

# A NEUROLOGIST'S NOTEBOOK

# THE MIND'S EYE

*What the blind see.*

BY OLIVER SACKS

In his last letter, Goethe wrote, "The Ancients said that the animals are taught through their organs; let me add to this, so are men, but they have the advantage of teaching their organs in return." He wrote this in 1832, a time when phrenology was at its height, and the brain was seen as a mosaic of "little organs" subserving everything from language to drawing ability to shyness. Each individual, it was believed, was given a fixed measure of this faculty or that, according to the luck of his birth. Though we no longer pay attention, as the phrenologists did, to the "bumps" on the head (each of which, supposedly, indicated a brain-mind organ beneath), neurology and neuroscience have stayed close to the idea of brain fixity and localization—the notion, in particular, that the highest part of the brain, the cerebral cortex, is effectively programmed from birth: this part to vision and visual processing, that part to hearing, that to touch, and so on.

This would seem to allow individuals little power of choice, of self-determination, let alone of adaptation, in the event of a neurological or perceptual mishap.

But to what extent are we—our experiences, our reactions—shaped, predetermined, by our brains, and to what extent do we shape our own brains? Does the mind run the brain or the brain the mind—or, rather, to what extent does one run the other? To what extent are we the authors, the creators, of our own experiences? The effects of a profound perceptual deprivation such as blindness can cast an unexpected light on this. To become blind, especially later in life, presents one with a huge, potentially overwhelming challenge: to find a new way of living, of ordering one's world, when the old way has been destroyed.

A dozen years ago, I was sent an extraordinary book called "Touching the Rock An Experience

of Blindness." The author, John Hull, was a professor of religious education who had grown up in Australia and then moved to England. Hull had developed cataracts at the age of thirteen, and became completely blind in his left eye four years later. Vision in his right eye remained reasonable until he was thirty-five or so, and then started to deteriorate. There followed a decade of steadily failing vision, in which Hull needed stronger and stronger magnifying glasses, and had to write with thicker and thicker pens, until, in 1983, at the age of forty-eight, he became completely blind.

"Touching the Rock" is the journal he dictated in the three years that followed. It is full of piercing insights relating to Hull's life as a blind person, but most striking for me is Hull's description of how, in the years after his loss of sight, he experienced a gradual attenuation of visual imagery and memory, and finally a virtual extinction of them (except in dreams)—a state that he calls "deep blindness."

By this, Hull meant not only the loss of visual images and memories but a loss of the very idea of seeing, so that concepts like "here," "there," and "facing" seemed to lose meaning for him, and even the sense of objects having "appearances," visible characteristics, vanished. At this point, for example, he could no longer imagine how the numeral 3 looked, unless he traced it in the air with his hand. He could construct a "motor" image of a 3, but not a visual one.

Hull, though at first greatly distressed about the fading of visual memories and images—the fact that he could no longer conjure up the faces of his wife or children, or of familiar and loved landscapes and places—then came to accept it with remarkable equanimity; indeed, to regard it as a natural response to a nonvisual world. He seemed to regard this loss of visual imagery as a prerequisite for the full development, the height-

ening, of his other senses.

Two years after becoming completely blind, Hull had apparently become so nonvisual as to resemble someone who had been blind from birth. Hull's loss of visuality also reminded me of the sort of "cortical blindness" that can happen if the primary visual cortex is damaged, through a stroke or traumatic brain damage—although in Hull's case there was no direct damage to the visual cortex but, rather, a cutting off from any visual stimulation or input.

In a profoundly religious way, and in language sometimes reminiscent of that of St. John of the Cross, Hull enters into this state, surrenders himself, with a sort of acquiescence and joy. And such "deep" blindness he conceives as "an authentic and autonomous world, a place of its own. . . . Being a whole-body seer is to be in one of the concentrated human conditions."

Being a "whole-body seer," for Hull, means shifting his attention, his center of gravity, to the other senses, and he writes again and again of how these have assumed a new richness and power. Thus he speaks of how the sound of rain, never before accorded much attention, can now delineate a whole landscape for him, for its sound on the garden path is different from its sound as it drums on the lawn, or on the bushes in his garden, or on the fence dividing it from the road. "Rain," he writes, "has a way of bringing out the contours of everything; it throws a coloured blanket over previously invisible things; instead of an intermittent and thus fragmented world, the steadily falling rain creates continuity of acoustic experience . . . presents the fullness of an entire situation all at once . . . gives a sense of perspective and of the actual relationships of one part of the world to another."

With his new intensity of auditory experience (or attention), along with the sharpening of his other senses, Hull comes to feel a sense of intimacy with nature, an intensity of being-in-the-world, beyond anything he knew when he was sighted. Blindness now becomes for him "a dark, paradoxical gift." This is not just "compensation," he emphasizes, but a whole new order, a new mode of human being. With this he extricates himself from visual nostalgia, from the strain, or falsity, of trying to pass as "normal," and finds a new focus, a new freedom. His teaching at the university expands, becomes more fluent, his writing becomes stronger and deeper; he becomes intellectually and spiritually bolder, more confident. He feels he is on solid

ground at last.

What Hull described seemed to mean astounding example of how an individual deprived of one form of perception could totally reshape himself to anew center, a new identity.

It is said that those who see normally as infants but then become blind within the first two years of life retain no memories of seeing, have no visual imagery and no visual elements in their dreams (and, in this way, are comparable to those born blind). It is similar with those who lose hearing before the age of two: they have no sense of having "lost" the world of sound, nor any sense of "silence," as hearing people sometimes imagine. For those who lose sight so early, the very concepts of "sight" or "blindness" soon cease to have meaning, and there is no sense of losing the world of vision, only of living fully in a world constructed by the other senses.

But it seemed extraordinary to me that such an annihilation of visual memory as Hull describes could happen equally to an adult, with decades, an entire lifetime, of rich and richly categorized visual experience to call upon. And yet I could not doubt the authenticity of Hull's account, which he relates with the most scrupulous care and lucidity.

Important studies of adaptation in the brain were begun in the nineteen seventies by, among others, Helen Neville, a cognitive neuroscientist now working in Oregon. She showed that in prelingually deaf people (that is, those who had been born deaf or become deaf before the age of two or so) the auditory parts of the brain had not degenerated or atrophied. These had remained active and functional, but with an activity and a function that were new: they had been transformed, "reallocated," in Neville's term, for processing visual language. Comparable studies in those born blind, or early blinded, show that the visual areas of the cortex, similarly, may be reallocated in function, and used to process sound and touch.

With the reallocation of the visual cortex to touch and other senses, these can take on a hyperacuity that perhaps no sighted person can imagine. Bernard Morin, the blind mathematician who in the nineteen-sixties had shown how a sphere could be turned inside out, felt that his achievement required a special sort of spatial perception and imagination. And a similar sort of spatial giftedness has been central to the work of Geerat Vermeij, a blind biologist who has been

able to delineate many new species of mollusk, based on tiny variations in the shapes and contours of their shells.

Faced with such findings and reports, neurologists began to concede that there might be a certain flexibility or plasticity in the brain, at least in the early years of life. But when this critical period was over, it was assumed, the brain became inflexible, and no further changes of a radical type could occur. The experiences that Hull so carefully recounts give the lie to this. It is clear that his perceptions, his brain, did finally change, in a fundamental way. Indeed, Alvaro Pascual-Leone and his colleagues in Boston have recently shown that, even in adult sighted volunteers, as little as five days of being blindfolded produces marked shifts to nonvisual forms of behavior and cognition, and they have demonstrated the physiological changes in the brain that go along with this. And only last month, Italian researchers published a study showing that sighted volunteers kept in the dark for as little as ninety minutes may show a striking enhancement of tactile-spatial sensitivity.

The brain, clearly, is capable of changing even in adulthood, and I assumed that Hull's experience was typical of acquired blindness—the response, sooner or later, of everyone who becomes blind, even in adult life.

So when I came to publish an essay on Hull's book, in 1991, I was taken aback to receive a number of letters from blind people, letters that were often somewhat puzzled, and occasionally indignant, in tone. Many of my correspondents, it seemed, could not identify with Hull's experience, and said that they themselves, even decades after losing their sight, had never lost their visual images or memories. One correspondent, who had lost her sight at fifteen, wrote, "Even though I am totally blind . . . I consider myself a very visual person. I still 'see' objects in front of me. As I am typing now I can see my hands on the keyboard. . . . I don't feel comfortable in a new environment until I have a mental picture of its appearance. I need a mental map for my independent moving, too."

Had I been wrong, or at least onesided, in accepting Hull's experience as a typical response to blindness? Had I been guilty of emphasizing one mode of response too strongly, oblivious to the possibilities of radically different responses?

This feeling came to a head in 1996, when I received a letter from an Australian psychologist

named Zoltan Torey. Torey wrote to me not about blindness but about a book he had written on the brain-mind problem and the nature of consciousness. (The book was published by Oxford University Press as "The Crucible of Consciousness," in 1999.) In his letter Torey also spoke of how he had been blinded in an accident at the age of twenty-one, while working at a chemical factory, and how, although "advised to switch from a visual to an auditory mode of adjustment," he had moved in the opposite direction, and resolved to develop instead his "inner eye," his powers of visual imagery, to their greatest possible extent.

In this, it seemed, he had been extremely successful, developing a remarkable power of generating, holding, and manipulating images in his mind, so much so that he had been able to construct an imagined visual world that seemed almost as real and intense to him as the perceptual one he had lost—and, indeed, sometimes more real, more intense, a sort of controlled dream or hallucination. This imagery, moreover, enabled him to do things that might have seemed scarcely possible for a blind man. "I replaced the entire roof guttering of my multi-gabled home single-handed," he wrote, "and solely on the strength of the accurate and well-focused manipulation of my now totally pliable and responsive mental space." (Torey later expanded on this episode, mentioning the great alarm of his neighbors at seeing a blind man, alone, on the roof of his house—and, even more terrifying to them, at night, in pitch darkness.)

And it enabled him to think in ways that had not been available to him before, to envisage solutions, models, designs, to project himself to the inside of machines and other systems, and, finally, to grasp by visual thought and simulation (complemented by all the data of neuroscience) the complexities of that ultimate system, the human brain-mind.

When I wrote back to Torey, I suggested that he consider writing another book, a more personal one, exploring how his life had been affected by blindness, and how he had responded to this, in the most improbable and seemingly paradoxical of ways. "Out of Darkness" is the memoir he has now written, and in it Torey describes his early memories with great visual intensity and humor. Scenes are remembered or reconstructed in brief, poetic glimpses of his childhood and youth in Hungary before the Second World War: the sky-blue buses of Budapest,

the egg-yellow trams, the lighting of gas lamps, the funicular on the Buda side. He describes a carefree and privileged youth, roaming with his father in the wooded mountains above the Danube, playing games and pranks at school, growing up in a highly intellectual environment of writers, actors, professionals of every sort. Torey's father was the head of a large motion-picture studio and would often give his son scripts to read. "This," Torey writes, "gave me the opportunity to visualize stories, plots and characters, to work my imagination—a skill that was to become a lifeline and source of strength in the years ahead."

All of this came to a brutal end with the Nazi occupation, the siege of Buda, and then the Soviet occupation. Torey, now an adolescent, found himself passionately drawn to the big questions—the mystery of the universe, of life, and above all the mystery of consciousness, of the mind. In 1948, nineteen years old, and feeling that he needed to immerse himself in biology, engineering, neuroscience, and psychology, but knowing that there was no chance of study, of an intellectual life, in Soviet Hungary, Torey made his escape and eventually found his way to Australia, where, penniless and without connections, he did various manual jobs. In June of 1951, loosening the plug in a vat of acid at the chemical factory where he worked, he had the accident that bisected his life.

"The last thing I saw with complete clarity was a glint of light in the flood of acid that was to engulf my face and change my life. It was a nano-second of sparkle, framed by the black circle of the drumface, less than a foot away. This as the final scene, the slender thread that ties me to my visual past."

When it became clear that his corneas had been hopelessly damaged and that he would have to live his life as a blind man, he was advised to rebuild his representation of the world on the basis of hearing and touch and to "forget about sight and visualizing altogether. "But this was something that Torey could not or would not do. He had emphasized, in his first letter to me, the importance of a most critical choice at this juncture: "I immediately resolved to find out how far a partially sense-deprived brain could go to rebuild a life." Put this way, it sounds abstract, like an experiment. But in his book one senses the tremendous feelings underlying his resolution—the horror of darkness, "the empty darkness," as Torey often calls it, "the grey fog that

was engulfing me," and the passionate desire to hold on to light and sight, to maintain, if only in memory and imagination, a vivid and living visual world. The very tide of his book says all this, and the note of defiance is sounded from the start. Hull, who did not use his potential for imagery in a deliberate way, lost it in two or three years, and became unable to remember which way round a 3 went; Torey, on the other hand, soon became able to multiply four-figure numbers by each other, as on a blackboard, visualizing the whole operation in his mind, "painting" the suboperations in different colors.

Well aware that the imagination (or the brain), unrestrained by the usual perceptual input, may run away with itself in a wildly associative or self-serving way—as may happen in deliria, hallucinations, or dreams—Torey maintained a cautious and "scientific" attitude to his own visual imagery, taking pains to check the accuracy of his images by every means available. "I learned," he writes, "to hold the image in a tentative way, conferring credibility and status on it only when some information would tip the balance in its favor." Indeed, he soon gained enough confidence in the reliability of his visual imagery to stake his life upon it, as when he undertook roof repairs by himself. And this confidence extended to other, purely mental projects. He became able "to imagine, to visualize, for example, the inside of a differential gearbox in action as if from inside its casing. "I was able to watch the cogs bite, lock and revolve, distributing the spin as required. I began to play around with this internal view in connection with mechanical and technical problems, visualizing how subcomponents relate in the atom, or in the living cell." This power of imagery was crucial, Torey thought, in enabling him to arrive at a solution of the brain-mind problem by visualizing the brain "as a perpetual juggling act of interacting routines."

In a famous study of creativity, the French mathematician Jacques Hadamard asked many scientists and mathematicians, including Einstein, about their thought processes. Einstein replied, "The physical entities which seem to serve as elements in thought are . . . more or less clear images which can be 'voluntarily' reproduced and combined. [Some are] of visual and some of muscular type. Conventional words or other signs have to be sought for laboriously only in a secondary stage." Torey cites this, and adds, "Nor was Einstein unique in this respect.

Hadamard found that almost all scientists work this way, and this was also the way my project evolved."

Soon after receiving Torey's manuscript, I received the proofs of yet another memoir by a blind person: Sabriye Tenberken's "My Path Leads to Tibet." While Hull and Torey are thinkers, preoccupied in their different ways by inwardness, states of brain and mind, Tenberken is a doer; she has travelled, often alone, all over Tibet, where for centuries blind people have been treated as less than human and denied education, work, respect, or a role in the community. Virtually single-handed, Tenberken has transformed their situation over the past half-dozen years, devising a form of Tibetan Braille, establishing schools for the blind, and integrating the graduates of these schools into their communities.

Tenberken herself had impaired vision almost from birth but was able to make out faces and landscapes until she was twelve. As a child in Germany, she had a particular predilection for colors, and loved painting, and when she was no longer able to decipher shapes and forms she could still use colors to identify objects. Tenberken has, indeed, an intense synesthesia. "As far back as I can remember," she writes, "numbers and words have instantly triggered colors in me. . . . The number 4, for example, [is] gold. Five is light green. Nine is vermillion. . . . Days of the week as well as months have their colors, too. I have them arranged in geometrical formations, in circular sectors, a little like a pie. When I need to recall on which day a particular event happened, the first thing that pops up on my inner screen is the day's color, then its position in the pie." Her synesthesia has persisted and been intensified, it seems, by her blindness.

Though she has been totally blind for twenty years now, Tenberken continues to use all her other senses, along with verbal descriptions, visual memories, and a strong pictorial and synesthetic sensibility, to construct "pictures" of landscapes and rooms, of environments and scenes—pictures so lively and detailed as to astonish her listeners. These images may sometimes be wildly or comically different from reality, as she relates in one incident when she and a companion drove to Nam Co, the great salt lake in Tibet. Turning eagerly toward the lake, Tenberken saw, in her mind's eye, "a beach of crystallized salt shimmering like snow under an

evening sun, at the edge of a vast body of turquoise water. . . . And down below, on the deep green mountain flanks, a few nomads were watching their yaks grazing." But it then turns out that she has been facing in the wrong direction, not "looking" at the lake at all, and that she has been "staring" at rocks and a gray landscape. These disparities don't faze her in the least—she is happy to have so vivid a visual imagination. Hers is essentially an artistic imagination, which can be impressionistic, romantic, not veridical at all, where Torey's imagination is that of an engineer, and has to be factual, accurate down to the last detail.

I had now read three memoirs, strikingly different in their depictions of the visual experience of blinded people: Hull with his acquiescent descent into imageless "deep blindness," Torey with his "compulsive visualization" and meticulous construction of an internal visual world, and Tenberken with her impulsive, almost novelistic, visual freedom, along with her remarkable and specific gift of synesthesia. Was there any such thing, I now wondered, as a "typical" blind experience?

I recently met two other people blinded in adult life who shared their experiences with me.

Dennis Shulman, a clinical psychologist and psychoanalyst who lectures on Biblical topics, is an affable, stocky, bearded man in his fifties who gradually lost his sight in his teens, becoming completely blind by the time he entered college. He immediately confirmed that his experience was unlike Hull's: "I still live in a visual world after thirty-five years of blindness. I have very vivid visual memories and images. My wife, whom I have never seen—I think of her visually. My kids, too. I see myself visually—but it is as I last saw myself, when I was thirteen, though I try hard to update the image. I often give public lectures, and my notes are in Braille; but when I go over them in my mind, I see the Braille notes visually—they are visual images, not tactile."

Arlene Gordon, a charming woman in her seventies, a former social worker, said that things were very similar for her: "If I move my arms back and forth in front of my eyes, I see them, even though I have been blind for more than thirty years." It seemed that moving her arms was immediately translated for her into a visual image. Listening to talking books, she added, made her eyes tire if she listened too long; she seemed to herself to be reading at such times, the

sound of the spoken words being transformed to lines of print on a vividly visualized book in front of her. This involved a sort of cognitive exertion (similar perhaps to translating one language into another), and sooner or later this would give her an eye ache.

I was reminded of Amy, a colleague who had been deafened by scarlet fever at the age of nine but was so adept a lipreader that I often forgot she was deaf. Once, when I absent-mindedly turned away from her as I was speaking, she said sharply, "I can no longer hear you."

"You mean you can no longer see me," I said.

"You may call it seeing," she answered, "but I experience it as hearing."

Amy, though totally deaf, still constructed the sound of speech in her mind. Both Dennis and Arlene, similarly, spoke not only of a heightening of visual imagery and imagination since losing their eyesight but also of what seemed to be a much readier transference of information from verbal description—or from their own sense of touch, movement, hearing, or smell—into a visual form. On the whole, their experiences seemed quite similar to Torey's, even though they had not systematically exercised their powers of visual imagery in the way that he had, or consciously tried to make an entire virtual world of sight.

There is increasing evidence from neuroscience for the extraordinarily rich interconnectedness and interactions of the sensory areas of the brain, and the difficulty, therefore, of saying that anything is purely visual or purely auditory, or purely anything. This is evident in the very titles of some recent papers—Pascual-Leone and his colleagues at Harvard now write of "The Multimodal Organization of the Brain," and Shinsuke Shimojo and his group at Caltech, who are also exploring intersensory perceptual phenomena, recently published a paper called "What You See Is What You Hear," and stress that sensory modalities can never be considered in isolation. The world of the blind, of the blinded, it seems, can be especially rich in such in-between states—the intersensory, the multimodal—states for which we have no common language.

Arlene, like Dennis, still identifies herself in many ways as a visual person. "I have a very strong sense of color," she said. "I pick out my own clothes. I think, Oh, that will go with this or that, once I have been told the colors." Indeed, she was dressed very smartly, and took obvious

pride in her appearance.

"I love travelling," she continued. "I 'saw' Venice when I was there." She explained how her travelling companions would describe places, and she would then construct a visual image from these details, her reading, and her own visual memories. "Sighted people enjoy travelling with me," she said. "I ask them questions, then they look, and see things they wouldn't otherwise. Too often people with sight don't see anything! It's a reciprocal process—we enrich each other's worlds."

If we are sighted, we build our own images, using our eyes, our visual information, so instantly and seamlessly that it seems to us we are experiencing "reality" itself. One may need to see people who are color-blind, or motion-blind, who have lost certain visual capacities from cerebral injury, to realize the enormous act of analysis and synthesis, the dozens of subsystems involved in the subjectively simple act of seeing. But can a visual image be built using nonvisual information—information conveyed by the other senses, by memory, or by verbal description?

There have, of course, been many blind poets and writers, from Homer on. Most of these were born with normal vision and lost their sight in boyhood or adulthood (like Milton). I loved reading Prescott's "Conquest of Mexico" and "Conquest of Peru" as a boy, and feel that I first saw these lands through his intensely visual, almost hallucinogenic descriptions, and I was amazed to discover, years later, that Prescott not only had never visited Mexico or Peru but had been virtually blind since the age of eighteen. Did he, like Torey, compensate for his blindness by developing such powers of visual imagery that he could experience a "virtual reality" of sight? Or were his brilliant visual descriptions in a sense simulated, made possible by the evocative and pictorial powers of language? To what extent can language, a picturing in words, provide a substitute for actual seeing, and for the visual, pictorial imagination? Blind children, it has often been noted, tend to be precocious verbally, and may develop such fluency in the verbal description of faces and places as to leave others (and perhaps themselves) uncertain as to whether they are actually blind. Helen Keller's writing, to give a famous example, startles one with its brilliantly visual quality.

When I asked Dennis and Arlene whether they had read John Hull's book, Arlene said, "I was

stunned when I read it. His experiences are so unlike mine." Perhaps, she added, Hull had "renounced" his inner vision. Dennis agreed, but said, "We are only two individuals. You are going to have to talk to dozens of people. . . . But in the meanwhile you should read Jacques Lusseyran's memoir."

Lusseyran was a French Resistance fighter whose memoir, "And There Was Light," deals mostly with his experiences fighting the Nazis and later in Buchenwald but includes many beautiful descriptions of his early adaptations to blindness. He was blinded in an accident when he was not quite eight years old, an age that he came to feel was "ideal" for such an eventuality, for, while he already had a rich visual experience to call on, "the habits of a boy of eight are not yet formed, either in body or in mind. His body is infinitely supple." And suppleness, agility, indeed came to characterize his response to blindness.

Many of his initial responses were of loss, both of imagery and of interests:

A very short time after I went blind I forgot the faces of my mother and father and the faces of most of the people I loved. . . . I stopped caring whether people were dark or fair, with blue eyes or green. I felt that sighted people spent too much time observing these empty things. . . . I no longer even thought about them. People no longer seemed to possess them. Sometimes in my mind men and women appeared without heads or fingers.

This is similar to Hull, who writes, "Increasingly, I am no longer even trying to imagine what people look like. . . . I am finding it more and more difficult to realize that people look like anything, to put any meaning into the idea that they have an appearance."

But then, while relinquishing the actual visual world and many of its values and categories, Lusseyran starts to construct and to use an imaginary visual world more like Torey's.

This started as a sensation of light, a formless, flooding, streaming radiance. Neurological terms are bound to sound reductive in this almost mystical context. Yet one might venture to interpret this as a "release" phenomenon, a spontaneous, almost eruptive arousal of the visual cortex, now deprived of its normal visual input. This is a phenomenon analogous, perhaps, to tinnitus or phantom limbs, though endowed here, by a de-

vout and precociously imaginative little boy, with some element of the supernal. But then, it becomes clear, he does find himself in possession of great powers of visual imagery, and not just a formless luminosity.

The visual cortex, the inner eye, having now been activated, Lusseyran's mind constructed a "screen" upon which whatever he thought or desired was projected and, if need be, manipulated, as on a computer screen. "This screen was not like a blackboard, rectangular or square, which so quickly reaches the edge of its frame," he writes. "My screen was always as big as I needed it to be. Because it was nowhere in space it was everywhere at the same time. . . . Names, figures and objects in general did not appear on my screen without shape, nor just in black and white, but in all the colors of the rainbow. Nothing entered my mind without being bathed in a certain amount of light. . . . In a few months my personal world had turned into a painter's studio."

Great powers of visualization were crucial to the young Lusseyran, even in something as non-visual (one would think) as learning Braille (he visualizes the Braille dots, as Dennis does), and in his brilliant successes at school. They were no less crucial in the real, outside world. He describes walks with his sighted friend Jean, and how, as they were climbing together up the side of a hill above the Seine Valley, he could say:

"Just look! This time we're on top. . . . You'll see the whole bend of the river, unless the sun gets in your eyes!" Jean was startled, opened his eyes wide and cried: "You're right." This little scene was often repeated between us, in a thousand forms.

"Every time someone mentioned an event," Lusseyran relates, "the event immediately projected itself in its place on the screen, which was a kind of inner canvas. . . . Comparing my world with his, [Jean] found that his held fewer pictures and not nearly as many colors. This made him almost angry. 'When it comes to that,' he used to say, 'which one of us two is blind?'"

It was his supernormal powers of visualization and visual manipulation—visualizing people's position and movement, the topography of any space, visualizing strategies for defense and attack—coupled with his charismatic personality (and seemingly infallible "nose" or "ear" for detecting falsehood, possible traitors), which later

made Lusseyran an icon in the French Resistance.

Dennis, earlier, had spoken of how the heightening of his other senses had increased his sensitivity to moods in other people, and to the most delicate nuances in their speech and self-presentation. He could now recognize many of his patients by smell, he said, and he could often pick up states of tension or anxiety which they might not even be aware of. He felt that he had become far more sensitive to others' emotional states since losing his sight, for he was no longer taken in by visual appearances, which most people learn to camouflage. Voices and smells, by contrast, he felt, could reveal people's depths. He had come to think of most sighted people, he joked, as "visually dependent."

In a subsequent essay, Lusseyran inveighs against the "despotism," the "idol worship" of sight, and sees the "task" of blindness as reminding us of our other, deeper modes of perception and their mutuality. "A blind person has a better sense of feeling, of taste, of touch," he writes, and speaks of these as "the gifts of the blind." And all of these, Lusseyran feels, blend into a single fundamental sense, a deep attentiveness, a slow, almost prehensile attention, a sensuous, intimate being at one with the world which sight, with its quick, flicking, facile quality, continually distracts us from. This is very close to Hull's concept of "deep blindness" as infinitely more than mere compensation but a unique form of perception, a precious and special mode of being.

What happens when the visual cortex is no longer limited, or constrained, by any visual input? The simple answer is that, isolated from the outside, the visual cortex becomes hypersensitive to internal stimuli of all sorts: its own autonomous activity; signals from other brain areas—auditory, tactile, and verbal areas; and the thoughts and emotions of the blinded individual. Sometimes, as sight deteriorates, hallucinations occur—of geometrical patterns, or occasionally of silent, moving figures or scenes that appear and disappear spontaneously, without any relation to the contents of consciousness, or intention, or context.

Something perhaps akin to this is described by Hull as occurring almost convulsively as he was losing the last of his sight. "About a year after I was registered blind," he writes, "I began to have such strong images of what people's faces

looked like that they were almost like hallucinations."

These imperious images were so engrossing as to preempt consciousness: "Sometimes," Hull adds, "I would become so absorbed in gazing upon these images, which seemed to come and go without any intention on my part, that I would entirely lose the thread of what was being said to me. I would come back with a shock . . . and I would feel as if I had dropped off to sleep for a few minutes in front of the wireless." Though related to the context of speaking with people, these visions came and went in their own way, without any reference to his intentions, conjured up not by him but by his brain.

The fact that Hull is the only one of the four authors to describe this sort of release phenomenon is perhaps an indication that his visual cortex was starting to escape from his control. One has to wonder whether this signalled its impending demise, at least as an organ of useful visual imagery and memory. Why this should have occurred with him, and how common such a course is, is something one can only speculate on.

Torey, unlike Hull, clearly played a very active role in building up his visual imagery, took control of it the moment the bandages were taken off, and never apparently experienced, or allowed, the sort of involuntary imagery Hull describes. Perhaps this was because he was already very at home with visual imagery, and used to manipulating it in his own way. We know that Torey was very visually inclined before his accident, and skilled from boyhood in creating visual narratives based on the film scripts his father gave him. We have no such information about Hull, for his journal entries start only when he has become blind.

For Lusseyran and Tenberken, there is an added physiological factor: both were attracted to painting, in love with colors, and strongly synesthetic—prone to visualizing numbers, letters, words, music, etc., as shapes and colors—before becoming blind. They already had an overconnectedness, a "cross talk" between the visual cortex and other parts of the brain primarily concerned with language, sound, and music. Given such a neurological situation (synesthesia is congenital, often familial), the persistence of visual imagery and synesthesia, or its heightening, might be almost inevitable in the event of blindness.

Torey required months of intense cognitive discipline dedicated to improving his visual im-



agery, making it more tenacious, more stable, more malleable, whereas Lusseyran seemed to do this almost effortlessly from the start. Perhaps this was aided by the fact that Lusseyran was not yet eight when blinded (while Torey was twenty-one), and his brain was, accordingly, more plastic, more able to adapt to a new and drastic contingency.

But adaptability does not end with youth. It is clear that Arlene, becoming blind in her forties, was able to adapt in quite radical ways, too, developing not exactly synesthesia but something more flexible and useful: the ability to "see" her hands moving before her, to "see" the words of books read to her, to construct detailed visual images from verbal descriptions. Did she adapt, or did her brain do so? One has a sense that Torey's adaptation was largely shaped by conscious motive, will, and purpose; that Lusseyran's was shaped by overwhelming physiological disposition; and that Arlene's lies somewhere in between. Hull's, meanwhile, remains enigmatic.

There has been much recent work on the neural bases of visual imagery—this can be investigated by brain imaging of various types (PET scanning, functional MRIs, etc.)—and it is now generally accepted that visual imagery activates the cortex in a similar way, and with almost the same intensity, as visual perception itself. And yet studies on the effects of blindness on the human cortex have shown that functional changes may start to occur in a few days, and can become profound as the days stretch into months or years.

Torey, who is well aware of all this research, attributes Hull's loss of visual imagery and memory to the fact that he did not struggle to maintain it, to heighten and systematize and use it, as Torey himself did. (Indeed, Torey expresses horror at what he regards as Hull's passivity, at his letting himself slide into deep blindness.) Perhaps Torey was able to stave off an otherwise inevitable loss of neuronal function in the visual cortex; but perhaps, again, such neural degeneration is quite variable, irrespective of whether or not there is conscious visualization. And, of course, Hull had been losing vision gradually for many years, whereas for Torey blindness was instantaneous and total. It would be of great interest to know the results of brain imaging in the two men, and indeed to look at a large number of people with acquired blindness, to see what correlations, what predictions could be made.

But what if their differences reflect an underlying predisposition independent of blindness? What of visual imagery in the sighted?

I first became conscious that there could be huge variations in visual imagery and visual memory when I was fourteen or so. My mother was a surgeon and comparative anatomist, and I had brought her a lizard's skeleton from school. She gazed at this intently for a minute, turning it round in her hands, then put it down and without looking at it again did a number of drawings of it, rotating it mentally by thirty degrees each time, so that she produced a series, the last drawing exactly the same as the first. I could not imagine how she had done this, and when she said that she could "see" the skeleton in her mind just as clearly and vividly as if she were looking at it, and that she simply rotated the image through a twelfth of a circle each time, I felt bewildered, and very stupid. I could hardly see anything with my mind's eye—at most, faint, evanescent images over which I had no control.

I did have vivid images as I was falling asleep, and in dreams, and once when I had a high fever—but otherwise I saw nothing, or almost nothing, when I tried to visualize, and had great difficulty picturing anybody or anything. Coincidentally or not, I could not draw for toffee.

My mother had hoped I would follow in her footsteps and become a surgeon, but when she realized how lacking in visual powers I was (and how clumsy, lacking in mechanical skill, too) she resigned herself to the idea that I would have to specialize in something else.

I was, however, to get a vivid idea of what mental imagery could be like when, during the nineteen-sixties, I had a period of experimenting with large doses of amphetamines. These can produce striking perceptual changes, including dramatic enhancements of visual imagery and memory (as well as heightenings of the other senses, as I describe in "The Dog Beneath the Skin," a story in "The Man Who Mistook His Wife for a Hat"). For a period of two weeks or so, I found that I could do the most accurate anatomical drawings. I had only to look at a picture or an anatomical specimen, and its image would remain both vivid and stable, and I could easily hold it in my mind for hours. I could mentally project the image onto the paper before me—it was as clear and distinct as if projected by a camera lucida—and trace its outlines with a pencil. My drawings were not elegant, but they

were, everyone agreed, very detailed and accurate, and could bear comparison with some of the drawings in our neuroanatomy textbook. This heightening of imagery attached to everything—I had only to think of a face, a place, a picture, a paragraph in a book to see it vividly in my mind. But when the amphetamine-induced state faded, after a couple of weeks, I could no longer visualize, no longer project images, no longer draw—nor have I been able to do so in the decades since.

A few months ago, at a medical conference in Boston, I spoke of Torey's and Hull's experiences of blindness, and of how "enabled" Torey seemed to be by the powers of visualization he had developed, and how "disabled" Hull was—in some ways, at least—by the loss of his powers of visual imagery and memory. After my talk, a man in the audience came up to me and asked how well, in my estimation, sighted people could function if they had no visual imagery. He went on to say that he had no visual imagery whatever, at least none that he could deliberately evoke, and that no one in his family had any, either. Indeed, he had assumed this was the case with everyone, until he came to participate in some psychological tests at Harvard and realized that he apparently lacked a mental power that all the other students, in varying degrees, had.

"And what do you do?" I asked him, wondering what this poor man could do.

"I am a surgeon," he replied. "A vascular surgeon. An anatomist, too. And I design solar panels."

But how, I asked him, did he recognize what he was seeing?

"It's not a problem," he answered. "I guess there must be representations or models in the brain that get matched up with what I am seeing and doing. But they are not conscious. I cannot evoke them."

This seemed to be at odds with my mother's experience—she, clearly, did have extremely vivid and readily manipulable visual imagery, though (it now seemed) this may have been a bonus, a luxury, and not a prerequisite for her career as a surgeon.

Is this also the case with Torey? Is his greatly developed visual imagery, though dearly a source of much pleasure, not as indispensable as he takes it to be? Might he, in fact, have done everything he did, from carpentry to roof repair to making a model of the mind, without any con-

scious imagery at all? He himself raises this question.

The role of mental imagery in thinking was explored by Francis Galton, Darwin's irrepressible cousin, who wrote on subjects as various as fingerprints, eugenics, dog whistles, criminality, twins, visionaries, psychometric measures, and hereditary genius. His inquiry into visual imagery took the form of a questionnaire, with such questions as "Can you recall with distinctness the features of all near relations and many other persons? Can you at will cause your mental image . . . to sit, stand, or turn slowly around? Can you . . . see it with enough distinctness to enable you to sketch it leisurely (supposing yourself able to draw)?" The vascular surgeon would have been hopeless on such tests—indeed, it was questions such as these which had floored him when he was a student at Harvard. And yet, finally, how much had it mattered?

As to the significance of such imagery, Galton is ambiguous and guarded. He suggests, in one breath, that "scientific men, as a class, have feeble powers of visual representation" and, in another, that "a vivid visualizing faculty is of much importance in connection with the higher processes of generalized thoughts." He feels that "it is undoubtedly the fact that mechanics, engineers and architects usually possess the faculty of seeing mental images with remarkable clearness and precision," but goes on to say, "I am, however, bound to say, that the missing faculty seems to be replaced so serviceably by other modes of conception . . . that men who declare themselves entirely deficient in the power of seeing mental pictures can nevertheless give lifelike descriptions of what they have seen, and can otherwise express themselves as if they were gifted with a vivid visual imagination. They can also become painters of the rank of Royal Academicians." I have a cousin, a professional architect, who maintains that he cannot visualize anything whatever. "How do you think?" I once asked him. He shook his head and said, "I don't know." Do any of us, finally, know how we think?

When I talk to people, blind or sighted, or when I try to think of my own internal representations, I find myself uncertain whether words, symbols, and images of various types are the primary tools of thought or whether there are forms of thought antecedent to all of these, forms of thought essentially amodal. Psychologists

have sometimes spoken of "interlingua" or "mentalese," which they conceive to be the brains own language, and Lev Vygotsky, the great Russian psychologist, used to speak of "thinking in pure meanings." I cannot decide whether this is nonsense or profound truth—it is this sort of reef I end up on when I think about thinking.

Galton's seemingly contradictory statements about imagery—is it antithetical to abstract thinking, or integral to it?—may stem from his failure to distinguish between fundamentally different levels of imagery. Simple visual imagery such as he describes may suffice for the design of a screw, an engine, or a surgical operation, and it may be relatively easy to model these essentially reproductive forms of imagery or to simulate them by constructing video games or virtual realities of various sorts. Such powers may be invaluable, but there is something passive and mechanical and impersonal about them, which makes them utterly different from the higher and more personal powers of the imagination, where there is a continual struggle for concepts and form and meaning, a calling upon all the powers of the self. Imagination dissolves

and transforms, unifies and creates, while drawing upon the "lower" powers of memory and association. It is by such imagination, such "vision," that we create or construct our individual worlds.

At this level, one can no longer say of one's mental landscapes what is visual, what is auditory, what is image, what is language, what is intellectual, what is emotional—they are all fused together and imbued with our own individual perspectives and values. Such a unified vision shines out from Hull's memoir no less than from Torey's, despite the fact that one has become "non-visual" and the other "hyper-visual." What seems at first to be so decisive a difference between the two men is not, finally, a radical one, so far as personal development and sensibility go. Even though the paths they have followed might seem irreconcilable, both men have "used" blindness (if one can employ such a term for processes which are deeply mysterious, and far below, or above, the level of consciousness and voluntary control) to release their own creative capacities and emotional selves, and both have achieved a rich and full realization of their own individual worlds.