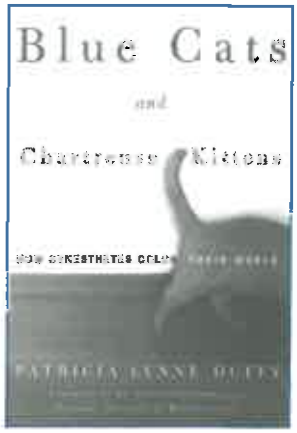
REVIEW

Hearing Colors, Tasting Shapes



Blue Cats and Chartreuse Kittens: How Synesthetes Color Their World

by Patricia Lynne Duffy
W. H. Freeman and Company, 2001
187 pages $23.95 hardcover

Reviewed by Simon Baron-Cohen, Ph.D.

This book is a delight. As far as I know, this is the first time a synesthete has written about what it is like to live with this neurological condition—one in which the senses are intermingled, so that the spoken word "cat," for example, may consistently be experienced as blue. Most of us are familiar with firsthand accounts of psychiatric or medical conditions, but *Blue Cats and Chartreuse Kittens* goes further. It gives us the subjective perspective, but also summarizes the history of ideas about synesthesia —all through the eyes of author Pat Duffy.

Synesthesia is usually called a medical (specifically a neurological) condition, but Duffy's account persuades me that we should regard it, as well, as a gift, the gift of enriched perception. She is fortunate enough to be both a journalist and a synesthete, one gift allowing her to communicate clearly about the other. From her earliest memories of perceiving the world differently as a child, and eventually sharing her secret with her father (see excerpt on page 79), her account is not only moving and evocative, but historical and scientific.

WHAT IS SYNESTHESIA?

Synesthesia is a condition in which stimulation of one sense automatically triggers a perception in a second sense, although there has been no direct stimulation of this second sense. Thus, a sound might automatically and instantly trigger the perception of vivid color, or vice versa. Combinations of synesthesia that have been reported include sound giving rise to visual perceptions ("colored hearing") and smell giving rise to tactile sensation. Colored-hearing synesthesia appears to be the most common, while certain combinations—for example, touch stimulating hearing—almost never naturally occur.

There are two types of synesthesia, developmental and acquired. Developmental synesthesia begins in childhood, always before age four. It is different from psychotic phenomena such as hallucination and delusion; nor is it brought on by drug use. Developmental synesthesia also differs from imagery that arises from our imagination: Synesthesia is vivid, involuntary, and unlearned. It is estimated to occur in at least 1 per 2,000 people, mostly women.

Acquired synesthesia, on the other hand, can result from using psychoactive

drugs such as LSD or mescaline. Neurophysiological studies suggest that LSD causes synesthesia by inhibiting the serotonin-containing neurons of the raphe nuclei; mescaline acts on the noradrenergic system. This drug-induced synesthesia, unlike the developmental variety, is transient, usually has its onset in adult life (or whenever the drug is used), produces sensory combinations that do not occur naturally, and often is accompanied by hallucinations and other loss of touch with reality.

BIOLOGY OR METAPHOR?

In *Blue Cats and Chartreuse Kittens*, Duffy discusses authors, poets, artists, and musicians thought by some to have had synesthesia. The list is impressive: the composers Liszt, Rimsky-Korsakov, Messiäen, and Scriabin; the poets Basho, Rimbaud, and Baudelaire; the painters Kandinsky and Hockney; and the novelist Nabokov. Duffy cautions us that none of these individuals was formally tested for synesthesia. The mixing of sense modalities in their creations may be purely artistic, a deliberate use of metaphor or analogy. Baudelaire, for example, apparently believed in the unity of sensation, as implied by his poem "Correspondences."

Metaphor is easy to confuse with developmental synesthesia. For example, we might say "This color is louder than that one" or "His voice sounds cold." Distinguishing metaphor, as used to achieve a "pseudo-synesthesia," from biologically based developmental synesthesia requires objective testing. The key differences are that in metaphor no sensory perception is necessarily triggered, the artist often acknowledges that the description is merely an analogy, and any synesthesia-like linking of senses is voluntary, an artifice.

SCIENCE GRAPPLES WITH SYNESTHESIA

As *Blue Cats and Chartreuse Kittens* explains, the last decades of the 19th century saw many accounts of the condition, most notably Francis Galton's "Inquiries into Human Faculty and Its Development." With the rise of behaviorism, however, scientific interest in synesthesia declined; very little on it appears in the scientific literature from the late 1920s onward. Behaviorism, after all, sought to banish all references to mental states—all introspective reports—as unscientific, and synesthesia is only revealed through a person's self-reported mental experience.

Within the last two decades, synesthesia research has enjoyed a renaissance. Duffy traces how disciplines within cognitive neuroscience have contributed new information and theories, leading to widespread recognition of this condition as a neurological reality. One foundation of this new acceptance is structured, formal testing for colored-hearing synesthesia. The test measures a person's consistency in reporting color descriptions of words on two or

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more occasions, when they are unaware that there will be a retest. Where synesthesia exists, this consistency should be found regardless of the interval between test sessions. Indeed, consistency has typically been 90 percent or more, even when subjects are retested after many years and stringent criteria are set for the consistency of descriptions.

BRAIN CONNECTIONS LOST AND FOUND

Over the past 200 years, several explanations of the cause of synesthesia have been advanced. In her readable style, Duffy summarizes the most notable of these hypotheses.

What is called the Preserved Neural Connectivity theory holds that, beyond the normal human fetal stage, the brain does not have direct neural connections between the auditory and visual areas. This theory goes on to suggest that, probably for genetic reasons, in individuals with synesthesia the pathways between the auditory and visual areas of the brain exist beyond the early embryonic stage, when normally such connections would die off. Certainly there is evidence that these connective pathways between the auditory and visual areas of the brain exist during fetal development in other species, such as the macaque monkey and the domestic cat. These pathways, or projections, are transient; typically, they disappear approximately three months after birth. There is some evidence that they may exist in human newborns and, as in cats and macaques, get pruned as the brain biologically matures.

If so, synesthesia could be a normal stage of perceptual experience in the developing infant. When it appears later in life, synesthesia of the kind Duffy experiences might result from the persistence beyond the neonatal stage of neural information passing from the auditory to the visual areas of the brain. This suggests the intriguing possibility that we are all synesthetes until, somewhere around three months of age, the maturation of the cerebral cortex gives rise to sensory differentiation and we lose our connections between these two areas.

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A second, rather controversial theory has been advanced by Richard E. Cytowic in *The Man Who Tasted Shapes* (1994). He proposes that synesthesia occurs because "parts of the brain get disconnected from one another...causing the normal processes of the limbic system to be released, bared to consciousness, and experienced as synesthesia." Cytowic concedes that he has no direct evidence for a particular neural structure in synesthesia, but given the "stunning shut-down of the cortex" observed in his imaging study of blood flow in the brain of a patient with synesthesia, he believes the limbic areas are the "seat of synesthesia."

Cytowic's assertion that the limbic system is the critical brain center for

synesthesia has been tested. Direct proof of the involvement of the limbic system would have been provided by evidence of blood flow changes in that brain region; but, unfortunately, the technique Cytowic used—133 Xenon inhalation—does not permit such deep structures to be imaged. This is not a limitation shared by PET (positron emission tomography), so the importance of the limbic system in synesthesia can be evaluated using this technique.

This was one of the questions addressed in the study of colored-hearing synesthesia by Eraldo Paulesu and colleagues at London University. Duffy focuses on this study both because of its importance in evaluating Cytowic's limbic theory and because it moved the whole field forward. Paulesu's study compared brain activity in synesthetes and in normal people who were listening either to words or pure tones while lying in a PET scanner. The synesthetes in this study characteristically experienced perceptions of color when they heard words but not other sounds. This made possible a comparison of brain activation in synesthetes listening to words, synesthetes listening to pure tones, and controls.

Reporting the results, the researchers noted two brain areas of particular interest: the posterior inferior temporal cortex and the parietal-occipital junction. These were active in the synasthetic brain while a subject was blindfolded and listening to words, but were not active in the normal brain. Both of these brain regions are known to be involved in perception of colors. By contrast, in none of the groups was there any suggestion of limbic system involvement. This single study both failed to support the limbic theory and identified new brain areas as the candidate "seats" of synesthesia.

BLAMING COLORED ALPHABETS

Yet another theory of the cause of synesthesia is "learned association." This is the hypothesis that, in colored-hearing synesthesia, the correspondences reported between colors and words or sounds are simply learned. The idea is that sounds and colors are associated in colored alphabet books or letters that the individual saw as a child. Duffy correctly points out that this is an unsatisfactory account of developmental synesthesia for several reasons. First, six times as many women as men are reported to experience synesthesia. Why would so many more women than men form such associations? Transmission from mothers to daughters (through the daughters imitating their mothers) may be a possibility, but it is tenuous. A satisfactory explanation based on different socialization of boys and girls that would lead to the sex ratio in synesthesia is far from obvious.

Another problem for this theory arises from a careful examination of the colored alphabets experienced by synesthetes, where consecutive letters are often described in closely related colors. For example, M as olive green, N as emerald green, O as washed-out, pale green. It is quite the opposite in colored alphabet books. Publishers go to great lengths to ensure that consecutive letters are printed in very different colors. This is additional evidence

against the learned association theory. Furthermore, a comparison of the colored alphabets experienced by synesthete siblings (or mothers and daughters who are synesthetes) reveals substantial variation. Different family members with synesthesia have been known to argue about the color of sounds and letters. If colored alphabets were acquired through learned associations, we would expect much greater similarity in the color-letter correspondences of people in the same family.

NEW CONTENDERS

What are some promising new theories of synesthesia? Duffy argues that the genetic theory of synesthesia is a strong contender. A genetic mechanism might account for the preserved neural connectivity between the visual and auditory parts of the brain as the synesthete matures. Our group's recent study of seven family trees supports the idea that the condition is inherited. This study showed that "multiplex" families exist (that is, those with several affected relatives), most commonly mothers, sisters, or daughters sharing the condition. Molecular genetic studies are in progress. Even if the genetic theory is true, though, we do not yet understand its mechanism. One possibility is the involvement of genes that regulate the migration and maturation of neurons within the developing brain. Another is the genes regulating apoptosis, a process by which a surprising amount of our infant brain is pruned away by programmed cell death as we mature.

Another robust contender is the modularity theory. To know that a perception is visual, auditory, olfactory, or tactile, we must have a way of identifying information as being of one sensory kind or another. We may do this via what Rutgers University philosopher Jerry Fodor calls the modular structure of sensation. According to this theory, in nonsynesthetes each of the senses is functionally discrete (modular) and "encapsulated," whereas in individuals with synesthesia, modularity has broken down. As a consequence, in colored-hearing synesthesia, for example, sounds have visual attributes. Testing the modularity theory in terms of neuroanatomy may have to await new techniques for studying the anatomy of the brain after death.

A WORLD OF DIFFERENCE

Duffy's fine book communicates the excitement of this field for her fellow synesthetes and for the rest of us not thus gifted. She shows us how investigations suggest that colored-hearing synesthetes are consistent in their descriptions of word-color correspondence and in their accounts of their experiences. Synesthetes also appear to exhibit different patterns of brain activity when they perceive the world. If, as Duffy suggests, scientists are able to prove conclusively that genetic factors cause synesthesia, then synesthesia may teach us how unusual wiring in the brain can lead to altered perception, and how ultimately genes may control the way all of us—whether we hear colors, or taste shapes, or not—differ from one another in the way we take in the world around us. ■

EXCERPT

From *Blue Cats and Chartreuse Kittens: How Synesthetes Color Their World* by Patricia Lynne Duffy. ©2001 by Patricia Lynne Duffy. Reprinted by arrangement with Henry Hold and Company, LLC.

I WAS SIXTEEN WHEN I FOUND OUT. THE YEAR WAS 1968. My father and I were in the kitchen, he, in his usual talk-spot by the pantry door, my sixteen-year-old self in a chair by the window. The two of us were reminiscing about the time I was a little girl, learning to write the letters of the alphabet. We remembered that, under his guidance, I'd learned to write all of the letters very quickly except for the letter "R."

"Until one day," I said to my father, "I realized that to make an 'R' all I had to do was first write a 'P' and then draw a line down from its loop. And I was so surprised that I could turn a yellow letter into an orange letter just by adding a line."

"Yellow letter? Orange letter?" my father said. "What do you mean?"

"Well, you know," I said. "'P' is a yellow letter, but 'R' is an orange letter. You know—the colors of the letters."

"The colors of the letters?" my father said.

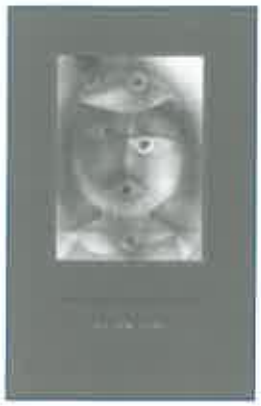
It had never come up in any conversation before. I had never thought to mention it to anyone. For as long as I could remember, each letter of the alphabet had a different color. Each word had a different color too (generally, the same color as the first letter) and so did each number. The colors of letters, words and numbers were as intrinsic a part of them as their shapes, and like the shapes, the colors never changed. They appeared automatically whenever I saw or thought about letters or words, and I couldn't alter them.

I had taken it for granted that the whole world shared these perceptions with me, so my father's perplexed reaction was totally unexpected. From my point of view, I felt as if I'd made a statement as ordinary as "apples are red" and "leaves are green" and had elicited a thoroughly bewildered response. I didn't know then that seeing such things as yellow P's and orange R's, or green B's, purple 5's, brown Mondays and turquoise Thursdays was unique to the one in two thousand persons like myself who were hosts to a quirky neurological phenomenon called synesthesia. Later in my life, I would read about neuroscientists at NIH and Yale University working to understand the phenomenon....But that day in the kitchen, my father and I, never having heard of synesthesia, both felt bewildered. For me, it was one of those coming-of-age moments when I glimpsed that the world might not really be as I had grown up perceiving it. It was a moment when that most basic of questions that binds human beings socially, "do you see what I see?" seemed to hang in a vacuum, independent of any shared context.

I suddenly felt marooned on my own private island of navy blue C's, dark brown D's, sparkling green 7's, and wine-colored V's. What else did I see differently from the rest of the world? I wondered. What did the rest of the world see that I didn't? It occurred to me that maybe every person in the world had some little oddity of perception they weren't aware of that put them on a private island, mysteriously separated from others. I suddenly had the dizzying feeling that there might be as many of these private islands as there were people in the world. ■

REVIEW

Psychiatry Needs Brain Science to Shine



The Unbalanced Mind

by Julian Leff
Weidenfeld and Nicolson, 2001
158 pages $23.95 hardcover

Reviewed by Jonathan A. Leonard

Are we entering an era of reform in American psychiatry directed against overreliance on psychiatric drugs? There are signs that we are and, if so, that is a good thing.

Reform is needed because psychiatrists entering practice today are often shoved into pill-pushing posts by managed care organizations and HMOs that give them little time (commonly 15 or 20 minutes) to diagnose each case and prescribe a drug. It is needed because few U.S. medical school graduates want to practice psychiatry this way, and so more than half of today's psychiatric interns are recruited from abroad. It is needed because most mental hospitals have closed their doors. It is needed because time spent in psychotherapy is often minimal or is eliminated altogether. It is needed because, even when therapy is provided, the psychiatrist's coordination with the psychologists, therapists, and counselors providing therapy, as well as with people providing assorted social services, is often weak. Is is needed, in the final analysis, because this pattern of ill-coordinated, marginal treatment causes many of the mentally ill to get disconnected from health care, thereby feeding a vast torrent of human misery that embraces—among others—roughly 200,000 mentally ill homeless people, 280,000 mentally ill prison inmates, and more than a million other Americans with severe mental disorders like schizophrenia, bipolar disorder, and major depression who receive no health care whatsoever.

Because therapy is on the neglected side of all this, new books effectively espousing therapy are welcome. Julian Leff's *The Unbalanced Mind* is such a book.

THE CRITICAL CAREGIVER

Leff is an English psychiatrist, a professor at the Institute of Psychiatry of London with a distinguished career in social and cultural psychiatry. As befits a leader in this field, he has an ax to grind: He wants everyone to comprehend the great impact that social and cultural factors can have on mental illnesses, and how investigation of those factors can lead to improved therapy. He devotes much of his book to this task, directing attention to his work and the