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Synesthesia

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Abstract

Synesthesia is a neurological condition in which two or more bodily senses are merged so that the detection of each is mismatched. In this paper I will investigate the history of this condition, the primary researchers, the neurological factors, whether it is perceptual or cognitive and how it relates to metaphors and the consciousness debate in philosophy.

What is Synesthesia?

'Until very recent years, it was supposed by philosophers that there was a typical human mind which all individual minds were like... Lately however, a mass of revelations have poured in which make us see how false a view this is.'

-William James, 1890

In the first neuroscience class that I took, I learned that the human brain has three primary functions: to create a sensory reality, to integrate information and to produce behavior (Kolb & Whishaw, 2005). We live our lives assuming that our sensory realities are somewhat universal and that when one person hears a flute playing a song that the next person has the same general experience. What if we found a small group of people for whom sensory experiences are mingled and interchanged and didn't resemble what we experience at all? When they hear the flute playing they see a specific shape in a specific color. Well this seemingly alien situation does exist, the group of people are called synesthetes and their condition is called synesthesia.

Throughout my research I have come across countless definitions of synesthesia and suggestions as to what to classify it as (a syndrome, a disorder, a condition etc.). I choose to classify it as a condition because I think that the word implies a positive account of something that has no apparent adverse side effects. The definition that I agree with most after considering all the studies is from Ramachandran and Hubbard (2001) who call it, "...a curious condition in which an otherwise normal person experiences sensations in one (sensory) modality when a second modality is stimulated." This is a very simple, easy to understand definition that (with the exception of the word 'normal' which I believe is relative) conveys the general idea of synesthesia clearly. Although it is referred to as a condition, synesthesia is not listed in the DSM-IV since synesthesia does not generally interfere with normal daily functioning like the mental disorders of the DSM-IV. In fact, most subjects appear to enjoy their added sensory experiences and wouldn't have it any other way. There are however, some criteria for diagnosing synesthesia, much like those that would appear in the DSM-IV developed by neurologist and synesthete Richard Cytowic (2002):

- Synesthesia is involuntary and automatic.
- Synesthetic images are spatially extended, meaning they often have a definite 'location'.
- Synesthetic percepts are consistent and generic (i.e. simple rather than imagistic).
- Synesthesia is highly memorable.
- Synesthesia is laden with affect.

There are various types of synesthesia that one can have. From 175 case histories (finding synesthetic subjects is difficult which leads to small sample sizes), researcher Sean Day has identified 19 different types. They range from

the most common, grapheme-color, and sound-color to the least common (which there are five of and only one case of each) sound-odor, temperature-color, taste-touch, touch-smell, and vision-touch. Other reported cases include colored pain, colored sexual orgasms and colored personalities. While nearly every possible combination of experiences is logically possible, not all have been identified.

Synesthetes are very particular about their associations. A 'J' is not just orange but the dull orange of an old cat's fur, for example. They also seem to get irritated if they see a grapheme in the 'wrong' color. Synesthesia is almost always idiopathic but can also be acquired with the ingestion of hallucinogenic drugs such as LSD and mescaline, and also has been found to be very common in patients with temporal lobe epilepsy. These alternative ways of acquiring the condition offer new insights and paths for future research. If synesthesia can be triggered using drugs then are there latent connections in our brains or do only people with a predisposition get the experience? This is something that has not been studied due to the ethical factors in using illegal drugs for experiments.

Prevalence estimations have varied from 1 in 25,000 (Cytowic, 1989) to 1 in 20 (Galton, 1880) but the most widely cited statistic comes from Baron-Cohen et. al. (1996) which is 1 in 2000. Ramachandran and Hubbard have recently claimed that this is an underestimate and their informal samples have suggested a number closer to 1 in 200. The gender ratio has been determined to be 6:1 with females being more likely to have synesthesia (Baron-Cohen et. al., 1996). The large difference in the prevalence rates may be attributed to the fact that many synesthetes live "in the closet" for lack of a better term. They may have revealed their condition when they were young but may have been told that they were just using their imagination or being silly so they decided to keep in to themselves. Another account for the differences could be the lack of consistent criteria for diagnosing synesthesia.

History of Synesthesia

A distinction must be made between true and false ideas, and that too much rein must not be given to a man's imagination under pretext of its being a clear and distinct intellection. -Leibniz, 1670

The earliest notations of synesthesia were made by Sir Frances Galton (who happened to be Charles Darwin's cousin) in the 19th century. He was also the first to suppose that this condition ran in families (this has since been proven to be true). Synesthesia was first acknowledged at the turn of the century when famous people such as Vladimir Nabokov and Duke Ellington and showed signs of the condition. The oldest study that I found regarding synesthesia besides Galton's work was done in 1942 and was followed by little

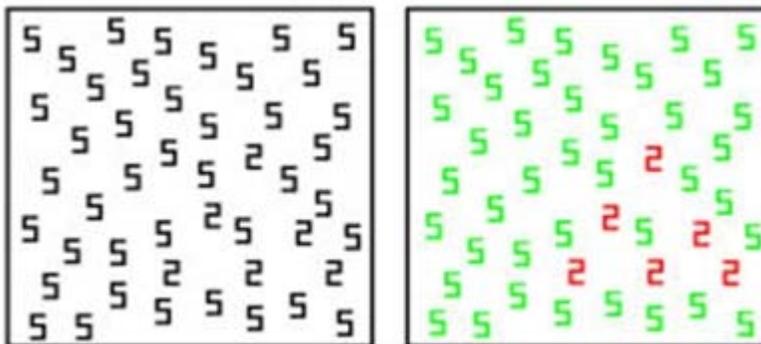
else until the past two decades when research has intensified as we learn more about the brain. This first early report (Karwoski et. al., 1942) focused on the fourth most common (Day, 1999) type of synesthesia that involves colors being evoked from sounds. It detailed a variety of tests the researchers did to their subjects and the results were in the form of traditional psychological principles rather than any causal factors or neurological basis for the phenomenon. In the early 1990's there was a 'synesthesia renaissance' which has been said to have started with Richard Cytowic's book *The Man Who Tasted Shapes* and this is when some ground-breaking research was revealed by some of the key professionals in the field.

The Primary Researchers

Because synesthesia is such a rare condition, there have been only a handful of researchers that are on the forefront of the current studies. The most prominent would be neurologist Vilayanur S. Ramachandran MD, PhD. who is the director of the Center for Brain and Cognition at the University of California. He has published many papers on perception, color and motion, and phantom limb syndrome before settling in on synesthesia in the late 1990's. His popular article entitled, "*Hearing colors, tasting shapes.*" was originally published in *Scientific American* (2003), later reprinted in *Scientific American Mind* (2005) and also just recently reprinted in a special edition of *Scientific American Mind* called "*Secrets of the Senses*" (2006) and has brought this mysterious condition to light in a pop-culture type way for the general public. Also notable are Richard E. Cytowic, M.D. and Simon Baron-Cohen, PhD. both of whom are considered pioneers and experts in the field.

Is Synesthesia Perceptual or Cognitive?

Ramachandran and Hubbard devised some clever experiments to determine the answer to this question. Their tests included pop out displays using 2's and 5's (shown below), showing a grapheme in the subject's periphery and testing whether Roman numerals and other, similar symbols elicited the same response as the basic grapheme.



The image on the right is what non-synesthetes see and the image on the left is what they synesthetes see. Even though it is slightly difficult to decipher the 2's and 5's for us, the corresponding colors are seen immediately for the synesthetes. It was thus determined that synesthesia is a perceptual effect (Ramachandran and Hubbard, 2001) because of the results of these experiments now the next step is to determine how and why it happens.

Neurological Findings

The neurological way synesthetes experience their condition has been defined in recent studies thanks to the technology of PET scans, MRI's and fMRI's. The action has been determined to take place in the left side of the brain in the numbered visual cortex areas. In this area we have areas V1, V2, V3, V4 and V5, each being responsible for a specific part of visual functioning such as motion, direction, color and perception. The consensus seems to be that in a grapheme-color synesthetic subject, area V4 is activated while areas V1 and V2 show no activity. It was previously thought that there could be no visual experience without activity in V1. This indicates that there is some cross-activation in these areas, much like what happens with the hand and face areas of phantom-limb patients. It is no coincidence that V4 is adjacent to V1 and V2 and that grapheme-color synesthesia is the most common type. Another startling finding is that when synesthetes actually view colors, their left V4 does not activate in the usual manner in color visual stimulation.

Although controversial, the "neonatal hypothesis" is generally accepted as a causal explanation of synesthesia and states that we are all born with the neurological workings of synesthetes but for most of us, the mismatched connections were destroyed during the pruning process that occurs during infancy. It has been suggested that a single gene mutation in the X chromosome causes this lack of pruning (Ramachandran & Hubbard, 2005) because the condition is genetic and tends to be passed down through the mother.

This discovery is only a theory of how the potential for synesthesia is made. One may be born with the phenotype for less synaptic pruning but one is not born with certain word, smell, color or taste associations, these are learned in childhood. It remains a mystery why certain numbers, for example, are certain colors to synesthetes and while some have suggested that things such as colored fridge magnets or colored letter blocks influence the associations, this speculation has been disproved because it cannot explain other associations such as those that involve taste or hearing for example.

So why did this gene survive? We all know that through evolution, genes that have no use eventually die out so why has the synesthesia gene remained? There is no apparent direct benefit to having this gene so we can infer that there must be an attached trait like the sickle-cell anemia situation. The most obvious would be that a larger proportion of synesthetes are artists

and writers than non-synesthetes suggesting that they have a higher propensity for understanding metaphor which is a key to knowledge and knowledge is a key to survival.

Synesthesia and the Art of Metaphor

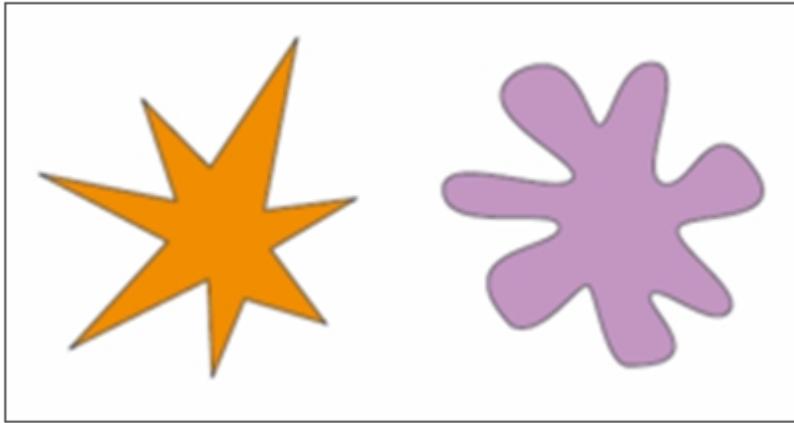
“The metaphor is perhaps one of man's most fruitful potentialities. Its efficacy verges on magic, and it seems a tool for creation which God forgot inside one of His creatures when He made him.”

- Jose Ortega y Gasset

Upon first reading the color-grapheme associations that are most common such as ‘O’ being white and ‘T’ being blue, my initial thought were empathetic, I could ‘see’ or understand that an ‘O’ seemed to be white and a ‘T’ seemed blue so is there a bit of synesthesia in everyone? This is probably not the case. Most of us have the ability to comprehend metaphors and the location in the brain that has been associated with this ability is the angular gyrus.

A striking finding uncovered by Ramachandran and Hubbard concerning synesthesia and metaphor is a continuation of their finding that the angular gyrus is where sensory information converges. They discovered that people with damage to this area experienced loss of the ability to name objects or to recognize written or spoken names of objects (anomia). More intriguing was that they also lost the ability to understand metaphors. Ramachandran and Hubbard suggest this hypothesis, “Could it be that the angular gyrus...evolved originally for cross-modal associations but then became co-opted for other, more abstract functions such as metaphors?”

A popular experiment to demonstrate this is the “Booba/ Kiki Effect”. In this experiment, originally designed by Gestalt psychologist Wolfgang Kohler, two shapes (shown below) are shown to subjects. They are asked which one is a ‘booba’ and which one is a ‘kiki’. An overwhelming 98% of subjects chose the curvy figure as a ‘booba’ and the pointed figure as a ‘kiki’.



By understanding how this effect works, we can think of this type of cross-activation (sound and shape) as similar to how synesthetes' perceptual maps are cross-activated.

Synesthesia and the Philosophical Debate on Consciousness

"Within psychology and neuroscience, some new and rigorous experimental paradigms for studying consciousness have helped it begin to overcome the stigma that has been attached to the topic for most of this century."

-David Chalmers

A continuing debate in the field of philosophy is how to explain human consciousness and the subjectivity of the human experience. David Chalmers has coined the phrases "easy problems" and "hard problems" of consciousness with the easy problems being, "...those that seem directly susceptible to the standard methods of cognitive science, whereby a phenomenon is explained in terms of computational or neural mechanisms." (Chalmers, 1997) and the hard problems being those phenomena that cannot be explained that way, the subjectiveness of personal experiences. It has been said that synesthesia may shed light on the 'hard problem' of consciousness by throwing functionalism out the window and reassessing what it means to have subjective qualia when it seems that synesthetes are experiencing a type of qualia distinct from what the rest of us "sense-segregated" people do. Functionalism posits that qualia are merely input-processing-behavioral output types of experiences and nothing more. Because it would take only one instance of non-functionalism to invalidate the theory, it would seem that synesthetic experiences such as colored-hearing do this. This is a debatable issue however and Bryson Brown, chair of the Philosophy Department at the University of Lethbridge gives this argument,

"Synesthesia is, first, evidence that the categorization system linking conscious perceptual states to the proper sensibles can get mixed up in ways

we don't think the corresponding properties of physical things and events can. Some strong assumptions about the 'givenness' of these claims that a sound is red (for example) would be needed to make the case that such descriptions of our conscious states are really correct descriptions of them... So I don't think it can make a strong case against functionalism, at least, not without a lot of philosophical backup (which I would be dubious about)."

Conclusion

The amount of progress that has been made with synesthesia research in the past twenty years is amazing. The future is ripe with possibilities for more discoveries. One of the limitations of studies so far has been the lack of a large subject-base but the revelation of some more recent famous people having synesthesia such as scientists Nikola Tesla and Richard Feynman (grapheme-color type) and the acceptance of this condition by science, we can hope that more people will come forward with this curious condition and we can have greater subject groups available for research.

"Nature reveals herself through exceptions. Those objectivists who tried to dismiss synesthesia throughout history seem to have forgotten this maxim. Far from being a mere curiosity irrelevant to real questions, synesthesia turns out to illuminate a wide swath of mental life and forces us to think some fundamental issues regarding mind and brain."

-Richard E. Cytowic

About the Author

Fourth year psychology student at the University of Lethbridge with interests in consciousness, metaphysics and philosophy of mind. This paper was done as an independent study under Dr. Robbin Gibb (NEUR 3990) and I wish to thank her for her support with this project. I also wish to thank Dr. Bryson Brown, Chair of the Philosophy Department here at the University of Lethbridge for his contributions to the paper.

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