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Shades of color

By Jenni Herrick
Colorado State University

Courtney joined me in the lounge and settled into the chair across from my own. Right away I was captivated by her story. "When I hear music, I see colors," she said. "When I smell certain smells, I see colors. Or even when I think of a person, there is a very strong color association with that person."

Courtney Van Evera is a charismatic, 24-year-old woman with a giggly personality and a curiosity toward her environment and everyone in it. What she experiences is called synaesthesia. The Greek root *syn* means "together," and *aisthesis* means "sensation."[1] This phenomenon is best explained as a cross-wiring in the brain causing the onset of one sense to trigger another.[2]

Her face lit up and she did her best to contain her giggling. It looked as if she had a secret that had to be told. "What I experience is – with every sense like hearing, taste, touch, smell – " she counted off on her fingers, "I see colors…All my senses are involved with it, so it's kinda like they all get crossed into sight with colors."

Many cases of synaesthesia have been documented starting as early as 1880 when a paper was published in *Nature* on this condition by Francis Galton, a cousin of Charles Darwin.[1] However, it wasn't until recently in 1999 that scientists started to explore synaesthesia as a "genuine sensory experience."[1] Before then, it was just assumed that these experiences were either being made up or that they were a product of the use of drugs such as LSD.[1]

The senses of a person who experiences synaesthesia can become intertwined in many different ways. Because synaesthesia occurs with any combination of intersecting senses, psychologists have counted more than 100 different existing combinations.[1] The most common of which are colored-hearing synaesthesia, where a sound triggers the perception of color, and letter/number to color synaesthesia, where numbers and letters are perceived to be in assigned colors no matter the coloring of the ink on the page.[3] Courtney experiences both of these, as well as color synaesthesia triggered by tastes, smells, and even concepts of people's personalities. Studies show that people who have one type of synaesthesia are likely to have another type as well.[1]

Courtney explained that she used the colors that she sees associated with numbers and letters to help her through elementary school. Through Courtney's eyes, numbers and letters are not seen as the black print on a page but instead appear slightly different in colors and shades. She said that this was how she learned to spell – by memorizing the color patterns of the letters in words. As for math, Courtney memorized what colors equal other colors. She said it is her own personal internal categorizing system. "Colors help me memorize things. I did well in spelling and vocabulary and I very easily memorized math and multiplication tables…I mostly memorize things that

I need to, by categorization. I think I tend to do that in my life anyway. But it's all color coded in my head, so it makes it a little bit easier for me to memorize."

Upon hearing that, I shared that I use an external system of six different colored pens and colored note cards; one color of pen with one color of card is one category. Courtney must have seen this as an opportunity to show me her math skills. "Well," she exclaimed, "that's 36 different categories."

Of course, it is. But I couldn't find the words to confirm that she was correct. I was amazed at the effortless speed with which she was able to answer. Not more than two seconds after telling her that I mix and match six different colored pens with six different colored cards did she have the answer of just how many categories are in my system. She giggled and explained to me that "purple times purple equals green and purple." The number six is purple while the number three is a green hue.

Viewing numbers and letters in color is one thing, but what about objects or concepts more complex than numbers and letters? Courtney explained that more complicated concepts, such as peoples' personalities and the concept of time, can have many different colors "wrapped up in them." This makes sense; we see an individual letter on this page as flat and just simply a letter. However, we see complicated concepts, such as people, as changing and inconsistent; less reliable than a simple letter. Courtney went on to say that "the first impression of someone might be one color and then a different part of their personality might be a different color or a memory might be a different color."

"The first letter of the person's name is always a big indicator to what the color will be," Courtney explained. "The first thing I learn about you is your name and then the first letter is capital, so it's bigger." It is not uncommon to have the first letter or the capitalized letter of a word to bleed or blend its color over to the next letters of the word.[1] The capital "J" in my name is purple. Courtney explained to me that because of this, parts of my personality are "mostly associated with purple."

"It's the same with music." Courtney explained that music can be as complicated as people are. "Notes will be different colors. So, maybe that's why I like music so much; it's like this color show in my mind. Or different instruments can bring different colors into my head." She stated that overlaps in color are common with complex concepts. Courtney's ability to visualize colors brought on by sound is known as higher synaesthesia whereas colors seen simultaneously with physical objects (such as actually being able to see a number or a letter on a piece of paper) is known as lower synaesthesia.[3,4]

Psychologists have put together a test, known as the pop-out test or the segregation test, to use when trying to determine if a person experiences synaesthesia.[1,5] The most common example of this test is forming a hidden pattern, such as a triangle, using 2s among a scattered placement of 5s.

All the print is in black and the 2s and 5s are exact mirror images of each other. For non-synaesthetes finding the pattern of 2s among the 5s would take more than a few minutes. Synaesthetes should – being able to perceive the 2s as a different color than the 5s – pick out the pattern almost instantaneously. A study conducted by scientists Vilayanur Ramachandran and Edward Hubbard showed that synaesthetes found the shape that the 2s created up to 90% of the time which is how well non-synaesthetes did in finding the triangle shape constructed out of the 2s when all the numbers actually were shown to them in color.[1]

Some synaesthetes participating in the pop-out test would, however, need to be informed that it is 2s and 5s that they are looking at. Because the test is done using mirror images of the those numbers, the 2s and 5s appear in the form that we see with digital numbers, and it may be hard to interpret numbers out of what is being seen. Courtney explained that if she is not able to tell what a number or letter is, then it wouldn't appear in the assigned colors. This holds true with not being able to read somebody's handwriting: "The style of handwriting itself might have its own color in my mind," Courtney explained. "I'd have to know what the word was for it to have the color it should have."

Until the point when synaesthetes discover that the majority of other people do not share this same crossing of senses, it isn't uncommon for those who experience synaesthesia not to realize that these occurrences are unusual.[6]

Courtney shared what it was like for her when she discovered that not everyone viewed the world as she did. "So at college, I was 20 years old and I did not – I had *no idea* – that this wasn't normal until this time." Courtney cleared her throat and continued, "I was sitting at this table with a bunch of people, and I was like 'Hey! What color do you guys see when you think of three?' And *no one* knew what I was talking about. Everyone was just like 'I…I…I don't. I just see the number three." She sat up straight, raised her eyebrows, "And," she started dramatically, "the guy sitting next to me told me, 'You see colors because a nerve never grew apart in your brain." Courtney giggled as she imitated the voice of the person who told her this. "And I was like 'Oh my gosh!' and, so," she shrugged, "that's when I knew." Courtney went on to tell me that the guy explained to her how children have really strong color association, but that in most people, the nerve that is responsible for this grows apart and loses that ability.

In truth, it's not a matter of a nerve never growing apart but really several nerve connections never having been severed. At infancy, up to 100% more neuronal connections exist within the brain than in adulthood.[7] At about the age of five, a large amount of these neuron connections start to disappear; this includes parts of the cortical areas which aid in our visual perception.[7] The severing of those connections is called pruning.[7] The body seems to prune off pre-marked connections as most everyone's connections are about of the same consistency by adulthood. Because the connections to be pruned are pre-marked, it is suspected that the risk for synaesthesia is genetic.[5,8]

Even though it is estimated that as many as one person in 200 experience synaesthesia, an answer as to how this occurs in the first place has yet to be found.[1] However, the theory that is most agreed upon, the persevered neural connectivity theory, lines up the closest to what Courtney's friend explained to her the day she discovered the uniqueness of her experiences. The persevered neural connectivity theory suggests that the pruning process is incomplete. This is known as the hyperconnectivity hypothesis.[9-11]

Why is it that some senses are so separate in the first place while others are not *completely* separate. For example, taste and smell are so closely connected that when the sense of smell is lost, one's ability to taste is hampered.[12] So why is it, for example, we can only *see* a painting hanging on a wall but not *hear* it?

Our brains do not have a connection between the auditory and the visual areas, although those connections did exist before the pruning process.[8] The parts of the brain that translate sight, sound, and color –the temporal lobe, the parietal lobe, and the occipital lobe – all meet in one place of the brain known as the TPO junction (temporal, parietal, occipital).[1] If the connections tying these receptors together were never severed, the translation of sound in one lobe would then bounce into the translators of the other two lobes creating a cross-wiring of senses.[1] This would account for color-hearing synaesthesia.

Yet another explanation known as the disinhibition-unmasking hypothesis also exists.[13-16] This suggestion credits synaesthesia not to inefficient pruning but to a possible imbalance of chemicals traveling around the different regions of the TPO junction and causing a miscommunication between a person's senses.[1] In spite of the research completed on this hypothesis, psychologists favor the hyperconnectivity explanation due to the same pruning process having been observed in other mammals.[7]

Synaesthesia, even though considered a neural condition, does not appear in the Diagnostic and Statistical Manual of Mental Disorder (DSM) for psychology. According to the manual, a diagnosis for a disorder is not made unless what the person is feeling is causing what they would consider to be an "interference in life."[17] Only a few cases of synaesthetes have reported feeling a sensory overload, whereas a high number of reports state that synaesthetes are not bothered by their experiences, and most of them feel that it's like a gift of having "hidden sense."[18]

Courtney is not bothered by her experiences. On the contrary, she said, "It makes me feel special." She sat back and sipped her peppermint steamer. "I feel like it's like a little present from God," she smiled, "like I have a little something extra."

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