The voice that sounded like Spaghetti and M&Ms: A Review of Synesthesia

By Stephanie Newton

If you've seen Fantasia, you know what it feels like to see music. Symphonies are converted to scenes and landscapes; sounds are visualized as a plethora of colors, shapes, and movements. For most people, this is a hypersensual experience, but for a select few, hearing colors and seeing music is a perfectly normal way to experience the world. Synesthesia is the condition in which a stimulus of one sense triggers the perception, or experience, of another sense. For example, words, letters and numbers can evoke colors, sounds can evoke smells, or days of the weeks can have certain shapes.

Why can't I experience this too?

The prevalence of synesthesia is debatable because it is not well documented. Some say that it is present in an estimated 1 out of every 25,000, while other sources say 1 of every 2,000 people. Another source claims that synesthesia is not as uncommon as it is recorded to be. On the contrary, some say that everyone is slightly synesthetic. Evidence from drugs such as LSD and mescaline lead some to think that many non-synesthetes' brains have the potential to be synesthetic, since these drugs can induce synesthetic experiences in people who do not normally experience it. However, it is easy to confuse synesthesia with metaphors, or learned associations. Many of us would say that a low pitch has a dark tone, but this may be something learned only in certain musical cultures—and this connection exists only in the abstract; we do not physically see darkness when listening to a deeper note. Similar stories and cases of this neurologically-based condition have been recorded from different cultures and time periods, demonstrating that synesthesia is more than just a learned association. In his book *Speak, Memory*, Vladimir Nabokov describes his own syndications of letters and colors:

> The long 'a'of the English alphabet . . . has for me the tint of weathered wood, but a French a evokes polished ebony. This black group also includes hard 'g' (vulcanized rubber) and 'r' (a sooty rag being ripped). Oatmeal 'n', noodle-limp 'l', and the ivory-backed hand-mirror of 'o' take care of the white. (Lemley 1999)

A high proportion of synesthetes are artists, musicians, or writers. Creativity tests have shown that on average, synesthetes show more fluency, flexibility, and aesthetic sensitivity than non-synesthetes; therefore it makes sense that art and music and creation of aesthetically pleasing constructs would

come more naturally for a synesthete. Other famous synesthetic artists and writers include Franz Liszt, Nikolai Rimsky-Korsakov, Charles Baudelaire, and Wassily Kandinsky. However, it is difficult to prove whether these people actually had developmental synesthesia or whether they learned associations between different senses later in life, as we do so often in the form of metaphors.

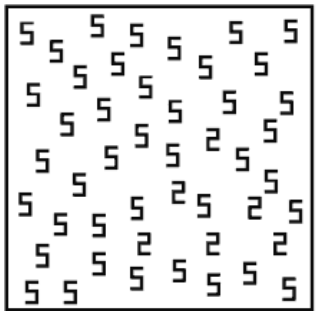
Many synesthetes do not realize that they experience the world in an unusual way. They grow up with multi-modal experiences—for them, that letter has always triggered that color for as long as they can remember—so they either assume everyone experiences the world in that way, or do not consciously think about it. This suggests that synesthesia is a condition that begins in early development, and perhaps even from birth. There is evidence that very young children can have synesthesia. Richard Cytowic recounts how one of Muriel Nolan's earliest memories is wondering why a can of white paint her father was using smelled blue. Parents may report that their children, from a very young age, connect tastes to colors, or describe certain people as having colors and textures.

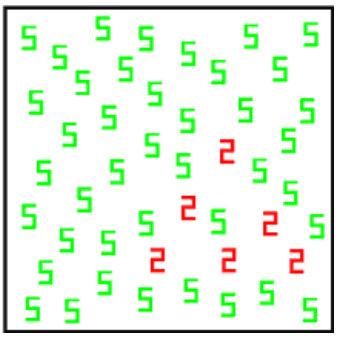
How do I know they're telling the truth? Show me the science!

But how can a person smell a sound or see a pitch? For a person who does not experience this, it is easy to question the validity of a synesthete's claims. However, there are some common characteristics and consistencies between most synesthetes that make for a convincing case as to the authenticity of the condition. In most cases, the connection is unidirectional: seeing a certain letter may evoke a color, but seeing that color does not generate the perception of that letter. The connection is also involuntary, which means that synesthetes do not consciously decide on a smell to always accompany a pitch; rather, it happens automatically and beyond their control. In addition, the perceptions are often evoked in external space. A person may actually see a color being superimposed on a letter, or may see shapes just beyond their face, rather than inside the body or the mind. One can imagine the taste of a lemon inside the mind, but it is different from feeling the sourness on your tongue. Lastly, associations are consistent within one person, for example, a person who experiences Tuesday as blue will generally report the same combination years later. Different people with the same type of synesthesia will disagree, however, on what perception each stimulus evokes. According to Baron-Cohen, a synesthete who associates color with words describes how "the colors perceived by other synesthetes have so little connection, in fact, that, like unwanted radio signals, they are immediately jammed from my mind. As soon as Elizabeth describes her color for a word, I replace it in my mind with my own." Associations are unique to each person, but generally consistent over their lifetime. One exception to this rule is in children: the color that a child perceives in a certain letter may change slightly as they get older. Another child saw colors in accordance with different people and personalities, and the colors

varied in brightness and strength in strangers verses when he got to know someone better.

Is this just a feeling they have, or are they actually perceiving this seemingly unrelated connection? Historically, most accounts of synesthesia have been based purely on subjective personal reports, so in order to study the phenomenon, there must be a way of scientifically quantifying it. One synesthete makes it clear that while some synesthetes do visually experience color in connection with another sense, they still perceive the true color of objects. The synesthetic experience is not completely replacing the true color. But true to their claims, experiments on reaction time show that synesthetes really do experience the extra sense. In one experiment, the subject is presented with a box full of 5s and 2s (left). The twos, at a quick glance nearly indistinguishable from the 5s to the non-synesthetic eye, form a shape among the other numbers. Synesthetes who experiences colors in connection with certain numbers are able to discern the shape of the twos much more quickly than non-synesthetes, presumably because they actually see different colors in response to the numbers, and are able to use this extra visual cue to quickly pick out the shape. What do you see?





Now look at the diagram again with the twos colored red and the fives colored green. Can you discern the shape more easily?

How does this happen?

This leads us to think about when and why synesthesia develops. There is some evidence that it involves genetics, because it has been shown to run in families, most commonly from mother to daughter (synesthesia is more prevalent among females). Curiously, although perhaps coincidentally, Nabokov saw a particular letter as blue, his wife who was also a synesthete saw it as red, and his son sees that same letter as purple! However, if the condition is inherited, how is it associated with systems that are learned, such as numbers and letters? Most likely, there are both inherited and environmental components. Too often we get caught up in the "nature verses nurture" debate, without considering the possibility that these two influences are interdependent and work together to create an outcome. Perhaps only certain neural conditions provide the potential for synesthesia, and whether or not the person actually develops it depends on exposure and experience.

Theories

There are various theories as to how synesthesia works, focusing particularly on the ideas of the differing methods of perception of infants and adults. A common theme in neuroscience is the idea of "pruning," or the systematic cutting back of unneeded brain cells during early life. A baby is born with many more cells than he or she will use in a lifetime. During the first several years of life, the brain undergoes a massive editing phase in which it gets rid of cells that it is not using. Maurer's developmental theory of synesthesia targets the pruning prodedure, asserting that all human infants have synesthesia, but at around four months of age the senses undergo modularization, a process by which they become separate from one another. In synesthetes, there may be reduced pruning and consequently incomplete modularization during infancy, which allows the senses to continue being connected throughout life. Evidence of this is the Cross-Modal Transfer (CMT) hypothesis, which states that babies have an abstract representation of objects in their mind, allowing them to recognize an object using one sense, even though it has only been experienced previously in another sense. For example, by looking at exploration time, researchers hypothesize that babies may be able to recognize an object by seeing it, even if they have only previously touched it with their hands and mouths. This is also related to the Neonatal Synesthesita (NS) Hypothesis, which predicts that babies do not distinguish between different senses; they experience every stimulus in every sense.

But if synesthesia is present when we are infants, why does it disappear as we age? Is there an evolutionary benefit to having each sense being separate from the others? Baron-Cohen suggests that modularity may allow for faster and more efficient processing of environmental stimuli. However, most synesthetes do not see their condition as a disability; rather, it is a part of everyday life. It is how they understand the world, and in some cases the world is even enriched. Only in certain circumstances may synesthesia be maladaptive, such as in the case of JR, who hears noises in response to colors and also see colors in response to sounds. Some environments with too much color or noise were simply too stressful for her, and provoked information overload.

The brain basis

To deduce a neurological basis for synesthesia, researchers Romke Rouw and H. Steven Scholte examined the brains of synesthetes using functional magnetic resonance imaging and diffusion tensor imaging (to measure activation and connectivity between different brain regions, respectively). They observed non-synesthetes, those who experience the unusual sensations as happening inside their mind, known as 'associators,' compared to synesthetes who experience it in the external world, also called 'projectors.' They found that stimuli that induce a synesthetic experience cause increased activity in certain brain regions, as compared to stimuli

experienced only in the appropriate modality. There were also increased connections in synesthetes in areas of the brain implied in various levels of processing. In order to consciously see an object, a message containing information about that object must pass through various checkpoints, from the retina to brain areas deciphering shape and color, to brain areas that integrate all the information and give us a comprehensive idea of the object. In synesthetes, extra connections were seen in both purely visual information areas and higher perception areas. Connections were even stronger in projector synesthetes as compared to associators. The authors hypothesize that synesthesia is a result of small structural changes (as opposed to widespread physical abnormalities), which could be a result of a decrease in the weeding out of neuronal connections during development, as discussed before. The insight that Rouw and Scholte offer could provide a key into our understanding of how we sense the outside world.

Another study by Nunn looks at different areas of the brain that are active when synesthetes and non-synesthetes hear a word spoken out loud. Non-synesthetes have activation in the part of the brain that processes sound cues and spoken language, which is to be expected. Synesthetes who "hear colors" when they listen to a word have activation in this area also, as well as areas of the brain that are normally used for seeing color. This is a different way of showing that in synesthetes, there is an unusual connection that causes an additional part of the brain to be active, thus involving an extra sense.

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Many times we subconsciously assume that we see the world the way it is, and that everyone else sees it in this way too. However, synesthesia suggests that the way we see, or even hear, smell, and feel things, is subjective and modified by our brains. We do not see the world exactly as it is, because our brains pick out relevant information and combine it to give us a picture of what we need to know. Sometimes this overall picture can be different for each person. We have all had those moments when we say to a friend in surprise "that's never happened to you before?" Although we all live in the same world, we each unintentionally create our own internal world, and we have few ways of knowing what other people's worlds are like. As Baron-Cohen says, "a theory described by Claviere states that synesthesia is pathological. Perhaps. And perhaps we are all crazy." For all we know, we could each be crazy in our own way—keep this in mind the next time you find yourself eating a slice of "sharp cheddar," or using the phrase "I see what you're saying." Are you really?

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