The exposition of this topic continues with a reprise of early theoretical considerations of biofeedback, the meaning and value of theta brain rhythms in human thought, creativity, and "transpersonal psychology." This selection makes clear the fact that the Greens saw self-regulation by means of biofeedback not so much as an end in itself as a gateway to approaching personal development of a much broader sort, leading to personal transformation. [Eds.]

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VOLUNTARY CONTROL OF INTERNAL STATES: PSYCHOLOGICAL AND PHYSIOLOGICAL

Elmer E. Green, Ph.D., Alyce M. Green, M.A. & E. Dale Walters
Research Department, The Menninger Foundation, Topeka, Kansas

The first part of this article is a summary of a technological paper presented at the 1969 International Congress of Cybernetics and is included in order to explain the electrophysiological instrumentation and the methodological developments that make possible an instrumented transpersonal research project, *psychophysiological training for creativity,* which is a primary aim of our work.[1]

Speaking of instrumentation and methodology during a discussion on scientific creativity, Lord Adrian, the well-known biologist, said, "New ideas in science are induced by new discoveries and at the present time it seems to me that the most potent factor in promoting new discoveries has been the introduction of some new technique, some new tool, that could be used for exploring natural phenomena."[2] Since the electronics explosion that accompanied World War II, sensitive transducers, high-gain amplifiers, and sophisticated computer techniques have been developed and applied to psychophysiological research. Now, through the use of some of these tools, it is possible both to promote and to detect changes in physiological variables that are particularly related to and indicative of changes in attention, consciousness, thought, and emotion.

The importance to our culture of this now-developing methodology for enhancing voluntary control of internal states can hardly be overstated. In recent years, scientists in every nation have come to realize that voluntary control of behavior is of primary importance if we hope to establish an ordered

society or even maintain a society. Without stretching the imagination, the long-range implications and the effects for society of a population of self-regulating individuals could be of incalculable significance. . . .

. . . It is not possible to define in an operational way the meaning of the word "voluntary," but all of us have a *feeling* of voluntary control, at least part of the time, regardless of the psychophysical and metaphysical implications of that feeling. Few people realize, however, that that feeling or intuition of freedom has unusual significance in respect to the autonomic nervous system, the so-called involuntary nervous system, nor do they realize that the "psychophysiological principle" when coupled with volition makes it possible to regulate a number of important involuntary functions, and at least theoretically to regulate in some degree every psychological and physiological function of one's being.

The psychophysiological principle *[presented earlier, and one of the central concepts in the Greens' work—Eds.]* affirms that "Every change in the physiological state is accompanied by an appropriate change in the mental-emotional state, conscious or unconscious, and conversely, every change in the mental-emotional state, conscious or unconscious, is accompanied by an appropriate change in the physiological state." This closed Newtonian type of principle, when coupled with volition, which is at present of indeterminate origin, makes possible a psychosomatic self-regulation. Whether volition has origin beyond the physiological matrix as a metaforce is the essence of the mind-body problem, but this is not of concern in the present paper. It is sufficient that research using newly developed feedback techniques has demonstrated that volitional control of a number of internal states, psychological and physiological, is relatively easy to achieve.[3-10]

Before discussing methodology and illustrative experiments, brain waves and reverie, hypnagogic imagery and creativity, it is useful to focus attention on the neurological systems that are involved . . . The central nervous system is divided into the archipallium, the old brain that man shares with the other vertebrates, and the neopallium, the new brain whose most significant development is in man, dolphins notwithstanding.

The . . . divider between conscious and unconscious systems and processes . . . is a continuously undulating boundary between conscious and unconscious processes (and brain structures), as attention shifts from one brain region to

another. For instance, when one learns to drive a car many of the at-first-conscious striate muscular activities upon which much attention is lavished gradually become unconscious, and eventually it is possible when the mind is preoccupied to drive through miles of traffic without awareness of other cars or traffic signals. . . .

. . . If it were now asked how the autogenic feedback training system might be related to transpersonal psychology and in particular to research in creativity, we would direct attention to the important implication of the fact that hypnagogic and dream-like images occur in subjects during a state of reverie.[11] This "reverie" that accompanies the semiconscious production of theta waves and low-frequency alpha seems to be associated with and make possible, under certain conditions, the detection of hypnogogic-like imagery, the *sine qua non* of creativity for many outstanding people. In order to remain conscious and alert during theta production without long autogenic or yoga-like training, it seems that it will be necessary for most people to make use of instrumental aids such as those, for example, which we are developing and testing.

It is necessary to mention at this point that our research in the transpersonal area is only in its beginning stages. Ordinarily, the report presented here would be delayed 2 or 3 years until data were analyzed and security assured, but it seems that the discussion of possible scientific methods for the study of transpersonal processes may be immediately useful because of the experiential explosion into "altered states of consciousness."

Before discussing instrumentation and procedures for research in imagery we wish to summarize briefly some of the recent developments in creativity research and indicate the converging lines of evidence that indicate that "psychophysiological training for creativity" is a reasonable hypothesis.

Main avenues of research in this area have been the efforts to identify traits and abilities related to the creative process, exemplified by the work of Guilford and his associates and to isolate personality characteristics related to creativity, exemplified by Cattell and Barron and their associates.[12-17] Another approach has been the effort to gain insight into the creative process and how it might be enhanced in others by studying the accounts of creative activity as experienced and reflected upon by thinkers and artists of distinction, as in Ghiselin's *The Creative Process: A Symposium.*[18] A few attempts have been made to study

creativity through the use of hypnosis.[19,20] Efforts to increase or "train for" creativity have included methods such as "brainstorming" and "synectics."[21-23] A large array of literature has discussed the possibility of developing the creative potential in young children and older students. A varied sample might include Mearns, Getzels & Jackson, MacKinnon, and Cattell.[24-27]

Recent attempts to elicit and investigate creativity through the use of psychedelic drugs represent a direct manipulation of psychophysiological variables; however, this technique is not suitable for work with the general population, and is most definitely not applicable for enhancing or facilitating the release of latent creativity in students.[28-30] New methods must be used to study creativity as associated with psychophysiological variables in a student population.

In considering the possibility of psychophysiological training for creativity, it is useful to draw attention to (a) the existence of a link or relationship between alpha-and-theta-rhythms in the brain wave and reverie-and-hypnagogic imagery, and to (b) the existence of a link or relationship between reverie-and-hypnagogic-imagery and creativity. It can be inferred from the above juxtaposition that the areas of alpha-and-theta-rhythms and creativity may indeed overlap, and that training in the production and control of alpha-and-theta-rhythms may make possible an enhancement of creativity in individuals whose potential is yet unrealized.

Alpha-and-Theta-Rhythms and Reverie-and-Hypnagogic Imagery

Consider some of the evidence that links low-frequency alpha and theta rhythms with a state of reverie and hypnagogic imagery.

1. Pilot experiments in our laboratory with three subjects who were self-trained over a period of 15 to 30 years in internal scanning techniques (meditation) demonstrated an unusually high percentage of 6-8 1/2 Hertz waves in their EEG records during periods of deep reverie.[31] Two of the three subjects had long trains of theta waves. Both reported the presence of hypnagogic-like or dream-like images, which they said was customary in their internal-scanning experience. The third subject was able to reduce his normal alpha frequency from 9.5 Hertz down

to about 8.3 Hertz during 1-minute trials and reported this as a preliminary mind quieting imageless stage in moving toward a deeper state of reverie.

2. In a reaction time (RT) and states-of-consciousness experiment performed in our laboratory, essentially a "sensory deprivation" experiment, it was found that monotony was a significant factor in the production of hypnagogic-like images.[32,33] Twelve subjects were tested for reaction time in three EEG sessions, each of 11/2 hours duration. The RT stimulus was the "bump" of a lightweight button on which the subject's finger rested. The duration between the "bump" and subsequent "press" on the button was the RT measurement. Electronic equipment was arranged to count cycles of alpha rhythm and give the stimulus (without warning) in alpha trials, coincidentally with the appearance of the third, sixth, or ninth wave of the alpha burst. In *non-alpha* trials, the machinery gave the stimulus at 0.3, 0.6, or 0.9 second, after the end of an alpha burst. After responding with a "Press," the subject made a forced-choice categorization of the focus of his attention at the time of stimulus presentation, according to the outline below.

ATTENTION		
INTERNALLY FOCUSED, WITH	EXTERNALLY FOCUSED	
"Hypnagogic" thinking imagery	in the environment	on the finger

Hypnagogic imagery was described to the subjects as pictures or words that they did not consciously generate or manipulate, but which sprang into the mind "full blown," so to speak. Quite often in the experiment, reports of "hypnagogic imagery" were associated with drowsiness and the presence of theta waves. These images were called to conscious awareness by the RT stimulus and were generally accompanied by a burst of alpha waves. Usually associated with beta waves were reports of concrete images or external objects.

One subject reported that the stimulus caused him to suddenly become aware of "little pictures" in his mind that he did not know were there. He described a "void" into which the pictures "popped" when the stimulus was given. Without the stimulus, he said, he would not have been able to remember what was in his mind. From a number of similar reports in the reaction-time study and from the reports of pilot subjects in other experiments we hypothesized that the presence of alpha rhythm indicated a state of consciousness conducive to recall and devised the recall test previously mentioned to test this hypothesis.[35]

The hypnagogic-like effect of monotony in the reaction time experiment was not totally unexpected. A number of writers, including Huber and Shattock, have stressed the use of monotony in developing awareness of normally unconscious material.[36,37] Shattock's description of a flash of imagery during his training in meditation-walking is an almost perfect example of the hypnagogic experience.

3. Kasamatsu and Hirai have reported that in an hypnagogic vital role of imagery attention control unusual significance of reverie EEG experiment with Japanese Zen masters it was found that (a) as the subject began to turn his attention inward, continuous trains of alpha rhythm appeared in the record, (b) the dominant frequency of the alpha pattern began to decrease toward the alpha-theta border region, and finally (c) the subject, in a state of reverie, produced long trains of theta waves.[38]

4. Anand, Chhina, and Singh reported that in a study of Indian Yoga masters theta waves were found associated with inward-turned attention (samadhi). They also reported that during an alpha phase the control of attention achieved by these subjects was so intense that neither flashing lights, sounding gongs, vibration, or the touch of a hot glass test tube could disrupt the state of concentration and cause "alpha blocking." These observations demonstrate that a high degree of attention control is associated with the maintenance of specific EEG states.[39]

The above four items indicate that an important relationship exists between hypnagogic imagery, alpha-theta EEG patterns, and certain states of consciousness that, because of their inward-turned nature, we have chosen to associate with the relatively undifferentiated Western word *reverie.*

Reverie-and-Hypnagogic-Imagery and Creativity

Reverie is a state of unusual significance because with it is associated hypnagogic-like imagery in which unconscious processes are often revealed to the waking self in symbols, words, or gestalts.

McKellar and Simpson in an investigation of hypnagogic imagery say that their subjects described images that seemed to differ from dreams in that they were "more vivid," and "more realistic."[40] Also, they "come and go in a flash," and "resemble lantern slides," and "contained detailed material which I didn't know

I knew." Their subjects reported four main characteristics of hypnagogic images: (a) vividness, (b) independence of conscious control, (c) originality, and (d) changefulness. The authors comment that "Hypnagogic images merit investigation in that they may represent an instance in which greater knowledge of the 'normal' may illuminate the 'abnormal.'"

The hypnagogic images described by McKellar and Simpson's subjects are remarkably similar to the creative images described by Kekule. He tells of a series of deep reveries in which atoms "gamboled" before his eyes, leading to his creative images theory of molecular constitution:[41]

> One fine summer evening I was returning by the last omnibus, "outside" as usual, through the deserted streets of the metropolis, which are at other times so full of life. I fell into a reverie, and lo! the atoms were gamboling before my eyes. Whenever, hitherto, these diminutive beings had appeared to me, they had always been in motion; but up to that time I had never been able to discern the nature of their motion. Now, however, I saw how, frequently, two smaller atoms united to form a pair, how a larger one embraced two smaller ones; how still larger ones kept hold of three or even four of the smaller; whilst the whole kept whirling in a giddy dance. I saw how the larger ones formed a chain . . . I spent part of the night putting on paper at least sketches of these dream forms.

The last of this series of dreams led to his famous discovery, which has been called "the most brilliant piece of prediction to be found in the whole range of organic chemistry."

> I turned my chair to the fire and dozed. Again the atoms were gamboling before my eyes. This time the smaller groups kept modestly in the background. My mental eye, rendered more acute by repeated visions of this kind, could now distinguish larger structures, of manifold conformation; long rows, sometimes more closely fitted together, all turning and twisting in snakelike motion. But look! What was that? One of the snakes had seized hold of its own tail, and the form whirled mockingly before my eyes. As if by a flash of lightning I awoke. . . .

Thus, through the dreamed symbol of the snake biting its tail Kekule derived the revolutionary proposal that some organic compounds occur in closed chains or rings. It is small wonder that he urged his contemporaries in science, "Let us learn to dream, gentlemen."

Many other creative people have described the states of reverie, dream, or near-dream in which creative solutions and inspirations have come to consciousness. Robert Louis Stevenson's ability to dream publishable plots by commanding "the brownies" of his mind to furnish him with a story is well known. Well known, too, is Poincare's description of mathematical ideas rising in clouds, dancing before him, and colliding and combining into the first Fuschian Functions as he lay in bed, awaiting sleep.

A. E. Housman, the Poet, has described his ideas as a "bubbling up" saying "the source of the suggestions thus proffered to the brain was an abyss. . . ."[18] Rollo May tells of the Nobel Prize winner who dreamed the sought-for formula, wakened, and in his excitement hurriedly scribbled it on a paper handkerchief—-only to find he could not read it the next morning.[42] Each succeeding night he concentrated on redreaming it and after several nights he did. This time he got up immediately and carefully recorded the formula.

In addition to the above few examples, there are literally hundreds of other anecdotes which show, beyond doubt, that in some way not yet perfectly understood, reverie, hypnagogic imagery (and its partner, hypnopompic imagery and creativity arc associated).[43] Worth noting is the fact that the terminology used in describing the state we have called reverie is extremely varied, as for instance, the "fringe" of consciousness, the "pre-conscious," the "off-conscious" and the "transliminal mind," and "transliminal experience."[20,44-46]

It may be asked at this point "What reason is there to believe, that just because low-frequency alpha and theta waves have been found to be associated in some people with reverie and hypnagogic-like imagery, the reverse will be true; that *training* a subject to achieve or produce theta waves or low-frequency alpha, a purely physiological accomplishment, will bring about a state of reverie in which hypnagogic-like images and other such phenomena will appear?" To answer this question it is first necessary to point out that a semantic trap exists in the frequently used phrase "training a subject to achieve, or produce, theta waves or low-frequency alpha." In actuality there is no such thing as training in brain-wave control; there is training only in the elicitation of certain subjective states that are accompanied by oscillating voltages in the cerebral cortex, detected through the subject's skull and scalp. Brain waves, as such, are not known to have any sensory representation whatsoever by means of which they can be detected. What *are* detected and manipulated in some unknown way

are foci of attention, thought processes, and subjective feelings. The *voluntary*-controls program in our laboratory is one of thought, emotion, and attention control. Brain wave control, temperature changes, and striate muscle tension reduction in our work are thought of primarily as physiological correlates of psychological processes. It is desirable to remain aware of the primacy of the psychological state in discussing this type of research, even though it is convenient to use the "shorthand" of terms such as alpha training, temperature training, etc.

The unique value of feedback instrumentation is that it gives the subject an immediate indication of his progress. Through external feedback, the subject is enabled to filter out from the welter of internal *existential* cues, those particular ones which he must learn to manipulate.

It is also important to differentiate between (a) voluntary control of internal states, as reflected in craniospinal, autonomic, and central-nervous-system indicators; and (b) conditioned control of such indicators, as in animal work and in some human work. Voluntary control can liberate the individual from conditioned responses, and bring a degree of freedom from normally unconditioned responses.[47,48] It is important that the above distinction be kept in mind and examined in every situation where it is proposed to use psychophysiological training methods with humans.

Voluntary control moves toward increased inner freedom; conditioned control moves toward loss of inner freedom.

So, in answer to the preceding question it can be said that we do not attempt to train people in the production of low-frequency alpha and theta rhythms, but rather to train them in the voluntary control of certain existential states whose central-nervous-system correlates are revealed by the presence of low-frequency alpha and theta rhythms in the EEG record.

The physiological goals of this research are related only indirectly to the peripheral nervous system. The main goal main involves voluntary control of the central nervous system so goal that those states of awareness that are associated with conscious control of alpha and theta rhythms in the brain can be studied.

Laboratory Training for Imagery. Laboratory sessions for the self-induction and study of imagery will be similar to projected those already described, except that only percentage-of-research alpha, frequency-of-alpha, and percentage-of-theta will be used for feedback. For formal study, 12 subjects will be selected from the 18-man group of college students who have already received training for control of muscle tension, temperature of the hands, and percentage-of-alpha.

Visual feedback of frequency-of-alpha and percentage-of-theta will be presented by switching on two additional bars of light on the feedback panel previously described. The frequency bar is arranged so that a change in the frequency of alpha from 12 Hertz to 8 Hertz causes the bar to rise from the bottom to the top. The theta bar rises to the top when the subject produces continuous theta waves for a 10-second period. One of the pilot subjects mentioned above could essentially do this, and also could communicate verbally during trains of theta.

In addition to the visual display of EEG data, we have developed a stereo-audio feedback system in which the frequency in each of the four major EEG bands (for O_1 and O_2 occipital areas) is multiplied by 200. Amplitude is also controlled in each frequency band. The audio signals representing the EEG bands, when appropriately recombined for each ear provide a modernistic biological orchestra.[49-51] The experimenter is provided with on-off switches that give him individual control (for training purposes) of each brainwave band in the auditory feedback to each ear. Although stereo audio feedback will be experimented with in work with pilot subjects, our experimental group of 12 college students will be trained with feedback only from the left occiput, in both lab and home sessions. Audio feedback is especially useful for imagery training because the eyes-closed paradigm will be used part of the time.

Home Training. In our work in "voluntary controls training" over the last 4 years we have experimented with (a) Autogenic Training practiced only in the lab, (b) Autogenic Training practiced both in the lab and at home, (c) Autogenic Feedback Training practiced only in the lab, and (d) Autogenic Feedback Training practiced both in the lab and at home. It seems that the combination of both home and lab practice with autogenic feedback is the most effective system and it is the training method that is presently in use. Associated with

home practice is a log book in which the subject makes an entry for each session, describing his successes and failures, and any particular states of consciousness or unusual physical states that he has experienced.

For home training in relaxation and temperature control, subjects are given portable temperature-sensing meters to help them develop skill in the technique of passive volition. The subject fastens a thermistor to a finger with Scotch tape and tapes another thermistor to his forehead. Since the forehead generally cools and the hands become warmer when the sympathetic nervous system relaxes, the *change* in differential temperature between these two body locations can be used as an indication of autonomic relaxation. The same autogenic phrases which are used in the lab are also used at home.

Because EEG signals are of low amplitude (10 to 100 microvolts), it has in years past required highly sensitive amplifiers encased in laboratory-type machines to detect brain waves. Recent electronic developments have made it possible, however, to obtain low-cost portable alpha detectors that the subject can use at home. The use of portable brain-wave detectors will begin when the present triple-training program is concluded in May 1970. Alpha sensors will be modified in our laboratory so that the presence of both alpha and theta waves may be detected at the same time. The presence of alpha will be signaled to the trainee by a tone having a frequency of about 2000 Hertz and the presence of theta by a tone having a frequency of about 400 Hertz. The alpha-theta detector will also include (in our modification) three elapsed-time indicators. The first gives total time of the session. The second gives alpha time, and the third gives theta time. Another modification, the use of which is discussed below, is a mercury-switch-and-chime circuit that brings the subject to consciousness if he becomes drowsy.

Group Training. Home-training devices, coupled with autogenic feedback procedures, make possible the simultaneous training of groups. One feature planned for this work is a once-a-week group meeting in which individual experiences will be analyzed and compared with those of other members of the group. In this, as in the work already described, daily logs will be kept. Experience to the present indicates that once the feedback technique for producing specific physiological states is mastered, mechanical devices can be dispensed with. The subject apparently learns to detect and manipulate the

internal conditions and cues which are associated with success in his efforts and no longer has need for crutches. As in other-kinds of group work, skillful leaders are needed. For this purpose we expect to train professional psychologists and psychiatrists who have already volunteered for this training.

HYPNAGOGIC-LIKE IMAGERY

The previous discussion has been concerned almost entirely with the psychophysiological system which helps the subject to develop or enhance those internal states in which it is especially easy to become aware of hypnagogic-like imagery. Not all subjects are immediately aware of this imagery, however, and it is necessary to intervene at critical moments during training sessions in order to intensify the subject's state of awareness. This is accomplished mainly by automatic devices. If the subject lapses into drowsiness or if he produces long trains of theta waves without reporting imagery, a chime sounds, drawing him back (or up, or down) into increased consciousness, usually with an accompanying burst of "paradoxical" alpha, paradoxical because an external stimulus under normal waking conditions generally produces or enhances beta waves.

One of the automatic devices used for enhancing awareness of normally unconscious imagery is an omni-directional tilt detector, a mercury-switch finger ring. The ring is placed on a finger of the subject's dominant hand, which is continuously held up, balanced on the elbow so as to minimize muscle strain. From pilot work with the hand-balancing technique we have found that if the subject's attention or consciousness diminishes below a certain threshold level the forearm will begin to tilt. This closes the mercury-switch circuit and sounds a chime that brings the subject back to an above-threshold level of conscious attention in which he can report the imagery and the subjective states which preceded or were associated with loss of balance. The ring is to be used in both lab and home practice sessions.

During lab sessions an additional circuit monitors the subject's output of EEG frequencies in the alpha-theta border region and if the subject produces trains of theta waves or low-frequency alpha (near 8.0 Hertz) for a number of seconds, the chime is sounded. Since drowsiness is often evidenced by a low-voltage

EEG pattern of varying cycle-to-cycle duration, provision is also made for operation of the chime by an experimenter who monitors the EEG record visually. This feature will be automated as soon as possible. When we described the ring procedure at a seminar given at the Maryland Psychiatric Research Center in 1968, someone likened it to a "subliminal dredging operation," and this, in a way, characterizes the process. The purpose is not to investigate the characteristics of individual subjects, however, but to study the general processes, conditions, and contents of consciousness during a state of deep reverie. This combination of reverie and awareness seems to be an essential (though maybe not sufficient) ingredient of creativity. Tart has also found the arm-balancing method to be useful in studying reverie and says:[52]

> Despite the tremendous increase in research on nocturnal dreaming over the past 15 years, little has been done about studying the hypnagogic period: the prevailing scientific opinion has lightly dismissed this as an unimportant "transitional" period. Yet it seems clear that this period can be prolonged and yield material as rich as any nocturnal dream for at least some individuals. It can be studied easily, even at home. . . .
>
> The problem in studying the hypnagogic state in oneself or others is that the material experienced is generally forgotten rapidly, especially as subsequent sleep intervenes between experience and reporting. A simple method to overcome this in studying hypnagogic phenomena is to lie flat on your back in bed, as in going to sleep, but keep your arm in a vertical position, balanced on the elbow, so that it stays up with a minimum of effort. You can slip fairly far into the hypnagogic state this way, getting material, but as you go further muscle tonus suddenly decreases, your arm falls, and you awaken immediately. Some practice with holding the material in memory right after such awakenings will produce good recall for hypnagogic material.[52,p. 73]

One use for the upheld-hand technique is to help maintain a degree of striate muscular tension. According to Meares, the maintenance of striate tension is not inconsistent with control of various autonomic functions, while working with passive volition.[48] Contrary to one theoretical concept, total relaxation may not be conducive to the maintenance of a consciously manipulable psychophysiological state. The present experiment has relevance to Meares' position and also to Luthe's concept of the conditions under which Autogenic Shift takes place, and corresponds with the maintenance of striate tension and monotonous activity by

Zen and Yoga practitioners.[36-38,53,54] The hand-balancing method takes continuous effort (in maintaining consciousness) during a monotonous situation and it is this feature of the method, of course, that is effective.

Without going into detail, verbal reports elicited from subjects when the chime sounds during lab sessions will be grouped according to the particular brain-wave category with which they are associated (by a "blind" forced-choice method, into categories such as beta, alpha, theta, beta-theta, beta-alpha, alpha-theta, flattened signal, etc.) and then the reports in each category will be analyzed by "blind" examiners according to an image-classification scheme adapted from Wallach and Kogan.[55] In this way we expect to find that some of the EEG categories will be described in existential terms that will give insight into the nature and content of the associated imagery. Most of the procedures described above have been tried with a few pilot subjects, without the aid of the automatic chime.

One of the most useful contributions of this research to transpersonal psychology is expected to be the powerful instrumental method it will provide for training in internal awareness and control. Even though such an aid is merely a door-opener to internal awareness and even though individuals can be expected to eventually leave all such tools behind, short-term use is expected to be highly significant, especially in learning how to combine conscious and unconscious processes in the creative shaping of ideas. A formal experiment in imagery-and-brain-waves with college students will not be completed and evaluated in less than 2 years, but during that time additional pilot experiments will be conducted to develop methods for manipulation of hypnagogic images. We accept Walkup's hypothesis:[56]

> . . . creative persons appear to have stumbled onto and then developed to a high degree of perfection the ability to visualize-almost hallucinate-in the area in which they are creative. And their visualizations seem to be of a sort that lend themselves to easy manipulation in the thinking process. This is illustrated by reports from many of the great inventors of the past and it is easy to demonstrate that individuals differ enormously in the kind and degree of their ability to think in such manipulatable visualizations. If correct, this aspect of creativity suggests many research attacks and many potential changes in education for creative activity.

In addition to their significance in education and creativity, the concepts and methods discussed above are important for psychology, psychotherapy, and psychosomatic medicine.

1. Psychology has long suffered, at least in the United States, from the exclusion of "attention" and "consciousness" because these words could not be operationally defined. Now it is hoped to help reinstate these once-abandoned concepts through the use of feedback techniques, and even more, help reintroduce volition into experimental psychology. With a few exceptions, volition has been largely ignored in the United States for 70 years, since the days of William James. Johannes Schultz, be it noted, is a German, and Roberto Assagioli, the author of *Psychosynthesis*, in which volition is of great significance, is an Italian.[57] Carl Jung, of course, was a Swiss.

2. Psychotherapists would be able to develop in many patients deep reverie and imagery in a short period of time through the use of feedback techniques.

3. Psychosomatic medicine is an obvious area for application of feedback techniques. In the last year, for instance, two subjects and several patients at The Menninger Foundation have reduced or eliminated chronic headache through Autogenic Feedback training (in our laboratory or as patients of Dr. Joseph Sargent) using the portable temperature feedback meter for home practice. So far there have been no failures. One of the subjects, with a few minutes of daily practice after using the feedback meter as an aid for only 2 weeks, has been free from headaches for almost a year without medication. She also taught herself to increase the temperature of her feet at night and was able thereby to alleviate a difficult insomnia problem.

The elimination of warts through hypnosis, a well-established fact, is possibly a function of local blood flow diminution. In appropriate situations, voluntary starvation and absorption of cancerous growth through blood flow control might be found to be feasible. This would be a challenging area for research and might lead to an understanding of some of the presently unknown factors responsible for spontaneous remission of malignancies.

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Gardner Murphy must be given due credit for stimulating and promoting biofeedback research by his development of proprioceptive feedback concepts since the early 1950's and for his effort, along with Barbara B. Brown and Kenneth Gaarder, to establish the Bio-Feedback Research Society, which met for the first time in 1969.

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33. Hypnagogic-like, rather than hypnagogic, because our subjects were trying to remain awake rather than to go to steep.
34. Robert R. Holt, in a paper which stresses the importance of imagery and recall (1964), concludes with the following words: "I want to mention briefly one speculative implication of the work on imagery, which to me opens the most exciting vistas. . . . Several lines of evidence are beginning to suggest that the capacity for an astonishingly complete recording of experience may be virtually universal, and that the problem is primarily one of getting access to the traces . . . the vehicle of the extraordinary recall is imagery. . . . The indirect means of Imagery may furnish the key to the fabulous storehouse of memory, if we can learn how to make use of this neglected capacity."
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