Chapter 8

subjective realities

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In altered states of consciousness such as dreaming sleep, trance, or psychedelic drug states, persons may experience subjective realities much as, ordinarily, they experience their existence in the external world. Even though there may be a recognition that the reality experienced is internal, still the person may feel himself to participate with some or all of his senses in the subjective reality that dominates awareness.

Although the term is inexact, most persons may best understand the experiencing of a subjective reality as a waking dream. In the altered state, however brought about, imagination is vivified to the extent that the person, usually with eyes closed, sees clearly the subjective reality, hears, touches, and is touched, is aware of moving about, and otherwise functions as persons sometimes do in dreams. Also, as in some other kinds of dreams, the person may be a spectator only, observing the subjective reality somewhat as a film is experienced in a theater.

The possibility of experimentally giving persons access to subjective realities opens up many other possibilities for the enhancement of creativity, learning, and types of self-expression conducive

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to healing and personality development and integration. In the following pages we will describe experiments aimed at realizing these possibilities, utilizing novel instruments to alter consciousness, and in some instances greatly accelerating mental processes as becomes possible when, in altered states, we break out of the learned tyranny of time.

Throughout history people have used altered consciousness as a gateway to subjective realities, and of course to realize other goals. Rituals, drumming, dancing, chanting, fasting, ingestion of mind-altering plant substances, these and many other means have been used to the end that visions might be obtained, or glimpses of the future, and to accomplish healings and give experiences of transcendence and ecstasy.

In our own laboratory we have worked with many of these ancient and primitive enabling procedures, and also with some other instruments and methods: "sensory deprivation" or reduction of sensory inputs; varieties of audio-visual environments; stroboscopic lights; various psychedelic drugs;[1] meditation; brain wave and muscular relaxation self-regulated by means of biofeedback training; trance states self-induced and induced by the Altered States of Consciousness Induction Device, which will be described; electrical stimulation of the brain (by attached, not implanted, electrodes); and still other means.

"CRADLE OF CREATIVITY"

The Altered States of Consciousness Induction Device (ASCID) is a tool devised and used by us to alter consciousness and so gain access to subjective realities. ASCID is essentially a metal swing or pendulum in which the research subject stands upright, supported by broad bands of canvas and wearing blindfold goggles. This pendu-

[1] R. Masters and J. Houston: *The Varieties of Psychedelic Experience* (New York: Holt, Rinehart and Winston, 1966; paperback: Delta, 1967). *Psychedelic Art* New York: Grove Press–Balance House, 1968. "Toward an Individual Psychedelic Psychotherapy," in B. Aaronson and H. Osmond, eds., *Psychedelics: Their Uses and Implications* (New York: Doubleday Anchor Books, 1970). These and other writings describe in detail the authors' work with mind-altering chemicals. That work was concluded more than five years ago, but it is directly relevant to the research described in this paper.

lum, hanging from a metallic frame, carries the subject and moves in forward and backward, side to side, and rotating motions generated by involuntary movements of the body of the subject. Frequently, then, a trance state ensues within two to twenty minutes, and may deepen as the spontaneous or directed experiencing of a subjective reality continues to unfold.

Our own work with ASCID over several years suggests that the main tendency of the largely *undirected* research subject is to experience "worlds" or subjective realities which are fantastic and reminiscent of fairy tales, myths, and science fiction. Sometimes religious- and mystical-type experiences have occurred. The subject's experience also may be guided, and demonstrated possibilities of problem-solving and varieties of artistic work have led us to sometimes refer to the device as a "cradle of creativity."

As an example of the very largely undirected and mythic-religious-type experience, a young college graduate in the ASCID experienced herself as dying and then as being reborn as the mythic Prometheus. After "an eternity of death" she experienced "a tremendous cosmic life force entering my body through my feet. . . . This force then traveled up my body. I had superhuman strength and powers and experienced myself to be Prometheus. I was chained to the side of a rock on a mountain. The chains did not bother me because I knew I had the strength to free myself at will." She then had a powerful emotional experience of bringing fire to mankind and to various individuals, the fire being in each case symbolic of a gift of great importance to the respective persons. With each gift, she felt a more and more intense personal fulfillment.

> "The whole experience," she wrote later, "was so positive and profound that I was in a state of total awe and wonder. . . . The effects have really been far reaching. I feel myself to be boundlessly happy and at complete acceptance and peace with myself. I see life much more clearly and on many different levels. I feel myself to be in an active connection with the harmony and unity of nature and the cosmos through a force I guess you'd call love. I think this whole new way of being comes from the realization and experience of the goodness and strength of my unconscious. . . . I think the whole experience takes on even more meaning when it is known that I knew very little about the unconscious or any experience with it, and that I knew nothing about religious experiences. Since I returned home I have been doing as much reading as possible on these subjects. My reading points out even more clearly the awesome profundity of what I experienced. . . ."

Similar experiences have been observed, some more typical of classical religious experiences and appearing to meet the criteria for "authenticity" set forth by scholars of religion and mysticism. For our part, as phenomenologists, we do not evaluate but only describe, leaving others to debate ontological and metaphysical questions set aside by us as unanswerable by any known means. We do feel, however, that some of the experiences we will describe should not be dismissed as just artistic or religious fantasies. Their significance undoubtedly is greater than such a dismissal would suggest. And in some of these cases we surely are looking at processes that have been basic to art and to religion.

"SELF-CREATING" WORKS OF ART

Research subjects with whom we intend to work repeatedly are trained so that they will become familiar with various aspects of the subjective realities. For example, they are trained in *Visionary Anthropology,* a mind game we have devised that requires the subject to visit a "world" and describe for us its customs, its art, and whatever else may be of interest. The subject "lives in" this subjective reality; and as he is encouraged to look at paintings and listen to music, we require of his brain-mind to produce these works of art for his enjoyment and so that he can describe them. This is an indirect exploration of the "automatisms" familiar to students of the creative process. We also work with these automatisms directly in experiments with various types of artists.

Such work explores the creative process and the psychology of imagination, but at the same time the experiment may be used to help an author overcome problems blocking the completion of a novel or some other literary work. For example, an author in his mid-30s had been unable for almost a year to complete the final chapter of his novel. Standing in the ASCID, in trance, he was told that he would be able to just watch as the chapter appeared before him as if made into a film. He would see his characters and hear

them speak, but he would only observe and not consciously create.

After he had experienced the chapter in this way, he was told to remember what he had seen and heard, but now to look and listen again since his unconscious was going to provide another version of the chapter that he might prefer to the first version. This was done, and in all he experienced four such performances of the chapter. After the fourth, he urgently requested that the experiment be terminated so that he could go home and write. He worked all night and most of the next day, finishing the book. The chapter was judged by him and his publisher to be equal to other chapters in the book. By tapping a subjective reality a creative block of a year's duration was broken through.

Other novelists, in the ASCID, have been enabled to "become" one or more of their own fictional characters, and as the character participate in a realistically lived through segment of the novel. In other cases, research subjects have been told just to observe while a short play or film was performed, or a picture appeared on a canvas, or a song was sung or played. These latter examples of "musical imagery" are less familiar to most people than are visual images or even visual narrative sequences having a resemblance to various types of works of art.

Many composers of music, however, have reported experiences, frequent or occasional, of auditory musical imagery, complete or fragmentary compositions, original and equal in quality to compositions created by the person by any other means. This musical imagery is of course literally heard, just as visual images are literally seen. The imagery may be of a voice or voices singing, of a single instrument, or a combination of instruments, and even of an entire orchestra playing. In vividness the imagery may range from faint and barely audible on up to a painful loudness, again comparing with visual imagery which may be barely illumined on up to a painful "blinding light." Beethoven, Berlioz, Mozart and Wagner are among the noted composers who have experienced these "automatic" and "self-creating" works of art. In a few cases the recording of such seemingly "given" imagery has been the usual method of composition. E. T. A. Hoffmann, for example, often remarked to his friends that "When I compose I sit down to the piano, shut my eyes, and play what I hear."

EXPERIMENT IN MUSICAL IMAGERY

A research subject, a young woman in her 20s, was the published writer of several popular songs. Upon her request, she was accepted as a subject for an ASCID experiment, but she was given no information that any special task would be required of her. She had stood in the device for only one minute when her head slipped involuntarily forward, the agreed-upon signal that she was in trance and as deeply in trance as she felt she would go for the present, and that she was ready to communicate. The subject then was instructed concerning a phenomenon we have called *accelerated mental process* (AMP), but which those who identified and first worked with the phenomenon termed "time distortion."

This pioneering work was accomplished by Linn Cooper and Milton Erickson and described by them in a book published in 1954.[2] The authors were hailed at the time as having opened up the way to possible major breakthroughs in creativity, psychotherapy, and possibly learning. However, research has been limited, and even this has been discouraged by the usual complaints that the phenomenon must be invalid because it fails to improve the learning of nonsense syllables.

In the case of our subject, she was now instructed that in a trance, as in dreaming sleep or drug states, it is possible to greatly increase the rate of thought or amount of subjective experience beyond what is ordinarily possible within a given unit of clock-measured time. For example, in trance, a person might experience within a few minutes as measured by the clock such a wealth of ideas or images that it will seem to him hours, or days, or even longer must have passed for so much to be experienced. But only a few minutes of objective time have elapsed; the change has been on the level of subjective, experiential time; and the explanation lies in the phenomenon of AMP.

Following this explanation, an illustration of AMP revivification of experience was provided. She was told that she would now

[2] Linn F. Cooper and Milton H. Erickson: *Time Distortion in Hypnosis* (Baltimore: Williams & Wilkins, 1954).

find herself back at a stadium where, a few days before, she had observed a football game. She would be given three minutes of clock time, and this would be quite sufficient, with AMP, for her to subjectively see the game through from beginning to end. Nothing would seem hurried, all would be as before, but the several hours of subjective experience would occur within the amount of clock time given. When, at the end of three minutes, the subject was asked to report, she said that she had seen the game in its entirety and had been waiting for a while alone in the stadium, everyone else having left.

The subject then was told: "Now you are going to find yourself walking down a street in a city on a misty evening, and you will feel the mist and smell the odors of the street and hear the street noises, and you will be aware of your body, a little tired, as you walk, and of wanting to have something to eat and drink. You will find yourself approaching a little cabaret, and go inside and order for yourself a sandwich and some beer, and while you are sitting there a singer will come out and perform. The songs she will sing will be ones you have never heard before, and they will be songs that you like. You will stay listening to her just as long as you want to, and you will commit these original songs to memory. You will have all the time you need to do this, staying for an hour or however long you want, and you will need only two minutes of clock time for these things to happen."

Asked if she understood, the subject smiled and said she was already enjoying the beer and sandwich and was waiting for the singer. She was told: "You have two minutes, starting *now!*" After a little less than two minutes, she asked, "Well, do you want to hear the song?"

The subject then sang for us a very pleasant song, complete with lyrics, and after that announced she had two others, which she also sang, apologizing when she felt she had forgotten some of the lines. Asked if she had ever heard or thought about any of the songs before, she said that two were definitely new to her but possibly one line of the other song was something she had thought about before. Asked her opinion of the songs, she said that one was complete but the other two might require some additional work to be ready for publication. All of the songs were of the sort she had written in the past—pleasant, sentimental tunes.

Two more similar experiments were carried out, and more songs were produced by the subject. Since all of these songs might have been already created by the subject, but preconscious, it was decided to elicit from her music quite unlike any of her usual compositions. As we were about to begin, however, she complained that she was tired of standing for so long in the ASCID. The goggles and supporting straps were removed, and the subject was told to "Bring your trance with you over to the couch." She lay down, reporting her state of consciousness to be unchanged, and experimental work was resumed.

"Now," she was instructed, "you will find yourself on a path in a jungle with huge, lush plants and trees overhead and moonlight filtering down through. Move along that path on a warm night in the jungle, not being afraid but moving as a sleepwalker, slowly being drawn towards something, you don't know what. (Here she interrupted to say that she was moving down the path.)

"Until you come to a clearing, and inside of that clearing a ritual is being performed. There are bodies glistening, a fire leaping in the center of the clearing, people dancing, drums beating, a very wild, primitive kind of scene. But it all expresses and creates a oneness . . . an extremely wild, primitive, frenetic sort of music, forging a collective consciousness among those who are participating in the ritual. Completely primitive. I want you to listen to this, to absorb it, to be able to sing it, and it will be a kind of music that can create a primitive unity of consciousness among those who hear it. Listen to them, look at them, feel what they're feeling. The message will be oneness in *their* terms. You have one minute of clock time, but that will be enough for you to stay with them for as long as you like, and that clock minute begins *now!*"

At the end of the minute the subject, reporting herself to be still quite elated, sang for us a very wild and effective chant that continued for several minutes. She then was asked to tell us about what she had experienced:

> At first I was standing off to one side, kind of watching and making mental notes about what they were doing. Then I was doing it with them because it was a sound that just went all around and in me and out of me. I was doing it with them and they were dancing. My body wasn't dancing but it was into all the rhythms that they were into. Then they were sitting. There was a silence and they all

> sat, they all fell down kind of, they didn't sit slowly, but instead they all fell down into sitting positions. They all kind of curled themselves up into themselves and put their heads down. Everybody had their eyes closed but it didn't matter, you didn't have to look or touch anybody because the feeling was just all over, in the ground and the sky and everything. This feeling, it was just part of the ground and the sky and the people, you know, there just wasn't any you and me and world around. I was just one with them and they were all one voice and one breathing together. At first I was frightened, because they already were into it when I got there, but then pretty soon I was where they were. But not right away, because they were really, really far, far out. . . . Once before, in group chanting, I experienced something a little like this, but then there was a lot more mind in it. This was all body and skies and earth, and then it wasn't really people. For a while you couldn't experience it as a "we," because there was just a one. Then it wasn't even human, it was just a physical being that I was part of.

At the conclusion of these experiments, the subject said that she was fascinated and pleased, but felt a little guilty, "as if I have just been eavesdropping on some other reality and didn't really create anything." But, she added, "If I didn't create that music, then who did create it?"

The question she raises is one that has interested artists and students of genius and the creative process for centuries. Once assumed to be gifts from the gods, automatisms are now generally attributed to a creative unconscious, whatever that might be. Those who experience the phenomenon are often, even more than others, impressed by the feeling that the work has been "given," not created by them. Even so astute a psychologist of the creative process as Nietzsche felt obliged to grapple with the question of who or what had provided him with his *Zarathustra.*

To say the least, it must seem remarkable to encounter some unconscious process able to create according to specifications and providing for consciousness music to be heard as auditory images and sung by cabaret singers, primitives, or perhaps played by an orchestra. The same process, manifesting in a trance or psychedelic drug state, and complying with suggested AMP, has been observed by us to almost instantaneously provide fictional or dramatic works, or at least fragments thereof, and images of paintings or sculptures. It may equally well be enlisted for problem-solving or psychotherapy.

AMP AND LEARNING

With accelerated mental process (AMP), or "time distortion," it appears to be possible to very quickly and dramatically learn, or perhaps rehearse and apply learnings which were previously ineffective, and to do this within the context of a subjective reality.

For example, a Jesuit priest felt that he had been "traumatized" by his experience of a thirty-day "retreat" during which he had failed in succeeding to realize many of the tasks and objections of the Jesuit spiritual exercises. In three minutes of trance, and with AMP, he relived the entire thirty days but, this time, "paid very close attention," applied his knowledge gained from listening so closely, and completed the exercises very successfully. Afterwards, he was relieved of what he considered to be symptoms produced by the trauma, and he felt more self-assured, much more at ease with other people, and more creative. With respect to the latter, he was able to produce and have published a series of papers he had long planned but been unable to write.

In another case, a young art student worked as a research assistant for the authors, and demonstrated an ability to self-induce deep trance states. She participated in many kinds of experiments, and displayed an unusual ability to regulate her own states of consciousness and so disinhibit capacities when required for a particular task. She was not, however, improving as an artist, and she requested that an experiment be devised to enable her to better make use of the talent and skills she believed herself to have.

It was agreed that this would be attempted, and she was asked to go outside and execute a drawing. She returned with a crude sketch of some branches to which, in the upper left corner of the paper, she added a drawing of her foot. She then, upon request, went into a deep trance and was told that she would now study with a very fine art teacher, and that she would carefully learn and apply the instruction she was going to receive. On this occasion, she would receive a full day's instruction and for this only five minutes of clock time would be required. At the end of this period, she came out of the trance and expressed surprise that daylight was

still coming through the window. She was sent outside to make another sketch of the same vine-covered branch she had drawn a little earlier. In about thirty minutes she returned, showing us a sketch that was clearly a considerable improvement over her first effort, and that showed a previously lacking ability to work in detail.

For the next two days, the subject was given several more five-minute intervals, each to be experienced as a full day of art instruction. At the end of each of these sessions she was given some object to draw, and a continuing, definite improvement in her work was noted.

Five days from the date of the first experiment, the subject was requested to go into a deep trance and then was told that she now would have the opportunity to study for an entire semester with her art teacher. She would study drawing, she would learn a great deal, she would work very hard, and she would be able to live through the entire semester within thirty minutes of clock time.

At the end of thirty minutes, the subject was wakened but insisted that she must go back into trance to complete a "great drawing" she was working on when interrupted. She was told, however, that it now was time for her to execute that drawing on real paper and in the waking state. She agreed, but said a large sheet of paper was required, and urgently asked that it be obtained at once. When we found drawing paper to meet her needs, she asked to return home immediately so that she could get to work. She then worked intensely for most of two days and, at the end of that time, had completed a drawing that evidenced skills well beyond any to be seen in her previous work.

In this drawing, the tree and vines that had figured in the first two drawings are retained as segments of an elaborate fantasy. The work is very crowded, as often happens when an artist executes a work conceived during AMP experiments. The work also is expressive of conflicts, and served to exorcise some of these. The drawing was experienced as a major creative breakthrough, and the subject has preserved her gains and has continued to improve during the eighteen months since the experiment was completed. Her work not only is technically much better, it is more sophisticated, original, also more simple and serene. The subject's own comments written a

few months after the experiment include the following summary and evaluation of results:

> Being in a very deep trance I was told that I would experience a one-semester drawing course. During this course I would have a master teacher at my side whenever he was needed, and I would do all that was necessary to fulfill the course requirements.
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> I have an unusually poor recollection of this session. However, I do know that I produced a very large number of drawings, some of them being done time and again until perfect. Also, that many things were happening in my head besides just drawing. I can still see myself coming and going to class, and know that at the time I must have lived life in a normal way throughout that one semester. And so, it seems that the time that passed within my mind was several months.
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> At the end of the course I had done many drawings. It was quite evident that my skill had greatly improved because of all the practice I had had. Of these drawings I was to choose one and, while out of trance, actually reproduce it. This I did. My drawing has no name, I do not even know what it might mean. But it is a statement of what was seen and worked out during my course.
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> . . . Directly following the last session I was physically exhausted. My head felt as if there was no way my neck could ever support it. It felt just as if it had been stretched, and when put back into shape another 50 pounds or so had been added. Also, it pounded a bit, something which must be known as a headache to others, but something I had only experienced once or twice before. These adverse effects were gone as soon as I slept.
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> The value of the session has lived on. The drawing itself is an example. My art teacher could hardly believe that I had done the drawing, and I, too, am surprised. As far as my talent goes, I am (or, rather, was) extremely wild and undisciplined. I never finished anything. However, since that drawing I have improved almost too much to be conceivable. My work is now disciplined and carefully thought out. Shading has reached a more advanced level, and my work is so much more creative. I am now on the threshhold of another stage of development—at last I am able to draw from within me, rather than just copying the naturalistic world which can be seen all around. I feel much more contented to be drawing what cannot be seen by all.

It is very difficult to assess such experiments and hope to determine whether anything was learned and, if so, in what sense something new might have been learned. It is also difficult to say whether the improvement has resulted from the overcoming of a

creative block or, if not that, what the cause of the improvement may have been. Neither can we hope to measure the amount of experience lived through by the subject. Much more research is needed, but what is clear is that mental processes may be accelerated and that this acceleration may be very great within the context of a subjective reality. Results make it undeniable that AMP within a subjective reality sometimes provides the means to approach with good likelihood of success various tasks, creative objectives, and psychotherapeutic goals.

IMAGE MEDITATION: DEATH-REBIRTH

The most effective known means for changing values and for transforming personality remains the religious or mystical experience, however induced and whatever name employed to describe it. Even approximations to the more profound experiences of these kinds may be emotionally very powerful and beautiful. Potent psychic energy sources may be tapped, and there may be an activation of healing and growth mechanisms that apparently have to be triggered or disinhibited before becoming active in behalf of the person. Here we will describe an experiment that often yields emotionally powerful approximations to the most profound experiences aimed for by the various spiritual disciplines. These experiences, also of subjective realities, may in addition bring individuals close to realities traditionally termed ultimate. In any case, they should be of considerable interest to psychotherapists and scholars of both art and religion, as well as to psychologists exploring the creative process and religious experience.

The experiment is done with both individuals and groups. Research subjects are told to close their eyes and to pay no attention to the world around them, except for the experimenter's voice. As consciousness moves deeply inward, they are told, they will see a series of images, and each of these images, successively, will be a symbol representing the person. Each successive symbol will be more profound than the last and more comprehensive. Finally, a symbol will emerge that is the most profound and comprehensive of all, and the person then should hold in mind and meditate upon that symbol.

When some time has elapsed, we next tell the subjects that they are going to experience something that can be very powerful, a symbolic death and rebirth. To achieve this, they should observe the self symbol very, very closely. As they observe it, the symbol will grow smaller, smaller and dimmer, until at last it disappears. Then the person will experience death, and, after that, when death has been known fully, there will be a rebirth. Subjects are told that they do not have to have this experience, but that it is now available to them if they do want to have it.

In one group experiment the subjects were members of a class taught by one of the authors. The course was in "Phenomenology of Religious Experience," and the experiment was conducted to enable students to better understand the experiences written about by such authors as William James and Evelyn Underhill. It was perhaps the first—but should be by no means the last—example of a course offering "field trips" in experiential and subjective realities.

Members of this college course selected to participate were eight young women, ages 21 to 25. Two of them later described the death-rebirth experience as follows:

The first subject's self-symbol emerged as "a circle which soon changed form and became a curved sea shell, the kind you can listen to. I watched it become filled with spirit which created itself anew as flesh . . . I understood the symbol immediately: the round receptivity of a shell, its emptiness to spirit. The significance of the shell's transformation into flesh—into softness and sensitivity—was obvious. As the symbol became smaller, there was a heightening of intensity and emotion. I experienced fear of the death process, which was grasped as a loss of so much of self that destruction and creation appeared terrifyingly one. . . . Everything appeared possible and impossible at once. . . . I was filled with an unquenchable desire and fear before the death-rebirth event.

"I remember being in the throes of death and not knowing what my outcome would be. This not-knowing was central to my choice to surrender to death. As I experienced myself rising from the depth of death, I knew that the gift of life was before me, and I reached out for it. I was filled with an ecstatic relief and acceptance that seemed to embrace my whole being. Then I felt as if my spirit were being quickened and reformed and was pulsing within. After

that, an intense passivity and sense of being filled. I became aware of the tears on my cheek which had come during the struggle."

The second subject's symbol was a circle filled with white fire. As she observed it, "The circle became smaller and smaller, drawing my vision of it to a tiny velvet line. It finally disappeared and I felt myself go totally silent in waiting. Then there was a tremendous slow motion kind of explosion and upsurge and outgo of energy all around and from the point where the light disappeared. It was incredible. Then the circle grew and grew to infinite proportions within me, and all the sound was white. It was a silent Beethoven symphony throbbing all over the place. All the colors in the world were transformed in the whiteness and alive glow of this fire. . . . I grew huge and transparent, filled and permeated with the light and fire. And I thought: My God is a God of Love and He lives within me.

"When I opened my eyes the whole room was living brown, then as I shifted my vision from the wood to the books and the ceiling, I was part of all there was, yet wholly myself. Beautiful is all I can say."

EXTERNAL STIMULI-SUBJECTIVE REALITY

In some other experiments, an audio-visual environment is used by us to induce altered states of consciousness, and as an example of the incorporation of external stimuli into subjective realities.

The audio-visual environment used in the experiments to be described here was originally created with the invaluable assistance and guidance of Don Snyder, a leading multimedia and lumia artist. In this environment, slides are projected over the surface of an 8-by-8-foot semicircular rear projection screen behind which the subject is sitting. The subject sits up close to the curved screen, so that the images occupy his entire field of vision, and he has the feeling of almost being "in" the slide projection. Sound, most often electronic music, but also sometimes Sufi or Zen chanting, comes to the subject through headphones or from speakers situated at each side of him.

The visual program consists of dissolving 2-by-2-inch slides, projected by two projectors over the entire surface of the screen. The

program is exactly repeatable since the sound tape controls at pre-programmed intervals both the changing of the slides and the flexible (1 to 20 seconds) duration of the slide dissolves. Most of the audio-visual programs consist of from 120 to 160 slides and are of from 30 to 45 minutes duration.

The slides, each one an original painting, painted with transparent colors on 2-by-2-inch squares of glass, are abstract and intended either to elicit specific emotional and projective responses or to facilitate and encourage free projection—a "seeing into" the abstraction which itself is as free of suggestive materials as possible.

As ordinarily worked with, the audio-visual environment induces a mild altered state of consciousness or trance, and in a minority of cases much more profoundly altered states, or deep trances. Characteristic responses include such phenomena as time disorientation, empathy, anxiety, euphoria, body-image changes, religious and erotic feelings, projected imagery, pronounced relaxation, feelings of mild intoxication, a strong sense of wanting to go, or being drawn into, the image. The following description by a woman in her 70s is fairly typical of what might be experienced by a responsive, but not exceptionally responsive, subject:

> As I sat behind the screen watching all those colors and abstract designs whirl and swirl and dissolve into each other continuously I had no idea what they were supposed to do to me. It was a strange, bewildering, slightly frightening experience but pleasurable, incredible, awesome, like watching the Northern Lights I saw once, or it was like being a witness at the beginning of the world. Then it felt like the chaos of the modern world and of abstract art. The sounds in the earphones on my head were mostly unpleasant, my eyes and ears were being bombarded. It was impossible to think.
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> I began to feel uncontrollably sleepy. I wanted to succumb and go to sleep but doubted if that would be of any use to you. Therefore I forced myself to remain awake. . . . When you came for me at the end I arose, and I had no concept of how long I had been there—it seemed like a very long time and yet like a few minutes. I was amazed to discover that I could scarcely walk, my limbs were so heavy, my mind in a pleasant but disoriented state. I recall I said, "I feel as if I've had five champagne cocktails."

An exceptionally strong sensory response was made to the same program by a female subject in her early 20s, setting the stage for a subsequent and unique experiment. Her remarks are made just following the audio-visual stimulation:

> Wow! I craved it, really craved it, and wanted more, especially more touch sensations. I was getting the most touch when the music was loudest, and there were sort of erotic sensations that got more intense when there were dots on the screen. . . . At first I was just looking at it, but soon I was taking part, feeling the rhythms all through my body. I put my head back to try to breathe better and began breathing through my mouth rather than through my nostrils, breathing hard, especially at a crescendo when everything was throbbing. Toward the end I didn't notice anything because I was feeling so much. . . .
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> I felt crucified, was thoroughly exhausted but wanted more. At one point I was extremely tense, then it got delicate again with softer colors. At another point I was seeing lots of eyes, phallic forms, wombs, circles, openings, things to be pierced. The sensations got very erotic. . . . Sometimes, I would start rocking. I often wanted to close my eyes and just fall in. . . . At some point, I stopped thinking and just *was*. . . . It was so profound, the craving for more, my whole body was just aching for it.

The subject also mentioned that her sense of time was "lost," and she repeatedly emphasized that the music was not just heard, but was experienced as tactile sensations and as "intense physical vibrations."

In the case of the subject being described, her very intense sensory-erotic response to the audio-visual program was recalled by us a year or so later when we were considering a novel experiment to demonstrate one of various means by which mystical-type experiences might be enabled to occur. The subject by this time had worked with us repeatedly and was an excellent deep trance subject, although she disliked the notion of hypnosis and usually required that trance be induced by placing her in the ASCID. If that was not feasible, she would agree to imagine herself to have been placed in the ASCID, whereupon a deep trance would immediately result.

In preparation for the planned experiment, the subject, in deep trance, was given one minute, with accelerated mental process, in which to reexperience the audio-visual environment. She reported having done this, and gave a description of her responses that was almost identical to the one recorded earlier. She then was told that at some future date she would physically go into the audio-visual environment, and she then would respond as she had done the first time, and as she had done again a moment ago, only

on this future occasion all of her responses would be much more intense, and it also might be that the most pleasurable of her responses would be experienced as being of extremely long duration. She was told she would have a post-trance amnesia for these instructions, but, without remembering, would carry out the instructions on the occasion of the experiment, whenever it might take place.

Several months after this suggestion was given, the subject was placed in the audio-visual environment where she experienced a loss of ego boundaries in the perceptual sphere, although an incomplete ego dissolution with respect to awareness of self. She declared that what had happened was indescribable, but that she would tell about it as best she could. The experience had been extremely pleasurable for her, and might be called a kind of *esthetic* mystical experience. Excerpts from her verbal report follow:

> It's the images and colors that take you into it. Then, "colors" is the wrong thing to say, because you stop making identifications in the sense that you recognize "blue" as in a separate category of experience. I had the sense that there was only one color—not that I was seeing monochromatically, but the colors were all just color. . . . And it was without any sense of an environment, or it felt as though all the environment was my own body. . . . I just can't describe it, but I feel obliged to produce for you, and as soon as I say it I know that I haven't been able to produce anything that really mirrors what happened. . . . I'm also not wanting to give the impression that I picked up a drug store copy of some book on mysticism that says "all is one." See, this is not on a *theoretical* level that I am speaking, not on a level of abstraction that says we all are one. . . . What I am talking about is an actual *sensory* experience. I want to convey how it felt, and it was a total, actual experience.

Essentially, this experiment was based upon the observation that prolonged and intense sensory stimulation may result in a mystical-type experience, and that the experience will be pleasurable if the sensory stimuli are pleasurable ones. Such an approach to mystical experience might perhaps be called body-mind affirmative, as distinguished from other, more common approaches taking the *via negativa,* or ascetic path of obliteration, the traditional mystic's way.

CONCLUSION

The authors have described some experiments involving altered states of consciousness and subjective realities. Some of the experiences mentioned have obvious value and pragmatic applications, while others are explored more to obtain basic knowledge that may lead to productive applications in the future. The experiments open up areas of experience which many people have thought to be largely inaccessible, or accessible only by such means as mind-altering drugs or very lengthy and arduous dedication to spiritual disciplines.

One reason why so little has been done to realize many of the mind's potentials, is that experiences such as some of those we have been describing always tend to be either overvalued or undervalued. They tend to be regarded with superstitious awe, dismissed as "airy nothings," or they are feared because of superficial resemblance to some experiences of psychotic persons. Human potentials will begin to be more fully realized when psychologists, psychiatrists, and others have ceased to be so fearful of the mind, while retaining respect for the mind.

A truly rational approach to the nonrational is one of the most urgent needs of mankind, and a true collaboration of reason with imagination would open the way to realization of much more fully human personalities, with many personal and interpersonal conflicts resolved in a greater creativity available for the benefit of all.

Chapter 9

i can't believe i saw the whole thing!

Isaac Asimov

In 1971 the Nobel Prize for physics went to Dennis Gabor, a Hungarian-born British subject now working in America. He had earned the award in 1947, nearly a quarter-century before, by inventing a process of recording images in a way that reproduced far more information than could be done by any other technique known. Because it contains virtually all the information, Gabor named the process "holography," from Greek words meaning "the whole message."

For sixteen years the process and the name slumbered in technical journals. Then in 1963 two electrical engineers at the University of Michigan, Emmett N. Leith and Juris Upatnieks, carried the Gabor technique a step further and made the front pages of newspapers.

Where Gabor had worked with electron waves and had applied his technique to improving the images formed by electron microscopes, Leith and Upatnieks applied the techniques to light. Using the then newly developed laser, they produced a transparent sheet of film that was grayish in color, like an underexposed photographic film, and used it to form a three-dimensional image in remarkably fine detail, and they did it without lenses.

How was it done?

To begin with, let us consider photography, a process that is

by now quite familiar to us (though when it was first developed over a century ago it seemed just as mysterious to the general public).

Photography depends on the ability of light to initiate certain chemical changes. Without going into detail, we can say that light causes a colorless solution of a certain type to precipitate tiny black granules. If the solution is mixed with gelatin, coated on a film, and allowed to dry, the entire film will turn dark if it is exposed to light briefly and then treated with appropriate chemicals.

Suppose, however, that the film is exposed to light only indirectly, that the light is allowed to shine on some object, and that only the portion of the light that is reflected off the object in the proper direction strikes the film. Some parts of the object will reflect light more efficiently than other parts will; some parts will reflect light directly toward the film, while other parts direct the light more or less away from the film; some parts will scatter the light that falls on them, sending it in many directions, while others will reflect the light without scattering.

The result of these differences in detail is this: The reflected beam of light will possess fine differences in brightness from point to point. When such a reflected beam of light enters our eyes, the pattern of varying light and dark is turned into a pattern of electrical impulses in the optic nerve. Our brain interprets the pattern in such a way as to give us an idea of the shape, the color, the texture, and so on, of the object that has reflected the light. We "see" the object.

But what if the same reflected beam of light falls on the photographic film? The pattern of varying brightness in the beam would then reproduce itself on the film. At a point on the film where there impinges a portion of the light beam that is quite bright, a considerable amount of chemical change is induced. Upon proper treatment, that point becomes dark indeed. Where there impinges a dim portion of the light beam, there is little chemical change and that part of the film remains light.

Producing a proper pattern on the film requires that the film be enclosed in a box. This prevents light from striking the film from anything other than the object we want to record. Also, from each point on the object a sheaf of reflected light fans out. If all this light entered the opening in the box, each part of the film

would be subject to some light from every part of the object and the result would be a featureless blurring of the entire film. To prevent this, a lens is placed in the opening. Light passing through the lens is collected into a focus and brought to the film in an orderly fashion. (The light-recording part of the eye, the retina, is also enclosed in a "box," the eyeball; and behind the eye's opening, the pupil, there is also a lens.)

The light focused on the film by the lens in the camera produces an image of the object that reflected the light—but in reverse. The brighter portions of the beam are recorded as dark spots on the film and the dim portions as light spots. The result is a "photographic negative."

If featureless light is made to shine through a photographic negative so that the light falls on a fresh film, the process is reversed again. All the dark places on the negative produce a dim portion of the beam passing through and are recorded as light places on the new film, and vice versa. The new result is a "photographic positive" that records the light-and-dark pattern of the beam exactly as it was reflected from the object.

If certain dyes are added to the film, advantage can be taken of the fact that some objects reflect light of particular wave lengths. If three images are superimposed on the film, each involving a different wave length of light, a photographic positive is produced that shows color rather than a mere dark-and-light pattern.

Assuming that the photography has been properly conducted, that the proper amount of light has entered the camera, and that the lens has been properly focused, one "sees" the object on the film as in reality, and the image is recorded for as long as the film endures.

But is the image really *exactly* like the reality? No, not really. Actually, the aspect of reality that the photographic image produces is quite incomplete. Suppose you look at an object—say two chessmen on a chessboard—through a small rectangular picture frame so as to make the object and its surroundings appear similar to the photographed image on the rectangular film. What then are the differences between the real object and the image? (Of course, you can touch and feel the real object and not the photographic image, but let us confine ourselves to visual properties only.)

Clearly it is possible to tell image from reality by vision alone.

Suppose you shift your head slightly as you look at the real object through the frame. What you see also shifts. From one position, the nearer chessman may obscure the one behind it; but as you move your head, the farther chessman seems to move out somewhat from behind the closer one. You see the real object in three dimensions and can look around an obstacle by moving your head.

This is not possible with the film. The film may give an illusion of three dimensions; a more distant object will look smaller than a similar object that is closer; the lines of a chessboard may show perspective. Still, however clever the photographic image, the appearance of three dimensions remains an illusion and nothing more. No matter how you shift the position of your head, the image that you see never changes. You see one view and one view only.

Another difference is this. In looking at a real setting, you can focus your eyes on a nearer object, leaving a farther one out of focus, or, in reverse, you can focus on the farther at the expense of the nearer. You can move back and forth at will from one focus to the other. The image has a single focus. If the farther chessman is photographed a bit out of focus so that the nearer one is clear and sharp (or vice versa), nothing you can do with your eyes can bring the out-of-focus portion into focus.

The reason for these limitations of the ordinary photograph is that it is the recording of the intersection of the light pattern with a flat, featureless surface (the photographic film). The intersection, not surprisingly, has the properties of a flat surface, and in the process the reflected beam of light loses all its three-dimensional information. Photography ("the light message") is not holography ("the whole message").

But suppose you record the intersection of the light pattern with something more complex than a featureless, flat surface. Suppose you record the intersection of the light pattern with *another light pattern.*

A beam of light consists of very tiny waves. The pattern in a beam exists because some light waves have a greater amplitude than others do (they move farther up and down). This means the pattern is brighter in some places than it is in others. The pattern also exists because some light waves are longer than others, which means that the pattern shows different colors from place to place.

If two beams of light cross each other at an angle, particular

waves in one beam may happen to match particular waves in the other. Both waves move up and down together. The result is that they reinforce each other. In combination the two move up and down farther than either would separately. The combination of waves is brighter than either alone would be.

In this way, when two patterns cross, the waves interfere with each other to form a new pattern of light and dark that wasn't present in either of the two original patterns. The new pattern is called an "interference pattern."

If you have an interference pattern, you can, in theory, work out two patterns that could, in combination, form the interference pattern. The trouble is that any of an infinite number of combinations could have formed the interference pattern and that there would be no way of deciding exactly which combinations did the job in reality.

Of course, if you knew one pattern of the two that formed the combination, you could calculate the other. To do this most easily, however, you would want the known pattern to be as uniform as possible. If one beam of light were simply uniform from one side to the other, with no variations in brightness or color, then the pattern of the other beam could be determined from the resultant interference pattern.

But how are we going to get a beam of uniform light—a "reference beam"? Ordinary sunlight won't do. Sunlight might look blank and patternless, but it consists of a mixture of many colors of light waves in a whole range of wave lengths. To work out the components of an interference pattern, where the simpler of the combining beams is as complicated as apparently featureless sunlight, is impractical.

But how about producing a single color of light by heating some chemical substance that will then emit a single wave length of light? Even that is not enough, for some of the light waves go in one direction, some in another. Even a beam of ordinary monochromatic (one-color) light is not really featureless.

In fact, when Dennis Gabor first worked out the techniques of using interference patterns, there was no conceivable way these techniques could be employed for light waves. Nowhere, either in nature or in the laboratory, did a beam of light exist in which all the waves were of exactly the same length and moving in exactly

the same direction. Unless such a beam could be found or could be made, there was no reference beam blank enough to allow us to calculate the pattern of the other beam with certainty from the interference pattern of the two. Gabor used his technique for wave-forms other than light waves where a calculation could be made.

But then in 1960 the American physicist Theodore Howard Maiman constructed the first laser. The laser is a device that produces a powerful beam of light in which all the waves are of exactly the same length and in which all the waves move in exactly the same direction. At last the truly blank reference beam existed. The laser beam contains no pattern, no "information." When it crosses a reflected beam, all the information in the interference pattern can be referred to the reflected beam alone.

Suppose, then, we set up a situation as follows. A laser beam is made to shine obliquely on a piece of glass that is so treated as to allow half the beam to pass through, while the other half is reflected. The half of the beam that passes through continues to travel in a straight line until it passes through a rectangular opening. The half of the beam that is reflected strikes some object, and some of it is reflected again in such a way as to pass through the same rectangular opening.

The original laser beam (without a pattern) crosses over the richly patterned reflected beam and produces an interference pattern. All the information of the interference pattern would refer to the pattern of the reflected beam. If you were to look through the opening from the other side, you would see the object clearly despite the interference pattern formed with the laser beam.

However, instead of allowing the eye to look through the opening, suppose we put a photographic film in the opening. In that case a photograph will be taken of the interference pattern. All the light and dark areas will be recorded. The pattern would be so fine, however—the alternate patches of light and dark so tiny—that nothing would be visible to the eye. The film would merely take on a slight grayness.

The successfully exposed and fixed film, carrying the interference pattern, is a "hologram."

Now suppose that a laser beam is made to shine on the hologram at the same angle as the original laser beam when the hologram was formed. The laser beam illuminates the same interference pattern that had been set up when, originally, it had crossed the reflected beam. (Techniques had been developed whereby ordinary white light can be substituted for laser light at *this* stage.)

If you look through the hologram illuminated by the laser beam, matters will be exactly the same (from the visual angle) as when you looked through the opening previously. You will see the object as if it were actually there. You will see it in its actual size, its actual appearance, and even its actual three-dimensional characteristics. The hologram is the whole message.

If, through the hologram, you are looking at the image of the two chessmen, one partly behind the other, and you move your head in one direction, you will see less of it. Furthermore, you can focus on the nearer chessman, allowing the rear one to go somewhat out of focus.

Of course, you can't do more to the image than you could do to the real object; it would be unreasonable to expect to do so. When you look at the real object through a rectangular opening, there is a limit to how far you can see around an obstacle. If you move your head too far in one direction or another, you can move yourself out of the range of vision through the opening. The hologram fixes the opening, and you can't move beyond it. In the case of the real image, you can move around and behind it to look at its rear but only at the expense of getting entirely away from the opening. Therefore, you can't do that in the case of the holographic image.

Then, too, you can expect no surprises in a single *photograph* of a holographic image. A photograph taken of such an image is only a photograph, quite two-dimensional, and in itself has no holographic properties. However, you can take different photographs of the same holographic image; you can take photographs at different focuses and from different angles. The individual photographs may be ordinary, but a number of them taken together will give you a hint of the versatility of the holographic image.

There are some important ways in which a hologram, which has recorded an interference pattern, differs from an ordinary photograph that has recorded a flat intersection of a reflection pattern. For one thing, there is no such thing as a hologram negative or a

hologram positive. If all the white-and-dark areas of an interference pattern were reversed, it would still be the same interference pattern carrying the same information.

Then, too, a hologram is recorded without a lens. Different parts of the interference pattern are not focused on different parts of the hologram. Instead, every portion of the hologram is bathed in the crossing over of the two beams of light so that the interference pattern is recorded again and again on every part of the hologram.

If you cut a hologram in half, you are *not* left with two halves of a complete picture. Each half of the hologram can be used to produce the complete holographic image. If you tore the hologram into ten ragged pieces, each piece could be used to produce the complete holographic image. If you scratched the hologram, the part actually scratched would be spoiled, but all the rest would still produce the complete holographic image with no signs of a scratch upon it. If you punched a hole in the hologram, you would still get an image with no sign of a hole. Dust upon the hologram would not interefere either, because the portions not covered by dust particles would still do the work.

There is, however, a limitation.

The interference patterns on the different parts of the hologram—actually repetitions of the same pattern—reinforce one another. The more repetitions there are of the pattern, the sharper and clearer the image is. As the hologram is torn into smaller and smaller pieces, or as it is subjected to more and more holes and scratches or to a thicker and thicker dust cover, the dimmer and fuzzier the image becomes.

You can see this if you imagine someone writing his name with a very light pressure on a hard pencil and with a very shaky stroke. The name may be too dim and shaky to make out. If he repeats the process, though, writing his name over and over again in the same place, there will be repeated places where the pencil strokes will cross one another and where the result will be a darkening.

In the end, after hundreds of repetitions, there may be a gray area around the main thrust of his pencil strokes, but the crossings will concentrate along the lines and curves the writer is trying to make. The result will be that his name will appear sharper, darker,

and more even than any single pencil stroke could have made it.

If you then imagine the pencil strokes removed one by one, the whole name will still be there, but it will gradually grow dimmer and fuzzier. This is analogous to removing more and more of the pattern repetitions on the hologram by tearing, piercing, scratching, or dusting.

What are the applications of holography? To what use can it be put?

It is not revolutionizing the world all at once, for there is more to technological innovation than the mere working out of a new concept. It has to be made competitive; the concept has to be translated into hardware that will do something not only better than before but more conveniently, more simply, more cheaply, or all three.

For instance, holograms can be made of some structure in double exposure. The object being holographed is left unstressed the first time and is placed under some stress the second. The difference in the interference patterns produced represents defects of one sort or another in specific places in the structure being holographed. In this way holography can be used to test airplane wings, for instance, nondestructively. However, such objects can also be tested by X-rays and ultrasonic sound, and holographic techniques are not sufficiently better or cheaper or more convenient to cause a wholesale shift in nondestructive testing as yet.

Holographic techniques could be used to produce three-dimensional television or movie effects, but holography produces too much information for television or movie techniques to handle just yet. Holography must wait for the older systems to catch up to its advances.

Nevertheless, holography can do some things right now that cannot be done otherwise. One interesting application is its use in deblurring fuzzy photographs. It was the desire to do this that led Gabor to the original invention of the technique with respect to electron microphotographs.

Photographs can be blurred through known failings in the system used. However, a laser beam can be passed through the blurred photograph, and an interference pattern can be produced that will cancel out the effects of the failings. A new photograph appears in which the blurring has been greatly reduced.

The technique has been applied very successfully to the photographs taken by electron microscope. Such deblurring extends the range through which electron microscopes can produce successful magnifications. By use of the technique, the double helix of virus nucleic acid was shown for the first time, and eventually single atoms may be made out.

It is also quite possible that holograms will be employed for the storage of information, a use for which their three-dimensional properties are not needed. For instance, holograms might replace ordinary photographic techniques in many cases, since the holograms would be insensitive to scratching and minor damage that would be sufficient to spoil ordinary photographic film. TV cassettes may therefore become holographic eventually.

Then, too, hundreds of pictures can be recorded holographically on a single piece of film. When laster light is made to shine through the film at a series of angles, each differing slightly from the next, a whole series of different interference patterns is formed with a whole series of different objects. These can then all be projected as a laser beam shines on the completed hologram, first at one angle, then at another. Image after image appears and the *Encyclopaedia Britannica* might be stored on a hologram the size of a sheet of typing paper—a sheet that under ordinary photographic techniques could record but one image and no more. This same ability to store enormous quantities of information may result in the development of holographic memories for computers.

However, it is useless to attempt prediction too closely in order to see what holographic techniques might do, for instance, to aid medical diagnoses or surgical methods. Technology often takes surprising turns. Holography is a versatile means of handling large quantities of information, and exactly how it may be applied could depend on ingenious discoveries that would prove as sudden, as unexpected, and as productive as Gabor's original inspiration proved to be.

Chapter 10

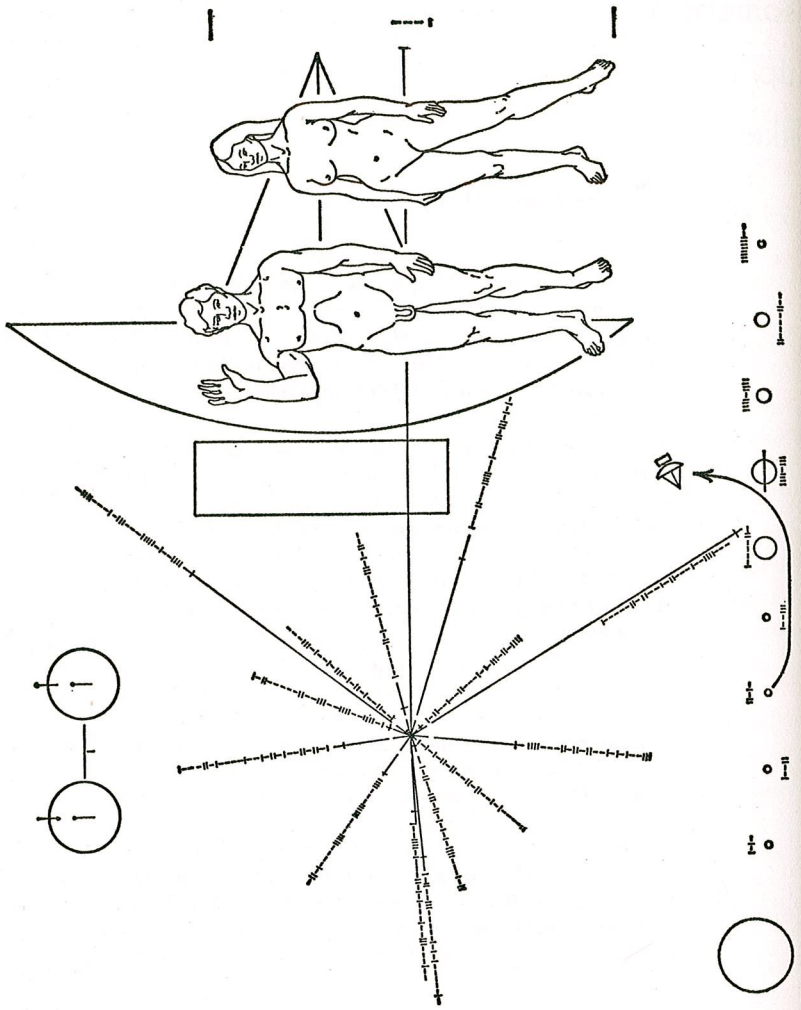
somebody up there like me

James Freedman and Henry Korn

In February of 1972, the National Aeronautics and Space Administration launched Pioneer 10, the first man-made object programmed to depart from the confines of our solar system not only for points unknown but perhaps even beyond imagining.

The rocket carries one of the most incredible communiqués in the whole of human history: a 6-by-9-inch gold-anodized plaque engraved with a message designed to communicate to a possible extraterrestrial recipient our cosmic location, epoch, and basic nature by showing a planetary chart, a pulsar map, a hydrogen molecule, and a picture of a man and a woman.

As testament to the effectiveness of the plaque's ability to stimulate communication, it readily succeeded in arousing the curiosity and further involvement of the coauthors of this article. Shortly after the launch, we interviewed one of its designers, Dr. Frank Drake of Cornell University and Director of the National Astronomy and Ionosphere Center in the hopes of gaining an understanding of the project's heady implications by recording the history of how it came to be. The first part of this article outlines that history and is followed by a speculative probe of the project's significance.



Despite a lifetime devoted, in part, to serious scientific investigation of the possibility of intelligent life on other planets (including a radio astronomy project in which he conducted a systematic search for signals from extraterrestrials), Dr. Drake was given no prior notice from NASA of their ambitious plan to dispatch Pioneer 10 outside the solar system after it completed its probe of the planet Jupiter. Happily, in November of 1971, Drake received word of the plan from a reporter from the *Christian Science Monitor* and was able to swing into action in time for the February launch.

In early December, Drake had an opportunity to share this information with a colleague, Dr. Carl Sagan, coauthor (with Russian scientist I. S. Shklovskii) of *Intelligent Life in the Universe,* an influential study of work in this field from the beginning of recorded history to 1966. Sagan and Drake dispassionately discussed NASA'S plan at a meeting in Puerto Rico. It was quickly agreed that the flight offered a unique opportunity to initiate the first attempt at direct visual communication with the beyond for both the value of the thing itself and to publicize work in this field.

While Drake and Sagan were aware that, if successfully intercepted, the rocket would yield much greater information about its sponsors than the plaque, they also agreed on the value of displaying a conscious attempt to communicate. Thus, they conceived of a plaque that would (1) show the creatures of earth by depicting a man and a woman; (2) impart some basic information on the chemical structure of our world by showing a hydrogen molecule; and (3) attempt to fix our time and galactic location by depicting a map of our solar system and a chart of pulsars known to be emanating from earth by 1972.

On December 8, Dr. Carl Sagan, who had had previous dealings with NASA on the Mariner 9 probe, agreed to approch the agency on behalf of the Pioneer 10 Plaque project. One week later, he telephoned Dr. Drake to report approval for the plan. On December 22, Drake mailed the completed pulsar calculations to Sagan who turned the information over to his artist wife, Lynn Sagan, for final design.

JUST HOW MEDIOCRE WE ARE

Despite occasional bursts of energy and imagination, mankind, like the sun which grants us life, is a distinctly mediocre commodity. We lie together in the mid-outer reaches of one of the spiraling arms of stars that constitute our galaxy. Hot young stars seem to occur along the periphery of the system, farther out on the spiral arms, and the older ones cluster in the more densely populated nucleus. Our sun is neither at the periphery nor the nucleus; it lies somewhere between the outskirts and the center of the galaxy —what some astronomers have called the "suburbs" of the Milky Way.

There are perhaps 150 billion stars in the Milky Way. Of these it is likely that approximately two billion have habitable planets. The physical conditions for terrestrial life, as we know it, are quite common. Earth and its solar system are far from unique—in fact, they are rather typical. The amount of heat given off by our sun in comparison with other stars is neither very high nor very low. Since the mass, distribution, and atmosphere of orbiting bodies are determined in large part by the temperature of their star, the properties of our solar system, like the heat of its sun, are not exceptional. The number of stars that radiate the same approximate amount of heat as our own is very high. And the number of stars that appear to resemble our sun in all aspects, not just heat, is as much as two percent of all stars in the universe.

The conditions for life, using ourselves as a model, are therefore not unique in the universe. Among the numerous variations in galactic systems, we are one of many, many single-star solar systems. Position in the galaxy, proximity to other stars, temperature and age, and most other qualities of our star can not be described as out of the ordinary or extreme. The point is that the conditions of life require no special features—or special concatenation of features—that the universe of possibilities has to offer. The conditions of life are average conditions in most regards. That our star and planet support life can not be considered a "special instance."

TWO PERCENT OF INFINITY

We have said that the minimum estimate for the percentage of stars whose solar systems may have some life is two percent. Is two percent of the universe a lot?

This question poses a dilemma that is concealed by the reserve of most scientists and that unnerves anyone on first considering this subject. Two percent of the universe may seem to be very small when a finite number of things is considered; but it is a lot of infinity. The numbers and figures appear reasonable in one view, but extravagant in another. Any attempt to communicate with extraterrestrial intelligence is at once commendable, urgent, but insanely unreasonable.

Two percent of infinity is enormous. But if we argue—using our average selves as a standard—that the number of life systems occurring around other suns is infinite, we must also argue that the range of variable forms of life is equally infinite. When infinity is a factor, things increase predictably in kind, but increase in form by random and unknown factors.

To assume that our civilization, whose knowledge of radio is only forty years old, should have any basis for communicating with a civilization whose technology might have begun forty million years ago (to use an appropriately arbitrary number) borders on the ridiculous. The possibility of "living" beings existing in the universe is high, but there is not much likelihood they will be like us.

THE MEASURE OF OUR IMPROBABILITY

How fortuitous is the intelligence we possess? The structure of human chromosomes may give us some idea. Chromosomes play the major role during the reproductive process of a cell. They are elongated bodies and contain nucleic acids, DNA and RNA. A DNA molecule is made up of two strands along which are laid out it constituents, called nucleoside phosphates. There are four basic kinds of nucleoside phosphates, and their pattern on the strands governs the reproductive event. As strands of a DNA molecule separate, each seeks in the medium (that is, in its immediate

vicinity), the constituents for a new strand; but the new constituents must conform, in the process of combination, to the pattern established by the nucleoside phosphates along the original strand. This keeps the cell from replicating randomly, and assures that we are forever thus and no other.

In the DNA molecule is the genetic code; since it is due to this code that we are reproduced as we are, we may say that the code gives the most concise definition of who we are. There is an extremely large number of positions for nucleoside phosphates. Sagan and Shklovskii have given 4×10^9. In each of the slots, four different combinations are possible. The number of possible varieties of human chromosomes should be, then, *4 to the power of* 4×10^9. This number, according to Sagan and Shklovskii, is a "measure of our improbability." It is likewise a measure of our fortuity. Since we have said that the structure of the human chromosome is the most appropriate defining feature of our species, we may conclude that there are a lot of things that we might otherwise be.

From one point of view, this number might argue for our admirable evolutionary progress and complexity. More important, however, it indicates the inconceivable diversity that other possible forms of life, even with the same chemistry as ours, might assume. The probability of a form of life and intelligence identical to ours occurring in another galaxy is about as small as two percent of infinity is large.

DETECTING EXTRATERRESTRIAL INTELLIGENCE

Actual contact in the near future with intelligent life in other solar systems proceeds against severe odds, for reasons other than the unlikelihood of mutual comprehensibility. Even if another civilization developed along the same physical and mental lines as us, it is unlikely that it has emerged and evolved according to the same timetable. Furthermore, the likelihood that another civilization should know of our existence is slim. It is our radio emissions more than anything else that make us "visible" to others; and we made our debut into the public world of the universe only forty years ago. In 1960, Frank Drake erected a special receiver to search for signals from extraterrestrials. But only those solar systems less than twenty light years away would have, by now, heard of us and would

want intentionally to contact us. There are only fifteen such stars, and there is no guarantee that there is life on any of them.

What, then, is the possibility of receiving the "noise" of another civilization—its equivalent of the radio emissions of the earth—and other unintentional messages that make their way to outer space? We can see that the probability of that is small by looking at the future of communication technology on earth. As our technical competence increases, less wasteful means of sending electromagnetic waves will be devised; it is theoretically possible to prevent any radiation from escaping into space. If this happens within sixty years, the span of years that earth will have been "noisy" is not more than a hundred. And generalizing, the span of time that any planet with a technical evolution like ours will be "noisy" is only one hundred years of its entire existence. Our chances of detecting a nearby civilization going through its hundred years of noise prior to the perfection of more efficient means of sending signals seems very slight.

But perhaps getting in touch with extraterrestrials is not the most important consequence of knowing that they exist.

SPACE AS A MIRROR

As Pioneer 10 speeds toward the outer limits of the solar system bearing a plaque for our neighbors, a greater number of people than ever before see themselves not only as living on earth but living in space. Some critics of the project have protested the inferior role of the female on the plaque. Others have used the issue as the subject of a joke. One cartoon showed a bubbly spaceman telling his buddy that it was not supposed to mean anything—it was a work of art. To assume that other examples of life should share the very human failing of mistaking the content of the plaque for its form is in no way an aspersion on the intelligence of space people. It is a way of seeing ourselves more precisely.

The same is true for the scientist as for the cartoonist: conjecture on extraterrestrial life is in fact a springboard for the study of earth. When astronomers speak of technical civilizations in other solar systems, they are speaking also of the future of technological civilization on earth. Knowing life is "out there" is a fuse for the contemporary imagination.

Let us pose a typical problem. Suppose that a civilization has advanced technically well beyond the "noise" stage and has learned how to avoid wasting electromagnetic radiation, and in the process, has also learned to conserve *all* forms of energy, including that of the sun. What sort of signals may we expect from such a civilization? We solve the problem, of course, by using earth as an example.

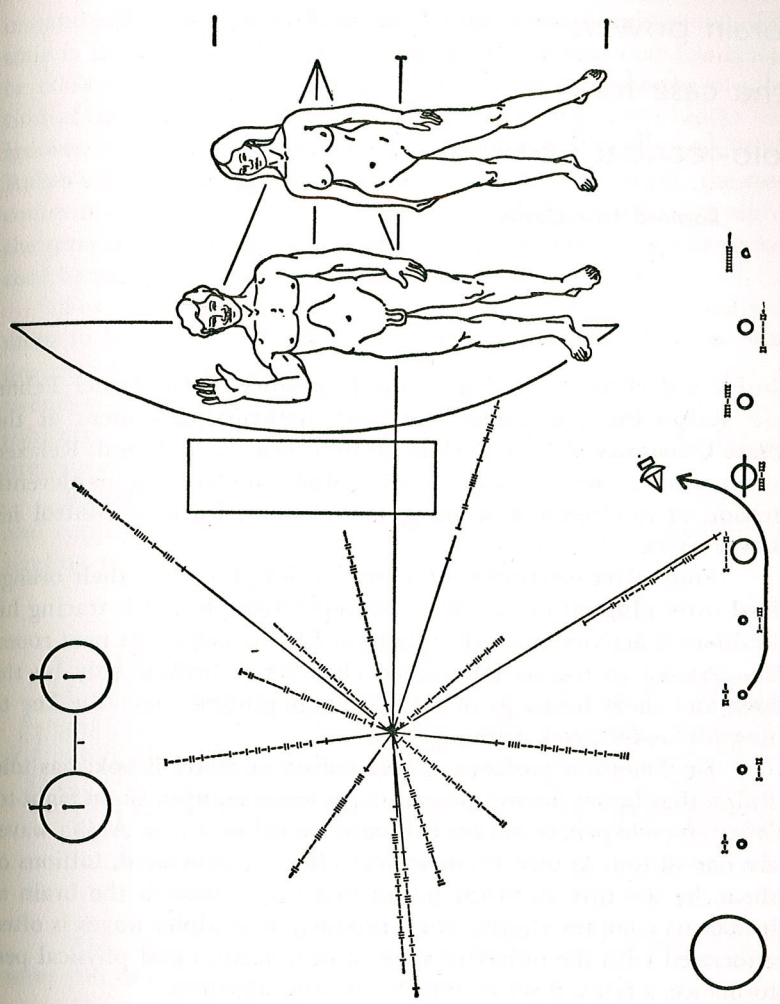
First of all, such civilizations will be difficult to contact. They will receive only the messages they have provisions for receiving, and will emit only the small amount of solar radiation that escapes from this shell. Given a reasonable width for the shell, one could estimate the wavelength of this escaping radiation to be approximately ten microns. Freeman Dyson has therefore suggested looking for signals of this wavelength—hence, "infrared stars"—as possible seats of highly advanced civilizations.

OUR LOT IN SPACE

Speculation on this matter raises the disturbing question: Will advanced civilizations be at all eager to enter into contact with others? Do curiosity and the desire for progress continue in an aging advanced society that has solved its problems?

An eminent astronomer and futurist, Sebastian Von Hoerner, has foreseen a number of crises for civilizations like ours; among them, he has included population density, irreconcilability of great political powers, natural aggressiveness leading toward self-destruction, and genetic degeneration. The solution of each of these demands the abandonment of some basic ideals: the ethics of competition, self-propagation, and progress. In short, in order to finally solve those problems that threaten contemporary society, there is but one hope. The notion of stagnation—an eternal present—must become a good and readily accepted reality. Stasis is simply a consequence of surviving the crises that threaten a developing civilization. One of its corollaries must be a disregard for anything that upsets the equilibrium of an unchanging society—including extraterrestrial contact. Inquisitiveness, by necessity, will have died. Thus, we are left with one final question:

Do technological civilizations survive?



Chapter 11

brain power: the case for bio-feedback training

Barnard Law Collier

Inside a darkened chamber in the laboratory of Dr. Lester Fehmi sits Ralph Press, a nineteen-year-old mathematics student at the State University of New York in Stony Brook, Long Island. Relaxed in an armchair with his eyes closed, Ralph is undergoing his eleventh session of bio-feedback training to help him learn to control his brain waves.

Four silver electrodes are pasted to Ralph's scalp, their orange lead wires plugged into an electroencephalograph that is tracing his brain-wave activity on thick ribbons of EEG paper in the next room. The silence in the sound-proofed chamber is broken only by the long and short beepings of a rather high-pitched tone: the key to Ralph's bio-feedback training.

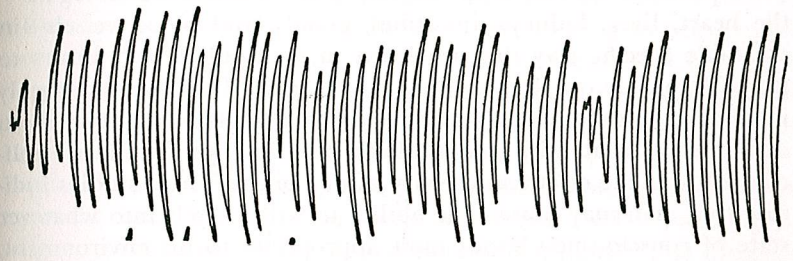
Dr. Fehmi, a professor of psychology at Stony Brook, has told Ralph that he can learn to increase his brain's output of an eight-to-fourteen-cycle-per-second brain sine wave called alpha. Alpha waves are one of four known brain waves. They are generated, billions of them, by the tiny electrical pulses that surge through the brain as it does its complex chores. High production of alpha waves is often associated with the objective state of peak mental and physical performance, a relaxed yet extremely sensitive alertness.

Dr. Fehmi and George Sintchak, the Stony Brook psychology

department's chief electronic engineer, have rigged the EEG machine and a computer so that each time Ralph's brain generates a burst of alpha activity the occurrence is recorded, timed, and almost instantly made known to Ralph by means of the beeping tone. The tone is Ralph's bio-feedback. It is an audible signal that lets Ralph be consciously aware of a visceral function, in this case the production of his alpha brain waves, which his mind ordinarily blocks out, ignores, or is unable to perceive without external assistance. When Ralph's brain generates only snippets of alpha radiation, the tone comes in staccato little blips. As he produces more and more alpha, the tone stays on longer and longer. Ralph, of course, wants to succeed by producing as much alpha as he can.

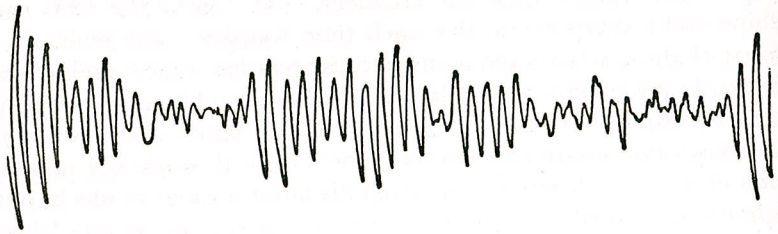
For nearly an hour, Ralph shows minute-by-minute improvement in his ability to keep the tone on. A computer read-out verifies that he is maintaining the tone for a cumulative average of twenty-eight seconds out of each minute. "He's one of our super-subjects," Dr. Fehmi remarks. "He's not the best, but he's getting pretty good."

Ralph's alpha waves are of high amplitude, very rhythmic and regular. This is what they look like as they are traced by the jiggling pens of the EEG machine:



"OK, Ralph," Dr. Fehmi says quietly over the intercom, "I want you to turn the tone off and keep it off."

The tone that Ralph has learned to sustain for upwards of three seconds now goes beep, beep, *blip;* within seconds, it has died away except for tiny random beeps. This is what it looks like on the EEG tracing as Ralph begins to stop his alpha waves:



"Now turn the tone back on," Dr. Fehmi says.

A pause of a second or so and the tone beeps back to life and stays on for seconds at a time. Then on, off, on, off. The tests continue until it is clear that Ralph is in personal command of his brain's alpha-wave activity as evidenced by the EEG machine's record.

A steady flow of new scientific findings indicates that, with the aid of the teaching technique called bio-feedback training, man can learn to control willfully his body and his state of consciousness to a degree that traditionally has been dismissed in Western cultures as mere trickery or condemned as somehow wicked or blasphemous.

Projects in hospitals and research laboratories around the world are convincingly demonstrating that it may be possible to learn personal mastery over the functions of our visceral organs—the heart, liver, kidneys, intestines, glands, and blood vessels—in the same specific way that we learn to manipulate our fingers to play Chopin or our legs to kick a field goal. There is also highly intriguing research going on in laboratories like Dr. Fehmi's to demonstrate that with bio-feedback training we can learn self-control over the electrical activity of our brain. These studies indicate that man may possess the ability to will himself into whatever state of consciousness seems most appropriate to his environment, to accomplishing a task at hand, or to some special pursuit.

The implications of bio-feedback training are proving terribly easy to overstate, given the limited amount of solid experimental evidence that presently exists. People seem peculiarly ready nowadays to lunge at the adventurous prospect of employing new methods and modern technology to explore and conquer one's own brain and body instead of, say, the moon or Southeast Asia. The propensity for exaggeration about progress in this area frightens prudent

scientists. Already they are encountering the con artists, the charlatans, and the quacks who are taking people's money by glibly mouthing the jargon associated with bio-feedback research and similar studies of the mind's control over internal organs. This caveat is offered early because it is difficult to keep one's imagination reined in unless one is warned that much of the data accumulated so far are limited to experiments with rats, monkeys, rabbits, or other lab animals. And the remarkable results with animals may not travel well from the laboratory to humans. Nevertheless, research teams are reporting an ever increasing number of cases in which human subjects have unquestionably gained conscious control over visceral organs once thought beyond the mastery of the mind.

In Baltimore, for example, Dr. Bernard T. Engel, a psychologist, and Dr. Eugene Bleecker, a cardiovascular specialist, have conducted bio-feedback training sessions with eight patients suffering from premature ventricular contractions, a dangerous irregularity of the heartbeat involving the heart's main pumping chamber. With significant success, these patients have learned to speed, slow, and narrowly regulate their heart by force of mental discipline alone.

At the Gerontology Research Center of the National Institute of Child Health and Human Development, Dr. Engel and Dr. Bleecker use a visual form of bio-feedback training to help patients control their heart. In a typical experiment, the patient lies quietly on a hospital bed in a small, windowless laboratory near Dr. Engel's office. The electrodes of an electrocardiograph are attached to his chest and pulse points, and the EKG machine is hooked up with a specially programed computer. On the bed table in front of the patient sits a small metal box fitted with a red, a yellow, and a green light in the same pattern as a regular traffic signal. The display is hooked into the computer, which almost instantly analyzes the EKG readings and provides bio-feedback information to the patient by means of the flashing colored lights.

The first phase of the training is speeding the heart rate. The patient may be told that when the yellow light goes on he will know that his heart is beating faster; the green light flashing on means it is slowing down. A small meter next to the light box indicates to the patient what percentage of the time he is succeeding in keeping

the yellow light lit. The goal for the heart patient, of course, is to gain control over the lights and his heartbeat in the same way Ralph Press controlled the beeping tone and his alpha-wave production: by sheer mental effort, and without any muscular exertion—which amounts to cheating.

After a patient learns to speed his heart, he is then taught to slow it down with the red light and later to keep it beating within narrow normal limits, with the three lights acting as too fast, too slow, and normal signals. Some of Dr. Engel's patients have achieved a 20 per cent speeding or slowing of their heart—about sixteen beats a minute from an eighty-beat-per-minute base. This self-willed rate change in one direction or the other tends to even out the irregular beats. Why? Researchers are not quite sure, but it works.

But what happens when the patient goes home, away from Dr. Engel's bio-feedback light box? The final stage of the five-phase training program is the stepped withdrawal of the bio-feedback light signals. The patient, after extensive training, finds he can deliberately alter his heartbeats in the desired direction without artificial feedback. One of Dr. Engel's patients could still remember how to control his rate after two years. That Dr. Engel's patients retain what they have learned without the aid of an electronic device to provide feedback is what excites many researchers who feel that we may be capable of discovering unknown mechanisms, or "feedback loops," within ourselves that will allow us, after some basic training, to monitor our viscera and their functions at will throughout life.

In Boston and New York City, scientists are trying to see how people with hypertension can effectively lower their abnormally high blood pressure by thinking it down. Under the direction of Dr. Neal E. Miller, a professor of physiological psychology at Rockefeller University in New York and a pioneer in the brain sciences, experiments are now proceeding to discover if human subjects can learn to control the contractions of their intestinal tract. Laboratory rats have learned to control these contractions with notable success. If humans can do as well, it could mean relief from much suffering for people with spastic colons and similar gastrointestinal ailments usually associated with stress and psychosomatic illness.

Dr. Miller was in the forefront of what seemed, just a decade

or so ago, a vain and somewhat foolhardy challenge to the bedrock idea that the viscera and the autonomic nervous system that controls them operate entirely independently of an animal's deliberate control. Dr. Miller has traced back to Plato the dogma that the organs controlled by the autonomic nervous system function at a kind of cave-mannish level, learning only in classical Pavlovian fashion to react to such stimuli as sour lemons and growling bears. On the other hand, the somatic, or cerebrospinal, nervous system, which transmits nerve signals from the brain to the spinal cord and directly to the skeletal muscles, can learn by the sophisticated trial-and-error instrumental process. Perhaps the Greeks considered it an act of hubris to believe that they, not the gods, exercised command of their heart, brain, and guts. Dr. Engel, who also has studied the accumulated prejudices against the viscera, can recite a chain of erroneous proofs put forth until only a few years ago by scientists who, with a kind of religious fervor, had shunned anatomical facts and new information in order to steadfastly support Plato.

At the root of the research reports on bio-feedback training is what Dr. Miller describes as "an almost complete change in our way of thinking about our viscera and their ability to learn. We are now able to regard the activities of our internal organs as behavior in the same sense that the movements of our hands and fingers are behavior. This is the basic stem of it all, but just where this rather radical new orientation will lead, we can't be sure yet."

Some indications that we can possibly control our viscera have been around for centuries without anyone's grasping their import. Dr. Miller points out that actors and actresses can control their tear glands, which are visceral organs, to make themselves cry on cue. It is possible that some classical conditioning is involved: The actor recalls something sad and the sadness makes him cry. But many actors and actresses say they can cry without any recalling, that all they have to do is think "cry" and the tears flow.

Magicians and mystics and meditators have often gained mental control over visceral organs to a significant degree. Harry Houdini is said to have been able to swallow and regurgitate a key that would unlock him from some otherwise unopenable box. If he did this, it would mean he had gained mastery over the muscles of his esophagus and stomach, part of the viscera.

A few yogis, it would seem, can control their metabolism to

some extent. But whether or not they "cheat" by using skeletal muscles instead of only their mind to perform their tricks is unknown. Scientists have found that some yogis who can "stop" their hearts so that no pulse or sound of beating can be detected are actually performing what is called the Valsalva maneuver. By taking a deep breath, closing their windpipe, and breathing hard to increase the pressure inside their chest and around their heart, they collapse the veins to the heart and clamp off the return of blood. This arrests heart sounds and the pulse, but an EKG shows that the heart is still beating and usually quite fast. "We must reexamine a lot of phenomena we may have dismissed as fakery before," Dr. Miller says.

The belief in a "superior" somatic nervous system and an "inferior" automatic nervous system was so strong that, according to Dr. Miller, "for more than a dozen years I had extreme difficulty getting students or even paid assistants to conduct experiments on the control of internal organs." But Dr. Miller persisted, and his research has led many other scientists to abandon the old dogma. He has shown that the internal organs in animals and to a significant extent in man, as well, are capable of learning by trial and error—and with a startling degree of specificity and discrimination. In one experiment, which Dr. Miller particularly enjoys mentioning, he and his research colleague, Dr. Leo V. DiCara, tuned their instrumental conditioning process down so fine that a rat learned to blush one ear and blanch the other. In almost all of his animal experiments, Dr. Miller paralyzes the rats and other lab animals with curare, a powerful drug used by South American Indians to tip their poison darts. The curare interferes with all the nerve impulses that keep the skeletal muscles working—including respiration. The paralyzing of the skeletal muscles ensures that the animals do not "cheat" by somehow using their skeletal muscles to affect their visceral responses. (It is thus far a frustration for Dr. Miller and others that non-curarized animals are slower to learn viscerally than the curarized ones.)

The difference between the way the body learns by classical conditioning and by instrumental conditioning is crucial to understanding how bio-feedback training works. Classical conditioning, or learning, always demands a stimulus that elicits an innate response. For example, the first time you ever saw a lemon, nothing

much happened with your saliva glands, which are visceral organs. But after you first tasted its sour juice, your saliva glands automatically secreted lots of saliva to dilute and wash away the puckering citric acid. You cannot control the response of your saliva glands to the lemon juice, and after you have tasted several lemons your mouth will start watering at the very sight of one. You have been classically conditioned to salivate at the sight of lemons. The same thing works for other such stimuli: a mad dog, for example. The sight of one will boost your heart rate, increase your adrenaline flow, and generally activate other innate fear responses.

The process of instrumental learning is much less limited since it requires no specific stimulus to provoke a response. If you want to sink a twelve-foot golf putt, for instance, there is nothing anyone can offer you, not a lemon or $5,000, that will get your body to hole the ball out with Pavlovian sureness. But by the process of trial and error, or instrumental conditioning, you can learn to coordinate your muscles and other responses. You stroke the ball toward the hole and it glides by. You try again and again. Each time you get closer. You are not aware of precisely what you are doing to improve; you cannot say which muscles are contracting or relaxing and in what order. But you get closer nonetheless, and each near success is a reward that is likely to keep you trying. At last you are in control of your muscles, your responses, and the golf ball. It plunks into the hole. This trial-and-error process is called instrumental learning.

Now imagine that you are trying to make the same putt blindfolded. Very difficult, if not impossible. Why? Because something essential is missing from the learning process: feedback. In this case, the feedback is the sight of the ball getting closer to the cup. Of course, you could learn to make the putt blindfolded if you substituted for the feedback of your visual perception the voice (feedback) of your caddy. He might, at the simplest level, say "yes" when your direction was right and say nothing or "no" when it wasn't. He might offer more guidance: "A little more to the right" or "A little to the left and harder." You would still be badly handicapped by the imprecision of your caddy's secondhand information, but eventually you would sink one and then perhaps quite a few.

Our mind is in some ways like the blindfolded golfer where the viscera are concerned. Scientists are trying to find new ways to

remove the blindfold, which is enormously difficult indeed, or to substitute the guidance of the caddy-type feedback for sensory information about visceral organs that the mind for some reason dismisses or never perceives. Dr. Fehmi's beeping tone and the minivolt currents of pleasurable brain stimulation that lab rats get are simple reward bio-feedback signals; Dr. Engel's colored lights represent more guidance. All are examples of bio-feedback used to instrumentally condition internal organs by letting the mind know, within predetermined limits, what those organs are up to.

One path of bio-feedback research has branched slightly away from the strictly therapeutic approach and is investigating the ability of human beings to exert purposeful control over their visceral functions, especially their brain functions, with the goal of making the essentially healthy person better able to cope with his world. At the United States Navy Medical Neuropsychiatric Research Unit in San Diego, California, Dr. Ardie Lubin and Dr. David Hord, both psychologists, are studying the relationship between the output of alpha waves and sleep. What they want to determine is whether or not a person deprived of sleep can be returned to a state of effectiveness and acceptable decision-making capacity by willing himself into an alpha state for a certain length of time. Some preliminary tests have shown that alpha states may be recuperative.

At the Langley Porter Neuropsychiatric Institute, part of the University of California Medical Center in San Francisco, a research group headed by Dr. Joe Kamiya is exploring the possibility that brain-wave control may have important effects on health, creativity, and such mental functions as perception and memory. Dr. Kamiya is regarded by most psychologists as the pioneer in the field of brain-wave control. Dr. Kamiya and his research team have found that subjects who do best at mastering their alpha-wave output are those who have had some training in meditation, as in Zen. At Stony Brook, Dr. Fehmi has noted that musicians, athletes, and artists are especially adept at control over their brain waves. Conversely, he has found that subjects who come into his chamber and slouch in their armchair in the spaced-out way associated with drug trips produce precious little alpha.

It is frustrating to researchers that the subjects who are most proficient in gaining brain-wave control are often strangely tongue-

tied when it comes to telling just how they do it. Some say they relax and wipe everything from their mind. Others concentrate on some infinite point like a mystical third eye in the middle of their forehead. Some are unable to verbalize the experience at all.

"The best way I can describe the feeling of alpha," says Dr. Fehmi, "is a relaxed but alert and sensitive 'into-it-ness.' " Dr. Edgar E. Coons, a physiological psychologist at New York University and a musician, has been trained to produce alpha waves in Dr. Fehmi's lab; he says the alpha state "makes me feel as if I'm floating about half an inch above my seat." A talented young musician named David Rosenboom, who recently presented a bio-feedback brain-wave concert at Automation House in New York (brain-wave activity was fed into a computer and an ARP synthesizer; the result was a weird but not unpleasing effect), is the reigning champion brain-wave producer for Dr. Fehmi. When his alpha is really going strong in all parts of his brain, Rosenboom says he is plugged in to a "great energy source." Another musician named LaMonte Young, who keeps a forty-cycle "home" tone going in his Manhattan studio at all times, explained that he had no trouble generating alpha the first time he ever tried it, because his mind "is tuned to frequencies and intervals."

At the University of Colorado Medical School, Dr. Hans Stoyva has had notable success in teaching his patients how to relax specific muscles that tense up and cause certain kinds of tension headaches. The easing of pain has been swift and dramatic.

Dr. Martin Orme, director of experimental psychiatry at the University of Pennsylvania Medical School in Philadelphia, is studying the alpha-wave phenomenon with an eye toward finding out what exactly an alpha state does to or for an individual and how it might be beneficial to him. "It's not enough to know you can contemplate your navel," Dr. Orme says. "You then have to ask, 'What happens?' " Experiments conducted with subjects who have been trained to produce a reliably high alpha-wave output show, according to Dr. Orme, that critical thinking tends to interfere with alpha waves, but that alpha-wave production does not mean blunted intellectual capacity. What alpha production seems to do best for the alpha producer is relax him, insulate him from stressful critical thought, and rehabilitate his autonomic nervous system to some degree.

"What this may mean," Dr. Orme says, "is that alpha might be used to bring down the level of a person's anxiety to a point where he can function at his best. We all need a certain amount of anxiety to function. It is well accepted that we function best as anxiety rises to a certain point on a bell-shaped curve, and past that point we do increasingly worse as anxiety increases. If alpha can be used to knock down anxiety to the point on the curve where we work most effectively, it can be a most important development." However, Dr. Orme is quick to point out that "this is three levels or more from where we are now, but it is something to consider."

Another prospect for visceral learning is its use as a possible alternative to drugs. If, for example, a high alpha output can cause deep relaxation, or a specific focusing of bio-feedback training can loosen up a taut muscle, this could well substitute for the billions of tranquilizers consumed to achieve essentially the same effect. The advantage over drugs might be considerable. For instance, while a tranquilizer acts in a general way on the whole body or an entire bodily system (perhaps with unwanted side effects), bio-feedback training might be specific enough to do the job required and let the rest of the body function undisturbed.

"There is also," says Dr. Orme, "the general question of personal control and how we might be able to bring our emotions under control. We want to know, of course, to what extent an individual can gain control with precision and reliability over the things he fears. A good part of fear is the fear of fear. If you know you are going to be hurt, you will hurt more with exactly the same degree of hurting stimulus. If we can break into some of the feedback loops that are part of the fear cycle, we may be able to control unpleasant and unproductive anxiety."

To Dr. Orme, the goal is clear. "We may be able to become actual masters of our destiny. As a psychiatrist, my purpose is to enable man to decide his own fate instead of his juices deciding for him."

At Rockefeller University, Dr. DiCara, a burly ex-football player, is attempting to unravel some of the whys and hows of visceral learning. In one recent experiment, he and Dr. Eric Stone found that rats trained to increase their heart rate had significantly more of a powerful group of chemicals called catecholamines in their brains and hearts than rats who learned to *lower* their heart

rates. In humans, catecholamines are associated with hypertension and coronary artery disease. The possibility of learning to slow the heart rate to achieve beneficial effects on hypertension and heart ailments is intriguing; however, a major obstacle still to be overcome is the inability at present to measure catecholamines in the human brain.

An equally intriguing possibility has been raised by an experiment conducted by Dr. DiCara and Dr. Jay M. Weiss. Rats that had learned to slow their heart rates subsequently showed excellent ability to learn to move back and forth in a shuttle box to avoid an electric shock. Rats trained to speed their hearts learned very poorly and exhibited signs of extreme fearfulness by leaping into the air, squealing, and turning toward their tails with each pulse of shock instead of getting away from it. In contrast, the slow heart-rate rats took each shock in stride, with only "mild jerks," and slowly walked out of the electrified side of the box.

"It is crystal-clear," says Dr. Miller, with whom Dr. DiCara has worked as co-experimenter on many projects, "that heart rate training affects rats' learning. What is further indicated is that the training also affects their emotionality. We cannot jump from the laboratory to the clinic, but we may indeed find that in human subjects trained to lower their heart rates there could be an increased capacity to adapt to stressful situations and a corresponding decrease in emotionality."

The field of bio-feedback training and visceral learning is still only crudely charted. New research teams are forming to explore further; the mechanical and electronic spin-offs of the space age are providing the new tools and infinitely more sensitive measuring devices that are required for progress. But most of all there seems to be a new attitude.

"We have brought four to five thousand years of cultural myths into the laboratory to be investigated," says Dr. Miller, who, in just a few years, has seen the pendulum of interest swing from "great resistance to great readiness." Although he is understandably reluctant to speculate on what the future holds, he is nonetheless confident that the new knowledge about our internal organs will stimulate much more research into the astonishing ability of human beings to learn.

PART THREE

the impact of the new media

Discussions of the impact of the new media are necessarily speculative. Since most of the new media have yet to find widespread application, the consequences of their use cannot be known. Many of the new media have not been fully developed and it can be anticipated that with their technological sophistication will come many presently unpredictable impacts. Thus, discussion of their impact falls within the domain of that special way of thinking we call futurology. As it is true that fifty years ago our world could not have been accurately predicted it is certain that any description of what the world will be like under the influence of the new media is merely conjecture.

Nevertheless, if the question of impact is difficult to approach precisely, it is still worth our consideration. The essays that follow were chosen because of the implications of the new media they illuminate. Each points the way toward several fundamental changes the new media will help to bring about.

The new media will change perceptions, and changed perceptions lead to changed lives. I have included my essay "Lewis—The Electronic Person" as one example of the many accounts of

human beings who have developed new lifestyles and life orientations of greater compatibility with the age that lies before us than with our own. As the new media become the customary media of young people generational differences will increase in scope and magnitude. The electronic environment, cybernetic thinking, and perceptions formed by involvement with the new media will foster the growth of human beings whose lives are fundamentally unlike those lives which preceded them. My essay is a personal account of what I think will become a widespread phenomenon.

Few are as capable of describing the full range of new perceptions as is John Lilly. A pioneer of the cybernetic consciousness, Lilly has innovated many ways of applying what we know about systems to human and other life forms. Here the mysterious loses little of its wonder and gains a vocabulary and a way of thinking that brings those things believed to be incomprehensible into rational purview. Eventually as we learn from the new media we will translate new information into anthrocentric data. Lilly has begun the process. Paul Pietsch's essay is yet another insight into our own behavior. Pietsch's translation of holographic theory into a theory of the human mind points the way to one of the most, if not *the* most exciting avenues for future discovery: neurobiology.

Still many readers may find insight into the human mind of little importance to the conduct of day-to-day life experience. Peter Goldmark is the father of videotape and the holder of many of the major new media patents. His essay is a substantive account of the ways he feels the new media will affect current life/work styles. Though speculative, many of Goldmark's postulations appear to be quite reasonable, and we can be fairly certain that as the new media's impact is felt throughout society we will not continue to "conduct business as usual."

Though these essays do point to certain areas where impact is certain to be experienced they scratch the surface and only point to the overwhelming possibilities of transformation resulting from the new media.

Speculation of their impact is one way of trying to imagine a world that will be different from our own sooner than ours became unlike late nineteenth century America. Within certain fields like medicine, education and psychiatry the impact of the new media will be incalculable. As I have tried to indicate in earlier sections the

question that faces us is, How much of the future impact of the new media will be guided by reasonable and humane decision, and how much will be the result of the reckless assertion of the social and cultural narrowness so pervasive in the present environment. At the heart of the question of impact, then, is the present conflict of values. What we do or do not do today is a choice designing tomorrow.

Chapter 12

lewis— the electronic person

Barry Schwartz

I met Lewis in June, 1971, at a time when the tired critics were trying hard to drum up new labels for the 1970s. They were not succeeding. The politics of protest seemed to have spent itself in grieving. The *New York Times* pictured beer halls and football stadiums, complete with raccoon coats. *The Greening of America* seemed as removed from June of 1971 as did Kenneth Kenniston's *Young Radicals* from his book four years before, entitled *The Uncommitted.*

Elvis Presley had come back, while everyone sat in the doldrums of a social stasis. Jesus Freaks were trying hard to make us believe something was happening, but somehow the media men were not able to go far on religious fanaticism. Tim Leary had been excommunicated and was in exile; Eldridge Cleaver was thawing out in the North African sun. The songs of the 1950s returned, and company vice-presidents of the 1950s were now assuming the chairmanships. The war in Vietnam continued, but nearly everyone acted as if it had passed; the counterculture had passed, and nearly everyone acted as if it were still here. It was not a depressing time; it was a waiting time.

The first impression I had of Lewis was that, amidst the social lethargy of 1971, he could not stop moving. His legs leaped to the tune of some personal Olympics, his mouth made noises, his hands

drummed to the lead of some unknown guitar as he beat them against the sides of chairs. It was all very striking; Lewis had an energy I had not really seen before.

It would be easy to attribute the ritualistic motions of this twenty-year-old to random eroticism, hypertension, nonspecific neurotic behavior. Our first conversations confirmed my feeling that I did not understand Lewis. And since I like to feel I understand things, I knew that I could only enter into a relationship with him if I understood that I did not understand him. With his help I would come to know what Lewis was about.

Although Lewis and I shared much in common, held many of the same views on the world and on the trivial, and enjoyed many of the same activities, I found that our similar qualities had evolved in radically different ways. When I heard myself talking, I realized how much of what I know, my range of intellectual understanding, my background information, all derived from a very restricted and highly definable method of inquiry—print. Throughout our discussions I referred to things, ideas, persons, allusions, and metaphors known from literary experience; and my logic smiled when it flowed and frowned when it was required to question its own premises. In contrast to Lewis, I was a cognitive man. Though Lewis and I ultimately shared many philosophic, social, and cutural values, it was not by cognitive units and print logic that Lewis had achieved his brilliance.

Lewis was, in flesh and bone, what Marshall McLuhan and others said he would be. He was not literary, not particularly logical; he did not read, perhaps could not read, and many of his pronouncements were offered as one-liners, lacking full development, careful articulation, and the smooth logic that enabled me to consider my views as conclusions. Lewis's world view emanated from the lifelong experiences he had had with mind-expanding drugs, music, and electricity. Where I would say, "I remember when reading Sartre that . . . ," he would say, "It was when I was tripping at Steve's. . . ." Our conclusions might be the same, often identical, but the building blocks and the very foundation of our experience upon which our insights were based were fundamentally unalike.

I learned a great deal about the loss of absolutes, the relativity of experience, and the inconsequential nature of life itself by reading about it; Lewis learned about it by sensory declassification, experiences of time warp, and the entire range of philosophic insights to be had when, under the influence of LSD or sensory overload, he experienced his death and his rebirth innumerable times. Throughout our conversations we came to realize that our communication would not be satisfactory unless we stopped evaluating our methods and started sharing our conclusions.

Lewis's primary modes of learning were experienced as "trips." The word is helpful here because it suggests moving and changing, and in many ways this was one key to Lewis's value system. That which did not move, flow, or change was stagnating. We shared a deep dislike and distrust of "boredom." But for me boredom was intellectual, cognitive, and communicative stasis. Lewis experienced boredom as not moving, being held, being prevented from changing and behaving spontaneously. Though our responses to boredom were remarkably the same, our experience of it differed. Lewis experienced a time phenomenon where I experienced a flow phenomenon. Boredom was, in Lewis's mind, an abyss into which one fell, for he experienced time with enormous intensity. Boredom, in my terms, was a detour on a linear track. He defined boredom as sensory deprivation; I experienced boredom as intellectual dullness.

Other differences emerged. Lewis had no difficulty doing many things at the same time. He was always reacting to several experiences simultaneously. When I was doing something, an additional activity was perceived as a distraction. He would speak to me for hours, all the time listening intently to the pounding melodic rhythms of his favorite rock groups. Initially, at such times, I felt as if I could not hear myself think. He said it was not important to hear myself think; it was only important to think.

Lewis had a very simplistic view of the world: them and us; new consciousness and old. I had a very complex view of the world; there were many facets to consider, great intricacies, levels of contradiction and confusion, nuances that might escape my attention. If Lewis was a nit, I was a nit-picker.

While listening to music, Lewis would touch controls that altered the ranges of sound imperceptively, and having done so, he would radiate satisfaction. I could hear no difference. His car was wired like a sound studio. His home was full of buttons and dials. Above his bed hung a color television set, and on it he watched

the videotapes he made. On each side of the bed were enormous Altec Lansing speakers, the kind used in motion-picture houses. His work with videotape consisted mostly of original designs for sensory dislocation and highly innovative concepts for the creation of experiences. His fascinations with ideas that seemed to have no possible application, his unrealistic expectations of future events, his electronic disgust with the mechanical world were the chief features that separated us.

He did not, as one might expect, function well within the "straight" world, not nearly as well as I. But then again, he had less need to do so, for the world could offer him little more than the money he needed to fund his latest research project. He had no need for status, social approval, or a career. Though his relationship to the outside world would create enormous practical problems for him, perhaps even eventually defeat him, his was not a psychic problem, only a material one. Lewis had made up his mind about the world; his confusions arose only from the difficulties of implementing his strategies. He complained that he had to waste a lot of time.

But beyond his search for resources, the world he wished to live in was at home. Each day was spent inventing, coercing farfetched ideas into workable schemes, and relating to those who were already of his world. His interests ranged from sensory feedback devices, to nuclear engines, to human flying machines, to expounding the view that modern communication systems destroy the concept of the city. Whenever the pressure was on him, he sat near the AC plug.

Lewis was raised on electronic and psychedelic experiences. Surrounded by the middle-class values of his parents, he learned the relativity of all values, the insubstantiality of possessions, and the positive consequences of egolessness. While his parents talked of security, every night under the influence of some new media he experienced continual change. He does not read, partly by choice and partly, because of his time referencing, by necessity. He accepts his limitations while maintaining a view of himself as always changing, always capable of reincarnation. He feels he is an early forerunner of a new man, a result of voluntary evolution, born too early to be part of a community, born too late to submit to the mentality of the mechanical world. With others like him, he hopes

to create pockets of electronic sanity. Though he is bitter when evaluating young people generally, he is basically optimistic and is propelled by his own ability to get inside himself.

Though he is exceptional in the sense that he has had to compromise less than many, and has been less scarred by the encounter with old values, I believe that he is only a more substantial version of a sensibility found among many others who share his orientation, values, and perceptions.

I am not sure what it all means, and I suspect Lewis and I will know each other a very long time, partly in order to find out. Certainly we have influenced each other enormously. I think that I have made it possible for him to know more, and consequently to do more, and that he has done the same for me. If the print culture and the electronic environment are incompatible, they are so only in the extreme. Lewis and I were able to mesh the best of both worlds by incorporating aspects of each other's experience. In the end we were able to communicate, grow, and change together.

I think that I am more capable than Lewis of living in the present and that he is more prepared to experience the future. The media that taught him are new, and because they are new, he lives with a sense of discovery and immediacy. The media that are mine, and will always be mine, are not new and may soon be exhausted and unable to grow. If this is the case, they may tell us more about what has been and even what is; and yet, they may be increasingly unable to communicate what will be.

Lewis and I have lent our media to each other. How much we have mutually incorporated them will be known only in time, and that, at least at this moment, is the only thing we can be certain we will have.

Chapter 13

from dolphins to lsd: a conversation with john lilly

Sam Keen

SAM KEEN: If there is a cartographer of altered states of consciousness—of the highways and byways of the inner trip—it is John Lilly. You are indeed a rare combination of scientist and mystic. You have traveled from the natural sciences to the esoteric sciences. You seem to incarnate the dissatisfaction that many moderns feel with the narrowly scientific way of knowing and being in the world. But many people still think of you first as the man who communicates with dolphins, so perhaps this is a good place to begin your story. How did you get into dolphin research?

JOHN LILLY: There were several motivating interests. I had been working in brain and mind research for many years. In 1954 I began work in physical isolation in a water-filled tank. While floating around in the tank I began to wonder about the mind of an animal who lived in water all the time and had a brain the size of man's. I knew the dolphin had a cerebral cortex as large as a human's. What was going on in that brain? Some people argued that a large body required a large brain. But there was the example of the whale shark who weighed 40 tons and had a brain the size of a macaque monkey. So I began to ask: what is the dolphin doing with all that excess brain? When I began to study dolphin sounds I found they had an immensely more complex communication system than we do. This led me to question whether we might

establish interspecies communication. If this could be done it would show us what the human mind has in common with other creatures with large brains. This knowledge, in turn, might prove valuable if our space program should detect nonhuman, intelligent beings outside the earth.

KEEN: What were the major problems you faced in communicating with dolphins?

LILLY: The first problem was attitude. The human species is so arrogant it is difficult for us to entertain the idea that there may be superior beings swimming around in the sea. So we had to approach the dolphins with gentleness and respect and with the assumption that they had as much desire to communicate with us as we did with them.

Then there was the problem of the different structure of dolphin and human languages. Our vocal communication is airborne and is relatively slow. The dolphin sonic communication is waterborne and is thus about ten times faster than ours. This means the dolphin receives the bulk of his information about his environment acoustically while we receive ours visually. The visual inputs in the dolphin are only one tenth the capacity of our visual inputs, but their acoustical inputs are ten times greater than ours. So the total amount of information received by dolphins and humans from their environments is roughly the same. But the types differ. We are not going to understand dolphins adequately until we can translate their language to ours. We need to experience how they hear their world.

KEEN: How did you establish communication with them?

LILLY: It began with an accident. One day in 1955 we were listening to a tape of dolphin sounds. We suddenly got the weird feeling that the dolphins were mimicking our speech. In fact, they were laughing at us. So, someone suggested that we go out and see if one of our young dolphins, Elvar, would copy a word. We went into the tank and I shouted at Elvar "water." He came up, put his blowhole in the air and went "wa . . . ter," breaking the word in the middle. And so we started to work on the word *water* and within twenty minutes Elvar was copying it.

Later we set up a more intensive experiment in which a young woman, Margaret Howe, lived with and became teacher, friend, mother and lover to a young male dolphin by the name of Peter.

She taught him to reproduce simple words with humanoid sounds, to respond to greetings, to distinguish objects, to say the names of numbered balls, and to respond to elaborate directions. In time they developed genuine verbal and nonverbal communication. Margaret Howe would say "Peter, go get the orange ball." There might be five balls all of different colors floating on the water. Peter would go and bring back the blue ball, the green ball, etc. Every one but the orange ball. An operant conditioner observing Peter might conclude that he didn't understand what we were saying. But Margaret would say "He knows damn well what I mean because he brought me the orange ball five times in a row yesterday on command."

KEEN: If you can break the rules in a creative way it means you must understand the rules.

LILLY: Right. A pigeon might peck the right button five times but a dolphin won't. He is too smart and having too much fun. He changes the rules of the game because he is intelligent enough to get bored with over-simple games. He is trying to get a message across to you. You just can't do the operant-conditioning game with someone who is really intelligent and insists on having a good time. If you want to examine the intelligence of a superior being you have to be willing to observe him on his terms.

KEEN: Some critics suggest that neutral researchers cannot replicate your results. How do you answer this?

LILLY: The basic question at issue here is the status of the scientific observer: who is watching what under what conditions with what assumptions? If we are going to test the hypothesis that dolphins have intelligence equal to or superior to human beings, we have to be willing to adopt the perspective of the dolphins. Treat a dolphin like a stupid animal and that is all you will observe. The operant conditioner is sitting back as an omniscient observer judging the animal and expecting certain reproducible behavior. If he doesn't get that behavior he considers the animal stupid. He doesn't think to ask a new question, as one does with an intelligent human.

KEEN: A scientific observer must be willing to be changed by the object he is investigating.

LILLY: Yes. There is always continuous feedback between the observer and the system he is observing. The observer must always simultaneously be building a model of the system he is observing and of the observer. John van Neuman and Leo Szilard showed this for quantum mechanics. To do quantum mechanics correctly you have to have the quantum observer who goes down into the system to be observed and he has to follow certain laws of observation depending on the system. When he comes back into the Newtonian universe with its large assemblages of matter he must become a Newtonian observer. And when he goes up near the velocity of light he has to become an Einsteinian observer. So, when you start observing dolphins you have to become a dolphin observer. A dolphin observer is not, by definition, an operant conditioner. He must be sensitive, respectful and involved with his (hypothetically) superior animals in an ethical way.

KEEN: Why did you stop working with dolphins?

LILLY: In 1964 I built an eight-foot tank, filled it with sea water and began my work with LSD and physical isolation. The dolphins were in the same lab and I began to see the ethical implications of my beliefs about dolphins. If what I believed about dolphins was true I had no right to hold them in a concentration camp for my scientific convenience. So I decided to end the project. On the day I arrived at this decision, but before I had told any of my colleagues, my favorite dolphin decided to commit suicide.

KEEN: How does a dolphin commit suicide?

LILLY: Sissy just stopped eating. We gave her animal enzymes to stimulate her appetite and got her going for a while. But she finally decided to hell with it and stopped breathing. We had her for seven years, since she was nine months old, and she liked us better than she liked dolphins. After this, five more dolphins committed suicide within two weeks. So I told everyone about my decision and we turned the three remaining dolphins loose.

KEEN: Do you intend to do any further research with dolphins?

LILLY: If I could get the right conditions. I would have to have a wet house by the sea designed so the dolphins could come and go at will. Then I would like to have a family with young children that could learn to play and communicate with young dolphins. I think only such a long-range, free project will allow us to take the next step in interspecies communication.

KEEN: I would like to go back to your research on the effects of LSD and physical isolation. Was this connected with your dolphin work?

LILLY: No. I began the experiments with physical isolation when I was with NIMH in Washington. In neurophysiology there has long been a question of what keeps the brain going. Where are its energy sources? One obvious answer was that the energy sources are strictly biological and internal and they do not depend on the outside environment. But some people were arguing that if you cut off all the stimuli to the brain it would go to sleep. So we decided to test this hypothesis. This was easily done by creating an environment in a tank that would isolate a person from external stimuli. For a couple of years I periodically immersed myself in the tank and studied my states of consciousness. During this time I did not use LSD. Many of my colleagues at NIMH were working with it but I did not want to prejudice my observations about the psychedelic spaces I was getting into in the tank.

KEEN: What happens to your body when you are in a stimulus-free environment?

LILLY: You can forget your body and concentrate on the workings of your mind. But if any stimulus remains it becomes overwhelming. Once when I was in the tank a series of bubbles formed from the water and began to hit my foot. As each bubble traveled up my leg I experienced an exquisite pleasure. In fact, the pleasure was so great that it turned to pain when the bubbles began to come at about five-second intervals.

KEEN: Were the effects of physical isolation comparable to those you later discovered in using LSD?

LILLY: The effects are similar. It is possible in the tank for the person who knows how to relax, to *park his body,* to go into any of the psychedelic spaces without using LSD. Only the energy level differs. LSD allows you to jack the energy level way up. Physical, mental and spiritual energy runs higher.

KEEN: It is difficult to believe that physical isolation produces such dramatic changes. Do you need elaborate training or a special facility to get to psychedelic levels of consciousness without drugs?

LILLY: Certainly it is easier to reach a level of consciousness or a psychic space once you have been there before. But all the average person has to do is to get into the tank in the darkness and

silence and float around until he realizes he is programming everything that is happening inside his head. You are free of the physical world at that point and anything can happen inside your head because everything is governed by the laws of thought rather than the laws of the external world. So you can go to the limits of your conceptions.

KEEN: Your imagination is totally free?

LILLY: Well, I don't like the word "imagination." When you are in the tank you are certain of the reality of what you are experiencing. I started off with the notion that I was creating everything I experienced. But a lot of things happened that made me ask some radical questions about the nature of reality and different modes of perception. I began then to see that interpreting all the novel experiences in the tank as projections was an arrogant assumption.

KEEN: What kinds of experiences did you find difficult to interpret in common-sense terms?

LILLY: I went through an experience in which another person I knew apparently joined me in the dark, silent environment of the tank. I could actually see, feel and hear her. At other times I apparently tuned in on networks of communication from other civilizations in other galaxies. I experienced *parking* my body and traveling to different places.

KEEN: This could well sound like a report from a first-class schizophrenic. What kept you from interpreting these experiences as evidence of psychosis?

LILLY: I think the attempt to define all mystical, transcendental and ecstatic experiences which do not fit in with the categories of consensus reality as *psychotic* is conceptually limiting and comes from a timidity which is not seemly for the honest, openminded explorer. Also, I knew something about the world of psychotics. I had a complete training analysis with Robert Walder and had a speaking acquaintance with my own psychotic spaces, and I had worked with catatonic and schizophrenic patients. It was not psychosis I was exploring in the tank but belief structures. I was examining the way in which we program our beliefs and impose limits on what we may perceive and experience by these beliefs. I wanted to know what principles were governing the human mind. If we consider the human mind as a kind of computer, I was looking for

the basic programs which were built into the computer and the meta-programs which we impose upon the mind by conscious choice or unconscious compulsion. And I wanted to discover how many of the meta-programs could be raised to the conscious level and be changed, or reprogrammed.

KEEN: Did you discover any essential rules that can serve as guides to the explorer of inner space?

LILLY: After ten years in the tank I formulated a working rule: whatever one believes to be true either is true or becomes true in one's own mind, within limits to be determined experimentally and experientially. These limits themselves are, in turn, beliefs to be transcended. The limits of one's beliefs set the boundaries for possible experience. So every time you reach a limiting belief it must be examined and gone beyond. For the explorer there are no final *true* beliefs.

Compulsion is being trapped in a *known* psychic reality, a dead-end space. Freedom is in the unknown. If you believe there is an unknown everywhere, in your own body, in your relationships with other people, in political institutions, in the universe, then you have maximum freedom. If you can examine old beliefs and realize they are limits to be overcome and can also realize you don't have to have a belief about something you don't yet know anything about, you are free.

KEEN: Did you develop specific techniques in the tank for examining your limiting beliefs?

LILLY: Yes. I have just written a book, *The Center of the Cyclone,* that deals with the rules for exploring the inner-outer spaces of consciousness. The basic skill is one that has been known since ancient times. In yoga and in Eastern thought it has been called establishing the fair witness or the witnessing self. I think of it as becoming an observer and watching the operation of the programs which are governing your thinking and behavior. You can pull out of an experience, step back, and watch the program. Much of psychoanalysis involves gaining this skill of seeing how you have gotten trapped in the past with some program that solved a problem in childhood but that was overgeneralized and carried forward and has continued to operate in inappropriate situations. Tremendous energy is locked up in these old programs or what Jung called "autonomous complexes." You can release this energy if you get

enough distance from your emotional involvement in the programs to see them like an old movie on T.V. or like a tape loop that you have heard a thousand times. As soon as you get distance you realize you are not the programmer and you are not that which is programmed and you are not the program. Your identity becomes established as an independent agent. Once this ability to disidentify yourself from old programs, from programming, and from the programmer becomes generalized you have the key to higher states of consciousness. By refusing to identify with the programs you transcend them and gain a measure of control. In this way you begin to exercise the meta-programming powers of the human bio-computer, the ability to create self-consciously the principles that govern thought and behavior.

KEEN: Does the fair-witness technique work for dealing with present experience and future expectations as well as for examining compulsive patterns we have carried over from the past?

LILLY: Of course. Premature judgment and closure is the greatest danger for the person who wants to retain the psychic mobility of the explorer. A good general rule for dealing with situations where you are overwhelmed with novelty is: when you are in a new space where you can't account for what is happening on the basis of past assumptions, stay wide open and let your fair witness store all the information you receive. Later on you can slow down and play it all back without editing and can evaluate what has happened to you.

It is at least an ideal aim to be free of unexamined programs which govern thought and behavior. In Eastern thought this was what was meant by being free of karma. The fair witness is able to function without the imposition of limiting patterns from past experience. I have sometimes described this as the goal of making the human bio-computer general purpose. In this sense I mean that in the general-purpose computer there can be no display, no acting, no ideal that is unavailable to consciousness. This is also near to what Freud meant by the aim of making the unconscious conscious. There should be no boundaries within the computer.

KEEN: You describe continuous iconoclasm that is intoxicating and frightening. I can smell the wind blowing across the vast open spaces but I am not certain it is possible to live in an attitude of continuous exploration. Every time a system of beliefs breaks

down or is transcended, the result is chaos and anxiety. Social and psychological limits and boundaries are erected to keep chaos and anxiety within tolerable quantities.

LILLY: No! This is a perfect example of what we have been talking about. And once you recognize it you don't have to follow it. You don't have to suffer continual chaos in order to grow. That is the old Christian program—you can't have heaven without hell, you can't have a cosmos without chaos. This is what I call the trampoline effect.

KEEN: You seem to be challenging one of the more deeply held principles of identity that has governed the Western psyche. I think of Dostoevsky's vision: man knows the angel in himself only to the extent that he converses with his devil. Or of Freud's notion that ego is strong only to the degree that it has integrated the underworld of the id. There is no ascension into heaven without a descent into hell, no resurrection without crucifixion, no success without failure, etc. This rhythm, or oscillation, has been central to the Western notion of growth.

LILLY: I am not denying the existence of a duality, or plurality, in man. I only say that simultaneity rather than oscillation is a better, more economical way of dealing with this duality. You don't have to keep going down in order to go up.

Once you know any "negative" system such as fear exists you can get the energy out of it by rising above it through meditation and observation.

KEEN: There is a growing interest here in psychological disciplines and philosophy of the East. Meditation and yoga are almost as common today as prayer meetings were a generation ago. How did you get into mysticism?

LILLY: I left the Catholic Church when I was 13, when I decided that the whole mystical thing—God, angels, afterlife—was all childish nonsense. I went full speed into science. But when I began my work with physical isolation, I began to experience a super-self level, a network of inter-related essences. Your essence, my essence, everybody's essence is hooked together. And there is immediate and total communication with them all the time throughout the whole galaxy.

KEEN: Is this your way of rendering the experience out of which the classical notion grew that man is a microcosm of the macrocosm, that his reason or logos partakes of the reason or logos that informs all of reality?

LILLY: Yes. But that classical idea never made any sense to me until I experienced the network of intelligences, the galactic or universal network or what was called Universal Mind in Idealistic philosophy and Eastern religion.

In 1964, as the result of an accident, I went through a death experience. I was in a coma for twenty-four hours and was blind for two days after that. In the coma I entered a space I hadn't been in since I was twenty-two, when I had four wisdom teeth pulled under gas. I had also been in the same space at age seven when my tonsils were taken out and when I was five and had t.b. Each time I had almost died, or thought I was going to die. Two characters or guides kept turning up. Every time I have a job to do, these characters show up and tell me what the job is.

In the tank in the Virgin Islands I tried to get back to the place where I had met the guides by using LSD without the fear of death. In spite of some fear, I relaxed, as I was immediately in their space. The two guides began to come toward me from a vast distance. As they approached their presences became powerful and I noticed their thinking, feeling and knowledge pouring into me. Just as I felt I would be overwhelmed by their presence, they stopped. As they stopped, in effect they said, "We will not approach any closer as this seems to be your limit at this time. You can come back here any time once you have learned the routes. We are sent to instruct you. So far you have been doing your experiments in solitude and have learned some of the ways to get here. Now you should contact others like yourself who have these capacities, help them, and learn from them. Perfect your means of communicating with this level but stay in your body. There are other methods than LSD plus solitude for achieving these results."

After these initial contacts I began to feel the presence of my guides without going into their spaces.

KEEN: Does it now seem to you that these guides are more than poetic projections of your own imagination?

LILLY: The two guides may be aspects of my own functioning at the super-self level. They may be helpful constructs, or concepts. They may be representatives of an esoteric hidden school. They may be members of a civilization a hundred, a thousand years or so,

ahead of ours. Or I may be tuning in on networks of communication of a civilization beyond ours which is radiating information throughout the galaxy. I don't know.

KEEN: Much of your work with physical isolation and LSD seems to be an effort to establish a set of disciplines for dealing with kinds of experiences which a scientistic culture has considered paranormal or even abnormal. Are we now developing practices that will allow us some orderly access to altered states of consciousness?

LILLY: We are approaching a marriage between the modern scientific point of view and the old esoteric and mystical knowledge. Now we are exploring new modes of access to states of consciousness which have been experienced for centuries. It is an empirical approach to those dimensions of consciousness that Eastern thinkers spoke of as levels of enlightenment or satori. I want to elaborate a series of maps and some rules of the road.

KEEN: What kinds of maps have you developed for the outer spaces of human consciousness?

LILLY: The most helpful one for me was developed by Oscar Ichazo, the master who runs the school in Chile in which I have spent the last eight months. He uses the analogy of the length and frequency of sound waves to characterize the different levels of consciousness. Level 48 is the rational, neutral state. At this level your mind is operating efficiently but without emotion. This is the type of consciousness in which the head tripper lives most of the time. The experiences of different types of satori, or enlightenment, begin at level 24. Level 24 involves enjoyment in doing some activity that is done well and without conflict. This is the professional satori, the state of integrated work. As we move up in the psychedelic scale to level 12 we reach a state of blissful awareness. At level 12 you can't function smoothly in the world because you are in bliss. You still are in your body but the reality around you seems alive. This is the first level of a good LSD trip. At this level it is frequently difficult to speak. You accept the here and now. Sometimes this state can be reached in sexual intercourse. It is also the kind of enlightenment Zen speaks about. At level six you get out of your body for the first time. You become a point of consciousness, love, energy, warmth, cognition. This point is mobile. It can travel inside your body or into outer spaces. You still have your own I, your center of consciousness, but your body is not experienced.

At level three, the highest level of satori from which people return, the point of consciousness becomes a surface or a solid which extends throughout the whole known universe. This used to be called fusion with the Universal Mind or God. In more modern terms you have done a mathematical transformation in which your center of consciousness has ceased to be a traveling point and has become a surface or solid of consciousness. Here you lose the I almost completely although you do retain some memory of this state when you come back. It was in this state that I experienced "myself" as melded and intertwined with hundreds of billions of other beings in a thin sheet of consciousness that is distributed around the galaxy.

KEEN: If a person has this map available can he learn to get into these states of consciousness without using drugs?

LILLY: Yes, drugs may help in the sense that they give some awareness of the existence of different modes and levels of consciousness. Gradually a tolerance is building up in regard to marijuana and LSD, a new kind of permissiveness about all means for the alteration of consciousness. But once you know a space exists you can learn to get back to it. You can program yourself to move into any space you know exists if you use discipline and concentration.

This is the most turned-on country the world has ever seen. The rest of the world is way behind. Our kids are turned on to levels of consciousness and possibilities of travel into mental and spiritual spaces in an unprecedented way.

KEEN: Do you think the consciousness revolution will eventually change the way technology is used?

LILLY: It will improve it immensely.

KEEN: The exploration of inner space is producing a body of new knowledge. Who will disseminate it, and to whom?

LILLY: I see it being transmitted to and within the Establishment. The new exploration of consciousness is a way of life. You will be seeing it on television and in the other media. Already the younger generation is sharing its knowledge of how to alter awareness.

But the people I am most interested in are the successful heads of corporations and bureaucracies. Many of these people already operate at the level of satori 24. They are joyfully locked

into their work. But they have never had maps which suggested to them the possibility of achieving more blissful levels of consciousness.

What might happen if they could visualize the possibility of spending the weekend in satori 12, or even of achieving satori three, in which they would realize that their essences are hooked to every other essence in the whole universe?

KEEN: A touch of mystical madness might unite us to non-human forms of consciousness—we might even begin to feel a kinship with other members of our own species.

LILLY: It might turn out that exploring the far-out spaces of human consciousness is the fastest way to social transformation.

Chapter 14

shuffle brain

Paul Pietsch

Punky was a salamander. Or at least he had the body of a salamander. But his cranium housed the brains of a frog. I'd spent an entire season at the fringe of his clear-water world, asking who he was, with the neural juice of a totally different animal racing around inside, turning him on, tuning him in to his environment at a wave band beyond a normal salamander's spectrum. The answers, borne by his actions, flattened my scientific detachment, I confess.

Punky was only one in a long and varied series of brain transplants, experimental tests of the holographic theory, a theory about the language of the brain, a scientific treatment of nothing less than memory itself—the watering hole on the great subjective plain where thoughts and dreams, hopes and fears, pride and guilt, love and hate must drink to live, or else dry up, to vanish, like bone dust.

Years before, in Philadelphia, when I was first learning how to do operations like those on Punky, I was an instructor in a gross-anatomy dissecting lab. Class met in the afternoon. Insecure in my grip on what was then a newly acquired subject, I went in early each morning to do a dissection of my own. With class in session, the place roiled with the hurly-burly of people, alive and busy. But in the morning, when I arrived, it was silent, a room of death in the most complete sense of the word. Ugly gray light blared in through frosted windows and, without color, illuminated the rows of rag-

swaddled, tarp-wrapped cadavers. It wasn't frightening; it was lonely, the loneliest place I'd ever seen. Its tables were the biers of the world's unwanted, unremembered, unclaimed—as people. And they'd been forgotten long before their corpses were hoisted up and flopped naked on the diener's soapstone prep table. Nameless now, serial-numbered metal-ring tag tied around big toe, dirt still under cracked nail or maybe half-peeled-away red or pink nail polish. Valuable, in death, as things. Valueless before, as people. They were the unloved dead. For to be loved is to be remembered. They were the unhated dead, for the same abstract reasons. The unremembered dead, the truly dead. For memory is our claim to identity, and when it stops, we are no more.

At the end, when we were finished, my department held funeral services for the bodies. I went. But I went with a generalized grief that I carried back whole because my memory found no place to assign any part of it.

Still, in time, I did forget the details. But Punky revived my memories of those mornings back in Philadelphia. That's probably why I gave him a name. For the *Existenz* of Punky and his pals didn't stop with salamanders and frogs. It included my own species.

I will be talking here about the neural hologram, but I really should speak of brain information—a *holologic* principle, not only memory of past experiences. For the theory seeks to explain all the brain's stored programs, whether learned or wired in during embryonic life. It covers the mental yardgoods we unwrap to tailor "go: no-go" in reflexes. It supplies the cash for complex, reasoned associations. It works when the brain issues instructions to tune the A-string on a viola, or to make the baby cry because the milk is sour.

But holographic theory deals with the mode of neural messages, not specific molecules, mechanisms, or cells, as such. Like a multiplication table or counting system, it commits grand polygamy with place and time and circumstance. It treats the *how* rather than the *who*—like gravity acting on the apple, instead of the meat, the freckles, or the worm.

The holographic theory had its crude origins in the 1920s when psychologist Karl Lashley began a lifelong search through the brain for the vaults containing memory. By then, students of behavior had been readied for angry debate by a paradox that had begun to emerge on the surgical tables of the nineteenth century. Clearly,

the mental world had its biological base in the brain. Yet war, disease, and the stroke of the scalpel had robbed human brains of substance without necessarily expunging the mind. Lashley carried the problem to the laboratory and pursued it with precision tools, mazes, rats, controls, statistics.

Lashley also brought along the knife. With it, he found he could dull memory in proportion to the amount of cerebrum he cut out. But if he left a rat with any cerebrum at all, the animal could still remember. Not only did he fail to amputate memory, but one area of the cortex would serve it as well as another. He came to two controversial conclusions: intensity of recall depends on the mass of brain, but memory must be divvied up equally. "Mass action" and "equipotentiality" became his theme.

"Equibull!" a neuroanatomist friend of mine once declared. For the knives and battery poles of others had struck and dug into what seemed to be the specific loci of sight, scent, sound. Moreover, no clear and obvious physical precedent existed for equipotentiality. "I'm a scientist," my friend used to say, "not a goddamn Ouija board operator!"

But in 1948 physicist Dennis Gabor, trying to improve the electron microscope, accidentally stumbled over the optical hologram, a discovery that earned him the Nobel Prize in 1971. Lensless, 3-D photography was born. Within twenty years, the same principles had been extended to the brain.

Holograms take getting used to—like the idea that light can be both waves and particles, or that a curve gets you more quickly from star A to star B than Euclid's straight line. It's like getting accustomed to the notion that energy and mass are different ways of saying the same thing, or that time might shrink and expand. For holograms package information in a form disguised from our common sense, invisible behind the nominalistic curtains of our culture. But with patience, and a little open-mindedness, the intuition soon begins to drink up the principles—like relativity after Einstein or the shape of the earth after Columbus.

Familiar modes of information, even as complicated codes, reduce to bit parts, held, stored; according to the *summum bonum* of home economics and gross anatomy: "A place for everything, and everything in its place!" Not so a hologram (*holo* means whole). In it, the entire *shtick* of information, tamped down into a

minuscule transcendental code, repeats itself, whole, throughout whatever the system happens to be. Trim a hologram down to a tiny chip and the message still survives, whole, waiting only to be decoded. One piece will work as well as another. But the fewer the parts used in decoding, the less intense the regenerated image. In other words, holograms work in precisely the same way that the memories in Lashley's rats did—mass action and equipotentiality.

. . . A hologram captures not a thingy thing. It captures rules—a harmonic syllogism, a holologic. And it is the stored record of Hegelian skid marks produced when points and counterpoints bang into each other, physical or numerical, concrete or abstract. Mathematics in reverse. Indeed, they take getting used to. But the glory of holograms glows through during decoding back to the original image, when they not only behave like Lashley's rats but reveal feature upon feature of human brain function.

Holographers can construct, say, acoustical holograms and call back the original, not with sound, but with light or waves in some other form. Thus, built into holographic grammar is the automatic mechanism to shift gears, instantly, from one modality to another—how, for example, you can listen to someone and *write* what you *hear* him say as fast as you can work the muscles in your hand.

Such rapid, whole-scene shifts, involving forests of data, would be out of the question with the conventional message that must be translated bit by bit. In a hologram, it's all part and parcel of the principle. And the same thing shows up again in adding and modifying holograms. Holographers can construct multicolored, composite holograms, in steps, by adjusting wavelength, thus mimicking how we might anneal present and past into a totality. Or they can decode several holograms of the same thing into a multicolored original. In the process they can even change colors. When the brain does these things on its munificent scale, we talk in terms of abstract reasoning or imagination. And in this capacity the human brain outshines the largest digital computers. For computers digest bits. But the brain's motifs are informational wholes that can meld and blend without the go-between of a finger-counting bureaucrat.

The flexible rules of holography even allow, automatically, for a subconscious, a bad word in my own particular profession.

But consider an optical hologram. In decoding, it's possible to select a wavelength invisible to the naked eye, yet of sufficient energy to burn a monogram permanently onto the retina of an unwary onlooker. As with the subconscious, you don't have to see its wounds to ache from them.

Holographic theory would also explain the chemical transfer of memory—how information from the brain of one worm, rat, mouse, or hamster might be extracted into a test tube and injected into another animal, there to mediate recall in the absence of the recipient's previous experience. Such reports from a dozen laboratories over the past few years have excited the press and reading public. But in conventional scientific circles, I've heard them called such things as "oozings from the stressed seams of cracked pots." Yet a hologram can write itself into anything, including a molecule. At the very same time, the theory in no way at all restricts the brain's programs to molecules, as such. There's no rule against using, say, molecules, voltages on cells, or groups of neurons to carry the information. The program might even be carried at many different levels simultaneously.

Just who deserves credit as the first to apply holographic principles to the brain I'm going to allow historians of science to fight out. Lashley, of course, saw them at work in his rats and had both the genius and the courage to describe what nature showed. Certain of Pavlov's conclusions look hological. Gabor's powerful mind must have snared the notion the moment he tripped on the optical effect. Years later, in fact, he published a mathematical scheme of reminiscing. Philip Westlake, a brilliant UCLA cybernetician, has shown that equations of physical holograms match what the brain does with information. Karl Pribram and an army of colleagues at Stanford's medical school have invested a decade and a thousand monkeys, using the theory to work out details of how living brains remember.

Predictably, holographic talk provokes hot controversy. I recall not long ago delivering a lecture on the subject, when out of the audience jumped a neuropharmacologist, trembling with rage, demanding to know: "How can you account for something like Broca's area?" He was referring to a part of the cerebrum known for 100 years to be vulnerable to stroke accompanied by the loss

of speech. I cleared my throat to answer. But before I had the chance, a young psychophysicist, sprawled in a front-row seat, whipped his shoulder-length mane around and fired back, "You can't draw beer out of a barrel without a bung!"

It was a perceptive reply. For in holographic theory, functional centers such as Broca's area represent processing stations rather than storage depots. Rage, fear, hunger centers, the visual cortex at the back of the brain, or auditory areas at the sides—these would act not to house specialized information but to pump it in or to call out programs in the form, say, of snarl, smile, utterance, equation, kiss, or thought. And sharp lines of distinction between innate and acquired information fade as far as storage itself is concerned.

Still, the theory does not completely rule out uneven distribution of memory, particularly in the complex brains of higher animals. Indeed, it is not hard to make a case for different storage within the two hemispheres of the human cerebrum. Michael Gazzaniga recently published an intriguing book on what has been known for almost twenty years as "split-brain" research. Begun in the early 1950s by Meyers and Sperry at Cal Tech, the technique involves cutting the corpus callosum, a broad thick strap of nerve fibers between the hemispheres. Success in the lab with cats and monkeys prompted neurosurgeons to split the corpus callosum in the human brain. They did so to alleviate violent, prolonged, drug-resistant grand mal epileptic seizures, and they had remarkable success, medically. But the patients emerged from surgery with two permanently disconnected personalities. With more such operations, the left cerebral hemisphere emerged as the dominant, verbal, arithmetic side, while the right brain held recollections of form and texture. The tendencies appear to hold whether patients were left- or right-handed. Early in 1971, music was found among the repertoire of the right hemisphere. Yet the outcome of split-brain surgery has never been absolute, nor the individual patient's subsequent behavior totally predictable. Both hemispheres can generate music in some people, and the right may have a vocabulary. In addition, a totally illiterate right hemisphere can learn to read and write in less than six months—as though it had a tremendous head start. On top of this, Gazzaniga's observations convince him that the consignment of memories to one side of the brain emerges with maturity. Children seem to employ both hemispheres. Thus it would seem that the brain can reshape its contents and make decisions about what will go where. But it is also quite possible that split-brain research identifies not unequal storage but unequal access. Like the reflected image of a written message, meaning would stay the same but translation would entail different steps. The cerebral hemispheres, after all, do mirror rather than carbon-copy each other.

At any rate, the brains of human beings and our close relatives seem to be many brains, orchestrated by virtue of connections like the corpus callosum. Moreover, our multisystem cranial contents seem to be in flux, physiologically. Different lights can flash off and on, moment to moment. Some of the switches lie under our direct control; others are no more within our deliberate, intellectual reach than the impulses driving a hungry shark or an amorous jackrabbit.

Holographic theory does not deny conclusions of split-brain research. But it insists that, whatever the system used for storage, the information shall be layered in whole and repeated throughout. It denies that memory depends on minced-up and isolated bits filed in specific pigeonholes. Just what happens to be going on inside a brain when it's loading up with a particular hologram may determine which areas may and may not act as targets—or how vivid the reconstructed scene becomes during some later translation into conscious form.

THEORIES AND EXPERIMENTS

. . . My purpose in working with Punky and his pals was to make or break my faith in the holographic theory of neural storage. And I was a skeptic, at the outset.

When I began this work the only prima facie experimental evidence to link the general theory involving holographic principles to brains had come from ablation studies—subtracting from brain substance. Subtraction is an incomplete test. To see the incompleteness is to see how the salamanders relate to the theory. Thus, let's spend a little time doing a few imaginary experiments.

Imagine several hundred Xerox copies of this unholographic page, but reproduced on transparent plastic sheets. Now stack the

sheets so that each letter, word, and line forms a perfect overlay with its replicates below. Now subtract a sheet—two, three, or any number, for that matter—only keeping the stack straight. What happens? Loss or unevenness in density, perhaps. But as long as we keep the *equivalence* of one page, we preserve the message. The reasons are obvious. First, we're working with a system containing a redundant message. Secondly, when we eliminated some parts, we merely allowed what was beneath to shine through. But we certainly don't have a holographic system. This is how I viewed the results of ablation studies.

Let's try another series of experiments with the transparencies. Let's throw the pile up in the air, arrange some of the sheets in a new order, cut some of the sheets into pieces and reglue the pieces randomly—reshuffle, in other words. Now we would distort the message and know it very quickly. Why? *Meaning* in a conventional message (or pattern) depends on relationships *among* parts and subparts—sets and subsets. When we scrambled relationships, when we messed up the system's anatomy, we wrenched the carriers of meaning. We might also have done this by adding a transparency with a different message. But when we merely took away parts from our redundant system, we created empty sets and voided rather than distorted relationships.

But suppose the linotype operator had set a hologram? Then our reshuffling experiments would have produced far different results. We would not have introduced changes in the meaning of the message. For in a hologram meaning lies *within*—not among—any sets we might produce by simple physical means. And in reshuffling we would be shifting whole messages around, exchanging their positions without really getting at components. Trying to dissect out a hologram's subunits is like trying to slice a point, or stretch that infinitesimally small domain by an amount no larger than itself. No, a knife won't reach inside the heart of a hologram. Of course, in practice we might trim a system to such small proportions that the image upon decoding would be too dim to register. Or in a physical experiment we could destroy or distort the medium and make it technically impossible to decode. That's why we opted for imagination—to bypass engineering details.

But look at the implications of our imaginary experiments. Look at the predictions. If we really want to test holography against

redundancy, we ought to shuffle the brain. If it houses conventional messages, we would find out very quickly. But if programs exist in the brain according to holographic principles, scramble though we may, we won't distort their meanings. And that is where salamanders come in.

BRAIN TRANSPLANT

A peaceful, quiet world, the salamander's—unless you happen to be a dainty little daphnia or a cockeyed mosquito larva whiplashing to the surface for a gulp of air. Or even worse, the crimson thread of a tubifex worm. For it is the destiny of the salamander to detect, pursue, and devour all moving morsels of meat small enough to fit inside his mouth. He eats only what moves. And he adjusts his attack to fit the motion of his fated quarry. When he sees the tubifex worm, or picks it up on sonar with his lateral line organs, he lets you know with a turn of his head. Position fixed, half-swimming, half-walking, he glides slowly, deliberately, along the bottom of his dish, careful not to create turbulence that, in the wilds, would send the worm burrowing deep into the safety of the mud. Reaching his victim, he coasts around it, moving his head back and forth, up and down, to catch swelling and shrinking shadows and vibrations and permit his tiny brain to compute the tensor calculus of the worm's ever-changing size.

The size of a four-year-old's little finger, salamanders sustain injury and recuperate like few other creatures on earth. Consider, for example, what I call the Rip Van Winkle paradigm. Remove a salamander's brain. The behaviorally inert body continues to live, indefinitely. Transplant the brain to the animal's broad, jelly-filled tail fin for storage. After a month or two, slide the brain out of the fin and return it to the empty cranium. In a couple of weeks, after the replant takes, the animal behaves as if the operation had never occurred. He's awake again, a free-living, prowling organism, like his normal brothers and sisters.

That same tail fin will accommodate hunks of brain pooled ad hoc from several different salamanders. The pieces quickly send out thousands of microscopic nerve fibers that weave a confluent network. Does such a mass of brain tissue work? Communicate im-

pulses? Splice a length of spinal cord on each end of the mass as a conduit to the skin. Then, on one side, graft an eye, pressing the cut optic nerve against the piece of spinal cord. On the other side transplant a leg, making sure that it touches the conduit. Wait a couple of weeks to allow the optic nerve to invade the spinal cord on the one side and the cord on the other to sprout fibers into the leg to reinnervate its muscles. Now aim a spotlight at the tail and focus on the grafted eye. If you can hit the light switch at the correct tempo, you can make the transplanted leg stomp a tarantella.

Yet if my experiments were to be a fair test of the holographic theory, I'd have to insure two things. First, the experimental salamander would have to be capable of sensing a tubifex worm. Secondly, he'd have to be able to command his body and jaw muscles into action. I was sure this could be done with salamanders by preserving the medulla, the transitional region between spinal cord and the rest of the brain. In the medulla lie input stations for touch from the head, the salamander's efficient sonar system, and the sense of balance from a carpenter's level like internal ear. Also, impulses that bring jaw muscles snapping to life are issued directly from the medulla. It does for head muscles what the spinal cord does for, say, the biceps or muscles in the thigh. And in salamanders the medulla serves as a relay station for information to and from spinal cord and brain. Higher animals have such stations too. But evolution added long tracts that function like neural expressways.

There are actually five main parts of the brain common to all vertebrates, including man. The cerebral hemispheres that predominate within our own heads are small lobes on the tip end of a salamander's brain. But during embryonic life our own cerebral hemispheres pass through a salamander stage.

The next region back, known as the diencephalon, is where the optic nerves enter the brain. Distorting this region would and did create blindness in certain experiments. A so-called messencephalon or mid-brain connects diencephalon to medulla. These were the parts I would shuffle.

Amputating brain in front of the medulla turned off the salamander's conscious behavior and, of course, feeding along with it. But, if I stayed out in front of the medulla, I'd be leaving sufficient input and output intact for whatever programs surgery might deliver up.

This is not surgery in the nurse-mask-sutures-and-blood sense. It goes on under a stereoscopic microscope. Very little bleeding. No stitches. Just press the sticky, cut tissues together and permit armies of mobilized cells to swarm over and obscure the injured boundary line. There is only room in the field of operation for a single pair of human hands. The animals sleep peacefully in anesthetic dissolved in the water. Trussed lightly against cream-colored marble clay, magnified, they look like the prehistoric giants of their ancestry. A strong heart thrusts battalions of red blood corpuscles through a vascular maze of transparent tissues. No bones to saw. Under fluid your instruments coax like a sable-hair brush.

In more than 700 operations, I rotated, reversed, added, subtracted, and scrambled brain parts. I shuffled. I reshuffled. I sliced, lengthened, deviated, shortened, apposed, transposed, juxtaposed, and flipped. I spliced front to back with lengths of spinal cord, of medulla, with other pieces of brain turned inside out. But nothing short of dispatching the brain to the slop bucket—nothing expunged feeding!

Some operations created permanent blindness, forcing animals to rely on their sonar systems to tell them what was going on outside. But the optic nerves of salamanders can regenerate. Still, for normal vision to return, regenerating optic nerves need a suitable target, as Roger Sperry showed many years ago. I was able to arrange for this, surgically. And when I did, eyesight recovered completely in about two weeks—even when the brains came from a totally different species of salamander and contained extra parts. As far as feeding was concerned, nature continued to smile on holography. Not one single thing about the behavior of this group of animals suggested the drastic surgery they had undergone.

The experiments had subjected the holographic theory to a severe test. As the theory predicted, scrambling the brain's anatomy did not scramble its programs. Meaning was contained within the parts, not spread out among their relationships. If I wanted to change behavior, I had to supply not a new anatomy but new information.

Suppose, though, that parts of a salamander brain in front of the medulla really have no direct relationship to what a salamander does with a worm? Suppose feeding stations exist in the medulla or spinal cord (or left leg), awaiting only consciousness to ignite

them? If this were true, the attack response on worms—the principal criterion in the study—would be irrelevant, and shuffle brain experiments would say very little about the holographic theory. A purist might have taken care of this issue at the outset.

"New experiments required," I scribbled in my notes. "Must have following features. Host: salamander minus brain anterior to medulla. Donor: try a vegetarian, maybe young Rana pipiens tadpole. But, first, make damn sure donor brain won't actively shut off salamander's attack on worms."

My working hunch was that the very young leopard frog tadpole would make a near-perfect donor. His taste for flies comes much later on in development. While he's little, he'll mimp-mouth algae from the flanks of a tubifex and harm nothing but a little vermigrade pride. Then, too, from experiments I'd carried out years before, I knew frog tissues wouldn't manifestly offend salamander rejection mechanisms, not to the extent that they would be destroyed. Thus, if grafted brains didn't perish in transit across the operating dish, they would become permanent fixtures in their new heads.

Whether a tadpole brain would or would not actively shut off worm-recognition programs in salamanders I had to settle experimentally before calling Punky into the game. Here, I transplanted tadpole brain parts but left varying amounts of host salamander brain in place. These animals ate normally, thus showing that tadpole brain, per se, would not overrule existing attack programs. As I had guessed, it was like adding a zero to a string of integers as far as feeding was concerned.

Now the scene was ready for Punky, the first of his kind through the run. He would surrender his own cranial contents in front of the medulla to the entire brain of a frog. If his new brain restored consciousness but gave him a tadpole's attitude about worms, he'd vindicate the shuffle brain experiments.

For controls, I carried out identical operations but used other salamanders as donors. Also, to assure myself that frog tissue itself would not affect appetite, I inserted diced tadpole in the fins and body cavities of still other salamanders. This procedure had no effect on feeding. Moreover, I had a hunch that Punky would remain

blind. So I removed eyes from other salamanders to get fresh data on feeding via sonar.

Punky awoke on the seventeenth day. Very quickly, he became one of the liveliest, most curious-acting animals in the lab. He did remain blind but his sonar more than compensated. A fresh worm dropped into his bowl soon brought him over. He'd nose around the worm for several minutes. He lacked the tadpole's sucker mouth. And I couldn't decide whether he wanted algae, or what. But he spent a lot of time with the worms. In the beginning, he had me watching him, wondering in a pool of clammy sweat if he'd uncork and devour the holographic theory in a single chomp. Yet, during three months, with a fresh worm in his bowl at all times, in more than 1,800 direct encounters, Punky never made so much as a single angry pass at a tubifex. Nor did any of his kind in the months that followed. The herbivorous brain had changed the worms' role in the paradigm. They were to play with now, not to ravage.

I kept Punky's group nourished by force-feeding them fresh fillets of salamander once a week. This meant the same thing had to be done with each and every control animal too. While the extra food did not blunt control appetites, the added work left me looking groggily toward pickling time when I could preserve the specimens on microscopic slides.

I routinely examine microscopic slides as a final ritual. But Punky's slides weren't routine. And on the very first section I brought into sharp focus, the truth formed a fully closed circle in the barrel of my microscope. His tadpole brain, indeed, had survived. It stood still in terms of development, but it was a nice, healthy organ. And from its hind end emerged a neural cable. The cable penetrated Punky's medulla, there to plunge new holographic ideas into his salamander readout, and into the deepest core of my own beliefs.

Chapter 15

tomorrow we will communicate to our jobs

Peter C. Goldmark

I would like you to join me in exploring how we could make use of communications technology on a much broader scale to ensure that in the year 2000 the United States will be a wonderful place in which to live and to work, whether one chooses the city or prefers the country.

Before we discuss solutions, let us look at the problem:

One of the disturbing effects of the rapidly increasing population is that the majority of people in most western countries have been compelled to live under conditions of extreme density, within the confines of cities and their suburbs. Today, nine-tenths of the United States population lives on less than 10 percent of the land.

If this trend continues, 200 million of the 300 million Americans anticipated for the year 2000 will be crowded into twelve urban centers on less than 10 percent of our total land area. More than half of the population, or 150 million people, will be in the three largest urban concentrations, namely: Boston-Washington, Chicago-Pittsburgh, San Francisco-San Diego.

Man is physiologically and psychologically unprepared for the stresses and strains which result from such living conditions. Available statistics show that it is in the high-density living areas

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that the problems of crime, pollution, poverty, traffic, education, etc., are the greatest.

Experience has shown that the problems are manageable in smaller towns and will remain so, if limits and standards are carefully planned for the development of these towns.

Today, in addition to our urban problems, we also have a rural problem. There exists a large migration of people from rural areas towards urban centers. The depopulation of rural areas has depressed them economically, and left many of them unable to provide the services that their residents need.

We now have roughly outlined the problem. Let us see what might be a solution. The more than 50 million Americans expected to be added to our population by the year 2000 should be able to live and work in either an improved urban or a new rural environment. To make this possible, a new rural society must be created. In this task, communications technology plays a key role.

In 1968, the President's Advisory Group on Telecommunications requested the National Academy of Engineering (NAE) to establish a committee on telecommunications. As an outgrowth of the President's request, the NAE created a panel for applying communications technology to alleviate urban problems and to make possible new living patterns based on fuller use of the nation's land resources. The NAE panel later joined with the Connecticut Research Commission (CRC) to form the NAE-CRC Joint Committee on "Cities of the Future," which I chair. The NAE panel is supported by a joint group consisting of the Departments of Housing and Urban Development, Justice, Commerce, Transportation, Health Education and Welfare, and also the U.S. Postal Service, and the Federal Communications Commission. *It is our belief that all necessary inventions have already been made and broadband communications sysiems now can be imaginatively applied to the needs of business, government, education, health care, and cultural pursuits to stimulate the development of the new rural society. The task is gigantic: It will present an urgent challenge to our youth, and all of us must direct at least part of our efforts to it. I believe the magnitude of this task will make going to the moon seem like a ferryboat ride.*

The approach to the new rural society does not mean the de-

urbanization of America. In our opinion, the main objective is to provide options for the additional millions of people, options which today do not exist. Conceivably half of the next 100 million Americans may prefer to live in an urban environment, whereas 50 million people already in the cities may wish to be part of the new rural society. This in itself may relieve the pressure on the cities, making it feasible to deal with their most urgent problems and to start them on a new life cycle.

We must recognize that to change the entire nation's living pattern requires more than communications technology alone. Before nationwide planning is undertaken, an exploratory program on a small scale is proposed in the attractive rural northeastern section of Connecticut where the population density is low and the need for planned economic development is high. This project is being funded by the U.S. Department of Housing and Urban Development in cooperation with Fairfield University. The first study phase is expected to begin shortly in Connecticut's Windham County Region, a slightly undeveloped area of approximately 650 square miles and involving ten townships. The study will be conducted jointly by Fairfield University and Goldmark Communications Corporation.

FOUR-PART PROGRAM TO HALT MIGRATION TO CITIES

Our "Cities of the Future" committee proposes a four-part experimental program designed to halt the migration of people from rural areas to the cities and to reverse the continuing trend of urban deterioration:

1. Study the office procedures and practices that usually result in meetings, memos, letters, presentations, etc., in business, industry and government. How can these procedures be transposed into broadband and other communications media? The results of the study should indicate how components of business or government could function effectively in rural communities.
2. Join with a number of towns in a given region in exploring how to establish standards and limits which will ensure the optimum rate and pattern of growth for the highest quality of life. The effort should be coordinated with relevant State agencies to assure that the development program is in the best overall interests of the State, and should establish the need for utilities, transportation, and other resources in line with the growth goals.
3. Experiment with a variety of communications equipment that could provide the services necessary for the business, government, and other aspects of life of the developing community.
4. Create an intergovernmental body of federal and state officials to initiate a coordinated, national effort based on the experiences gained by the study project.

NEW RURAL SOCIETY WILL EMERGE

We would like to give all Americans an opportunity to work and live in small but attractive rural communities. The persons who choose to settle in these communities will become the new rural society.

The society that we envision does not now exist because, in general, people do not want to move into a rural area, no matter how attractive, unless it offers jobs, adequate educational and health services, opportunities for cultural pursuits, entertainment, social contacts, and so on.

The British have long explored a solution to their own high-density population problems, and they are way ahead of us in creating new towns and enlarging old ones. In 1944, the Abercrombie Plan for Greater London provided for the establishment of a whole series of new towns around London, beyond the so called Green Belt.

The purpose of the plan was to relieve the concentration in Inner-London; to provide a better working and living environment; and to reduce the length of commuting trips. While thirty-one new towns were built and succeeded in attracting business and industry, office employment in London continues to expand. Clearly, the rate of generating new towns is not fast enough.

The British government concluded that the largest deterrent to decentralizing is likely to be the reduction in operating efficiency due to the stretching of communication links.

Another British study was made by a group called Joint Unit for Planning Research, which has engaged in one of the most thorough and controlled experiments in communications between widely separated operations. The Study concluded that:

1. The ordinary telephone is highly effective for one-to-one communications, particularly where familiarity between participants is high, conflict is low, and subject matter is well defined.
2. The greatest value of a wideband network suitable for television or picture-phone will lie in its ability to handle a wide range of auxiliary services such as graphics display, rapid facsimile, computer and data access, conferencing, etc.
3. There will be large-scale decentralization of employment from large metropolitan centers as the various person-to-person telecommunications systems improve.
4. The effect on the volume of business travel is likely to be negligible.
5. Most importantly, the chief effect of such telecommunication developments will be to increase the choices: The employee will be able to select the environment he wants to live in, and a company or government agency will have a wider choice of areas in which to locate.

It may be interesting to observe that in pursuit of their ruralization plans the British are currently designing broad band services on four fronts: (1) a national data network, (2) conference television, (3) dedicated cable educational television for the London area, and (4) household wired television.

FIVE NETWORKS FOR THE NEW RURAL COMMUNITY

Let us examine the services that communications technology can provide to a new rural community.

New communication networks could be divided into internal and external systems. The internal system, which is strictly within the bounds of towns, will consist of five basic networks:

Network One:

The primary network exists now only in the form of the telephone. It would be expanded into a full two-way random-access network able to accommodate voice, data, and two-way video-phone. This would be the most basic urban "nerve system" which will be as vital as streets, water, or power. *The most basic purpose of this system would be to put everyone in contact with everyone else within the city, no matter how dark the streets are, how heavy the traffic.* Since it will be linked up with computers, the same network will provide random access between man and machine, or between machines. *The network can be looked upon as providing a pipe into every home, office or library through which one can not only converse, but also transmit and receive written materials, pictures, data, etc.* Its most important contribution is to connect every terminal (telephone, videophone, teletype writer, etc.) with any other.

Network Two:

A second network would be in the form of AM-FM radio and television broadcasting, the extent depending on the channels available for the particular community. This could consist of one or more local stations preferably with network affiliations and educational television broadcasting.

Network Three:

The third internal network would be in the form of broadband cables carrying a multitude of television channels into individual homes. This network would include narrowband call-back for purposes of polling or making requests. Such two-way cable television systems are now already being tested. The cable network could also carry, if desired, off-the-air programs, originating either from local broadcast stations or from satellites. This cable network should be so designed that it has sub-centers in the local neighborhood which, in terms of program material, could cater to its own local audience. *As part of this network, general informational services would be made available to individual homes. One important example would be the ability to dial up important municipal events, such as meetings of the various town boards, i.e., Education, Finance, Zoning, Board of Representatives, etc. Through the network's two-way polling ability, public opinion on any issue under discussion could be almost instantly registered. Through a system of "frame freezing," vast amounts of information concerning travel, weather, pollution, shopping, traffic, various municipal and other public*

services, lists of cultural and entertainment events, etc., could be selected and seen on the home television screen.

Network Four:

The fourth information network superimposed on the town would be another broadband cable system, carrying approximately forty two-way television channels which would interconnect the major public institutions of the city: city hall, hospitals and nursing homes, schools and colleges, libraries, police and fire stations, bus and railroad stations, airports, and all other town services. This network would provide informational services among the vital institutions and key officials of town, ensuring their smooth operation.

Network Five:

Superimposed on the preceding four networks would be a town emergency service. This would include the "911" police and fire emergency system augmented by automatic identification of a caller's location and by a system to identify the location of vehicles operated by police, fire, sanitation, ambulance, utilities, and other large fleet operations.

In addition to the five networks making up the internal communication systems, the city of the future will have external systems, consisting of the following:

1. Incoming broadband cable or microwave circuits which connect the town's businesses, industry and government offices with their operations in other cities or countries. These are essentially dedicated point-to-point links.
2. Long-distance broadband circuits interconnecting the town's switched telephone and video-phone services with the corresponding switched services in other cities.
3. Common carrier broadband and narrow band services such as U.S. Postal Service, Western Union, and others for transmission of messages, printed material, data, etc., between towns and to other countries.
4. Incoming circuits for educational, cultural and recreational pursuits. These might include:
   a. Radio and television broadcast circuits both for private networks and public broadcasting.
   b. Two-way broadband educational television circuits interconnecting a small local campus with the region's central university.
   c. Broadband cable circuit as part of a national high-definition closed circuit television network bringing live Broadway, opera, concert and sports productions to theaters especially geared for such performances. The system would employ high resolution color television of at least 1,000 lines with cameras and projectors especially designed for live pick-up and large screen projection. The most suitable national distribution method for such signals may be through a synchronous satellite broadcasting several of these high-definition TV signals and received by local high-gain fixed antennas.

All these communication systems, properly integrated on a national basis, will go a long way toward realizing the New Rural Society.

I apologize that in this limited space we could only sample certain aspects of this very ambitious but essential plan. A beginning has been made, but for the ideas to become reality, scientists and engineers of this and the next generation must help. Very simply, this is an opportunity for science and technology to make one of its greatest contributions to man and his environment.