

What It's Like To Gain A Sense

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KRYS BOYD: We can't help but marvel at how babies grow from complete helplessness into little people who can feed themselves, walk and use and understand language within just a couple of years. But those are not the only big achievements of early life. Newborn brains also learn to interpret and respond to sensory information in order to make sense of the world. And most of us come to do this so well that we hardly can imagine a time before we could.

From KERA in Dallas -- This is "Think." I'm Krys Boyd. I'll confess I didn't exactly get this until I picked up a fascinating new book by Susan R. Barry, who is professor emeritus of biology and neuroscience at Mount Holyoke College. It's about people who lost sight and hearing at an early age and then had those senses restored in adolescence through medical technology. But it's not as simple as flipping a switch and turning on eyesight or hearing again. These folks literally had to train their brains to use the information they suddenly have access to. And their stories gave me a new appreciation for senses, I have long just taken for granted. The book is called "Coming to Our Senses: A Boy Who Learned to See, a Girl Who Learned to Hear, and How We All Discover the World."

And Susan Barry is here now to talk about it. Sue, welcome to Think,

SUSAN R. BARRY: Thanks.

KRYS BOYD: This is a subject close to your heart not only as a scientist, but as a person who gained stereo vision at the age of 48. How did your world change when suddenly you could see things in three dimensions?

SUSAN R. BARRY: It was surprising how much it changed. On the one hand, when I looked upon the world, everything before I gained 3D vision to how everything looked after I gained 3D vision made sense. That is, when I used to look upon the world -- without 3D vision -- when I basically saw with one eye or the other at a time because of my crossed eyes, because of my strabismus. When I looked out upon the world, I could still order things in depth, I could still say, "Oh, that lamp is in front of the wall. And there's a window in the wall and the world is outside." But I didn't see the space between things. So the space was very compressed. When I began to see in 3D, it was as if the world inflated, as if it went from a collage to like a dire ramaa. And I could see the space between individual objects, I had a much better sense of the distance between things. So I could still make sense of the world. Before I gained 3D vision and after I gained 3d vision, but it felt very different. Now I was in a three dimensional world, and I felt myself within this large space. As opposed to before I gained 3d vision, I felt like I was looking in on the world from a sort of short distance away. It was a very different feeling.

KRYS BOYD: Had you fully understood what you were missing before you could process visual information simultaneously with both eyes?

SUSAN R. BARRY: No, not at all. And this surprised me because I was a neurobiology professor. And I taught about stereopsis to the students in my class. I understood the mechanism behind stereopsis: how we take information from the two eyes, combine that information in the brain to see in 3D, to see that space between things. I understood it from a sort of theoretical point of view. And I thought that having an understanding from a theoretical point of view, would be enough to know what it would be like to experience seeing in 3D. And that turned out to be not at all the case. In fact, before I gained 3D vision, I had an encounter with the author and neurologist Oliver Sacks. And I had told him about my crossed eyes, he actually could tell I was cross eyed just by looking at me. And he asked me if I could imagine what the world looked like in 3D. And at that time, I told him that I thought I could because I taught about the subject and I understood it from a theoretical point of view. And almost nine years later, when I gained 3D vision, I sent him a letter and said, "You asked me this question: Could I appreciate the experience of 3D vision before I had it? And I told you that I thought I could. And I was completely wrong." And then I went on in the letter about all the new experiences I had with my 3D vision.

KRYS BOYD: I'm sure that delighted him. Did he write back to you?

SUSAN R. BARRY: Oh, absolutely. He wrote back to me within a few days, he came to visit me. Then he wrote a story about me called "Stereo Sue." That was his nickname for me, Stereo Sue, that appeared in The New Yorker magazine. And then it also appeared in his book, "The Mind's Eye," as a chapter, the chapter Stereo Sue. And he also wrote the foreword for my first book, my first book was called "Fixing My Gaze." And it was about this experience of gaining 3D vision. And he wrote the foreword for that book.

KRYS BOYD: You actually introduced this book, not with the success stories of the individuals you go on to profile, but with accounts of a man who regained sight and a woman who regained hearing in mid life. In both cases, the procedures were technically successful. But these people realized they had been happier before. What went wrong there?

SUSAN R. BARRY: So the first story, the one I introduced the book with, it's about SB, a man who was described by Richard Gregory, a famous visual physiologist and scientist, and Jean Wallace. And SB had been basically blind since infancy. And he gained vision following cornea operations when he was 52 years old. And at first, he was very excited about being able to see the world. But he realized over the next year and a half, that it was a struggle to see. It was a burden to see. He was receiving all of the sensory input, all of this visual input that he now was struggling to understand, and that everyone else around him seemed to just understand so effortlessly. And it became such a burden to him, that he became ill, and he died.

The second story I mentioned in the Hearing Well, about Beverly Biederman, was a woman who lost her hair in gradually throughout childhood, and then was deaf for more than 30 years before receiving a cochlear implant. And the implant paid for sound. But at first, again, it was so hard to deal with these new sounds. She didn't like the sounds, it was hard to understand what she was receiving. And she wrote that she felt quite simply that she wanted to die. And she did

eventually learn to embrace her cochlear implant and her new hearing. But that required a lot of work on her part, and therapy as well. And by therapy, I mean, speech therapy, hearing therapy,

KRYS BOYD: Most of us have no memory of this whatsoever. But whatever senses are available to us from birth, we all have to engage in a period of what's called "perceptual learning" in order to use and interpret those senses. Can you tell us a little bit about perceptual learning?

SUSAN R. BARRY: So the way I used perceptual learning in *Coming to Our Senses*, is using the definition that a psychologist Eleanor Gibson used. And what she would try to emphasize about perception is if we look out upon the world, let's say there's a tremendous amount to see. How do we extract the relevant information to us, and then, you know, concentrate on that, while ignoring stuff that, let's say, is less relevant to us at the moment? And perceptual learning is then that ability to extract the relevant information.

So, for example, one example I used in the book about perceptual learning had to do with my students at Mount Holyoke College. And I would take them often for a field trip just around the Mount Holyoke campus, which is very beautiful and full of beautiful nature. And I remember at one point asking them about horsetails, a kind of plant that basically looks like just one green stem. And I asked them to find the horse tails, and they at first couldn't figure out what I was asking. And then after I pointed out the horse tails to them, throughout the rest of the afternoon, as we're walking through the woods, they kept spotting those claims, those horse tails. So it as if the information was always there for them to see. Those particular plants were within their visual field of what they were looking at, but until I pointed them out to them and told them a little bit about the horsetails they didn't see them. After I pointed them out to them, the horse tails kept popping into focus. And so it was now they were extracting new information from the environment that they hadn't seen before. And that would be an example of perceptual learning.

KRYS BOYD: Alright, let's talk about the first of your really remarkable subjects in this book, Liam McCoy. He was born with albinism, which caused him to lose much of his sight in childhood. He was so adept at using his other senses to move through the world that even his mom didn't fully understand how bad his vision was.

SUSAN R. BARRY: That's right. And, of course, he had become so comfortable. For example, walking through his house, or through familiar environments, that people weren't aware of just how little he could see. When he was still a very, very little baby, his mom, at one point, decided to go into a room and see if Liam could find her. And what she discovered was that Liam went from room to room, looking for her. He was able to make his way through the house just fine. But when she said nothing whatsoever, so that he didn't, he didn't have any other way beside vision to spot her. He could not find her. And it pained her at that point, that she sort of hid from him in that way. It pained her to think about the fact that, you know, he couldn't see her. And the pains are to this day to think about that particular incident, and how she kept quiet, just to see whether or not Liam could see and realize then just how poor his vision was.

KRYS BOYD: So how did the opportunity come about for Liam to have his vision largely restored when he was 15?

SUSAN R. BARRY: So Liam had a number of visual issues. One was that he has albinism, which is a lack of the pigment melanin. People who have albinism tend to have white hair and very, very pale skin. And albinism, because of the lack of this pigment melanin also leads to problems with your eyes. The eyes, the retina does not develop completely normally. And there are also some disruptions between the connections between the eye and the brain. But in addition to his albinism, Liam had very, very, very severe myopia, or nearsightedness.

So his acuity, you know, as measured with that eye chart, was 22,000. Wow, normal acuity is 20/20. And so what his ophthalmologist Dr. Larry Tyson did, was insert into each of his eyes, a very, very powerful lens -- didn't remove his original lens, but inserted another lens into his eye that helped to correct that severe, severe nearsightedness. That nearsightedness was so bad, that glasses alone or contact lenses alone could not correct it, as well as having a lens inserted into the eye.

KRYS BOYD: Although the surgery was like, even more successful than his doctors had hoped. There was no dramatic, "I can see " moment when the bandages came off. What does Liam remember about those early post surgical dates?

SUSAN R. BARRY: So what Liam remembers is, one of the first things he did was stand up and start walking around. And even as he just stood, it seemed to him like the world was coming forward toward him because now he could see so much more of the world than he could before. And he kind of fell backwards. And then when he regained his balance, he walked down the hall, and he was walking with his mom and a woman nearby waved at him. And now we could see the person and he could see the wave. In fact, before his vision before his operations, his vision was so poor that he really couldn't see things in motion. And now we could see this person waving at him. And he asked his mom, "What was the woman doing?" And this really surprised his mom, Cindy, because when he had been a little boy, they would often pass the same bus driver, who would always wave at Liam. And Cindy would tell Liam to wave back. But clearly, Liam had waved back only because his mom had told him to, he had never recognized that the driver was waving. He never recognized what that motion of waving was all about. So he was beginning to see a lot of things. But he really wasn't making sense of them.

So when he would go outside, and he would try to walk, let's say along the sidewalk, he would see, let's say, a line in the sidewalk. And he wouldn't know if that line was due to this -- the, you know, the division between two sidewalk blocks. "Is that line there because there's a stick in the way that I need to step over?" "Is that line a shadow?" "Or is that line an indication that I'm at a curb, or a stairway that I need to go up or go down?" So what he was mostly seeing was lines and patches of color. And they did not immediately sort of come together the way they do for most of us into recognizable objects and landscapes. He just had to constantly try to puzzle out what he was seeing.

KRYS BOYD: Sure, because most of us look around and in whatever environment we're in, you know, I see a microphone in front of me and an office chair. People might be looking out their window and seeing trees or cars. We're sort of seeing objects but ultimately, those objects are built out of colors and lines, we just don't think of them that.

SUSAN R. BARRY: Exactly. We can see all the lines and colors that Liam would describe to me if we look for them. But our initial impression is not of that raw stimuli. Our initial impression is of whole objects arranged in three dimensional landscapes.

KRYS BOYD: How does he do with distinguishing faces?

SUSAN R. BARRY: Not well. Distinguishing faces is probably one of our greatest visual accomplishments. I mean, we can recognize hundreds of faces. We can recognize the face we haven't seen in a long time. We can recognize the face of someone who, let's say, was wearing glasses one day and not wearing glasses the next day, or had a beard one day and shaved it off the next day. Or someone we haven't seen in a long time.

And this ability to recognize faces is very difficult for people who undergo sight recovery, like Liam did. And so Liam depends much more on other aspects of a person -- the way their keys may jingle as they approach their footsteps, if they're coming in a car, the sound of the motor of their particular car, if they wear certain clothes at all times, he can use that he'll use all these other cues to recognize people. But recognizing faces is very difficult. And recognizing facial expressions, it's very difficult for him.

KRYS BOYD: So we've talked mostly about static objects and how he perceives those. But of course, he had to learn how to understand moving objects, things that are going fast around him. And yet, this is what blows my mind. He rides a bike to get around town. He rides fast, right?

SUSAN R. BARRY: Well, he rode faster than I ride. Now, I'm a pretty cautious bike rider. And he's a lot younger than I was when we did some bicycling together. But what was really interesting for me was to learn that one of the very first things he could do with his vision was play catch. And if you think about that, really play catch? I mean, here comes a ball, it's moving. It's a fairly small object. Playing catch was easier for him to do then, let's say, looking out on the world. And let's say seeing the ball sitting on a table and moving.

Well, it turns out that motion, the ability to detect motion, may not require a lot of visual experience. So there's that. And then there's the fact that when the ball is moving, he sees all of the ball, because it's all moving of a piece. And its movement distinguishes it from everything in the background, which is static and so it was actually easier to play catch, let's say and see the ball when it was moving than to see the ball if let's say it was sitting on a table with other stuff on the table. And so playing catch was one of the first things that he could do with his vision.

And then as for bicycling, he now was encountering something pretty new to him. And that was something called optic flow. So think about this when you're bicycling along or walking along or driving along -- you're moving forward. And the world around you seems to sort of approach you and then expand around you. Think about, you know, driving down a highway and thinking about those line lane markers in the highway. They seem to approach you and then expand around you as you're driving forward. And he learned to use that sense of optic flow, that apparent movement of the world as you're moving through it, to help guide him as he was bicycling from place to place.

KRYS BOYD: Okay, your other subject here is a young woman named Zora who had become profoundly deaf in the years before she received cochlear implants at the age of 12. She had learned language through reading?

That's right. So Zora was profoundly deaf from birth. And fortunately, her deafness was diagnosed by the time she was nine months old. And so her aunt Nedjma, who was taking care of her, then made it her life mission to teach Zora language. Now, one way a deaf child can learn language is through sign, the visual language of the deaf. But Nedjma did not know Sign and did not know anyone who knew Sign. And so she taught Zora English. And the way she did that was through these scrapbooks. What she would do is she'd look through magazines, she'd find pictures, let's say of shoes, and she'd cut all those pictures out and she put them in a scrapbook and she would write next to it, "shoe." And then she would tell Zora, "Let's put on your shoes." She'd show her a picture of Zora's shoes, the shoes in the scrapbook, the word shoes that they would talk about shoes. And in this sort of way, Zora began to recognize words and recognize that everything has a name. Shoes are called shoes. You know, an orange is called an orange -- that everything has a name. And there's a word for that name, and you can write that name. And so by the time Zora was three years old, she was already reading. And that is basically how she learned English, through language and reading.

KRYS BOYD: What made Zora's early experiences feel so chaotic once her cochlear implants were turned on?

SUSAN R. BARRY: Well, the first thing she described to me about turning on the cochlear implant when she's 12 years old. She knows exactly what's going on that she's getting, you know, this cochlear implant, it's about to be turned on. And she had been told by the audiologist -- Zora could read lips so she could communicate with people that way. She had been told by the audiologist that she would hear a beep. And then the audiologist sent a beep through her cochlear implant. This is the first sound that was heard. And what Zora experienced was a feeling. This sort of uncanny kind of frightening feeling. And she reacted to it. And when she reacted her audiologist and Nedjma got excited. And then she saw their lips moving. And I saw her lips were moving, she got that uncanny feeling again. And she began to think this uncanny feeling in my head, maybe this is hearing. And then the only audiologist sent a second beep into her implant. And she heard that and she realized, yes, what I'm hearing is sounds. I'm experiencing sounds. I am hearing.

KRYS BOYD: One of the things about her story that was interesting was getting these implants and not knowing how to make sense of sound. So if you or I were in a car and people are talking, we can pick out the sounds of voices over the roar of traffic and the drone of the engine. To Zora, initially, it was all just one sound clumped together.

SUSAN R. BARRY: That's exactly right. And that's exactly how she described it on that first day after she realized she was hearing. They went out into the streets of Toronto, and she could hear all of these sounds and they made no sense to her. And if you think about it, it's an amazing accomplishment of what we can do. I might be sitting here right now, and I can hear the fan from my computer, I can hear my voice, I can hear, let's say, some sounds outside and they all are arriving at my ears at the same time. And yet I can separate the sounds by their sources. I know which sound waves are coming from which source. And that was basically zoras challenge was to figure that out.

And it was made even more difficult for her because she had an implant, a cochlear implant, in only one ear. And we really need two ears to localize sounds well. So one way you can distinguish what where the sounds are coming from is by knowing where they're coming from. I might be talking to a person over to my right, and a bird is calling off to the left. And I know that "Oh, yeah, the person's voice is over there on the right, and the bird is over there on the left." And that helps to distinguish the sounds. Zora had a much harder time localizing sounds because she had only an implant in one ear, not in both. And so she spent a lot of time learning how to hear by actually doing an action. You open a box, it makes a noise. You push your chair along the floor, it makes a noise. So by using her own actions, and then hearing the results of those actions, she could begin to put together what the sounds meant.

KRYS BOYD: There were some pleasant surprises. She hadn't realized that laughter had a sound.

SUSAN R. BARRY: Oh, yeah. This was so moving to me. Zora was one of my students at Mount Holyoke College. And we would meet periodically for her to tell me about her story. And I remember I asked her What's your favorite sound? And without hesitation, she said it was laughter. She said, and this really amazed me, that when she was deaf, she didn't realize that laughter had a sound associated with it.

Sure, she knew speech had a sound associated with it, but it didn't really occur to her that laughter did. And when she used to see people laughing, she was well aware that they were laughing, but it didn't particularly make her wanna laugh. But when she heard laughter, that was infectious. And that made her want to laugh, too. Zora was very adamant in describing to me how much emotional impact sounds have. That hearing laughter was infectious made her want to laugh, hearing other sounds that we all find kind of annoying, she found annoying as well. But there was a huge emotional content to sounds. And that came as a big surprise to her. And to me as well, when she described this. But, certainly, her favorite sound was laughter.

KRYS BOYD: So, as you mentioned, Zora had understood words. She'd been reading and lip reading for many years. What did it take for her to learn to talk and understand spoken speech after she had her cochlear implant?

SUSAN R. BARRY: It took a tremendous amount of effort. And her aunt Nedjma would spend hours with her. They would start by, let's say, Zora seeing two words written down. And then she would hear a word, and it would be one of those two words that was written down. And she would say, "Oh." You know, let's say the word was green. And she would point to the word written down that was green, and then the list would get longer. So Zora would hear a word, and she would have to select it from a longer list of words. And then there would be no list whatsoever, she would hear the word and have to just recall what it was. And one of the things that helped her a lot, while learning was context, understanding the context of the speech. And, in fact, one thing that she learned, which I thought was very interesting, was that sometimes she'd be working with her aunt Nedjma, or occasionally with a speech therapist. And she's struggling, let's say, to understand the words that are being spoken by them. And the therapist would say, work harder, focus harder, and the harder that Zora would focus didn't seem to help. And she learned sometimes that the best way for her to understand speech was to be more relaxed. And when you're more relaxed, she could take in the overall context of the conversation. And by understanding the overall context, then you can begin to understand much more of the individual words that are spoken.

So it was through first learning to hear individual words, learning to grasp the context that she began to understand speech.

KRYS BOYD: Does she like music?

SUSAN R. BARRY: She does. And that was really interesting to me, because when I first was talking to Zora, about music, she told me, she really didn't listen to it. And this was back when she was a student of mine around the year 2010. And then when I went to visit her quite a number of years later, about six or seven years later, she enjoyed music. And when we would drive around in the car, she would turn on the radio to listen to music. She never heard music with normal ears. So the music that she hears with a cochlear implant may not be as rich as the music that we hear with normal ears. But that's not a comparison that Zora is going to make, because she never did hear with normal ears. The music that she likes tends to be music that has a strong beat, and is relatively simple. Not you know, not like Chopin or something with a lot of harmonics and not complicated music. But things that are that are simpler than that. And they have a relatively strong beat. That she enjoys.

KRYS BOYD: Sue, when you regain the ability to use both your eyes simultaneously and got stereo vision for the first time at the age of 48. It doesn't sound like you struggle to incorporate that new information in the same way that Liam and Zora did. What was the difference?

SUSAN R. BARRY: So the difference was something that I tried to say at the beginning of the show, it was that when I looked out upon the world with my 3D vision, the world inflated. I could see the space between objects. Objects contained more of a 3D shape to them, things looked

more textured. In other words, everything made more sense. In the past, I could see that let's say Object A was in front of Object B. Now I could see Object A in front of Object B. And actually that space or distance, I could have a bit much better idea of the space or distance between A and B. So the world made more sense after I gained 3D vision. For Zora and for Liam, when they gained their new sense, they were bombarded with information. For Liam, it was edges of things and lines and patches of color that didn't automatically coalesce into objects and landscapes. And for Zora, it was sound waves bombarding her cochlear implant, but didn't necessarily coalesce into meaningful sounds. And so the world for them was actually more confusing after they gained this new sense than beforehand. And so the struggle then is to take all this new stimuli, this raw stimuli, and turn it into meaningful objects, landscapes and events.

KRYS BOYD: They were both quite young when they regained or had the senses restored. Is the general consensus that young brains do better at learning to interpret this new sensory information than older ones?

SUSAN R. BARRY: Yes, the young brain is certainly more malleable than an older brain. But that's not to say that an older brain can't learn new things. It may require more effort, more work, more practice, to learn new things, understand what you're seeing and understand what you're hearing in an older person. It's going to take more work, but it doesn't mean that an older person can make strides in that direction.

KRYS BOYD: Susan R. Barry is professor emeritus of biology and neuroscience at Mount Holyoke College. Her book is called "Coming to Our Senses: A Boy Who Learned to See, a Girl Who Learned to Hear, and How We All Discover the World."

Sue, thanks very much for making time for us today.

SUSAN R. BARRY: Thank you. I enjoyed it,

KRYS BOYD: "Think" is a production of KERA in Dallas. Our team includes Stephen Becker, Paige Phelps, Mia Estrada, Nilufer Arsala and Micaela Rodriguez. Our interns are Angelica Perez, Temi George and Marissa Green. As always, I'm Krys Boyd. Have a great day.