"The Impact of Big Data Imaging on Mental Health"
With Vince Calhoun, Ph.D.

Transcript of Cerebrum Podcast

Guest: Vince Calhoun, Ph.D., is founding director of the tri-institutional Center for Translational Research in Neuroimaging and Data Science and a Georgia Research Alliance eminent scholar in brain health and image analysis. He holds appointments at Georgia State University, Georgia Institute of Technology and Emory University. Calhoun was previously the president of the Mind Research Network and Distinguished Professor of Electrical and Computer Engineering at the University of New Mexico. His work includes the development of flexible methods to analyze neuroimaging data, such as independent component analysis, deep learning for neuroimaging, data fusion of multimodal imaging and genetics data, neuroinformatics tools, and the identification of biomarkers for disease. Calhoun served as the chair for the Organization for Human Brain Mapping from 2018-2019 and is a past chair of the IEEE Machine Learning for Signal Processing Technical Committee.

Host: Bill Glovin serves as editor of *Cerebrum* and as executive editor of the Dana Foundation. He was formerly senior editor of *Rutgers Magazine*, managing editor of *New Jersey Success*, editor of *New Jersey Business* magazine, and a staff writer at *The Record* newspaper in Hackensack, NJ. Glovin has won 20 writing awards from the Society of Professional Journalists of New Jersey and the Council for Advancement and Support of Education. He has a B.A. in Journalism from George Washington University.

[Intro] Bill Glovin: The brain—as we all well know—is a big, complicated organ with billions of different kinds of cells and connections. If I've learned anything from editing a magazine about brain science all these years, it's that there is more that we don't know than we do know when it comes to all kinds of aspects. The impact of drugs on mental health and neuro diseases, the meaning of consciousness, development, creativity, empathy, the list goes on and on. And helping us to gain new insight like never before is a technology called imaging, which came along in the early part of the 20th century, but really started coming into its own in the 1980s. At the same time that imaging was evolving, so was something called computers.

And as each technology evolved, scientists began to use them both in tandem to gain new insights into the brain. Welcome to the Cerebrum Podcast, sponsored by the Dana Foundation in New York City and where we explore the matters of brain science with leaders in the field. Hi, I'm your host Bill Glovin and

today we are fortunate to have on the phone with us a true pioneer in this exploding field. I'd like to welcome in Vince Calhoun, author of our recent *Cerebrum* feature, “The Promise of Big Data Imaging and Mental Health.” You can find his article and all our magazine content at Dana.org.

[Snippet] *Vince Calhoun I don't see brain imaging as the solution to everything. I see it as a piece of a puzzle, which gives us biology and can help inform diagnostic categories, which are basically nosology. So how do we categorize mental illness? How do we understand it? We need more biological information.*

Bill Glovin: Vince is founding director of the Center for Translational Research in Neuroimaging and Data Science, which is part of Emory University, Georgia State University, and the Georgia Institute of Technology. Vince previously served as the president of the Mind Research Network and served as chair for the Organization for Human Brain Mapping. His work includes such things as component analysis, deep learning, data fusion, neuroinformatics and identifying biomarkers for disease. Welcome Vince and happy new year and thanks for agreeing to do this.

Vince Calhoun: My pleasure. I'm glad to be here.

Bill Glovin: Let's start with when someone asks you, so what do you do? How do you describe your job?

Vince Calhoun: Well, I basically tell people that I look at the brain and I work with brain imaging data. So, the idea is that we take pictures of the brain as it works, and we try to figure out what's going on with it and see if we can use that information to tell us something useful about individuals.

Bill Glovin: Can you encapsulate why big data imaging is important.

Vince Calhoun: Yes, as individuals, we are very different, right? And our brains are reflective of that as well. So, if you look at one person's brain, it's going to be hard to come up with something that can really be generalized to knowledge that you kind of apply to other people going forward. And so, looking at big data, lots of data, helps us to get signals that are, basically we can look at things that are more robust. We can check if they recur in individuals and get at not only individual brain patterns, but also look at what is shared across humanity and how that varies in certain conditions like mental illness for example.

Bill Glovin: It seems that in the neuroscience field, big data is most often used in either brain mapping connectivity or neural imaging. First, is that true? And second, if it is, why did you decide to focus on the imaging side of things?

Vince Calhoun: So, there's different ways data can be big. Data can be big in terms of its width and its depth. And by width, I mean, like you have a big image, right? You have lots of fine grain resolution in a given image. But in terms of just the depth, that would be I have many, many data sets that I can look at across lots of different people. And it's that latter piece that I think, actually both of them are important, but that latter piece is really critical to helping us learn patterns that are canonical, that are going to be reflective of something that can go into general knowledge. And I would say that I work on both imaging and connectivity kind of together. Because we take the images that we collect and we look at how they tell us about how different parts of the brain are connected, either wired together or how they fluctuate together over time.

Bill Glovin: At one point, David Van Essen wrote on the brain connectome project for us. Have you worked with him?

Vince Calhoun: I have interacted with him at the human brain mapping meetings before. I've obviously been aware of his work and do a lot of work in the connectome field as well. So yeah, I think that was a great project. The human connectome project really pushed the field forward in terms of being a good example of a large project that would collect lots of data. And then there are a whole bunch of spinoff projects now that really kind of set the stage for scaling up brain imaging studies.

Bill Glovin: Are you involved in any of those?

Vince Calhoun: Yes, I am involved in some of those spin projects. Yes. And I work with a lot of that data because it's all open data, it's shared, which is another big advance in the field. We figured out more how to share. It seems like such a trivial thing that you should learn to do as a child. But now we've kind of figured out how to confront issues related to privacy, how to get consent and share data and do that from the beginning, as opposed to waiting until the end, when everybody's published their studies and the data's mainly disappeared by that point. So, we try to share the data upfront and grow larger and larger data sets.

Bill Glovin: In the article, you make references to companies like Google and Amazon that use big data. And it seems like big data is everywhere, used by marketers and

just about everyone else. Is there any connection between what they do and what you do? In other words, can you learn from one another?

Vince Calhoun: Absolutely. Yeah. We're using a lot of the techniques that were developed to handle big data. Basically, it's things like moving data around, figuring out how to process, figuring out how to learn patterns in large data sets when you can't look at every single point one by one. So yes, we are using a lot of the same techniques, but they're customized to focus on neuroimaging applications. And so, I think we're learning. And also, likewise, a lot of these companies are starting to get into neuro inspired computing and learning about how the brain processes data, how that can help them in terms of developing compute strategies.

Bill Glovin: What inspired you to go into this field?

Vince Calhoun: So, when I was doing electrical engineering as my undergraduate degree and so I started working in areas of like radar, but then I just kind of started to see connections between biological relationships and engineering principles. Like you can model electricity in the human body or blood flow using engineering math, and engineering principles. And that was combined with learning about MRI and just being such a cool technology. You can use magnetic fields to noninvasively see what's going on in the body. And so those two things kind of converged. And then I started to move into sort of a biomedical engineering emphasis and got interested in the brain because that was right when FMRI, functional MRI, was discovered and came on the scene.

Bill Glovin: About what year was that?

Vince Calhoun: Early nineties, late eighties, early nineties.

Bill Glovin: It seems like you need a very specific skill set to be able to read data sets and work in this field. Right?

Vince Calhoun: Yeah. I mean, it's very interdisciplinary. You need a lot of different skill sets, but it's also not true that you need to know everything. So as long as you're working and this is sort of a trend in the field generally is that we're growing, again like physics, right? We're growing towards more team science type approaches where we collaborate with people and work together to cover all those bases. You need to know how to read data. You need to know how to process that data. Every type of data is different, and you need to know about neuroscience and the brain. And so, bringing people together from engineering fields,

neuroscience, psychology, psychiatry, neurology, etc., is really critical these days.

Bill Glovin: Well, speaking of a team approach, and you are the founding director of the tri-institutional Center for Translational Research in Neuroimaging and Data Science. Is it unusual to have three major educational institutions behind a single center, first, and second, when and why did you start the center? Why is it important and what kind of research is going on and how many people are conducting it? So, I guess that's a lot there, but I guess I'm wondering if you could just give me a summary of, you mentioned the team approach kind of thing.

Vince Calhoun: It's reflective of that team approach strategy. One of the things that I've been working on is sort of the technical aspect, kind of the data aspects of this. And I have found that there are a lot of groups that maybe are good at one piece or another piece, but don't have the infrastructure in place or the people in place to kind of leverage all of the advanced data mining strategies and data storage and data tools. And so that's really what we're doing is trying to connect with, for example, Emory has a lot of people that are focused on brain disorders and Georgia Tech has a lot of good data mining people.

Georgia State's very strong neuroscience and psychology. And so, bringing those together and the idea of the center was to create a collaborative space and that can be [inaudible 00:10:09] or in-person and allow people to get together and talk and brainstorm and also leverage some of the techniques that we've created. We've also been pulling in lots of different kinds of data. We're creating data sets that make it easy for people to access. And we're also actively collaborating and interacting with people who have questions and problems that we can potentially help with.

Bill Glovin: Are these kinds of collaborations going on at other institutions around the country?

Vince Calhoun: I think in general the field has become more and more collaborative as we've gone on. I like to think we have a little bit of a unique aspect in that we're sort of combining strong engineering technical expertise. We also have a focus on translation. So, we're trying to see if we can identify some of the pieces that we've worked on that could potentially be translated. We really want to have an eye on potentially some clinical applications and other aspects as well going forward.

Bill Glovin: In terms of clinical applications and mental health specifically, which the article focuses on, have you been able to make any deductions yet?

Vince Calhoun: It's very much still, I would say early days. Because in particular in psychiatric fields the diagnoses are fairly complex and fairly messy. And so, we are trying to use biologically driven information, brain imaging data, to help us update those categories and also looking at targeted areas where we can potentially see applications that might come out. Like, for example, I think I mentioned in the article predicting response to medication, right? When you sort of have a well-defined area that you can potentially use data to refine a future decision that's made.

Bill Glovin: It seems that the future of the field, you tell me, since you said there's a lot in front of us, is it tied to computer power and technology?

Vince Calhoun: Yes. I think compute power is a critical piece. Algorithms are getting more complex, but they're getting more powerful. But you can't run them, we come up with algorithms all the time and sometimes it gives us really interesting summaries of the data, but it takes many days to run on a small data set, given that the algorithms are so complex. And so, I think compute power is helping us push that forward. We do a lot of work with something called GPU's, which are used in sort of gaming, right? So those processors help us process data faster.

Bill Glovin: Where do you see the field in ten years?

Vince Calhoun: Well, I hope that we'll be at a point where we'll actually start to see some emerging clinical applications and refinements of diagnostic categories that can help. So, it's, again, I think it's kind of a circle, right? I don't see brain imaging as the solution to everything. I see it as a piece of a puzzle which gives us biology and can help inform diagnostic categories, which are basically nosology. So how do we categorize mental illness? How do we understand it? We need more biological information there. So, I think seeing that circle move forward and interact is something that's going to advance the field. So, I think in ten years it's likely that we'll have a few clinical applications that have emerged.

Bill Glovin: Anything in the culture that you might recommend for someone interested in this topic?

Vince Calhoun: You mean where I would point someone if they're interested? Yeah. I still think functional imaging is fascinating because we can put someone in a scanner and your brain, you're not doing necessarily anything that you've actively been told

to do. You're just kind of sitting there being yourself. You can see your brain fluctuate and you can see the brain regions kind of talk to one another. I think that's a really interesting area. There's so much we can do there still. So that would be an area that I would say should fascinate anybody.

Bill Glovin: Okay. Well, I think that's a great place to end. Again, I'd like to thank Vince Calhoun, author of our *Cerebrum* magazine article, "The Promise of Big Data Imaging for Mental Health." You can find his article at Dana.org. Again, we are brought to you by the Dana Foundation in New York City. I'm your host Bill Glovin, thanks for listening and a happy and especially healthy new year to all.