Matthew Martin Neural Aesthetics and Visual Systems – Nadin
Synesthesia 12.12.03

Though scientists have known about synaesthesia since the time of Charles Darwin, the language of science has only recently reached the point where it can begin to describe the biological functions of this phenomenon. Synaesthesia is a condition whereby the input from the sensory systems becomes intermingled or crossed, resulting in shapes that exhibit colors or numbers that produce a color, and it is present in an estimated 1 in 10,000, to 1 in 25,000 individuals. The study of synaesthesia has become increasingly important as scientists advance their understanding of neurological functions, the nature of perception and the way in which our biology forces us to relate to the world around us. It has also been fundamental to enquiry into the potential of human sensory systems and how they are interrelated, and how that interrelation changes the way we react to and create things like music and art.

Little understood for over a century, this condition has often been passed by as fakery, or, more recently, as singular to the use of certain psychotropic drugs, such as mescaline or LSD. Also common was the notion that synesthetes were simply more deeply gifted or more abstractly metaphorical than the "standard human being", meaning that their supposedly conjoined senses were a result of a more complex interrelationship of association than their brethren. Recently, however, science is beginning to deconstruct not only the brain, but the methods by which it constructs perception, through vision, sound and touch. It has found that these processes of sensation, while separated and

compartmentalized within the brain, all relate to and feed back to each other in a process of reentry.

Synesthetes (people with synaethesia) are people in whom one sensation produces a multiplicity of other sensations that someone without synaethesia might not expect. For example, it is possible for a synesthete to look at a shape, say a triangle and perceive not only the shape of the triangle, but the pervading sense that triangle smells of chicken or popcorn. Or, similarly, she might hear a single note – perhaps middle C – and not only hear the note, but "hear" an electric blue as well. While this conjoining of senses requires only two sensory systems, in many cases of synaethesia, the subject will experience the clashing of as many as four or even all five of his sensory systems to produce a sensation from just one stimulus.

It has been easy for scientists to dismiss this phenomenon or to ignore it out of an inability to study it in biological terms. There are a number of factors that insist, however, that it is not only worthy of, but also important to research and inquiry. Firstly, it has been asserted that a true synesthete experiences stability in terms of their sensory perceptions, that is to say that a triangle will always smell of ozone to them, and this perception does not change. It is also understood that this is a genetically transmittable condition, and is therefore a product of biological evolution, not a product of an abnormal psychology as some early critics believed. What all of this means to us is that there is a relationship between the cross-linkage of senses in these cases and the way in which our brains are neurologically wired to create our distinct perceptions.

There are a great many factors to synaesthesia which one might consider when looking at it from the point of neuroscience. Given the recent preponderance of work on the subject (some of which will be listed at the conclusion), I plan to address those points which my limited understanding of the field itself and my interest seem capable of processing. One of the fascinating aspects of synaethesia is the apparent imbalance among the currently sampled populations of sensory-combination distributions. It seems that hearing colors (which is the type of this condition which Russian Novelist Vladimir Nabokov's mother experienced) is the most common of all documented cases of synaesthesia. The next most common is seeing colors in letters and words (which both Nabokov himself and his son Dmitri both had). Smell and taste are very rare triggers having been documented fewer than 12 times in total, according to Cytowic. This is interesting in that is raises questions about the primacy of certain sensory processes and their dependence on other senses for the construction of the internal metaphor and narrative that makes up what we perceive as consciousness. For instance, it is asserted that the olfactory sense is perhaps the oldest" of our sensory systems, being wired to a very primtive part of our brain and being intensely involved in the memory system. Why then is this system so under-represented in this cross-sensory phenomenon? Can it be inferred that the olfactory and rhinal systems, being as old as they are, but no longer as biologically dominant as they were early in our biological development, are somehow less involved with the way in which modern humans construct our perceptual world? Or can it be inferred that these systems are now so intrinsic to our perceptions that they have become almost "hard wired", systems separate unto themselves?

Historically, synaethesia has excited interest among artists and musicians, though fervor which surrounded it in the mid- to late eighteenth century has faded somewhat. Modernism and synaethesia might be thought of as ideal brothers, or more accurately, modernism might be seen as a cultural manifestation of syaethesia; a kind of social cross-over. Artists and musicians sought to infuse art with aspects of importance not only to the sense of sight and sound, but of those of motion, smell and touch. Calder's mobiles and the many manifestos of the Futurists seem to illustrate this point, as do the works of Kandinsky and Goethe. The fusion of sight and sound embodied by his opera *Die Gelbe Klang* (*The Yellow Noise* or *Sound*) seems to parallel the neurological modality of the synesthete. For many intelligencia who were aware of this phenomenon in biological terms, synaethesia held the potential to be the universal signifier, the sense to rule all other senses, as it were. The concept of crossed wires, as old as Newton, experienced a renaissance under the auspices of synaethesia as the search for the equation by which one sense could be mechanically translated into another entered full swing. This idea of quantifiability had faded somewhat until the current time, where scientists slowly piece together the myriad relationships between the senses and the infinitely complex neurological wiring by which those interrelationships are accomplished. In some ways, we can wonder if this mechanistic view of the humnan mind was so poluar then because it enjoyed a kind of resonance with the idea of Newtonian mechanics and that its eventual laying aside is the result of a shift towards the theories of quantum mechanics and the Einsteinian view in the early twentieth century. Interestingly, as we struggle to unify the methods by which we describe the universe – Newtonian mechanics, quantum

mechanics, and the newer string theory – we once again discover this same problem of perception and unification being explored in the human mind. Again we find a parallel between the developing understanding of the evolution of ourselves and the evolution of our understanding of the construction of our perceptions.

In one particular case, Cytowic notes that the subject DS, on hearing music, "sees falling gold balls, shooting lines, metallic waves like oscilloscope rings" and that her favorite music is music which makes the objects move upward. I was particularly intrigued by this case for two reasons, the first of which being that it illustrated that the process of synaethesia was not confined to limited visual stimulus. DS perceived not only a shape (circle) as being part of the music, but a spatial projection of that shape (a ball). The "ball" itself is not a single piece of visual information, and it strikes me as fascinating that the aural stimulus affected the subject beyond the level of a single point in the visual system specific to a certain aspect – that of shape – and instead provided synthesis between sound and a concept – the shape of circle applied to three-dimensional space. To top it all off, she perceived these sounds as "in motion", creating them not only in space but in time as well. Secondly, this case was particularly interesting in that she expressed a preference for sounds that created a specific visual orientation. This expresses the notion that synaethesia is a phenomenon which is inescapable by those who have it; it is essentially part of their hard-wiring, and is assimilated into their notions of perceptual aesthetics.

Why, then, does this cross wiring occur? There are numerous different theories, and many, if not all of them require a staggeringly complex knowledge of the function of the brain. One of the easiest theories for the non-neuroscientist to understand has been put forward by V. Ramachandran and E. Hubbard, whose article in Scientific American describes one method of deconstructing synaesthesia (with an emphasis on the type in which numbers and colors are conjoined). They assert that

> "because both colors and numbers are processed initially in the fusiform gyrus and subsequently near the angular gyrus, number-color synesthesia might be caused by cross wiring between V4 and the number-appearance area (both within the fusiform) or between the higher color area and the number-concept area (both in the TPO). Other, more exotic forms of the condition might result from similar cross wiring of different sensory-processing regions. That the hearing center in the temporal lobes is also close to the higher brain area that receives color signals from V4 could explain sound-color synesthesia. Similarly, Matthew Blakeslee's tasting of touch might occur because of cross wiring between the taste cortex in a region called the insula and an adjacent cortex representing touch by the hands."

What they suggest is a physical cross-wiring that is a result of genetic mutation and therefore an abnormality in the human genetic makeup. They go on to suggest that it might not be a physical cross-wiring, and concede the possibility that the balance of chemicals traveling between neural connectors in specific areas could theoretically produce similar effects. The inhibition of brain areas by activity in neighboring areas could be upset by chemical imbalances resulting in a kind of "cross-talk". This is interesting when it is considered that 4% of patients suffering from limbic seizures also experience synaethesia during these episodes, seeming to indicate that it might not be strictly physical in nature, but a combination of a physical predisposition and chemical catalytic condition.

Lastly, the predisposition of artists to synaethesia, or perhaps the predisposition of synesthetes to the artistic mode is very interesting to me, especially since it is how I first

encountered the phenomenon. It is estimated that synaethesia is more prevalent by 5 to 7 times in artists, and this paves the way for a number of theories concerning synaethesia and the construction of metaphor. Psychologically, artists, poets, novelists, musicians all exhibit a greater capacity for metaphor, that is the ability to create a connection between two seemingly arbitrary things or concepts which ultimately clarifies or magnifies the nature of the relationship between the two as intrinsic to the nature of them both. Synaethesia, if we think about it as a genetic expression of that propensity for metaphor and the relationships between objects, becomes a potential train in all of us, explaining the vast differences in applied creativity in the human race. People who are able to link distant things exhibit, by definition, a higher capacity for creativity. Since higher cognitive functions are limited to specific (and often rather small) brain areas, it is possible that cross-talk between thee areas of abstract conception would play a part in the condition. Currently, it is believed the angular gyrus is the brain-region in which the information from touch, hearing and vision comes together to allow the construction of higher-level conceptions whose component sensory information is stored in the corresponding areas of the brain. Ramachandran and Hubbard postulate that it is the angular gyrus (which is believed to have developed in humans for basic cross-modal associations) governs the level of cross-talk between areas of abstract conception. They note that damage to this area can affect the ability to distinguish metaphors common to the general population. This, then, seems to oppose the notion that synaethesia is a genetic aberration, but rather the expression of an evolutionary trait which has survived because it is essential to the aspects of creativity and problem solving which distinguish our brains from other primates.

To study only what is know thus far would take a lifetime, and what is known is still very little. There is certainly disagreement about the causes and effects of this condition and debate as to whether it is an important avenue of study. I think that one conclusion has been reached, though, and that is that understanding synaesthesia is parallel to understanding a great many things, not only about human nature and biological construction, but about the physics that our biology is simply a manifestation of, and studying it will only increase our understanding of the mind with which we study it.

Works cited in this page, as well as sources I found illuminating in the course of this exploration are listed here. This is by no means a complete list, but it does reflect a number of the available avenues of study available.

Articles:
***Scientific American**; Hearing Color, Tasting Shapes*.
- a study by Vilayanur S. Ramachandran and Edward M. Hubbard

Synesthesia: Phenomenology And Neuropsychology
- a summary of knowledge by Richard E. Cytowic, published in ***Psyche***

Synaesthesia and Artistic Experimentation
- an article in ***Psyche*** by Cretien Van Campen responding to Cytowic's assertions about the role of synaesthesia in art.

Books:
Richard Cytowic's book, The Man Who Tasted Shapes was informative and accessible, if rather dense for the amateur reader.

Semir Zecki's Inner Vision also informed this writing by providing me with some of the basic knowledge needed to understand the complexities of the other works

The journal ***Psyche*** has provided contextual frames for the whole work, in addition to the specific sources cited above and is highly recommended for those looking for material on neuroscience and the study of the biology and psychology of the brain.