other planned products. Because I have over 60 hours of content—nearly 100 hours if you count *Books and Ideas*—I am planning to change the transcripts so that they will be going on sale for a reasonable price, rather than being free. I am also hoping to begin selling CDs of episodes, beginning with new episodes.

And I would like to create some continuing educational products. And this is something that I'm going to need some help with, so if there is anyone out there that has any experience in continuing education, I'd really like to hear from you. In particular, I would love to hear from somebody who works in the area of psychology, because I don't know anything about how to create continuing education products for psychologists.

For all these things I am open to collaboration and suggestions. My intention is to keep the podcast itself free, but to try to figure out other ways to generate income. I would prefer not to add a lot of advertising. As those of you who are long-term listeners know, Audible.com is the only ongoing advertising I have—and to tell you the truth, they don't pay me very much.

What about listener donations? Well, listener donations are important, and are very much appreciated. It's just that after two years of taking listener donations I've come to the realization that the number of people who will contribute is always going to be too small to do more than help me break even.

Besides trying to make money in 2010 I also want to reach a larger audience: And that's where you come in. As I said before, I want the podcast to remain free. That is my intention. And I'd also like to have it remain fairly low on advertising

content. However, I would very much like to get a larger audience, both for the *Brain Science Podcast* and for *Books and Ideas*.

So, I have to remind you again that your word of mouth, blogging, Twittering, etc., are extremely valuable. And if anyone has any ideas about how I can get a bigger audience, please let me know. I think probably the only downside of going to once a month was that it made it a little bit harder to reach new listeners.

OK. Well, I'm sure there's something I want to tell you that I'm forgetting—because I always do that. But I'm going to close for today. I want to thank you for listening—especially those that have been with me for the entire three years.

If you haven't sent me an email in awhile I'd love to hear from you. Tell me how long you've been listening and where you live. Those are two things I find particularly interesting. And I also love to hear about what people are doing, what line of work you're in, how you found the show, and, of course, your suggestions about future episodes.

It's true that, because I can only do a limited amount of material compared to all the neuroscience that's out there, I'm not able to put most of the suggestions I get onto the show. But if I keep hearing the same thing asked for by lots of people, that's when it gets to the point where I'm likely to put it on a show. So, don't be thinking, 'Well, I'm sure someone else has already suggested that'—because, really, the more I hear the same suggestion, the more I'm likely to do it.

Please don't forget to visit the website at brainsciencepodcast.com. If you aren't already subscribed, you'll find all the ways to subscribe there. If you're getting the show through iTunes, don't forget to leave a review. And don't forget to check out the [Facebook Fan Page](#) if you're on Facebook.

You can send me email at docartemis@gmail.com, or leave voicemail at the new voicemail number: 206-984-0358.

Thanks again for listening. I'll be back with you again in 2010.

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Transcribed by [Lori Wolfson](#)

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