9

"A Number of Scenes in a Badly Cut Film": Observation in the Age of Strobe

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In 1958, an experimental subject reported the following observation:

> It was as if I was looking into very deep water and seeing deep green coral or a coiled octopus in dark green and white—very deep. This stuff streaming out from the centre is just surface thought, but this was a deep thought. It impressed me a good deal psychologically like Jung's image—it has intrinsic significance or archetypal quality. The marble is deep; the ferns are deeper, but this was miles underneath it all. . . . A very unusual effect. It started as centrifugal motion, then the nucleus began to have an odd look and a little irregular snowflake began to form at "marble" depth and this grew and filled the whole field with salmon-pink ground bearing repeated identical irregular snowflakes. These then all melted into the impression of a THING! These small snowflakes melted into one large snowflake which became alive; it turned into a living creature—slightly eerie—like Quattermass.

The subject of the experiment was one out of thirty-five advanced psychology students or staff of the Department of Psychology at Cambridge University who were asked to stare into a strong source of intermittently flashing strobe light and to describe and draw the "visual phenomena evoked by the stimulus."[1]

The experimenter John R. Smythies reported that seven subjects undergoing the same experiment described seeing something like "bacteria seen under a microscope or pond life or powder on a liquid surface." One person saw "an aerial photo of a city with streets and blocks of houses . . . it is like looking at London from a tremendous height and seeing the whole lot swirling about," while another reported seeing "lovely tropical fish in a blue tank." Many described wallpaper—mostly Victorian—although one stood out as having "a terrific modern design" of "black lines with knobs on the end forming triangles." Some subjects saw "a continual stream of images of fully formed scenes, usually of commonplace objects and events such as trains, cars, street scenes, harbours, animals, peoples, etc." To one of them, these appeared to be "like a number of scenes in a badly cut film."[2]

Visions of this sort could appear without complicated machines. Where did these visions come from? Why were they so "extraordinarily vivid"? Why did they sometimes appear "coupled with a strong emotive sense of 'eeriness'"? Why were they frequently described as "deep," and why did they often appear to be under "clear rippling water"? When were they first seen, and when were they first described? How did they change scientists' views of what it meant to observe?

In 1823, the physiologist Jan Purkinje produced what later came to be called flicker effects simply by waving his fingers in front of one eye while staring at the sun. He drew the patterns that he saw.[3] A decade later, another scientist, David Brewster, noted that these effects sometimes appeared when "walking besides a high iron railing." What he saw "exceed[ed] any optical phenomena which I have witnessed." The visions were "so dazzling" that "the eye is soon obliged to withdraw itself from its overpowering influence," and so he prudently turned the other way.[4]

In *The Living Brain* (1953), the controversial neurophysiologist William Grey Walter suggested that intermittent flashes could appear spontaneously in the rain forest as light passed through tree leaves. He hypothesized that they could have caused important evolutionary developments, being perhaps the force that knocked the apes out of the trees and onto the ground, providing the first essential impetus for the transition to *homo erectus.* Flickering light, Walter argued, was the reason why we emerged as "sadder but wiser apes."[5]

Scientists had long compared these visions to others. Sometimes they classed them with afterimages, the images that persist in the retina after an observer has looked at bright objects or strong sources of illumination. At other times they compared them to pressure images that appeared when poking one's eyes with a moderate and long-continued uniform pressure. Some scientists classed them as entopic phenomena, that is, visualizations of the internal structures of the eye due to corneal inhomogeneities and to the shadows of the blood vessels. Walter asked whether these effects were comparable to the "peculiar responses" induced by "rhythmic stimulation" such as tickling or by listening to the beats of a tom-tom drum, which "have been endowed with mysterious and even magical properties since the dawn of consciousness."[6]

Despite the fact that many scientists claimed that these visions were

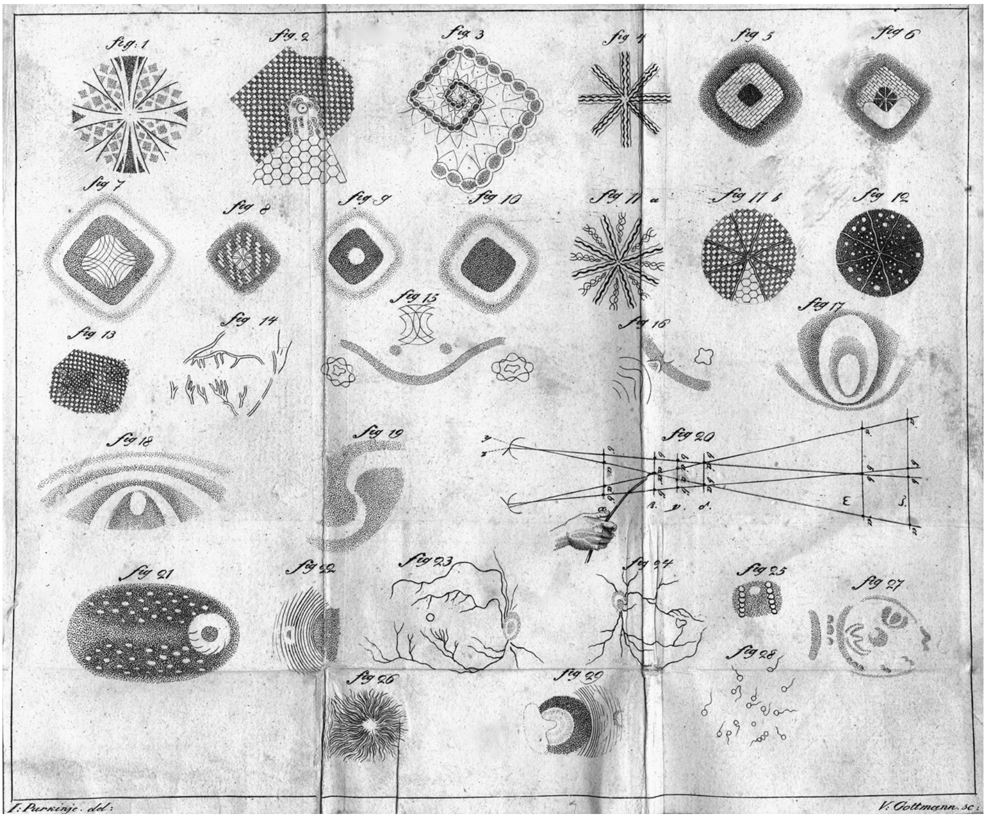

FIGURE 9.1. The first four figures starting from the top left-hand corner are "flicker" patterns. From Jan Evangelista Purkinje, *Beobachtungen und Versuche zur Physiologie der Sinne*, vol. 1, *Beiträge zur Kenntniss* [*sic*] *des Sehens in subjectiver hinsicht*, 2nd ed. (Prague: Kupfertafel, 1823).

ubiquitous and that they easily appeared in a number of everyday situations, they rarely described them and they rarely drew them.[7] In an important nineteenth-century book on optics, the German scientist Hermann von Helmholtz ventured only briefly into "this extremely perplexing region of the most manifold phenomena" and offered brief descriptions. He mentioned a "watered silk" effect that appeared when looking at intermittent sources of light, and a central rosette figure surrounded by dots increasing in size "which may possibly be compared to a rose with many petals."[8] Up to the middle of the twentieth century, only a handful of scientists besides Helmholtz had made "brief reference to hexagonal figures, grids, radial lines and mosaics."[9]

For a few years in the late 1950s a few scientists no longer looked away and instead developed new experimental systems to study and enhance these visions. They adopted high-power electronic stroboscopes, which became available after the war and which were used in scientific, military, and industrial settings to observe fast events. But they used them in an entirely different way. Instead of illuminating the phenomena under investigation, they stared directly into the strobe, sometimes with their eyes only a few centimeters from the source of light. For two years, from 1957 to 1958, they systematically recorded their visions. From these experiments, some concluded that common understandings of observation and reality needed to be changed. Few agreed. Instead of attempting to change the meaning of observation, most continued to simply look away.

To what can we attribute this disregard? And why did they so seldom describe their visions or represent them as drawings? Brewster maintained that observing these patterns required "courage" and that drawing them was nearly impossible because of their rapidly changing nature.[10] Although he hoped that "observers who have younger eyes than mine, and who have the courage to repeat the experiments . . . will be able to obtain an accurate representation of the pattern in question," his optimism was premature; almost nobody repeated these experiments for the following hundred years.[11]

Helmholtz claimed that the reason "most observers thus far have been able to establish only a comparatively few facts and to make a few new discoveries" had to do first with fatigue and safety: "[T]hese experiments soon prove to be so trying to the eyes that severe and dangerous ocular and nervous trouble may ensue." Precautions needed to be taken, and he advised "future observers . . . not to do too many in one day."[12] These experiments required not only "practice" but at times "self-sacrifice."[13] Prohibitions against certain types of self-experimentation in the sciences had been established since at least the eighteenth century. Extremes were legendary in the literature, such as the experiments of Johann Ritter, who stared at the sun for a record twenty minutes and for the next twenty-six days was unable to see black and white, instead seeing only reversed colors.[14] Although Helmholtz admired and at times praised these kinds of experiments, he nonetheless advised against them.

The second reason Helmholtz gave for ignoring these observations was that nobody knew how to explain them using existing theories. He asked scientists to focus instead on the "great mass of relevant phenomena . . . characterized by their energy, distinctness and constancy; even if we also find isolated and more transitory phenomena for which at present there is no perfectly satisfactory explanation."[15] In short: if unexplained, better ignored.

When electronic stroboscopic technologies started to appear in the first decades of the twentieth century, a few more scientists started to note these effects. The "birth of the stroboscope" is usually traced to 1832, when the Bel-

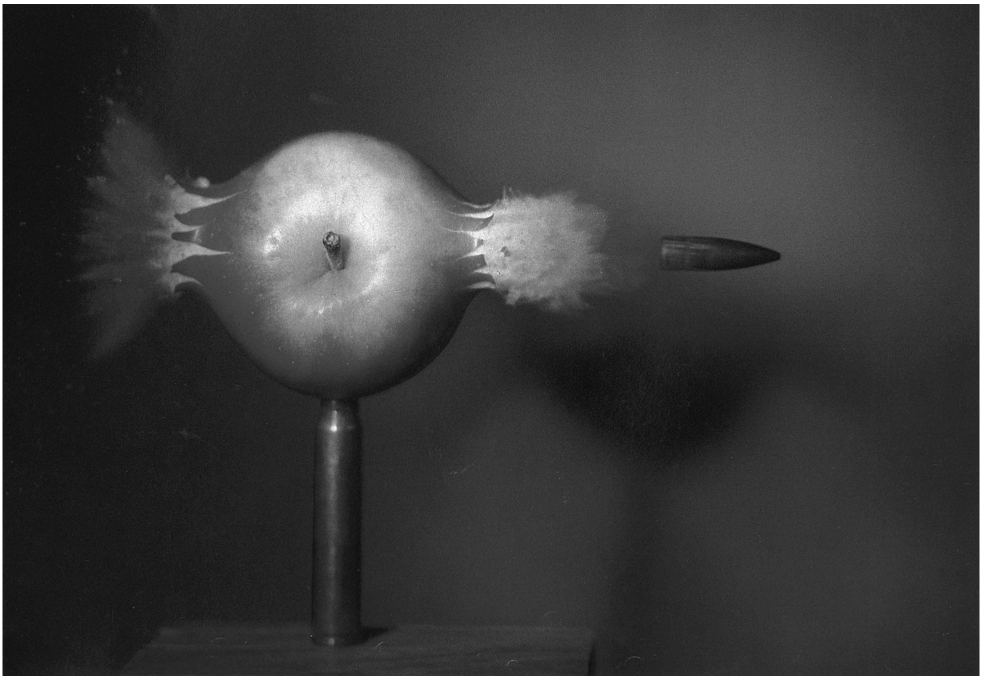

FIGURE 9.2. *Bullet through the Apple.* From Harold E. Edgerton and James R. Killian Jr., *Moments of Vision: The Stroboscopic Revolution in Photography* (Cambridge, Mass.: MIT Press, 1979), 107. Copyright Harold & Esther Edgerton Foundation, 2010, courtesy of Palm Press, Inc.

gian scientist Joseph Plateau used slotted disks turning at high speeds to provide a viewer with an illusion of movement. The mathematician and physicist Simon Stampfer built a similar apparatus and soon thereafter coined the term "stroboscope."

In the 1920s electronic stroboscopes for visualizing fast phenomena were already commercially available for industry. The development of this technology is usually credited to Harold Edgerton, professor of electrical engineering at MIT and author of well-known photographs of bullets in midflight and half-exploding balloons.

In 1942, the ability "to halt with a stroboscope and camera a bullet in flight" was hailed as one of the most important achievements of civilization, equal to the development of the telescope and microscope.[16] After World War Two, electronic strobes, such as those used and developed by Edgerton, were widely available; by 1954 there were thirty-nine different suppliers in the United States alone.[17]

A few scientists, however, used strobes in ways that strayed from conventional usage. These alternative experiments drew from a different tradition, of investigating the effects of light on humans. Such experiments contrasted sharply with those of Edgerton. Even in the rare cases when Edgerton aimed his machine at a person's eye to measure the time of a wink or to capture a delay in the iris's reaction to light, he ignored the effects of the strobe on the brain and the experience of the experimental subject.[18] He could not, however, prevent alternative uses of the technology. When he was not looking, some of his students stared directly into the machine. Edgerton never condoned these practices.[19]

Flicker before the Strobe

In the late nineteenth century, the English toymaker Charles Benham experimented with the effects that appeared when looking at black-and-white patterns twirling rapidly. Staring at a black-and-white disk, observers saw magical colors seemingly appearing from nowhere. Finding the pattern that best revealed these strange colors, he marketed a new product called the Benham top. Other spinning disks provided similar illusions. In 1928, the American psychologist Walter R. Miles picked up a five-inch paper disk for testing the speed of phonograph turntables and noticed that "if one fixates the center as steadily as he can, he observes phantom objects rippling and revolving in a most extraordinary manner." If he moved the disk in front of him he saw "grayish phantoms" and even a "reversible windmill illusion."[20] He perceived a breakdown between stasis and movement, life and inert objects: "The 5-in [Victor] disk considered as a *stationary visual stimulus* is the most *live* object of the kind that I have ever seen." He also noticed an eerie breakdown between listening and looking. Referring to the famous advertisement portraying a dog listening to a gramophone, he called attention to how the "world classic trade-mark 'His Master's Voice' shows our canine friend not only listening but looking." Yet, like others before him, he did not give further details about these visions, explaining that "the phenomena are so prominent and so bizarre that people as a rule object to looking at it for any but very brief intervals."[21]

In 1934, the Cambridge physiologist Lord E. D. Adrian and his student B. H. C. Matthews, who would later be known for their work measuring brain waves, investigated the effects of stroboscopic light on the brain. In an experiment considered foundational for electroencephalographic (EEG) research, they each stared into a 30-watt automobile headlight bulb covered with a spinning disk powered by a gramophone motor, and recorded the associated brain waves using an oscillograph. Their findings showed that, by varying the flash frequency, they could change the frequency of the recorded brain waves. Adrian and Matthews reported that "coloured patterns may be observed by looking at flickering lights" and that they had an "extremely unpleasant" feeling during the experiment. However, they did not describe these effects any further and instead tried hard to eliminate them. If their experiment was to work, the strange visions had to go: "If it is too bright the [visual] field may become filled with coloured patterns, the sensation is extremely unpleasant and no regular waves are obtained."[22]

In 1942, the noted scientist Heinrich Klüver became interested in these visions, noticing a connection between them and what he saw while experimenting with mescal "buttons" or peyote. For decades, he had been self-experimenting with the drug and extensively documenting his experience. Klüver noticed a similarity between mescal visions and those caused by flicker. "To produce flicker that is visible with open or closed eyes," he used an "alternating current of low intensity and frequency." Trying the experiment on others, he found that "when the current was on, . . . one subject, a student, suddenly saw the profiles of five faces looking to the right. These faces rapidly changed into other faces; they were seen through the 'muslin curtain' of flicker, as the subject expressed it."[23]

Many writers, poets, and artists had described drug-induced states (most famously Charles Baudelaire in *Le paradis artificiel* and Thomas de Quincy in *Dreams of an Opium Eater*), but only a few individuals had experimented with mescal.[24] Klüver was one of the few scientists to venture into this area. Although "the phenomena reported present such striking differences in appearance," he was able to find the "common elements" or "*form constants*" that "appear in almost all mescal visions."[25]

Interest in flicker continued sporadically in the following years. Two scientists, Carl R. Brown and J. W. Gebhard, analyzed these effects as part of a broader interest in "visual 'transient' phenomena."[26] They investigated the effects of intermittent light on the eye using a projector system and an episcotister that could display two to twenty flashes per second. The authors themselves were the two "observers," and their "observation of the visual field . . . disclosed a most remarkable and beautiful display of color and form perceptions."[27] The patterns and colors they observed were surprisingly limited: "all investigations indicate some regularity and constancy in the basic patterns observed."[28] For them, these were mainly a "radiating or 'windmill' pattern of yellow and blue of relative high brightness" and a "much dimmer . . . irregular mosaic of violet and yellow-green."[29] There was not a "limitless variety" in what they saw.[30]

Flicker Proved to Be a Key to Many Doors

William Grey Walter continued to experiment with the strobe in the tradition inaugurated by electroencephalographers. His research differed from previous investigations in that he used a high-power electronic stroboscope with a peak intensity comparable to that of 88,000 candles, manufactured by Scophony, Ltd., one of the earliest makers of television sets.[31] In contrast to previous experimental setups, such as Adrian and Matthews's automobile-lamp-with-gramophone system in which the length and frequency between flashes lasted much longer, his flash lasted only 10 μseconds.[32] Walter measured its effects on the brain by attaching electrodes to the subject's skull and amplifying the brain signals "ten million times or more."[33]

Walter and his coauthors found that the instrument could be used to invoke epileptic fits. It was common knowledge (at least since Roman times) that seizures could be provoked in epileptics by exposing them to flickering light (or simply by asking them to look at a potter's wheel). But Walter's results were particularly shocking because they occurred in patients who had never before suffered from epileptic attacks, and even if his subjects were under the influence of large doses of anticonvulsant drugs.[34] One alarming implication was that epileptic seizures could be induced in individuals who had "no personal record of any sort of fit."[35] While previously epilepsy had been understood as a condition affecting only a few individuals who carried the disease, Walter's research showed how it instead could be "latent" in all individuals to differing degrees.

Walter confirmed Adrian and Matthews's discovery that the flashes changed the electrical rhythmic patterns emitted by the brain. He speculated about ways in which they could be used to study (and perhaps adjust) the out-of-step cerebral rhythms associated with seizures, cerebral tumors, lesions, and other pathologies. Like Adrian and Matthews before him, Walter focused most of his investigations on what the EEG record revealed about the effects of strobe on the brain. But he also started to pay increasing attention to what the subject undergoing the experiment reported or saw. One result was clear: "As the flicker frequency is raised, the subject begins to see things which are not present in the stimulus." Walter noted that when he increased the strobe frequency, subjective sensations "of a mosaic or chessboard pattern, sometimes with a whirlpool effect superimposed," appeared. At other times these sensations were more akin to actual hallucinations, producing "impressions of bodily movement or of organized visual experiences of a bizarre and sometimes alarming nature."[36] He listed the "physiological and psychological effects" of staring into a strobe light in terms of their intensity. These varied from quite minor "visual sensations with characters not present in the stimulus" to "organized hallucinations of various types." Sometimes "the hallucinations described by some subjects were of a character so compelling that one subject was able to sketch them some weeks later."[37] The list of effects culminated with "clinical psychopathic states and epileptic seizures."[38]

Following Walter, neurophysiologists increasingly used electroencephalographic (EEG) techniques in combination with strobe stimulation. Yet they continued to focus mostly on the EEG record, ignoring the strobe visions. In 1949, during a routine investigation of a patient suffering from extreme anxiety, A. C. Mundy-Castle, a leading electroencephalographer working in South Africa, mentioned them briefly. One of his patients suffered from "vivid visual hallucinations" while he was exposed to the strobe light, informing the experimenter that his hallucinations consisted "primarily of things that happened during my life."[39] Intrigued by the "visual reconstructions from past experience" that were probably "released" from "some storage mechanism," Mundy-Castle ran more tests. In 1953 he experimented with an EEG machine and a strobe on approximately one thousand subjects who were asked to stare into a Scophony strobe at a distance of 9 centimeters. Like Walter, he noted "delusional or hallucinatory states directly evoked by flicker," which were "fortunately quiet rare."[40] He also described how many of his subjects reported visual effects "usually in the form of moving concentric rings with a faint cross or regular spoked figure radiating from the centre, together with myriads of small shadows or criss-crossed elements forming a shifting network of colours."[41] Like most researchers before him, Mundy-Castle was more interested in the EEG record than in the descriptions offered by his subjects. He stated strong reasons why he was unwilling to study these dream states: "The very nature of these responses, combined with their infrequency, renders controlled study impossible."[42] The notion of a "controlled experiment" as understood by Mundy-Castle and most other encephalographers of the time simply excluded these visions from scientific investigation.

Angiola Massuco Costa, a researcher who would become one of Italy's most important psychologists, took a slightly different perspective.[43] Experimenting on fifty subjects, she documented responses of a "fantastical-hallucinatory" nature, describing how subjects saw "horses, sails, tears, eyes, spiders," and she provided a few drawings. Some visions had "something similar to the artistic," and she speculated that they may have a "projective and symbolic value." They showed an "amazing liberty" comparable to that of artistic creativity. But how could a machine, the strobe, induce this freedom? Costa speculated that it must be a liberty of a different, restricted sort: "Obviously, I am not speaking of liberty (or spirituality) in a metaphysical sense."[44]

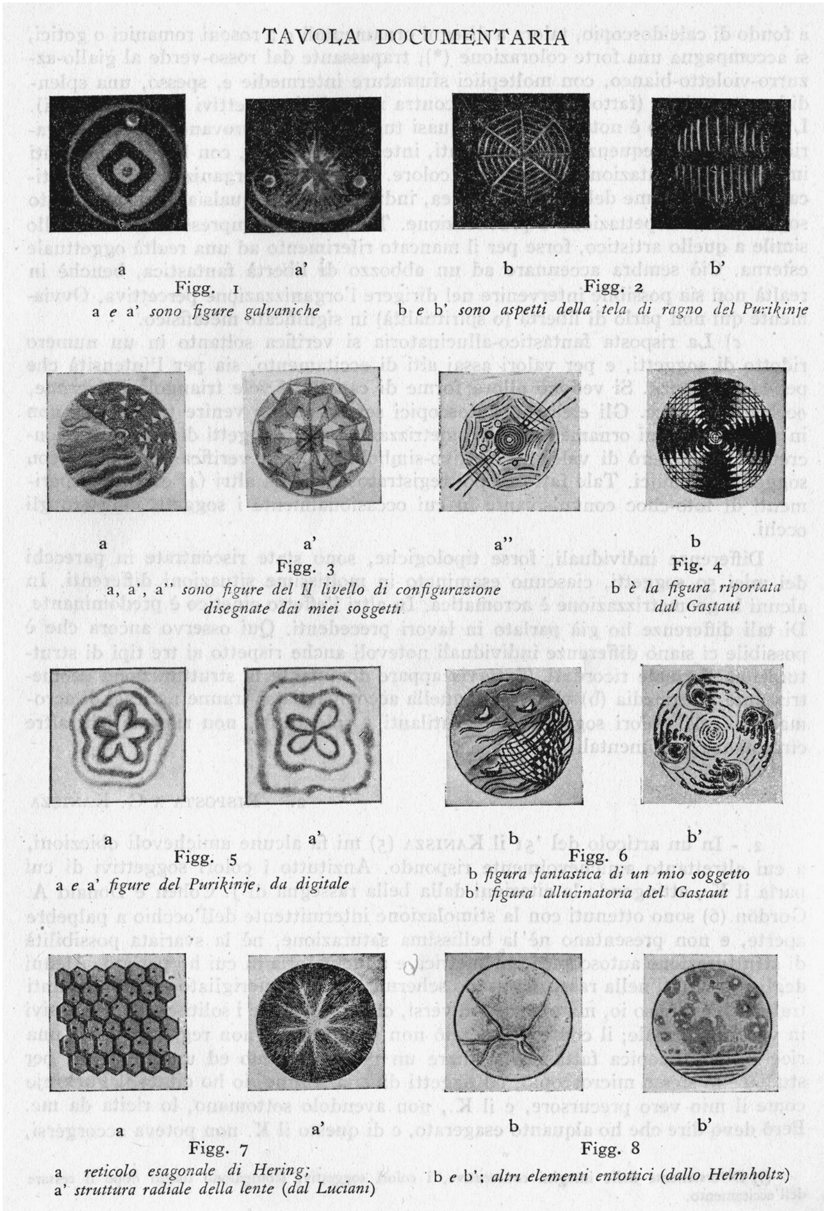

FIGURE 9.3. Stroboscopic patterns. From Angiola Massuco Costa, "L'effetto geometrico-cromatico nella stimolazione intermittente della retina ad occhi chiusi," *Archivio di psicologia neurologia e psichiatria* 14 (1953): 632–35.

By the mid-1950s, most scientists considered strobe visions to be hallucinations, similar to those evoked not only by spinning disks and mescal but by other conditions. Three Canadian researchers noticed that these visions could appear not only when the subject was overstimulated with a strobe light, but *understimulated* in a sensory-deprivation chamber. In dark chambers, subjects experienced hallucinations that were "quite similar to what have been described for mescal intoxication, and to what Grey Walter has . . . produced by exposure to flickering light."[45]

Richard H. Blum, a scientist from Stanford University, explored the connection of strobe visions and schizophrenia by studying them in combination with EEG results and Rorschach tests.[46] Blum came from working with the U.S. army during the Korean War in a classified experimental unit charged with finding ways to return traumatized soldiers to the front line; he would become famous for later experiments with LSD. In 1954 his main concern was to see how the strobe affected healthy, brain-damaged, and schizophrenic individuals. Enlisting "organics" (brain-damaged patients), "normals" and "schizophrenics," he asked them to relate what they had seen while exposed.[47] He drew a chart with rubrics of colors, patterns, and meaningful images. "Normals" mostly saw colors and patterns (with movement and depth) and "schizophrenics" saw most of the meaningful images of a hallucinatory character, such as fire, waves, crabs, umbrellas, subway tunnels, dandelions, and genitalia, among others. Blum speculated that these images arose from a "cortical free-wheeling" associated with schizophrenia. Although the reactions of the patients were varied and sometimes severe (one patient entered into a catatonic-like state that lasted three days), his results centered on counting the number of images, rather than on their particular content. According to Blum, differences in the type and number of visions seen under strobe illumination were a mark of each patient's differing "ability to respond adequately to the world outside."[48] Schizophrenic patients, whose visions were most numerous and most intense, clearly responded poorly to worldly demands.

A few years later, from 1957 to 1958, the British neuroscientist John R. Smythies reached different conclusions by embarking on a detailed project to study what an observer experienced when looking directly into a strobe. Smythies "borrowed and scrounged the simple equipment" that was now readily available from EEG labs.[49] Along with his students, staff, and subjects, he stared at the strobe and recorded observations while changing the stroboscope's frequency and varying other conditions. The more Smythies worked with the stroboscope, the more complicated the patterns became.[50] Smythies published both detailed verbal descriptions and drawings. Some patterns seemed like "pond life," "bacteria," "germs," or "plankton." Others

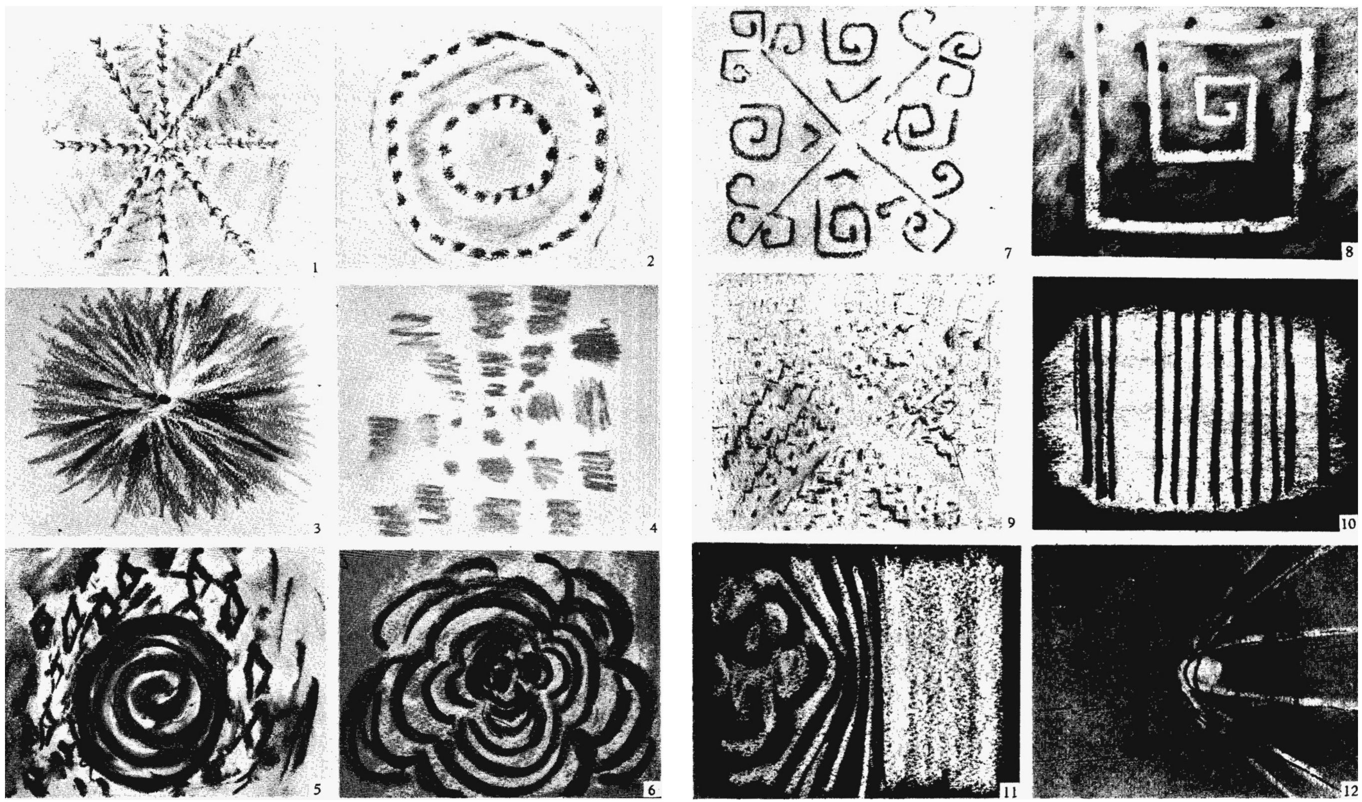

FIGURE 9.4A, 9.4B. Stroboscopic patterns. From John R. Smythies, “The Stroboscopic Patterns: 2,” *British Journal of Psychology* 50 (1959): 305–24, on 325–26.

were "described as 'streets and houses' swirling around." Nevertheless, certain patterns (such as alphabetical symbols) *never* appeared, enabling Smythies to classify the patterns into seven main types.

While most previous researchers were interested in the EEG record, for Smythies the "stroboscopic patterns" *themselves* proved valuable. He was well versed in electroencephalographic techniques, but in this project he left EEG records aside and instead asked his experimental subjects to describe and draw their visions in pastel colors. He included numerous images in his published articles.

Smythies lamented how current research on the living brain suffered from two related problems. Scientists could either study a large number of neurons using electroencephalography, or they could study a few of them using a microelectrode, but they had no means of studying the brain at an intermediate level. In contrast to both of these options, Smythies believed that stroboscopic patterns offered a third option, possibly correlating with personality tests or with electroencephalography. Drawing from the work of others before him, including his mentor Klüver, he tried to prove that the "form constants of hallucinations represents a worthwhile field of study."[51] The stroboscopic patterns revealed the "natural history" of the brain.[52]

Smithies concluded that the effects of staring into a strobe were similar to many other visual effects, such as those appearing when staring at rapidly spinning black-and-white disks, when poking one's eyes, in hallucinations occurring when entering into or coming out of sleep, in visualizations of entopic phenomena, and in the visual phenomena of insulin hypoglycemia. He also noted that when mescaline and the stroboscope where used together, hallucinogenic effects were visibly enhanced. And both were highly addictive.[53]

Smythies had come to work on the stroboscope after studying the effects of mescaline with the controversial neurophysiologist Humphrey Osmond.[54] With his coauthor, they developed the first biochemical theory of schizophrenia by arguing that a defect in the metabolization of adrenaline could produce in the body a substance similar to mescaline (called the M-substance) that then created the effects of the disease. In doing research with mescaline and lysergic acid (a precursor to LSD), Smythies and Osmond found similarities between their effects, concluding that the mental disorder might be a chemical disorder.

"A new and sinister development"

Smythies's research had wide repercussions. The famous psychologist Carl G. Jung became interested in his work, and he invited Smythies to his home, where they delighted in some harmless Freud bashing.[55] Smythies reported that Jung was intrigued by his assertion that mescaline visions have "nothing to do with the personality having them," and that he saw in his work with Osmond a corroboration of some of his theories on the collective unconscious.[56] Aldous Huxley read a paper by Smythies on mescaline and wrote to him saying that he very much wanted to try the drug. While Smythies could not personally deliver the drug to Huxley, he put him in contact with Osmond, who gave him his first dose while on a trip to California in the spring of 1953.[57] Aldous's experiences with mescaline were recounted in *The Doors of Perception* (1954), in which he mentioned the work of Smythies and Osmond on the connection between mescaline and schizophrenia. What intrigued Huxley was the same claim that interested Jung; that these experiences were not created by the person undergoing them, but rather that they came from elsewhere: "the work of a highly differentiated mental compartment, without any apparent connection, emotional or volitional, with the aims, interests, or feelings of the person concerned."[58] Huxley next experimented with both mescaline and strobe. In *Heaven and Hell* (1956), he cited "the words used by Dr. J. R. Smythies in a recent paper in the American Journal of Psychiatry" to talk about the nature of visionary experiences: "To sit, with eyes closed, in front of a stroboscopic lamp is a very curious and fascinating experience."[59]

According to Smythies, the direction of his research changed when his colleagues and he "unfortunately" recruited Harvard professor Timothy Leary in "a plan whereby mescaline would be made available only to a carefully selected group of academics—psychologists and philosophers." But Leary instead "opened a Pandora's box with the results that we have to live with today."[60] Smythies considered the drug revolution completely sinister and condemned any "recreational use of these hallucinogens."[61] Yet he could not prevent these developments from having a "bad effect" on his research and career. Most of his peers distanced themselves from his work and from their connection to Osmond. His fellowship at Cambridge soon ran out and was not renewed.[62] Nonetheless, with the help of some of his supporters, Smythies managed to complete his clinical training at Maudsley Hospital (October 1959) and then moved to Edinburgh for the next twelve years.

But EEG and strobe research continued, often in combination with new drugs. In 1959 at the Mental Research Institute in Palo Alto, the beat poet Allen Ginsberg was given LSD. His reaction to the drug was investigated with a stroboscope and an EEG machine.[63] The Veteran's Administration Hospital where Blum had set up his EEG strobe research a few years before became the site of government-sponsored research on the drug. Another subject, Ken Kesey, volunteered to try numerous drugs there, and later recounted his experiences in the famous novel *One Flew Over the Cuckoo's Nest* (1962). Experimenters could not keep their research completely in-house. Kesey started using LSD and the strobe in a different way, organizing the first acid drug parties illuminated by strobe light. By the end of the sixties the strobe had became essential paraphernalia of the drug revolution. It had traveled quickly from laboratories to hospitals, artist's studios, drug dens, and finally, to discos.

Ian Sommerville, William S. Burroughs's boyfriend, soon constructed a simple flicker machine, known as the "dreamachine" designed to democratize self-experimentation with flicker. Burroughs was so intrigued by flicker that he went to a lecture, talked to Walter, and publicized Walter's work. By the mid-sixties, Burroughs was advertising flicker as a way "to achieve the same results [as taking drugs] by nonchemical means."[64] He described using "flicker, music through head phones, cutups and foldins" to produce his novels, and he illustrated the technique in his films.[65]

Leary's interest in drugs was also accompanied by an interest in strobe research. In "How to Change Behavior" he wrote, "We have recently learned from W. Grey Walter and William Burroughs about photostimulation as a means of consciousness alteration. Concentrated attention to a stroboscope or flicker apparatus can produce visionary experiences."[66] The artist and poet Bryon Gysin wrote about the dreamachine in *The Process* (1969), earning for this the description by the famous punk rocker Genesis P-Orridge of being "a Dreamachine [in] human form." Sommerville, Burroughs, Leary, and Gysin all explained the effects of flicker by reference to Walter's work.

The uptake of strobe experimentation into visionary and extreme experiences often in combination with drugs by others outside of the scientific community, starting with Huxley and culminating with Leary, hurt Smythies's career. Smythies believed that some of the tasks of "Artists and Scientists" overlapped, explaining that "both have always been interested in exploring the transcendental worlds that expansion of normal consciousness leads to."[67] But few agreed.

Television

Strobe effects and visions were part and parcel of a burgeoning postmodern era. Artificial light became stroboscopic when Westinghouse's alternating current method won over Edison's direct current as a public utility. As a result, in America the glow of light started alternating sixty times per second and in Europe, fifty times. When the frequency of alternation became steadier in most households during the 1920s, everyday, artificially illuminated life started to beat with a regular, pulsating, stroboscopic rhythm. By the postwar era artificial light was only one component of a mass of other pulsating light sources. Russell J. Blattner, a leading pediatrician of the time, remarked how stroboscopic effects were all-pervasive by the early sixties: "Modern developments have increased the forms of flicker to which the seizure-prone person is subjected: fluorescent lighting, neon signs, motion pictures, and television." It was urgent, he argued, to study potential dangers lurking behind "the complexities of modern life and its attendant new forms of light reflection," particularly those of television. The doctor advised his patients to "to look away" from the set—especially if "shifting image or flicker is marked."[68]

These reactions to strobe or to an unadjusted television set led Smythies to build on a hypothesis of Walter, and to venture that visual perception functioned like television, claiming "that television uses the same mechanical principles as are used in the physiological mechanisms mediating visual perception."[69] Walter had concluded that the visual system in the brain did not work as a traditional cinematographic camera. Scientists could not produce hallucinatory effects with a strobe light and a cinematographic camera; yet these effects readily appeared if the strobe was used in combination with television. Differences between cinema and television became particularly evident when a film studio was illuminated by strobe. If the flashes coincided with moments between frames, nothing unusual appeared. If the flashes coincided with the frame frequency, the result was to have "no picture at all." In frequencies in between, a combination of these two effects appeared. But Walter noticed that "in no case will there be any 'hallucinatory' effects."

This result was completely different from the effects strobe produced on a television studio instead of on a film studio. If the strobe was directed at a scene being scanned by a television camera, strange pulses, dots, and dashes suddenly appeared across the screen, leading him to the conclusion that "the televisual system behaves very much like the neuro-visual one." The conclusion that the human visual system did not function according to traditional camera analogies was unavoidable "if we consider the [stroboscopic] effect upon the final picture of illuminating first a film studio and then a television one with a flickering light."[70]

The change in analogizing the visual mechanisms in the brain as televisual instead of cinematographic brought with it important changes in philosophy. Just as a television set does not "give us a *direct* view of the events televised," the televisual system in the brain also did not provide a direct view of reality. Smythies claimed that "current variations of naïve realism . . . in which it is believed that the physiological processes of perception mediate a *direct view* of the physical world, are wrong."[71] The "naïve realist" view that Smithies forcefully criticized informed common interpretations of what it meant to observe, including observations obtained with the stroboscope. When the stroboscope was used to illuminate fast phenomena, as Edgerton used it to produce his well-known photographs of bullets in midflight, viewers mostly explained what they saw in direct, realist terms. Edgerton's images were commonly described as "literal transcriptions" of nature, "a unique and literal transcript of that time world beyond the threshold of our eyes," furnishing "scientific records" written in a "universal language for all to appreciate."[72]

Smythies did not believe that observations were ever that simple. In subsequent publications he extended Walter's insight even further. He developed a system for finding out details about the inside of a television set *without opening it up*. The type of patterns on the television screen that appeared when a studio was illuminated by strobe depended on the type of raster mechanism inside the television. Analogously, Smythies speculated that the patterns that a person saw when staring into a strobosocope could "give us information as to details of operation of the mechanisms responsible for their production."[73] If scientists treated the brain "essentially as a 'black box'" where "the input is a temporally intermittent and spatially uniform light stimulus of the retina" and the "output is a report by the organism of the perception of geometrical patterns," a careful study of the patterns could shed light on the cerebral black box.

Walter's work, especially that which was aimed at a general readership, asked how modern bodies fit into a new postwar mass media system. The scientist lamented how modern life was "becoming more and more a one-way communication, from top and center down and out to the inert receivers."[74] Its characteristic was one of the "gaze" and the main instrumental culprit was television: "A passive solitary child gazing at the screen of a television receiver amuses only itself—the need to gaze does not promote or evoke habits of creativeness or generosity."[75] One-way mass media was "degenerating" our technologically expanded bodies into "something more like a spinal cord, able to receive instructions and implement reflex coordination" than a brain.

Television was dangerous, and so was cinema. Some dangers were immediate. Walter wrote of a case of a man who "found that when he went to the cinema he would suddenly feel an irresistible impulse to strangle the person next to him."[76] An investigator on epilepsy described two patients who "had difficulty on entering or leaving the cinema," and many others who passed out when "kneeling close to the [television] screen" or adjusting the set at close range.[77] But other dangers lurked in the future: "For Alice in Movieland the future looks drab; Tom Sawyer will have few adventures at the television set."[78] The life of the television spectator could never match a life of action.

"Observing the visionary world"

Strobe research did not fit with the widely held belief, as explained by a well-known psychologist who worked on intermittent light stimulation: "Our knowledge of the world is supposed to be built up only from the materials given by our sensory receptors."[79] Scientists had long known of exceptions to this general view, particularly those classed as illusions or hallucinations. The Swiss psychiatrist Eugen Bleuler defined hallucinations as "perceptions without corresponding stimuli from without."[80] The *Psychiatric Dictionary* (1940) defined them as the "apparent perception of an external object when no such object is present."[81] Under these definitions, strobe visions could be considered as one among many other types of hallucinations.

Interest in hallucinations was high in the late 1950s and continued into the next decade. In 1958 the American Psychiatric Association dedicated their yearly symposium to the topic, finding that it "was appropriate and timely" due to a "growing interest in the subject."[82] Investigations on LSD, mescaline, sensory deprivation, and schizophrenia dominated the conference. Research on strobe visions was notoriously absent. Why? The organizers of the conference claimed that there was "clear agreement among clinicians on the nature of the phenomena included under the term."[83] Yet strobe researchers did not agree. Smythies, the most important scientist to investigate the effects of staring into a strobe light, held a completely different view of observation, reality, and hallucinations.

Time and again what fascinated flicker researchers was how something could appear disconnected from its source of stimulation. For Costa it was "the missing reference to an objective external reality" that intrigued her.[84] Walter was fascinated by how the subject "begins to see things which are not present in the stimulus" and how even though "the stimulus source itself is white, stationary and featureless . . . all subjects report seeing coloured moving patterns."[85] Blum was enthralled by the "dissimilarity of response to similar stimuli."[86] Smythies stressed how "when we look at a uniform field under intermittent illumination, we do not merely see the stimulus but see instead these complex and interesting patterns."[87] Gebhard, one of the first and only scientists to have an interest in strobe visions, wondered why scientists were loathe to accept that there could be sensation beyond stimulation and insisted that they admit that "there are visual phenomena, although they correspond to no physical reality."[88] In consequence, he asked scholars to stop "theorizing in terms of functional 'atoms' of the form: stimulus-excitation-sensation." In this type of theorizing, he lamented, the "inevitable result is a body and soul (receptor, central projection and 'sensation') theory, logically no better than the body and soul theories of the most ancient tradition."[89]

But what was unique about strobe research was not merely its status as a form of hallucination. Rather, it revealed new fissures in a longstanding debate about what counted as reality. The debate was visible in the authors' different use of the term "observation." Klüver, for example, explained on numerous occasions that although he was clearly hallucinating under the influence of mescal, his "experiments" still lent themselves to perfectly clear scientific observation. Mescal "does not destroy the critical attitude of the observer."[90] His research was solidly based on "self-observations of qualified observers."[91] He, like most of his peers, used the terms "visions" and "observations" separately. His task was to "observe . . . the visions" and to "happily observ[e] the visionary world."[92] For most scientists who worked on strobe, to "observe" was qualitatively different than to merely see. It was more meaningful for science. "Observations" were much more than mere "visions." Brown and Gebhard, who self-experimented with a strobe light, described their work as "observations of the visual field."[93]

The word "observation" often highlighted the particular aspect of the experiment that mattered the most to the scientist. Adrian and Matthews, who focused on the EEG record and not on what the subject saw under strobe stimulation, used the word "observation" exclusively to describe the EEG record. The "observer" was the scientist in charge of the experiment, the "observation" was the EEG record, and the "subject" was the person exposed to the strobe light.[94] Blum, who focused on the relation between the EEG record and the quantity of visual imagery, also used the term "observation" in this way. Observations were the work *of* the scientist *on* his "subjects." The subjects themselves did not produce "observations" but "responses."

When Walter used the word "observation" it was again *of* patients and *of* records. The term did not refer to the testimony of the experimental subject.[95] In Walter's work "observations," although more important than "visions," were nonetheless secondary to "experiments." The introduction of flicker into EEG work was designed to "extend" an otherwise limited "field of passive observation."[96] Using strobe, "like a modern detective, we can not only tap the lines of communication, but even interject suitably phrased messages of our own and *observe* the reactions of the suspect."[97]

Smythies, in contrast, used the term "observation" to describe what the subject saw. Gesturing to his unusual use of the term, at least once he placed the word in quotation marks.[98] In other publications, he confronted the topic of "observation" directly. In his mescaline research, he ardently fought to prove that his visions counted as proper and legitimate forms of scientific observation. Mescaline was different from other drugs, he argued, because it left the subject's "observational integrity intact."[99] Although clearly hallucinating, he argued that subjects were nonetheless perfectly capable of "observing" for scientific purposes. Those who took mescaline often used visual metaphors ("They use such phrases as 'I saw,' 'As I gazed,' 'As I looked,' 'It is wonderful to see,' etc."), yet "observing" was an act that complemented the subject's experience of "looking." Smythies described his work with strobe as studying patterns that could be "observed by looking."[100] He expanded the meaning of the term "observation" and along with it of "reality." The hallucinating subject was, for him, an "observer." His view was radical, since he believed that what counted as an "observation," as a "hallucination," and—ultimately—as "reality" was culturally determined: "Thus it can be argued that the basic decision to call hallucinations 'real' or 'unreal' is a matter of convention and is determined by the rules in our language relating to the use of the word 'real' and is thus a matter of culture."[101] Eskimos, Plains Indians, and Western scientists had different views about the real, the hallucinated, and the observed.

Few scientists of the period could have agreed with the assertion that what counted as a scientific observation was cultural and conventional. In fact, this radical position highlighted the widely opposite view of observation that dominated the 1950s and its preceding centuries. For example, during the seventeenth and eighteenth centuries it was often considered to be mimetic. It was generally associated with the camera obscura, with geometrical optics, and with touch. From our perspective, the meaning of the term "observation" during that period was adequate for aristocratic societies in which bodies were clearly separated in interior and exterior parts and where art and science mixed comfortably. The view of observation from the 1950s also differed from how it was generally understood in the nineteenth century. Observation then was usually compared to photography, increasingly understood as a chemical process, and studied with physiological optics. In stark contrast to earlier centuries, it was tightly coupled with vision and sight and decoupled from touch. It was subjective and tied to the body—a concept apt for industrial societies of spectacle and surveillance, where art and science were separate disciplines and where human subjects increasingly became objects of observation.

For a very brief period during the late 1950s, a few scientists considered strobe visions a legitimate form of scientific observation. But their status as such would not last long. Perhaps some strobe researchers were asking too much. Miles claimed that spinning disks seemed to be alive, pointing to a breakdown between listening and looking. Gebhard asked his colleagues to eschew the whole stimulus-sensation language used in physiology, rewriting, in the process, theories of body and soul. Smythies not only advocated a new relation between science and art and between health and disease, but he even asked that observations be considered sometimes as wholly "disconnected" from the person experiencing them. The attempts from Beat artists to build machines and perform experiments were never strong contenders in the world of science.

By 1965 investigators used the word "by-product" to describe the strange effects of staring into a strobe light.[102] Only a few artists continued to highlight these effects. In 1966 the experimental filmmaker Tony Conrad made the film *The Flicker*, exposing the audience to stroboscopic lights in order for them to experience their hallucinogenic effects. Many left the movie theater disoriented, forgetting their bags, umbrellas and other personal belongings. What the audience underwent was described as "experimental art" or as a "countercultural experience" but hardly as a form of "scientific observation."

As flickering light (cinematographic, televisual, and other) proliferated, brightened, and became nearly all-pervasive, the controversial theorist Marshall McLuhan explained how all modern media could fit within two extremes. One extreme was revealed by "experiments in which all outer sensation is withdrawn, [and] the subject begins a furious fill-in or completion of senses." The other extreme was characterized by "the hotting-up of one sense." Both extremes produced similar responses: "The hotting-up of one sense tends to effect hypnosis, and the cooling of all senses tends to result in hallucination." McLuhan did not focus on the extremes, concentrating instead on the middle "comfort" zone of media. Yet it is these extreme cases that reveal how observation after the 1950s was increasingly described as *mediated* and studied as one node in a larger network of mass media communications.[103]

Notes

1. John R. Smythies, "The Stroboscopic Patterns: 1. The Dark Phase," *British Journal of Psychology* 50 (1958): 107.

2. Ibid., 110.

3. Jan Purkinje, *Beobachtungen und Versuche zur Physiologie der Sinne. Beiträge zur Kenntniss des Sehens in subjectiver Hinsicht* (Prague: Calve, 1823).

4. David Brewster, "On the Influence of Successive Impulses of Light Upon the Retina," *London and Edinburgh Philosophical Magazine and Journal of Science* 4 (1834): 241–42.

5. William Grey Walter, *The Living Brain* (New York: W. W. Norton, 1953), 100.

6. William Grey Walter, "Features in the Electro-Physiology of Mental Mechanisms," in *Perspectives in Neuropsychiatry*, ed. Derek Richter (London: H. K. Lewis, 1950).

7. These understudied and underobserved visions are comparable to the masses of artifacts that also escape our attention. See Bruno Latour, "Where Are the Missing Masses? The Sociology of a Few Mundane Artifacts," in *Shaping Technology/Building Society: Studies in Sociotechnical Change*, ed. W. E. Bijker and John Law (Cambridge, Mass.: MIT Press, 1992).

8. Hermann von Helmholtz, *Treatise on Physiological Optics*, 3 vols. (Mineola: Dover Publications, Inc., 1962), 2: 256.

9. John R. Smythies, "The Stroboscopic Patterns: 2. The Phenomenology of the Bright Phase and after-Images," *British Journal of Psychology* 50 (1959): 305.

10. Brewster explained: "I have never been able to draw the pattern, or to trace how the patches of interstices of the net-work spring" because "the patterns are constantly changing their colour, their intensity of light, and even their form." Brewster, "On the Influence of Successive Impulses of Light," 242.

11. Ibid., 242–43.

12. Helmholtz, *Treatise on Physiological Optics*, 229.

13. Ibid., 262.

14. Stuart Strickland, "The Ideology of Self-Knowledge and the Practice of Self-Experimentation," *Eighteenth-Century Studies* 31, no. 4 (1998): 453–71.

15. Helmholtz, *Treatise on Physiological Optics*, 260–61.

16. Paul B. Horton, "Does History Show Long-Time Trends?" *Scientific Monthly* 55, no. 5 (1942): 461–70.

17. In France, the brothers Laurent and Augustin Seguin used a machine, baptized the "stroborama," to observe and photograph rapid phenomena—mainly motors and propellers. In 1930 Westinghouse Research produced a "stroboglow," which, although not commercially available, flashed 100 times in a minute and could fit into two fifty-pound cases.

18. James R. Killian Jr., "The Meaning of the Pictures: Exploring the World of Time and Motion," in *Flash! Seeing the Unseen by Ultra High-Speed Photography* (Boston: Hale, 1939), 180–81.

19. Personal communication from Harold Edgerton's son, Robert Edgerton.

20. Walter Miles, "The Victor Stroboscopic Disk for Visual Experiments," *American Journal of Psychology* 40, no. 2 (1928): 313.

21. Ibid., 312.

22. E. D. Adrian and B. H. C. Matthews, "The Berger Rhythm: Potential Changes from the Occipital Lobes in Man," *Brain* 57, no. 4 (1934): 378.

23. Heinrich Klüver, "Mechanisms of Hallucinations," in *Studies in Personality* (New York: McGraw-Hill, 1942), 186.

24. Antonin Artaud's *Le tarahumaras* in the 1940s and Henri Michaux's *Misérable miracle* of the 1950s were two notable exceptions. Michaux considered his work both an "exploration" and an "experiment."

25. Heinrich Klüver, *The "Divine" Plant and Its Psychological Effects* (London: Kegan, 1928), 29.

26. J. W. Gebhard, "Chromatic Phenomena Produced by Intermittent Stimulation of the Retina," *Journal of Experimental Psychology* 33 (1943): 401.

27. Carl R. Brown and J. W. Gebhard, "Visual Field Articulation in the Absence of Spatial Stimulus Gradients," *Journal of Experimental Psychology* 38 (1948): 189.

28. Ibid., 195.

29. Ibid., 199.

30. Ibid., 197.

31. William Grey Walter, V. J. Dovey, and H. Shipton, "Analysis of the Electrical Response of the Human Cortex to Photic Stimulation," *Nature* 158 (1946): 540.

32. It could not go at "rates higher than 25 a second as the apparatus could not be run comfortably at higher speeds." Adrian and Matthews, "The Berger Rhythm," 380.

33. Walter, *The Living Brain*, 16.

34. Walter, Dovey, and Shipton, "Analysis of the Electrical Response," 541. Walter later would restate this point: "In some epileptics, stimulation of this type . . . can induce a characteristic seizure; attacks of petit mal, grand mal, and myoclonic jerkings have been readily induced by these means." Walter, "Features in the Electro-Physiology of Mental Mechanisms," 74–75.

35. V. J. Walter and William Grey Walter, "The Central Effects of Rhythmic Sensory Stimulation," *EEG Journal* 1 (1949): 65.

36. Walter, "Features in the Electro-Physiology," 74.

37. Walter and Walter, "The Central Effects," 65.

38. Ibid., 63.

39. A. C. Mundy-Castle, "A Case in Which Visual Hallucinations Related to Past Experience Were Evoked by Photic Stimulation," *EEG Journal* 3 (1951): 354.

40. A. C. Mundy-Castle, "Electrical Responses of the Brain in Relation to Behaviour," *British Journal of Psychology* 44 (1953): 322.

41. Ibid., 323.

42. Ibid., 322.

43. Angiola Massuco Costa, "L'effetto geometrico-cromatico nella stimolazione intermittente della retina ad occhi chiusi," *Archivio di Psicologia Neurologia e Psichiatria* 14 (1953). Angiola Massucco Costa was the founder of the Istituto Superiore di Psicologia Sociale in Italy.

44. Ibid., 633.

45. W. H. Bexton, W. Heron, and T. H. Scott, "Effects of Decreased Variation in the Sensory Environment," *Canadian Journal of Psychology* 8 (1954): 70–76.

46. Richard E. Morgan, *Domestic Intelligence: Monitoring Dissent in America* (Austin, Texas: University of Texas Press, 1980), 291.

47. Richard H. Blum, "Photic Stimulation, Imagery, and Alpha Rhythm," *Journal of Mental Science* 102 (1956): 162.

48. Ibid., 166.

49. He came to Cambridge from Australia, where he had worked with the leading neurophysiologist Sir John Eccles. After working in Cambridge he moved to the Galesburg State Research Hospital in Illinois and later to the Worcester Foundation for Experimental Biology in Shrewsbury, Mass. For his experiments he used an Aldis 500-watt projector covered by an episcotister and a standard EMI electronic stroboscope. He learned to work with electroencephalography while at the National Hospital, Queen's Square, in London. John R. Smythies, *Two Coins in the Fountain: A Love Story* (n.p.: BookSurge, 2005), 41.

50. Since the effects of the strobe on both eyes was frequently different from when only a single eye was used, Smythies concluded that the observed effects were not merely retinal.

51. Smythies, "The Stroboscopic Patterns: 1," 116.

52. Smythies, "The Stroboscopic Patterns: 2," 306.

53. Smythies, "The Stroboscopic Patterns: 1," 111.

54. These studies were done at the Psychiatric Unit of St. George's Hospital.

55. Smythies, *Two Coins in the Fountain*, 35–36; John R. Smythies, "A Visit to Dr. Jung," *Alabama Journal of Medical Science* 18, no. 1 (1981).

56. Smythies, *Two Coins in the Fountain*, 36.

57. Aldous Huxley, *The Doors of Perception* (New York: Harper, 1954), 12.

58. Aldous Huxley, *Heaven and Hell* (London: Chatto, 1956), 20.

59. Ibid., 56. Huxley warned his readers of the "slight danger involved in the use of the stroboscopic lamp," particularly in epileptics: "One case in eighty may turn out badly."

60. Smythies, *Two Coins in the Fountain*, 54.

61. Ibid., 54.

62. Ibid., 34.

63. Lee Schlain, *Acid Dreams: The Complete Social History of LSD* (Grove, 1985).

64. William S. Burroughs, "Points of Distinction between Sedative and Consciousness-Expanding Drugs," in *LSD: The Consciousness-Expanding Drug*, ed. David Solomon (New York: G. P. Putnam's Sons, 1964), 172. He described the dreamachine in Daniel Odier, ed., *Entretiens avec William Burroughs* (Paris: Belfond, 1969.

65. Allan Ginsberg analyzed Burrough's *The Soft Machine* (1961) in terms of the "Stroboscopic flicker-lights . . . [that] create hallucinations, and even epilepsy." Cited in John Geiger, *Chapel of Extreme Experience: A Short History of Stroboscopic Light and the Dream Machine* (Brooklyn, N.Y.: Soft Skull Press, 2003), 52. The films in "Towers Open Fire" produced by Burroughs in 1961–62 show dreamachine experiments.

66. Timothy Leary, "How to Change Behavior," in *LSD: The Consciousness-Expanding Drug*, ed. David Solomon (New York: G. P. Putnam's Sons, 1964), 105.

67. John R. Smythies, introduction to *Chapel of Extreme Experience* (Brooklyn, N.Y.: Soft Skull Press, 2003), 7–8.

68. Russell J. Blattner, "Photic Seizures—Television-Induced," *Journal of Pediatrics* 58, no. 5 (1961): 746.

69. John R. Smythies, "The Stroboscope as Providing Empirical Confirmation of the Representative Theory of Perception," *British Journal for the Philosophy of Science* 6, no. 24 (1956).

70. Walter, "Features in the Electro-Physiology of Mental Mechanisms," 77.

71. Smythies, "The Stroboscope as Providing Empirical Confirmation," 334. Emphasis in the original.

72. Killian Jr., "The Meaning of the Pictures," 22.

73. Smythies, "The Stroboscopic Patterns: 2," 307.

74. Walter, *The Living Brain*, 267.

75. Ibid., 268.

76. Ibid., 98.

77. Blattner, "Photic Seizures—Television-Induced," 747.

78. Walter, *The Living Brain*, 268.

79. Henri Pierón, *The Sensations* (1952), cited in Sanford Goldstone, "Psychophysics, Reality and Hallucinations," in *Hallucinations*, ed. Louis J. West (New York: Grune, 1962), 262.

80. Cited in Louis J. West, "A General Theory of Hallucinations and Dreams," in *Hallucinations*, ed. Louis J. West (New York: Grune, 1962), 276.

81. Cited in ibid.

82. Louis J. West, preface to *Hallucinations*, ed. Louis J. West (New York: Grune, 1962), vii.

83. West, "A General Theory of Hallucinations and Dreams," 276.

84. Costa, "L'effetto geometrico-cromatico," 633.

85. Walter, "Features in the Electro-Physiology of Mental Mechanisms," 74; Grey William Walter, *The Neurophysiological Aspects of Hallucinations and Illusory Experience* (London: Society for Psychical Research, 1960).

86. Blum, "Photic Stimulation, Imagery, and Alpha Rhythm," 164.

87. John R. Smythies, "The Stroboscopic Patterns: 3. Further Experiments and Discussion," *British Journal of Psychology* 51 (1960): 250.

88. Gebhard, "Chromatic Phenomena Produced by Intermittent Stimulation," 404.

89. Ibid., 387.

90. Heinrich Klüver, "Mescal Visions and Eidetic Vision," *American Journal of Psychology* 37 (1926): 513.

91. Klüver, "Mechanisms of Hallucinations," 198.

92. Klüver, "Mescal Visions and Eidetic Vision," 511.

93. Brown and Gebhard, "Visual Field Articulation," 189.

94. "The other (B.H.C.M.) [Matthews] is better in the role of observer than of subject, for in him the rhythm may not appear at all at the beginning of an examination, and seldom persists for long without intermission." Adrian and Matthews, "The Berger Rhythm," 382.

95. The fact that he considered the subject's testimony as secondary to the scientist's observations was also revealed in his choice of instruments. With a Toposcope, a machine used to evaluate various brain areas exposed to flicker, Walter claimed that the progress it brought about was comparable to the time when "a mosaic of aerial photographs" replaced "a traveler's tale." Geiger, *Chapel of Extreme Experience*, 17.

96. Walter and Walter, "The Central Effects of Rhythmic Sensory Stimulaton," 57.

97. Walter, *The Neurophysiological Aspects of Hallucinations*, 4. Emphasis added.

98. "[I]f an Archimedes spiral is rotated rather quickly and then 'observed,' the patterns for the subject can be evoked." Smythies, "The Stroboscopic Patterns: 3," 247.

99. John R. Smythies, "The Mescaline Phenomena," *British Journal for the Philosophy of Science*, 3, no. 12 (1953): 339.

100. Examples of his observation language are: "[C]oloured patterns may be observed by looking" and "the sensory patterns that can be observed on looking." Smythies, "A Preliminary Analysis," 523.

101. J. R. Smythies, "A Logical and Cultural Analysis of Hallucinatory Sense-Experience," *Journal of Mental Science* 102, no. 427 (1956): 341.

102. Sanford J. Freedman and Patricia A. Marks, "Visual Imagery Produced by Rhythmic Photic Stimulation: Personality Correlates and Phenomenology," *British Journal of Psychology* 56 (1965): 95.

103. Marshall McLuhan, *Understanding Media: The Extensions of Man* [1964] (Cambridge, Mass.: MIT Press, 1994), 32. For the transformations of the word "media" from the late nineteenth century to its use by Marshall McLuhan, see Raymond Williams, *Keywords: A Vocabulary of Culture and Society*, rev. ed. (Oxford: Oxford University Press, 1983).