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**NANCY** In a very deep sense, the brain is who we are. And so by looking at what it's made up of, what it's pieces are and  
**KANWISHER:** what each piece does, I think that's starting to sketch for us a picture of the mind.

**SARAH** Today on Chalk Radio, we're exploring our most critical biological asset, our brain. I'm your host, Sarah Hansen.  
**HANSEN:** My guest this week is a scientist and MIT Professor who studies the architecture of the brain.

**NANCY** I'm Nancy Kanwisher, and I'm an investigator in the McGovern Institute for Brain Research and a member of the  
**KANWISHER:** Department of Brain and Cognitive Sciences. And I study the human brain and how it's organized at a very macro scale level. I'm interested in big parts of the brain and what they do.

**SARAH** In addition to being an investigator, Nancy Kanwisher is a founding member of the McGovern Institute, which is a  
**HANSEN:** community of neuroscientists who are working to better understand the brain. I was curious how Nancy got into her field of research and the advancements that have developed over the years since she's been working in it.

**NANCY** When I started in cognitive psychology the methods we had available were pretty rudimentary. I measured  
**KANWISHER:** reaction time and accuracy when people did simple tasks looking at pictures and understanding sentences. And from that very sparse low-tech data of people's responses, behavioral responses in different tasks, we tried to infer the algorithms running in their heads. And that's kind of like trying to figure out how a car works just by driving it around.

And you could discover some stuff. You could probably figure out that there's something like gearshifts just by studying its behavior. You could figure out a bunch of things about car engines just by driving them around. I mean, you could figure out even more once you study the different ways that cars break down, like OK, sometimes they have this problem and sometimes they have that problem, and then from that you could infer, even if you didn't know anything before, what the different pieces of a car engine might do.

So for a long time, that's what our field had, is basically driving brains around and studying what happens when they break down. But then more recently these amazing methods came along that enabled us to look inside. And so in my first year in graduate school the first non-invasive study of function in the human brain was published on the cover of *Science*. And here was this unbelievably blurry picture, but nevertheless a picture of activity in the back of the head where visual cortex resides. And that picture just blew my mind.

And I wrote to every brain imaging lab in the world, there were only about 5 back then, and I said I have these ideas for experiments, and I sent them my proposals, and crickets. And so I kept at it, and it was, literally, 10 years before I got to do a brain imaging experiment. Spending a lot of that time beating on the doors trying to get access to the machines, but the machines were big and expensive.

They were controlled mostly by MDs, who to be blunt about it, didn't really know what psychological questions to ask because that's not their field. We psychologists are the ones with the questions. We were the ones who were studying minds and who knew what to look for in brains. But we psychologists didn't get to use the big fancy machines for another decade. And then it's been really quite a party since then.

**SARAH**  
**HANSEN:** Nancy explained to me that our most basic understanding of the brain has been known for a long period of time, 100 years or more. And interestingly, some of the most astounding discoveries have come not from studying the healthy brain but by studying damaged ones. More recently, with new technologies such as functional MRI, which is a specific type of MRI that scans for metabolic function in the brain, we've been able to expand and grow our knowledge in ways that provide information that's far more specific than we've ever had before.

**NANCY**  
**KANWISHER:** For a couple years we've had the idea that regions in the left side of the lateral, temporal, and frontal lobes are involved in processing language. And we've known that because people who have damage to those regions sometimes lose their language abilities. And similarly, we knew that somewhere in the back of the right hemisphere near the bottom there was some kind of function that was involved in face recognition. And again, we knew that from the small number of people who had damage to that part of the brain and lost their ability to recognize faces, sometimes without losing their ability to recognize objects, or words, or scenes, and that was strongly suggestive, that, hey, maybe there's a special bit of the brain for face recognition.

That kind of stuff has been known for a long time, but that was it, right? And then functional MRI came along and now we have dozens of regions of cortex where we have a pretty good idea of what each of those little patches of cortex does. And many of those regions do a very, very specific things like just thinking about what other people are thinking, or just understanding language, or just face recognition.

**SARAH**  
**HANSEN:** Facial recognition. That's a topic that gets talked about a lot at my house, mostly because my spouse seems to struggle with it. I was curious if this was typical.

**NANCY**  
**KANWISHER:** Never mind brain damage. Take perfectly normal people. You test a hundred of them on their face recognition abilities and what you find is that those abilities are widely varying. And some people are just awful, like the bottom two people in your group of 100, those bottom two people routinely fail to recognize family members. I mean, that's really bad. And the top 2% of people are so good that they routinely hide it from others because other people would find it creepy.

**SARAH**  
**HANSEN:** So I live with someone who on a scale of 1 to 10 probably a three. I would say I'm about a six. And where would you put yourself?

**NANCY**  
**KANWISHER:** Oh, I'm about a two or a three. I'm really bad. I have to ask my partner when we're watching a movie, is that the protagonist? Is that the other one? Oh, I'm bad. Yeah.

**SARAH**  
**HANSEN:** Wow. While each individual part of the brain is uniquely important, one big takeaway Nancy explained is that every mental function requires many brain regions. And understanding that is key to understanding how the brain operates as a whole.

**NANCY**  
**KANWISHER:** Nothing lives in just one piece of the brain. So even when I carry on about how some parts of the brain do very specific things, that doesn't mean that they do that very specific thing alone. Every mental function requires many different brain regions. The part that's involved in face recognition could not do its task without getting input from primary visual cortex and other basic visual regions. And there would be no use of face recognition if it didn't send its information to other parts of the brain that know things like your Rolodex of people. You have that someplace in the brain. It's not very well understood, but someplace you know all the facts you know about the people you know. And so each of those brain regions acts in concert with lots of other brain regions.

**SARAH** It's one thing to understand how the brain works in the abstract, but in her course, 9.13 The Human Brain, Nancy  
**HANSEN:** connects neuroscience with something much more personal. She begins the semester with a story, a personal anecdote she uses to paint a picture of all the various topics she seeks to introduce in her class.

**NANCY** It's widely recognized that people like stories and people resonate to stories. There's a whole developing meme  
**KANWISHER:** and science communication about how you're supposed to tell stories. And for a long time it's, like, yeah, I know I supposed to tell a story, but I just have my lectures and I don't know-- I don't know what story to tell or I-- and then I realized oh my god, I do have a story. And I was psyched to realize that, actually, that story echoes, to an eerie degree, all of the themes of the course.

And it's the story of a friend of mine who had a brain tumor, which was revealed very dramatically when he collapsed on the floor at my house unconscious. Horrifying, terrifying, but it pulls people in right away. He's fine now, to cut to the chase, totally fine, but in between, there was quite a scary and fascinating set of developments in which he had a benign tumor that was pressing against a region of his brain, that my lab had studied, that's involved in knowing where you are.

And I knew this guy pretty well, and so I had actually been noticing for a few years that he seemed to have lost his ability to navigate around in the world. And it scared me and worried me, but I just didn't even make myself think about it. And so I should have known what was up with this guy. I had all the data in front of me and I somehow didn't, until he collapsed on the floor and it kind of all came together. And I thought, oh my god, what's going on with his brain?

And further, eerily, we had actually scanned him in one of the standard experiments in my lab many years before, and so when he called me, after he collapsed, and he recovered a minute or two later and spent the day in the ER while they're trying to figure out what was happening with him, and all day long the ER docs are saying, oh, this is a heart thing, this is whatever, we'll figure it out. And after test, after test, after test, that night he calls me and he says, get over here right now. They found something in my brain. So I was just horrified.

And as I'm driving over to the ER, I called one of my lab techs and I said, hey, we scanned this guy years ago. See if you can dig around in the files and find the anatomical scans we would have made when we did that brain study. And so by the time I got there, the MRI tech did something they're probably not supposed to do, but they showed him and me pictures of his brain with this huge thing, the size of a lime, right in the middle of his brain. It was just horrifying.

And then I was able to look at the images that my lab had collected quite a few years before. And we could see it, even many years before. It was much smaller, but clearly visible. And that was very important, clinically, because it showed that this was a very slow growing tumor. And that was good news. And very diagnostic about what kind of tumor it was.

**SARAH** As scary as this experience was, not just for Nancy, but also for her friend, it led to some important discoveries.  
**HANSEN:** Nancy was able to test and receive results in real time about how her friend's navigation ability was impacted by the tumor. Because of this, she was able to confirm her own research about how his ability to navigate the world around him was impacted by the tumor pressing down on a specific region of his brain.

**NANCY** In the whole process of watching my friend go through this, I tested him on a bunch of tasks. He was totally

**KANWISHER:** game. It's like try drawing a floor plan of your apartment, and he draws this total mess. I mean, it just-- I've been in his apartment. I know what the floor plan is. And what he drew had just no relation whatsoever. And then I said, OK, try drawing a floor plan of the upstairs of my house. We were in the downstairs of my house right then. Couldn't do it.

And then I thought, well, maybe it's just complex multi-part images, things that are hard to reconstruct. So I said, OK, try drawing a sketch of a bicycle. So he draws a bicycle. It was not beautiful, but it was clearly recognizable. It had all the right parts in the right positions.

And that's a very low tech simple example of one of the main methods in my field, is studying people with brain damage and trying to analyze exactly what is it that's messed up and what is it that's preserved. And that shows you this implausible split. Why would you be able to remember the visual appearance of places but not the visual appearance of objects? But that's exactly what, actually, my own research predicted.

**SARAH** I asked Nancy how her students respond to hearing this story. She told me that students respond by asking

**HANSEN:** questions. This idea of investigating, questioning, and really holding on to curiosity is exactly what's at the heart of Nancy's teaching.

**NANCY** They proceed to ask all the questions that are the basic questions that we're going to explore in the course. I just

**KANWISHER:** tell them the story and then they say OK, did it get better? How long did you know? What other symptoms did he have? Did he have this particular other thing?

Did it affect other things besides scenes? How would you study it besides MRI? Would you-- on and on and on. But it's like every single question they ask, these are just the questions we ask in my field, which is one of the things I love about this field, is that it's not like quantum mechanics. You don't need to study for years and years and years before you even have the mental space where you can frame the questions. All of the questions of interest in my field are questions that any normal person can ask with no background whatsoever.

That's the cool thing about the brain, is we have one and we get to use it and we get to watch it in action. And we have already been wondering all these questions, whether we realize it or not. I mean, one of my favorite things to point out is that lots of questions that people have been wondering about anyway, like how solid is human knowledge.

We think we know this stuff. Do we really know it? Are we fooling ourselves? Those are questions that can be asked in lots of different ways, but one of the ways of asking them is to look at brain development and where the structure of the brain comes from. The kinds of questions that you can ask and sometimes even answer in my field are questions that lots of people wonder about.

**SARAH** This was a particularly powerful part of the conversation for me. The idea that this kind of study is accessible,

**HANSEN:** that's not something you typically infer when you hear cognitive neuroscience. Nancy Kanwisher wants to change that. Part of her mission is to allow everyone access to the knowledge generated by the field.

**NANCY** The public pays for the science we do in the lab, and so I think it's a moral obligation of scientists to give back.

**KANWISHER:** And I think I'm in the lucky position that the stuff I do is easily shareable with people. And so I think it would be just not OK not to share it. And so I try to share it whenever I can.

But it's also fun. It's really fun to get an idea across and see somebody resonate to it. So I think an educational goal that I don't think I've quite figured out how to do but that I aspire towards is to give people a push and encourage them to find a few things because that will teach them that they can then go find more on their own. I would love it if some of my research would actually help people, but it would be a lie if I told you that that's why I do it or that we have already been able to help a lot of people. That's just not true.

The real thing that motivates me is I just think it's the grandest scientific quest of all time to understand the human mind. And looking at a brain is a great way to do that. So that's really what I'm in it for, is just the pure fascination of understanding our own minds. To me, it's like all about sharing things that I think are cool because, actually, my teaching goal is to blow people's minds.

**SARAH** Blowing people's minds by teaching about them. It's one of the things that makes Nancy's course so compelling.  
**HANSEN:** And by the way, I asked Nancy if there were insights about teaching that she wished our listeners would share with her.

**NANCY** Well, there are all kinds of topics that I haven't figured out how to lecture on, that I just have a blind spot on, like  
**KANWISHER:** memory. This is a big part of the field. There's really beautiful work on it. Lots of people study it.

But I have just a hard time motivating what the big questions are, and so I don't actually lecture on memory. And I'm really embarrassed about that, but I just haven't figured out how to give a good lecture on it. That's one.

Emotions. I've never figured out how to lecture about emotions. And of course, everybody cares about them and they're really important and there are neural stories to be told and experiments to read about. And I am just not very good on that topic.

**SARAH** If you have insights to share, please get in touch with us at the link in our show notes. And when you do, you'll be  
**HANSEN:** joining Nancy in making cognitive neuroscience more accessible to all of us. If you're interested in learning from her open and free teaching materials or remixing them in your own teaching, you can find them on our MIT OpenCourseWare website.

Additionally, you can find Nancy's work at the McGovern Institute by visiting [McGovern.mit.edu](http://McGovern.mit.edu). Thank you so much for listening. Until next time, signing off from Cambridge, Massachusetts, I'm your host, Sarah Hansen from MIT OpenCourseWare.

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