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"How Did We Overlook Half The Brain For 100 Years?"

An Interview With Dr. R. Doug Fields

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And along the way, I've created a successful home-based publishing business all from my two-car garage.

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Published by:

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"How Did We Overlook Half The Brain For 100 Years?"

That's what scientists are asking themselves right now. And the half that was overlooked is huge. It's got them re-evaluating the way they look at paralysis, multiple sclerosis, Parkinson's, dementia – all brain related diseases – with new hope that breakthroughs will be just around the corner. And in this audio with R. Douglas Fields, Ph.D., author of *The Other Brain,* you'll hear all about it.

Dr. Fields says all brain science had previously been based on what's called the neuron doctrine, the stuff we all learned in biology about neurons, synapses and electrical transmissions. But do you remember anything about glial cells? Doctors always knew they were there, but they kind of just disregarded them away as "white matter."

As it turns out, the white-matter matters… a lot. And in this audio, you'll hear all about this amazing discovery in neuroscience, the a-ha moment that turned everything around, and why everybody is so excited about it.

You'll Also Hear…

- A hard look at the way science is funded – and how that can stifle even the most promising of research
- Exactly what glial cells do and specific examples of the kinds of glia research that could help everything from brain cancer to schizophrenia
- A little-known fact: the brain has its own immune system, and glial cells are its first responders – find out what that all means and how it works
- The surprising relationship exercise has on brain function and memory
- The "bad-guy" role glial cells can play in brain cancer, learning disabilities, psychological disorders and more
- How glial cells are expanding our knowledge of learning – and the interesting changes that happen to your brain after it learns to play an instrument or juggle
- Could glial-cell research have cured Sen. Ted Kennedy's brain cancer?

Dr. Fields says scientists are definitely playing catch-up when it comes to brain research because they ignored more than half the brain for so long. Glia makes up 85% of the cells in the brain, and in this audio you'll hear the amazing things that 85% can do.

Hi Kris Costello and I teamed up with Michael Senoff, to bring can bring you the world best health-related interviews. So if you know anyone struggling with their weight with cancer, diabetes, ADHD, autism, heart disease or other health issues send them over to Michael Senoff's HardToFindSeminars.com.

Kris: Today, we have Dr. Fields with us. So, Dr. Fields you have written The Other Brain Book and this is just exciting stuff and we are just so glad that you could be with us today.

Dr. Fields: Oh, thank you much.

Kris: How did you get interested in this field? You have some remarkable stories in there.

Dr. Fields: I am one of those fortune people who always knew what they wanted to do. I have always wanted to be a scientist from an early age and I loved biology and the brain was particularly intriguing to me, I mean, defines who we are, all our memories, perceptions and skills and dreams and how does it work?

Kris: How long you have been doing brain research?

Dr. Fields: Well, I have been at the National Institute of Health for 23 years, but whole professional career has been brain, neuroscience research, although I started out as marine biologist there in California at Scripps and also (inaudible) I studied shark brains.

Kris: Dr. Fields one of the things The Other Brain Book one of the reasons is so interesting, as you talk about how this is a unique moment in the history of brain science and how this is just revolutionizing what we have traditionally thought about how the brain works and you know for all the listeners what have we thought about how the brain works?

Dr. Fields: I am glad that you sense that because in the book I only hoped people would understand this excitement that we're feeling because the book is packed with information and medical information, but really this is a new dimension in brain function and emerges idea about how the brain works. So that's exciting

and I have heard about these revolution much like realizing the air flows at the center of the universe and we read about those, but to have how one happening in real time is very excited. So in the past all of our ideas about how the brain work were based on something called the neuron doctrine and that was that all information in the nervous system and competition takes place by electrical transmission of impulses through neuron communicating across synopsis and what we now discovered is that that fundamental assumption is not correct that there is another form of information flow in the brain that doesn't involve neurons.

Kris: And so you actually discovered in the laboratory, you watch these glial cells, is what they're called, you discovered a lot of this, right?

Dr. Fields: Well, yes. I made a lot of contributions, but so did many others. It has been a real dawning of new understanding. I should say that I think everybody is fascinated about how the brain works and how neurons can allow us to do all the things that our brain does, but only 15% of the cells in our brain are neurons and so the glial cells, which means glue have been largely over looked because they don't make electricity and it was worked in the lab, new techniques, forced us to rethink our fundamental assumptions to realize that there is information flow outside of neurons and through nonelectrical mechanisms and this is what I am calling the other brain, the glial part of brain.

Kris: Basically, the glia has a tremendous amount of work that it does in the brain and as I recall, I remember learning about this, we will not say how years ago, but you know just kind of that it didn't do much that it sat there.

Dr. Fields: Right, what was left out of the text, I mean, I am sure all of your listeners have seen pictures of synopsis on Zoloft commercials or text books, they never show the glia. The glia are 85% of the brain in terms of cell numbers and they are tightly surrounding the synopsis, so they were ignored because they were just felt to be structural packing material and serving mundane functions like cleaning up after neurons and maintaining the environment around neurons with the proper potassium and iron

concentration and feeding neurons and removing the neurotransmitters after neurons release them and I do all those things. They are also understood to be involved in disease, but the other shoe never dropped that this puts glia in position of control. Glia can control synopsis and we can see how important glia are in diseases, but we didn't stop to realize that geez if they're that important to disease, they might be doing something in normal brain function.

Kris: And you know, Dr. Fields that brings up something interesting question, why was this ignored?

Dr. Fields: That is the question that I am confronted with in writing this book, how did we over look half the brain for 100 years? Well, first of all, the eyes see what the mind is prepared to comprehend. We were taught as neuroscientist that neurons did it all and even though 6 times as many cells in the brain where right there looking at us, we didn't see them. The neurons were like celebrities in a faceless crowd and so we just ignored them, has little interest. Secondly, we were using the wrong tools for the job and there neuroscientist used microelectrodes to record electrical activity in neurons and I did that myself and we still do, but electrodes are death to the communication the glia cells are involved and because glia don't use electricity. And then the third thing is the scientific establishment, sort of, suppressed the development of this new idea and this is nothing sinister, this is always the way it is in science, an idea is thought to be not very important, so it doesn't compete well for grant funding, does not get published in major journals, other scientists don't hear about it and the scientist who work on these kind of unimportant cells are not highly esteemed, so this really suppresses the development of a field and it is always this way in any revolution of science, so that is one of the delights to look back and see how that's happened.

Kris: And who decides how it is not important?

Dr. Fields: Science is very collaborative and it is a sophisticated social interaction and if you discover something, it is really not science until it is validated and communicated in scientific journals around the world and there is a big process for that. There is

also a process for granting money to do research. You have to convince the committee that what you want to do is important and they have very limited funding.

Kris: So, you'vegot to be good at spreading the idea and you got to be good at getting the money?

Dr. Fields: That is right, that's right and so what happen in this field, is eventually like-minded scientists got together. We started a new journal, scientific journal neuroglia biology and then there was a place to publish this work and then slowly as the experiment progressed, and people learn about it, then field emerges and that is what happening.

Kris: In our book, The Other Brain Book, which the people want to find more out about it, they can go to the otherbrainbook.com that is by R. Douglas Fields, a researcher at the NIH. The glial cells, their role has tremendous implications for so many diseases that cause so much suffering for people, cancer, MS, HIV, psychiatric illnesses. Dr. Fields, can you talk a little bit about what this mean for some of these illnesses?

Dr. Fields: Well, you are right. It touches almost every neurological illness and brain function and maybe before going in to that you get a little preparation, I should say that the important concepts to get across about this revolution of glia is rediscoveries and that is that glia can monitor neurons, so they can sense neural activity. Secondly, glia communicate and third glia control neurons, so what you have is glia have the same neurotransmitter receptors that neurons have, which is a mystery why would they have neurotransmitter receptors? While it turns that they use those receptors to sense the neurotransmitter release at synopsis and then glia can communicate with each other by using chemical signaling, this allows them to pick up a signal from eavesdropping on neural activity, communicate through a glial network and then they can also release neurotransmitters, the same one neurons do, so now they can control another synopsis in a part of the brain that may not even be hardwired together. So that is the new dimension of brain function that glia gives us and from that we can then begin to understand how disease could be so relevant to glia because so many of our ideas about

neurologic illness are based on synoptic function all our drugs to treat neurologic illnesses and psychiatric illnesses, regulate neurotransmitters, but that is what glia do that is their natural job, they surround the synopsis, they pick up neurotransmitters and they remove them, they also release neurotransmitters, so this will involve glia in information progressing things like learning and memory, but also in any disease involving transmission, so that is one aspect of disease, but there are many, many others.

Kris: And so how much research money is going into looking at the role of glial cells in combating illness?

Dr. Fields: This situation has changed, it just exploded in the 4 years that I have been writing this book and now there is a great deal of funding going into. Half of the funding going into treating spinal cord injury for example is on glial research, it is so important. The other aspect of glial disease is that glia are the first responders in any disease or injury and perhaps I should say a little bit about the different kinds of glia because some of these are particularly important in disease. There are 4 basic kinds of glia, but one of the important ones is called microglia and the brain is isolated from the blood system because it is a very special environment, substances don't readily cross in to the brain from the blood stream and our immune cells cannot penetrate into the brain in normal circumstances. So the brain has its own immune system and that immune system is a type of glial cell, called microglia. Now, that makes glial cells in particularly microglia central to every aspect of infection, disease and injury, they are the first responders in stroke or any kind of injury to the brain. So we are talking about the microglia. Let me give some specific examples, dementia is a very severe problem in HIV. The brain is severely affected and thing that most people do not realize is that HIV virus does not infect neurons, it affects glia, so that is an example of the importance of the other brain on normal brain function, so microglia are very important in that. Another good example of glia that has been overlooked in disease is chronic pain. Chronic pain is different from normal pain, the kind of pain that saves from burning your finger on the stove. Chronic pain is very mysterious and has been difficult to treat because doctors really did not understand it. This pain

develops after an injury and often even after the injury heals, you have the back injury gets better, but these people develop excruciating pain and become dependent on narcotic pain relievers. Well, the reason it was so hard to understand is that the other brain was being overlooked. We now know that after a painful injury, glial cells sense a firing of neuo-pathways involved in pain and then they release substances that are important in healing, but they also increase the excitability of these pain circuits, so now the glia are releasing substances (inaudible) and other substances, molecules that cause pain. That is okay in the early part of healing because you want to leave a tender injury alone, so it will heal, but if they don't releasing that substance, the pain doesn't go away and these glia in the spinal cord and in the brain continue to excite these pain circuits and result in chronic pain. But realizing that glia are involved in pain and many other disorders is allowing new treatments and new drugs, entire new types of drugs to treat pain that have nothing to do with the neurons or operate differently from the drugs directed at neurons.

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Kris: And so, drugs that will basically stop glia from releasing substances?

Dr. Fields: Yes. The idea is either to stop them from releasing these compounds or just suppress their response to the neural signals that trigger the changes in glia. A good example there is marijuana, which is approved in many states for treatment of chronic pain that can't be controlled in any other way and recent findings show that the receptors for the active ingredient in marijuana that relieve pain are on glia; they're not on neurons. So there are even new drugs now being used in other countries, they are approved in Canada for example, which are THC derived drugs that will relieve pain by suppressing the response in glia.

Kris: So, Dr. Fields, one thing we really want to ask you about because we have had a lot of guests that deal with issues of autism and epilepsy, brain fog that kind of thing and you are

obviously the go to expert on how the brain in this new discovery with the glial cells is functioning. What is going on with these just astronomically high rates of autism in our country?

Dr. Fields: Well I think this is a lot debate on autism and I do not really have an answer for you except to say that autism is considered a complex disorder, but agreed to be a developmental disorder. And glia are key to the development of the brain in the fetus, they actually guide the migration of neurons to the right place in the fetal brain, they form the connections between the appropriate neurons, they act as guide posts and they stimulate the formation of synopsis, so we think in disorders like autism and other developmental disorders, which include things like schizophrenia, which we understand now that because the brain develops through childhood that that is also a developmental disorder that glia are involved in the disease in that way. There is a new dimension of glial involvement and other kind of glial cell that we have not talked about, which are the kind of glia that make the electrical insulation on the axons and if you're familiar with this from multiple sclerosis, the myelin, which is electrical coating on axons without this coating impulses will not travel the long distances very fast and communication can be disrupted as you can see with some MS can end up wheelchair bound, but this insulation increases the speed of impulse propagation through neural circuits 100 time. Well new methods of imaging and also new genarays have revealed changes in these glial cells that make myelin in disorders from schizophrenia to autism. And in fact in autism there is too much myelin, so we are now beginning to realize that brain function depends critically on the propagation of impulses through circuits of the brain where the flow of the information has to be synchronized and well-timed and the glial cells by insulating the axons and regulating the conduction time are involved in things like autism and schizophrenia.

Kris: And so how far out are we from having this research helping people recover from some of these illnesses?

Dr. Fields: Well, that is really happening now that people are appreciating the role of glia and it is touching many different fields, spinal cord injuries, an example. If you injure a nerve in your or arm,

it will heal eventually, but if you have an injury in your spinal cord, you're paralyzed for life and why is that the same injury affects neurons in the brain and in the spinal differently and it turns out that glia are the reason for paralysis. Glia actually blocks the regeneration of these axons in several ways after their cut and one of the surprises was that there are proteins in this myelin sheath that I was just describing that block the regrowth of axons. And that was a big surprise and talk about why nature would booby-trap the brain so that it cannot repair itself, but in direct response to your question, new drugs that block these proteins are being used right now in clinical trials to restore mobility and are being used now in patients and they definitely worked in experimental animals. Another example is cancer, a lot people may not realize that brain cancers have little to do with neurons. The brain cancer is caused by glial cells, glial cells that are growing uncontrollably. Neurons when they're mature, do not divide, so they are not in the position to become cancerous. Some of these cancers are very aggressive like the glial blastoma that Senator Kennedy suffered, it is a very aggressive kind of glial cancer. And new drugs that are directed towards particular molecules, on glia, are being used right now to treat the kind of cancer that Senator Kennedy, died from and these are very effective and this new treatment will allow the individual cells to be killed one at a time rather than having to have surgery and remove blocks of tissue and having cells escape the surgeon.

Kris: And you have a very touching description in The Other Brain about a colleague of yours, someone that was physician that was one of yours lectures who had brain cancer and was trying decide between radiation and chemotherapy and realizing the neither of those where great answers, so this provides some hope it sounds like with the treatment of glia cells.

Dr. Fields: Tremendous hope and then also at the time realizing how much catch-up we are playing because we dismissed this part of the brain so long and we have so much to learn about glia, how many are there, what controls their cell division and whether they become cancerous or not. Another thing that we have just discovered another indication of the revolution in science is causing as in the past that respond that neurons don't divide or

they are not born again in the adult brain, but a new research shows that things like exercise can promote the birth of new neurons in parts of the brain involved in memory for example and the mechanisms are being worked out under growth factors, which are factors that stimulate the growth of neurons and the birth of new neurons and these cells that are stem like cells in the adult brain, not fetal stem cells, but cells in the adult brain that respond to injury and to exercise. These are not neurons because neurons cannot divide, these are immature glial cells, so if we can learn to control the stem cells that nature has already provided we can begin to repair a lot of these diseases like Parkinson's, which is a disease involving the loss of the particular kind of neuron, so this is the very exciting in fact transplant of the glial cell is being used now to treat spinal cord injury. This is the first approved study on human of cell transplant to treat spinal cord injury and they are using a type of immature glial cells for that work.

Kris: And one of the things you also say about brain cancer, it grows in the glial cells?

Dr. Fields: Well, let me back up and say what is cancer? Cancer is uncontrolled cell division, cells just start to divide widely. You think about how important it is for cell division to be controlled, so the tissues maintain the constant shape and size despite the loss of cells throughout life, so this is a very tightly controlled process, but in cancer cell division just runs amuck and because neurons do not divide they don't become cancerous, but glial cells are dividing. They are stimulated divide under certain circumstances for example after an injury, which explains why you can see a promotion of cancer after injury. In any case, the glial cells lose their control on their normal cell division and become cancerous.

Kris: I love the way you described that the failure of the breaks that stops cell division and that the way were glial are actual killers for brain cancer.

Dr. Fields: That is right. All types of glial are in position to be cancerous because of that. There are some exceptions. There are some cells that lie in the brain, skin like cells that can become

cancerous, but by and large cancers of the brain are the glial cancers.

Kris: One of the things that we talk about quite a bit is the role of food and lifestyle in creating wellness and what do you think about food, how important is this as far as an effect on the brain?

Dr. Fields: Well, I would say that all those measure that we hear about to promote brain health in enriched environments and exercise and good diet and all of these things were learning worked through glia by and large because what is the source of these factors that nourish the neurons? Well the source are glia, PDNF is one of them, that I mentioned before, I believe, that is involved in stimulating the birth of new neurons, glia provides the energy source for neurons, so they extract nutrients from the blood and provide them to neurons in proportion to the neuronal demand. And another thing we have just discovered in the last few years is the glia control the blood flow to the brain and blood flow to the brain is very important for cognitive function, in fact I know you have seen these FMRI images of the brain, these brain scans where there will be a little red spots saying now that this part of the brain is involved in this function when they have a person do a certain task gets lights up; that technique is really looking at neural activity. It is looking at blood flow, which is very localize to those areas of the brain that have an increased need and it turns out that a kind of glia called astrocyte because they look a bit like stars. regulate the local blood flow they sense neural activity, increase neural demand and then they release substances that cause the capillaries of the vessels in the brain to dilate and bring more blood to that part of the brain. So I think every aspect of brain health is going to involve glial cells because they are the ones involved in all of these support functions that allow neurons to do their communication.

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Kris: Dr. Fields, if there are few things that you really want people to take away from your research and from this wonderful new book that you have written, The Other Brain, what would that be?

Dr. Fields: Well, I guess in addition to all of the information it is just the excitement of witnessing an emergence of a new dimension in brain function that is so exciting and so I'd like the book to portray that in addition to all of the information that is so important just the excitement seen through the eyes of a neuroscientist, watching it happen, to give an eye witness view, so that is the one of the things I have really hope the people to take away from it.

Kris: And you really accomplished that. You have a wonderful sense of storytelling and it was delightful read. I know I e-mailed you that my 7 year old overheard us talking about it and immediately was firing off questions, which of course, I had to reread the book to answer, but is delightfully written in very reader friendly, so we appreciate that.

Dr. Fields: Thank you.

Kris: And so what do you see in the future for this research? What kind of things you see happening?

Dr. Fields: Well, there are so many frontiers that are being advanced in different directions in glial research. In my own lab, we are most interested now in expanding our concept of learning, how the brain learns. In the past, all of our workers focused on the synopsis and I have studied memory and mechanisms of memory for long time and synopsis are very important, but now we are realizing that we have this communication that leads neurons that is in glial cell and it is moving as beyond the synopsis to realize that glia can be involved in learning skills for example like learning to play the piano. We have brain imaging methods now that allow us to see changes in part of the brain called the white matter where neurons are absent, so this is half of the human brain and it is composed of the connections between neurons and after you learn to play a musical instrument or learn to juggle, these brain imaging methods are showing changes in these regions with learning. So I am excited about just this aspect of brain function and learning that lies beyond neurons or even beyond synopsis. At the same time, we're very interested in disease and in developments of brain we are working in those areas as well.

Kris: And I am so glad you brought that up Dr. Fields about the learning because that is something we did want to ask you about also and you a lot of our listeners have children with learning disabilities and you know the rates of that in this country are phenomenal. I am sure you are aware 1 in 6 struggling with dyslexia or other learning struggles. What do you think is accounting for that?

Dr. Fields: Well, I would think more and more of these things, you can think of in terms of developmental disorders or maturation. Let us take a big view of the biological perspective on what the brain does. The brain allows us to cheat evolution in a way because our brains are evolved after we're born and it takes 20 years to wire up a human brain and it is wired up according to its environment. Your brain defers from mind because of the experiences we had in the schooling and our interests and that gave our brain a certain structure of wiring and capabilities that are unique to us and in a biological perspective that gives us an advantage in the environment that we are born in instead of a cavemen environment, that is what allows humans to excel and it is the human brain function to interact with the environment. So in terms of learning I think things like dyslexia definitely you know there is always this interaction between genes and environment and there is little we can do about the genes right now, but we can intervene with the environment, dyslexic children do learn read takes them a long time, but there is new evidence to show that their brain can be wire in order to process information involved in reading, so I guess I would like across that the human develops through the 20's and part of this development is glial involvement and forming insulation on the nerve pathways. Once that insulation is formed, then new sprouting and new connections is suppressed and that is the reason for riddle that I mentioned earlier, why did nature booby-trap the brain, so that when there were proteins myelin that block sprouts, the reason is that once your brain becomes adapted to the environment, it learns according to the environment that you are in that you do not lose that and so myelin stops sprouting. So to put it in another way we have the brains that we developed by the time you are about 20. You can learn new things after that in early 20's, but you will never be

world class cellist if you take up cello at age 30 probably, you have to start young.

Kris: So are glial cells involved in the learning disabilities or is that something completely different?

Dr. Fields: No the glial cells are involved in the learning disabilities because they regulate the development of the brain, the migration and the formation of the neurons and the formation of the synopsis are controlled by glia and this insulation of the fibers, that allow high speed impulse conduction through circuits involved in complex functions like reading, these are all glial processes.

Kris: Well, Dr. Fields, we want to thank you so much for joining us today and we look forward to hearing more about your incredible research that you are doing at the NIH and just recommend everybody pick up a copy of The Other Brain. Thank you so much, Dr. Fields.

Dr. Fields: Thank you very much, Kris.

That's the end of our interview, and I hope you've enjoyed it. For more great health related interviews go to Michael Senoff's HardToFindSeminars.com.