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The Relaxation Response†

Herbert Benson, John F. Beary, and Mark P. Carol*

IN THE Western world today, there is a growing interest in nonpharmacological, self-induced, altered states of consciousness because of their alleged benefits of better mental and physical health and improved ability to deal with tension and stress. During the experience of one of these states, individuals claim to have feelings of increased creativity, of infinity, and of immortality; they have an evangelistic sense of mission, and report that mental and physical suffering vanish (Dean). Subjective and objective data exist which support the hypothesis that an integrated central nervous system reaction, the "relaxation response," underlies this altered state of consciousness. Physicians should be knowledgeable of the physiologic changes and possible health benefits of the relaxation response.

THE PHYSIOLOGY OF THE RELAXATION RESPONSE

The relaxation response appears to be an integrated hypothalamic response which results in generalized decreased sympathetic nervous system activity, and perhaps also increased parasympathetic activity. This response, termed the "trophotropic response," was first described by Hess in the cat (Hess, 1957). The trophotropic zone is located in the area of the anterior hypothalamus. It extends into the supra- and pre-optic areas, septum, and inferior lateral thalamus. The response is mediated by the parasympathetic nervous system and electrical stimulation of this zone results in hypo- or adynamia of skeletal musculature, decreased blood pressure, decreased respiratory rate, and pupil constriction. Hess

stated, "Let us repeat at this point that we are actually dealing with a protective mechanism against overstress belonging to the trophotropic-endophylactic system and promoting restorative processes. We emphasize that these adynamic effects are opposed to ergotropic reactions which are oriented toward increased oxidative metabolism and utilization of energy" (1957, p. 40). The "ergotropic" reactions of Hess correspond to the "emergency reaction" first described by Cannon, popularly referred to as the fight or flight response and also called the "defense reaction" by others (Hess and Brugger; Abrahams et al.).

To better understand the relaxation response (the trophotropic response), a discussion of its counterpart, the fight or flight response (the ergotropic response) is ap-

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appropriate. The ergotropic *zone* extends from the anterior midbrain toward the hypothalamus. The response is mediated by the sympathetic nervous system. When the zone is electrically stimulated, it consistently produces dilation of the pupils, increased blood pressure, increased respiratory rate, and heightened motor excitability. Although at times one of these responses may be emphasized, Hess stresses that there are no foci that correspond to individual isolated responses such as in the cortical motor zone. Rather, "In the diencephalon, we are dealing with a *collective* representation of a group of responses which includes responses of the autonomic system as they make their appearance in the form of synergically associated mechanisms" (1957, p. 35). Cannon reasoned that this integrated response prepared the animal for "fight or flight" when faced with a threatening environmental situation. Man also responds to threatening environmental conditions or to environmental situations which require behavioral adjustment by a coordinated physiologic response which mimics that of the increased sympathetic nervous system activity of the fight or flight response (Gutmann and Benson).

The relaxation response in man consists of changes opposite to those of the fight or flight response.¹ During the practice of one well-investigated technique called Transcendental Meditation, the major elements of the relaxation response occur: decreases in oxygen consumption, carbon dioxide elimination, heart rate, respiratory rate, minute ventilation, and arterial blood lactate. Systolic, diastolic and mean blood pressures remain unchanged compared to control levels. Rectal temperature also remains unchanged while skin resistance markedly increases and skeletal muscle blood flow slightly increases. The electroencephalogram demonstrates an increase in the intensity of slow alpha waves and occasional theta wave activity. Muscle tonus, not yet measured in Transcendental Meditation, decreases in other relaxation techniques (Jacobson; Luthe, 1969). These

¹ See Wallace and Benson; Wallace, Benson, and Wilson; Levander et al.

changes are consistent with generalized decreased sympathetic nervous system activity and are distinctly different from the physiologic changes noted during quiet sitting or sleep. The changes occur simultaneously and are consistent with those noted by Hess.

THE TECHNIQUE OF ELICITING THE RELAXATION RESPONSE

Four basic elements are usually necessary to elicit the relaxation response in man:

(1) *Mental Device*.—There should be a constant stimulus—e.g., a sound, word, or phrase repeated silently or audibly, or fixed gazing at an object. The purpose of these procedures is to shift from logical, externally-oriented thought.

(2) *Passive Attitude*.—If distracting thoughts do occur during the repetition or gazing, they should be disregarded and one's attention should be redirected to the technique. One should not worry about how well he is performing the technique.

(3) *Decreased Muscle Tonus*.—The subject should be in a comfortable posture so that minimal muscular work is required.

(4) *Quiet Environment*.—A quiet environment with decreased environmental stimuli should be chosen. Most techniques instruct the practitioner to close his eyes. A place of worship is often suitable, as is a quiet room.

The efficiency of learning the various relaxation techniques appears enhanced when taught by trained instructors.

HISTORICAL SUBJECTIVE WRITINGS SUPPORTING EXISTENCE OF THE RELAXATION RESPONSE

Techniques have existed for centuries, usually within a religious context, which allow an individual to experience the relaxation response. For example, in the West a fourteenth-century Christian treatise entitled *The Cloud of Unknowing* discusses how to attain an altered state of consciousness which is required to attain alleged union with God (Frogoff). The anonymous author states that this goal cannot be reached in the ordinary levels of human consciousness, but rather by use of "lower" levels. These levels are reached by eliminating all distractions and physical activity,

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all worldly things including all thoughts. As a means of "... beating down thought," the use of a single-syllable word, such as "god" or "love," should be repeated.

Choose whichever one you prefer, or, if you like, choose another that suits your taste, provided that it is of one syllable. And clasp this word tightly in your heart so that it never leaves it no matter what may happen. This word shall be your shield and your spear... With this word you shall strike down thoughts of every kind and drive them beneath the cloud of forgetting. After that, if any thoughts should press upon you... answer him with this word only and with no other words. [Progoff, pp. 76-77]

There will be moments when "... every created thing may suddenly and completely be forgotten. But immediately after each stirring, because of the corruption of the flesh, it [the soul] drops down again to some thought or some deed" (Progoff, p. 68). An important instruction for success is "... do not by another means work in it with your mind or with your imagination" (Progoff, p. 69).

Another Christian work, *The Third Spiritual Alphabet*, written in the tenth century by Fray Francisco de Osuna, deals with an altered state of consciousness. He wrote that "Contemplation requires us to blind ourselves to all that is not God" (p. viii), and that one should be deaf and dumb to all else (p. 50) and must "... quit all obstacles, keeping your eyes bent on the ground..." (pp. 293-294). The method can be either a short, self-composed prayer, repeated over and over, or simply saying "no" to thoughts when they occur. This exercise should be performed for one hour in the morning and evening and should be taught by a qualified teacher. Fray Francisco wrote that such an exercise would help in all endeavors, making us more efficient in our tasks and the tasks more enjoyable. All men, especially the busy, secular as well as religious, should be taught this meditation for it is a refuge to which one can retreat when faced with stressful situations (Osuna).

The famous fifteenth-century Christian mystics Saints John and Terese described the major steps required to achieve the mystical state (Anon.; Saint Terese), which

include ignoring distractions, usually by repetitive prayer.

Christian meditation and mysticism was well developed within the Byzantine church and known as Hesychasm (Norwich and Sitwell, pp. 56-57). This method of repetitive prayer was described in the fourteenth century at Mount Athos in Greece by Gregory of Sinai and is called "The Prayer of the Heart" or "The Prayer of Jesus." It dates back to the beginnings of the Christian era. The prayer itself was called secret meditation and was transmitted from older to younger monks through an initiation rite. Emphasis was placed on having a skilled instructor. The method of prayer recommended by these monks was:

Sit down alone and in silence. Lower your head, shut your eyes, breathe out gently, and imagine yourself looking into your own heart. Carry your mind, i.e., your thoughts, from your head to your heart. As you breathe out, say 'Lord Jesus Christ, have mercy on me.' Say it moving your lips gently, or simply say it in your mind. Try to put all other thoughts aside. Be calm, be patient and repeat the process very frequently. [French, p. 10]

To reach such a state, a tranquil environment is necessary. "It may happen that a man who has been busy all day gives himself to prayer for an hour... so that during that time the thoughts of his earthly preoccupations are forgotten" (Ross, p. 87).

In Judaism, similar practices leading to this altered state of consciousness date back to the time of the second temple in the second century B.C. and are found in one of the earliest forms of Jewish mysticism, Merkabalism (Scholem). In this practice of meditation, the subject sat with his head between his knees, whispered hymns and songs, and repeated a name of a magic seal. In the thirteenth century A.D., the works of Rabbi Abulafia were published and his ideas became a major part of Jewish Kabbalistic mysticism (Scholem). Rabbi Abulafia felt that the normal life of the soul is kept within limits by our sensory perceptions and emotions, and since these perceptions and emotions are concerned with the finite, the soul's life is finite. Man therefore needs a higher form of perception, which instead of

blocking the soul's deeper regions, opens them up. An "absolute" object upon which to meditate is required. Rabbi Abulafia found this in the Hebrew alphabet. He developed a mystical system of contemplating the letters of God's name. Bokser describes Rabbi Abulafia's prayer:

... immersed in prayer and meditation, uttering the divine name with special modulations of the voice and with special gestures, he induced in himself a state of ecstasy in which he believed the soul had shed its material bonds, and, unimpeded, returned to its divine source. [p. 9]

The purpose of this prayer and methodical meditation is to experience a new state of consciousness, described as harmonious movement of pure thought, which has severed all relation to the senses. This is compared by Scholem to music and yoga (pp. 733-734). Scholem feels that Rabbi Abulafia's

... teachings represent but a Judaized version of that ancient spiritual technique which has found its classical expression in the practices of the Indian mystics who follow the system known as *Yoga*. To cite only one instance out of many, an important part in Abulafia's system is played by the technique of breathing; now this technique has found its highest development in the Indian *Yoga*, where it is commonly regarded as the most important instrument of mental discipline. Again, Abulafia lays down certain rules of body posture, certain corresponding combinations of consonants and vowels, and certain forms of recitation, and in particular some passages of his book "The Light of the Intellect" give the impression of a Judaized treatise on *Yoga*. The similarity even extends to some aspects of the doctrine of ecstatic vision, as preceded and brought about by these practices. [p. 139]

The basic elements which elicit the relaxation response in certain practices of Christianity and Judaism are also found in Islamic mysticism or Sufism (Trimingham). Sufism developed as a reaction against the external rationalization of Islam and made use of intuitive and emotional faculties which are claimed to be dormant until they are utilized through training under the guidance of a teacher. The method of employing these faculties is known as Dhikr. It is a means of excluding distractions and of

drawing nearer to God by the constant repetition of His name, either silently or aloud, and by rhythmic breathing. Music, musical poems, and dance are also employed in the ritual of Dhikr, for it was noticed that they could help induce states of ecstasy. Originally, Dhikr was only practiced by the members of the society who made a deliberate choice to redirect their lives to God as the preliminary step in the surrender of the will. Upon initiation to his order, the initiate received the *wird*, a secret, holy sound. The old Masters felt that the true encounter with God could not be attained by all, for most men are born deaf to mystical sensitivity. However, by the twelfth century, this attitude had changed. It was realized that this ecstasy could be induced in the ordinary man in a relatively short time by rhythmic exercises involving posture, control of breath, coordinated movements, and oral repetitions (Trimingham, p. 199).

In the Western world, the relaxation response elicited by religious practices was not part of the routine practice of religions, but rather was within the mystical tradition. In the East, however, meditation which elicited the relaxation response was developed much earlier and became a major element in religion and in everyday life. Writings from Indian scriptures, the Upanishads, dated sixth century B.C., note that individuals might attain "... a unified state with the Brahman [the Deity] by means of restraint of breath, withdrawal of senses, meditation, concentration, contemplation and absorption" (Organ, p. 303).

There are a multitude of Eastern religions and ways of life, including Zen and Yoga with their many variants, which can elicit the relaxation response. They employ mental and physical methods including the repetition of a word or sound, the exclusion of meaningful thoughts, a quiet environment, and a comfortable position, and they stress the importance of a trained teacher. One of the meditative practices of Zen Buddhism, Zazen, employs a yoga-like technique of the coupling of respiration and counting to ten—i.e., one on inhaling, two on exhaling, and so on, to ten. With time, one stops counting and simply "follows the breath" (Johnston,

p. 78) in order to free the mind from thought, no feeling, no emotion, nothing (Ishiguro,

Shintoism and other religions of Japan and the method of prayer is inspiring through the mouth, with a mirror at their leisure, the priest recites the sacred words, probably traditional religious (83). Fujisawa notes that this grand ritual of is doubtlessly the Taoism, of (p. 23). Taoism, of religions of China, methods similar to nothingness to achieve (Chang, p. 167).

Similar meditation in practically every religion is a form of feelings of ecstasy. In conjunction with tribal South America, India, Siberia, and Japan. or chant to bring one into solitude to the drum, plays Shamanistic trances

Many less traditional are flourishing in the state of consciousness techniques similar to relaxation response. Shu, Hare Krishna, Muslimism, Meher, ation for Research, but a few of these (

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p. 78) in order to achieve a state of no thought, no feeling, to be completely in nothing (Ishiguro).

Shintoism and Taoism are important religions of Japan and China. In Shintoism, one method of prayer consists of sitting quietly, inspiring through the nose, holding inspiration for a short time, and expiring through the mouth, with eyes directed toward a mirror at their level. Throughout the exercise, the priest repeats ten numbers, or sacred words, pronounced according to the traditional religious teachings (Herbert, p. 83). Fujisawa noted, "It is interesting that this grand ritual characteristic of Shintoism is doubtlessly the same process as *Yoga* . . ." (p. 23). Taoism, one of the traditional religions of China, employs, in addition to methods similar to Shinto, concentration on nothingness to achieve absolute tranquility (Chang, p. 167).

Similar meditational practices are found in practically every culture of man. Shamanism is a form of mysticism associated with feelings of ecstasy and is practiced in conjunction with tribal religions in North and South America, Indonesia, Oceania, Africa, Siberia, and Japan. Each shaman has a song or chant to bring on trances, usually entering into solitude to do so. Music, especially the drum, plays an important part in Shamanistic trances (Johnson; Segal, p. 29).

Many less traditional religious practices are flourishing in the United States. One aim of the practices is achievement of an altered state of consciousness which is induced by techniques similar to those that elicit the relaxation response. Subub, Nichiren Shu, Hare Krishna, Scientology, Black Muslimism, Meher Baba, and the Association for Research and Enlightenment are but a few of these (Needleman).

In addition to techniques which elicit the relaxation response within a religious context, secular techniques also exist. One method often used is gazing upon an object and keeping attention focused upon that object to the exclusion of all else (Lowell, p. 303, p. 343; Underhill, pp. 301-302). Others, the so-called nature mystics, have been able to elicit the relaxation response by immersing themselves in quiet, often in the quiet of

nature. Wordsworth believed "... that when his mind was freed from preoccupation with disturbing objects, petty cares, 'little enmities and low desires,' that he could then reach a condition of equilibrium, which he describes as a 'wise passiveness' or 'a happy stillness of the mind' . . ." (Spurgeon, p. 61). Wordsworth believed that anyone could deliberately induce this condition in himself by a kind of relaxation of the will. Thoreau made many references to such feelings attained by sitting for hours alone with nature. Indeed, Thoreau compares himself to a Yogi (Sanborn, pp. 210-211). William James describes similar experiences (pp. 76-77). A treatise on other such experiences may be found in Johnson's *Watcher on the Hills*.

OBJECTIVE DATA SUPPORTING THE WIDESPREAD EXISTENCE OF THE RELAXATION RESPONSE

Physiologic changes occurring during the practice of various techniques which elicit the relaxation response are summarized and referenced in the table. These consist, in part, of decreased oxygen consumption, respiratory rate, heart rate, and muscle tension. Increases are noted in skin resistance and EEG alpha wave activity. These changes are hypothesized to result from an integrated, hypothalamic response leading to decreased sympathetic nervous system activity. The neurophysiologic and neuro-anatomic pathways from the cortex to the diencephalon remain to be definitively established (Gellhorn).

Autogenic training is a technique of medical therapy which is said to elicit the trophotropic response of Hess or the relaxation response. Autogenic therapy is defined as "... a self-induced modification of corticodiencephalic interrelationships" which enables the lower brain centers to activate "trophotropic activity" (Luthe, 1969). The method of autogenic training is based on six psychophysiologic exercises devised by a German neurologist, H. H. Shultz, which are practiced several times a day until the subject is able to voluntarily shift to a wakeful *low-arousal* (trophotropic) state. The "Standard Exercises" are practiced in

a quiet environment, in a horizontal position, and with closed eyes (Luthe, 1969). Exercise 1 focuses on the feeling of heaviness in the limbs, and Exercise 2 on the cultivation of the sensation of warmth in the limbs. Exercise 3 deals with cardiac regulation, while Exercise 4 consists of passive concentration on breathing. In Exercise 5, the subject cultivates the sensation of warmth in his upper abdomen, and Exercise 6 is the cultivation of feelings of coolness in the forehead. Exercises 1 through 4 most effectively elicit the trophotropic response, while Exercises 5 and 6 are reported to have different effects (Luthe, 1969). The subject's attitude toward the exercise must not be intense and compulsive, but rather of a quiet, "let it happen," nature. This is referred to as *passive concentration* and is deemed absolutely essential (Luthe, 1972).

Progressive relaxation is a technique which seeks to achieve increased discriminative control over skeletal muscle until a subject is able to induce very low levels of tonus in the major muscle groups. Jacobson, who devised the technique, states that anxiety and muscular relaxation produce opposite physiologic states, and therefore cannot exist together. Progressive relaxation is practiced in a supine position in a quiet room; a passive attitude is essential because mental images induce slight, measurable tensions in muscles, especially those of the eyes and face. The subject is taught to recognize even slight contractions of his muscles so that he can avoid them and achieve the deepest degree of relaxation possible.

Hypnosis is an artificially induced state characterized by increased suggestibility (Gorton). A subject is judged to be in the hypnotic state if he manifests a high level of response to test suggestions such as muscle rigidity, amnesia, hallucination, anesthesia, and post-hypnotic suggestion, which are used in standard scales such as that of Weitzenhoffer and Hilgard. The hypnotic induction procedure usually includes suggestion (autosuggestion for self-hypnosis) of relaxation and drowsiness, closed eyes, and a recumbent or semisupine position (Barber, 1971). Following the induction

procedure, an appropriate suggestion for the desired mental or physical behavior is given.

So far it has not been possible to find a unique physiologic index which defines the hypnotic state (Barber, 1971). Physiologic states vary the same way during hypnosis as they do during waking behavior. Suggested states of arousal or relaxation are accompanied by *either* increased or decreased metabolic rate, heart rate, blood pressure, skin conductance, and respiratory rate, corresponding to the changes seen when these states are induced by nonhypnotic means (Barber, 1971). If the control state is the same as the suggested state, then of course, no change in physiologic parameters will be seen (Barber, 1961). For example, the study by Whitehorn et al. reported that the control oxygen consumption value of 217 ml/min was not significantly changed by hypnosis. However, subjects in this experiment were trained to relax before control readings were taken. Therefore, hypnotic suggestion to relax produced no further change.

Sentic cycles is another psychophysiology technique, devised by Manfred Clynes. A sentic "cycle" is composed of eight sentic states. A sentic "state" is a self-induced emotional experience, and the sequence of states used by Clynes is: no emotion, anger, hate, grief, love, sex, joy, reverence. A subject practices a cycle by thinking the state—e.g., anger—and responding with finger pressure on a key (which transduces the pressure for recording) as he sits and listens to a tape recording. The recording states which sentic state is present and when the subject should press the key.

Burrow described two kinds of attention: *cotention* and *ditation* (Burrow; Shiomi). Cotention is the subject's "... focus on the object of its environment." It is concentration on one thing exclusively. Ditation is described as "ordinary" wakefulness, in which state the subject's interest shifts from object to object. The state of cotention is induced by relaxing the muscles, closing the eyes, and resting them on a point imagined to be the center of a curtain of darkness in front of the subject.

Yoga has been an important part of Indian culture for thousands of years. It is

claimed to be the culmination of the efforts of ancient Hindu thinkers to "give man the fullest possible control over his mind" (Hoenig). Yoga consists of meditation practices and physical techniques usually performed in a quiet environment, and it has many variant forms. Yoga began as Raja Yoga, which sought "union with the absolute" by meditation. Later, there was an emphasis on physical methods in attempts to achieve an altered state of consciousness. This form is termed Hatha Yoga. It has developed into a physical culture and is claimed to prevent and cure certain diseases. Essential to the practice of Hatha Yoga are appropriate posture and control of respiration (Ramamurthi). The most common posture is called Lotus (seated on the ground with legs crossed). This posture helps the spine stay erect without strain and is claimed to enhance concentration. The respiratory training promotes control of duration of inspiration and expiration, and the pause between breaths, so that one eventually achieves voluntary control of respiration. Bagchi and Wenger, in studies of Yoga practitioners, reported that Yoga could produce a 70% increase in skin resistance, decreased heart rate, and EEG alpha wave activity. These observations led them to suggest that Yoga is "deep relaxation of a certain aspect of the autonomic nervous system without drowsiness or sleep."

Transcendental Meditation is currently a widely practiced form of Yoga. The technique, as taught by Maharishi Mahesh Yogi, comes from the Vedic tradition of India. Instruction is given individually, and the technique is allegedly easily learned at the first instruction session. It is said to require no physical or mental control. The individual is taught a systematic method of repeating a word or sound, the mantra, without attempting to concentrate specifically on it. It involves little change in life style, other than the meditation period of 15 to 20 minutes twice a day when the practitioner sits in a comfortable position with closed eyes.

Zen is very like Yoga, from which it developed, and is associated with the Buddhist religion (Onda). In Zen meditation,

the subject is said to achieve a "controlled psychophysiological decrease of the cerebral excitatory state" by a crossed-leg posture, closed eyes, regulation of respiration, and concentration on the Koan (an alogical problem—e.g., What is the sound of one hand clapping?), or by prayer and chanting. Respiration is adjusted by taking several slow deep breaths, then inspiring briefly and forcefully, and expiring long and forcefully, with subsequent natural breathing. Any sensory perceptions or mental images are allowed to appear and leave passively. A quiet, comfortable environment is essential. Experienced Zen meditators elicit the relaxation response more efficiently than novices (Sugi and Akutsu).

POSSIBLE THERAPEUTIC BENEFITS AND SIDE EFFECTS OF THE RELAXATION RESPONSE

Although advocates of many of the techniques which elicit the relaxation response offer anecdotal evidence to support claims of healthful and therapeutic benefits, only preliminary objective data exist at the present time which establish the place of the relaxation response in medicine. The regular practice of Transcendental Meditation leads to decreased systolic blood pressure in hypertensive subjects (Benson, Rosner, and Marzetta) and, in an uncontrolled retrospective study, was associated with decreased drug abuse (Benson and Wallace). The daily elicitation of the relaxation response predictably may be of value in situations where excessive sympathetic activity is present, situations which chronically evoke the fight or flight response and which may lead to prevalent, serious diseases such as hypertension (Gutmann and Benson).

The side effects of the chronic practice of the relaxation response have not been well documented. When the response is elicited for two limited daily periods of 20 to 30 minutes, no adverse side effects have been observed (personal observations, H.B.). When elicited more frequently, some subjects experience a withdrawal from life and symptoms which range in severity from insomnia to psychotic manifestations, often with hallucinatory behavior (personal ob-

servations, H.B.). Effects are difficult to evaluate on a prospective basis. In subjects with preexisting psychiatric problems, drawn to any treatment which promises relaxation, extensive prospective relaxation response studies in subjects suffering from drug abuse, psychiatric illness, and results soon.

If the relaxation response is of value in medicine,

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servations, H.B.; Ornstein). These side effects are difficult to evaluate on a retrospective basis since many people with preexisting psychiatric problems would be drawn to any technique which evangelistically promises relief from tension and stress. Extensive prospective investigations of the relaxation response are underway in subjects suffering from hypertension, headache, drug abuse, psychoses, and anxiety neuroses, and results soon should be available.

If the relaxation response proves to be of value in medicine, there exist many reli-

gious, secular, or "therapeutic" techniques which elicit it. This should not be construed so as to interpret religion in mechanistic terms. Belief in the technique in question may well be a very important factor in the elicitation of the relaxation response. Future studies should establish the most efficient method for a given individual.

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VOLUNTARY CONTROL OF INTERNAL STATES: PSYCHOLOGICAL AND PHYSIOLOGICAL¹

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The first part of this article is a summary of a technological paper presented at the 1969 International Congress of Cybernetics (Green, Green, and Walters, 1970) 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.

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" (Adrian, 1961). 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 meth-

¹The work discussed in this paper was supported in part by Grant MH 14439, National Institute of Mental Health. We thank Mr. Rex Hartzell and the personnel of the Biomedical Electronics Laboratory for their great assistance in the design, construction, and maintenance of psychophysiological feedback apparatus.

odology 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.

For about 200 years, medical doctors serving with the British Army or Civil Service in India sent back reports of a few such self-regulating people. The doctors claimed that these unusual individuals, called yogis, could regulate a number of "involuntary" physiological processes, such as heart rate or pain. This phenomenal control was obtained, they said, through long practice of specific mental, emotional, and physical disciplines.

In some parts of the Western world there was great interest in such reports, and by 1910 in this century, Johannes Schultz (in Germany) had developed a Western system of self-regulation by combining various ideas from his medical research, especially from hypnosis, with concepts from yogic methods. Although Freud gave up the use of hypnosis in therapy because its results were too unpredictable, it occurred to Schultz that the major defect with hypnosis might lie in the fact that the patient was not in control of the situation and therefore resisted in various ways the doctor's instructions. Schultz combined the free-will or volitional aspect of yoga with some of the techniques he had worked with, and eventually developed the therapeutic system to which he gave the name Autogenic Training; that is, self-generated or self-willed training (Schulz & Luthe, 1959).

Autogenic Training has had a measure of success, but it is handicapped by the fact that it normally takes considerable time for the subject, or patient, to learn it. It was the need to shorten the learning time associated with Autogenic Training and to adapt the system for research in states of consciousness which led to the development of the methodology discussed below. In essence, the autogenic "development," or movement, has been carried one step further by combining the conscious self-regulation aspect of yoga and the psychological method of Autogenic Training, with the modern instrumental technique called physiological feedback. Feedback of physiological information in our application generally consists of providing visual or auditory displays that show the subject what is happening in certain normally unconscious

*new tools for
exploring
natural
phenomena*

*combination of
Autogenic
Training and
physiological
feedback
training*

functions of his body' as he attempts to influence them by the use of mental, emotional, and somatic visualizations. We call this method *Autogenic Feedback Training*.²

Before leaving the subject of *Autogenic Training*, it is worth mentioning that after a patient learns to relax his striate musculature, as in *Progressive Relaxation* (Jacobson, 1938), he goes on to regulate blood flow in various parts of the body. This is followed by exercises in the control of heart rate, and if necessary the patient eventually focuses his control effort (under medical supervision) on the functional correction of psychosomatically sensitive areas, such as the gastrointestinal tract. In this connection it is noteworthy that for training in cardiac regulation, Schultz in the 1930's used a straightforward bio-feedback method; the subject's hand was placed over the heart region of his thorax in order to help him "discover" his heart. Gradually, as emotional and physiological harmony is obtained in distraught patients, autogenic therapy moves into psychological areas. In spite of a significant amount of success, *Autogenic Training* though over 50 years old is almost unknown in the United States; in the 1959 handbook by Schultz and Luthe, of 604 references only 10 are in English.

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, as we hypothesize it, 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 cou-

difficulties in defining "voluntary"

the psychophysiological hypothesis

discussion of diagram

pled 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 (Brown, 1970; Dewan, 1966; Green *et al.*, 1969; Green, Green, & Walters, 1970; Hart, 1967; Kamiya, 1969; Mulholland & Runnals, 1963; Nowlis & Kamiya, 1970).

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 diagram below is arranged to indicate brain areas associated with unconscious functions on the left and with conscious functions on the right. The peripheral nervous system is seen to be divided according to classical concepts into the autonomic system and the craniospinal system.

Unconscious Domain	Conscious Domain
1. archipallium, in the central nervous system	1. neopallium, in the central nervous system
2. control of smooth muscle and glands in the autonomic section of the peripheral nervous system	2. control of striate muscle in the craniospinal section of the peripheral nervous system
3. involuntary	3. voluntary
4. responsive to "passive volition"	4. responsive to "active volition"

The central nervous system is divided into the archipallium on the left, the old brain that man shares with the other vertebrates, and the neopallium on the right, the new brain whose most significant development is in man, dolphins notwithstanding.

The dashed line, the divider between conscious and unconscious systems and processes, is drawn as a straight line, but it is to be visualized as 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.

²Gardner Murphy must be given due credit for stimulating and promoting bio-feedback 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.

On the other hand, the involuntary nervous system is not necessarily "involuntary," even as the voluntary nervous system is not necessarily "voluntary." If we concentrate attention on our right hand for a few seconds, its temperature will spontaneously begin to rise or fall due to tensing or relaxing of smooth muscles embedded in blood vessel walls, depending among other things on our previous conditioning to self-examination. After training in temperature control, however, many subjects can increase or decrease the volume of blood in the hands at will. Consciousness of the specific neural pattern involved is *not* obtained, however, any more than there is consciousness of the neural network in the voluntary nervous system that causes the arm to move from side to side "at will"; in both cases, autonomic and craniospinal, the desired behavior is obtained through visualization of the desired event accompanied by volition. The significant difference in controlling these two systems is that for the control of the voluntary nervous system it is necessary to use *active* volition, and for control of the involuntary nervous system it is necessary to use *passive* volition. It must be admitted that this last sounds like a contradiction in terms. How can anyone have passive volition? It is paradoxical, but after learning to use passive volition it seems quite reasonable, though not easy to put into words. It might best be described as detached effortless volition.

A RELAXATION EXPERIMENT WITH FEEDBACK

Generally speaking, skillful control of striate muscle is originally developed with feedback of information from special sense organs, especially the eyes. In one area of striate muscle behavior, however, there is essentially no perceptual feedback. This is in the reduction of muscle tension down to zero. If an electromyographic (EMG) electrode is placed on the skin surface, over the dorsal muscle of the forearm for instance, it will usually detect a continuous firing of motor fibers, even though visible signs of tension may not exist and muscular feelings of tension may not exist; however, if the signal from the forearm is amplified, rectified, and then made visible to the subject by a meter, he can quickly learn to reduce the muscle tension to very low levels. In an experiment in our laboratory, using the EMG-feedback arrangement described above, 7 out of 21 subjects were able to achieve either zero firing or single-motor-unit firing in less than 20 minutes of a single session (Green *et al.*, 1969). This was a phenomenal performance that only one subject could do without feedback. He, oddly enough, had practiced yogic meditation for a number of years. Eleven of the 21 subjects

body image changes during experiment

passive and active volition

were able to achieve low tension levels with feedback but could not reach single-motor-unit firing in 20 minutes. Three of the subjects did not seem to succeed at all. They, incidentally, gave evidence of strain due to the experimental setup.

Of the seven subjects who approached zero levels in less than 20 minutes, five reported body-image changes, making statements such as "My arm feels like a bag of cement," "I feel a ton of lead," "It feels like it is moving away from me," "I had to look at it to see if it was still in the same place," etc. In naive subjects in a proper setting (reclining chair, quiet room, dim lights, etc.), relaxation generally spreads over a large part of the body, but we have found that a normal subject can learn, with a little practice, to dissociate his right forearm from the rest of his muscular system so that he can tense his left arm, leg muscles, or neck muscles, without causing any significant increase of tension in the right arm.

TRIPLE TRAINING PROGRAM WITH FEEDBACK

Preliminary experiments with feedback and with Autogenic Training led to our present formal project in which college men are being trained in the simultaneous (1) reduction of muscle tension in the right forearm, (2) increase in temperature in the right hand (as an indication of autonomic relaxation), and (3) increase in percentage of alpha rhythm in the EEG record. Visual feedback of muscle tension with a meter is initiated from a circuit of the type already described. Temperature feedback, also with a meter, is initiated from a thermistor taped to a finger of the right hand. Percentage-of-alpha feedback, initiated from a left-occiput-to-ear electrode arrangement, is achieved by allowing the subject to watch a third meter that shows the average percentage over a continuously computed 10-second epoch. That is, the meter continuously tells the subject what his average percentage of alpha has been over the preceding 10 seconds. More immediate knowledge of alpha production is obtained, of course, as the average rises or falls in response to the on-going EEG signal.

Feedback is displayed by three vertical bars of light on a panel in front of the subject. Each bar, becoming taller or shorter in correspondence with the behavior of a physiological variable, is literally the readout mode of an optical projection type of meter. The bars of light, 1/2-inch wide, can reach a maximum height of 5 inches, and give the subject an easy-to-see indication of his physiological behavior and voluntary control. The feedback circuits are arranged so that

(1) at complete relaxation (zero muscle tension) the left bar of the group of three rises to the top, (2) when a temperature increase of about 10° F is detected the second bar rises to the top, (3) when 100% alpha rhythm is maintained over a period of 10 seconds the third bar rises to the top.

A training sequence involves eight sessions, two per week, each of about 2½ hours duration, including 40 minutes for wiring. A number of psychological tests are given to each subject, mainly to determine his inward-outward orientation, which has been hypothesized to be significantly related to success in voluntary control of internal states. The tests include (1) the Eysenck Personality Inventory, for determination of extraversion-introversion; (2) the James I-E scale, for determining internal-versus-external control of behavior; (3) the Rod and Frame test, for determination of field dependence; (4) the flexibility scale, F_x , of the California Personality Inventory; (5) the Thurstone Concealed Figures Test, another field dependence test; (6) a visual Autokinetic test, for determining ego closeness to the environment (Voth, Mayman, 1967); (7) an Afterimage test, which seems to be related to internal awareness; and (8) a Recall test, for determining the relationship between recall and percentage of alpha. (The last two tests are of our own construction.)

A typical training session has several distinct phases. After the subject is comfortably seated he closes his eyes and relaxes for 3 or 4 minutes while various recording machines are adjusted. Training typically consists of the following phases:

1. Relax with eyes closed for 3 minutes; no feedback.
2. Relax with eyes open for 4 minutes; no feedback.
3. Maintain relaxation and "visualize," feel, warmth with eyes open for 4 minutes; no feedback.
4. Maintain relaxation and warmth, and establish a quiet inner-focused and alert state of mind for 4 minutes; no feedback.
5. Autogenic Feedback Training with *muscle tension* meter only; 3 minutes with autogenic phrases for relaxation initiated by the experimenter, followed by 4 minutes of silent practice with phrases. Relaxation phrases, of which about eight are used, follow a typical pattern. Three such phrases are, "I feel quite quiet." "My feet are heavy." "My ankles, my knees, my hips, feel heavy and relaxed."
6. Autogenic Feedback Training with muscle tension and *warmth* meters; 3 minutes with several autogenic phrases for warmth initiated by the experimenter, followed by 4 minutes of silent practice with phrases. A typical warmth

*testing of
inward-outward
orientation*

*typical trainee
comments*

*typical training
session*

4

phrase often emphasizes both relaxation and warmth. For instance, "My hands are heavy and warm."

7. Autogenic Feedback Training with muscle tension, warmth, and *percentage-of-alpha* feedback meters; 3 minutes with autogenic phrases for alpha enhancement initiated by the experimenter, followed by 4 minutes of silent practice with phrases. For control of percentage of alpha we have devised autogenic-like phrases that focus attention inward, away from the outside world, and emphasize the quiet but alert mind.
8. Twenty minutes of free practice with the three meters.
9. With feedback meters switched on, subject attempts to maintain peripheral-nervous-system passivation and central-nervous-system alpha-activation during discussion and interview for about 12 minutes.

For five experimental subjects whose training records have been almost completely evaluated, it was observed that relaxation results were quite similar to those reported above for the 7 out of 21 subjects who achieved unusually low tension levels in a single session; however, when attention shifted to warmth and alpha in the first two or three training sessions, subjects found that deep relaxation was difficult to maintain. In later sessions, however, control of relaxation improved. Zero muscle tension was not observed in any of the five subjects, but all reached very low levels and, when interviewed, reported definite body-image changes including such comments as "I felt I was floating above the chair." "[I am] sort of light like. I'm not even sitting here. I feel like I'm just detached in some way . . . you know, if I create some sort of image I feel as though I'm just there." Another subject said, during deep relaxation and high alpha, "It sounds funny, but . . . well, okay . . . it seems like there was some kind of force on the inside, flowing through my forehead out . . . not a hard pressure but you can feel it, like when you move your hand through flowing water."

In controlling warmth, subjects succeeded to an encouraging, though not remarkable, degree. The average voluntary increase in temperature of the finger for the group was about 3° F after three or four training sessions. One pilot subject (not a member of the triple training group) working only with the temperature meter was able to produce a change in hand temperature of 10° F in 2½ minutes after being requested to increase the meter reading. (This subject had practiced yoga.)

Three of five subjects were "alpha producers" under normal eyes-closed conditions, averaging about 75% alpha. In five

training periods they were able to increase their percentage of alpha during the eyes-open visual-feedback condition from 24% to 45% (group average). Visual examination of the records of nine additional subjects suggests that the increase in percentage-of-alpha in the eyes-open interview situation is not a chance occurrence for alpha producers, but we are not yet prepared to offer statistical evidence. In the group of five subjects, the two "non-alpha" producers gave a slight indication of an increase in percentage of alpha with training, from about 3% to 7%. If this tendency is borne out with additional subjects, a future experiment may seek to determine the extent to which the percentage of alpha in "non-alpha" subjects can be raised. An important observation is that every subject who learned to produce a relatively high percentage of alpha rhythm with eyes open was a natural high-level producer with eyes closed.

An especially interesting finding with these first five subjects was that in the *delayed* recall test of prose stories, the subjects who produced the highest percentages of alpha rhythm in their EEG patterns while they were recalling and *speaking* remembered the most material. Data reduction has been completed for so few subjects, however, that there is no certainty about the significance of this finding.

A tentative summary of our *physiological* findings with about 60 subjects over a period of 4 years in both feedback and Autogenic Training studies indicates that (1) relaxation of muscle tension to extremely low levels is quite easy to learn with feedback of EMG signals, but not nearly so easy with autogenic phrases alone; (2) control of warmth is significantly aided by feedback in comparison with autogenic phrases alone, and in some cases phenomenally, but does not generally become easy with just a few practice sessions in the laboratory; (3) increase in percentage of alpha rhythm with eyes open and while talking to the experimenter is easy to learn by feedback methods for those subjects who normally have a high percentage of alpha rhythm (above 30%) when their eyes are closed, but is not easy for subjects who do not normally produce alpha rhythm with eyes closed. There is nothing in Autogenic Training that corresponds with brain-wave feedback training, unless the Meditative Exercises (Schulz and Luthe 1959) can be said to be brain-wave training.

A tentative summary of our *psychological* findings are: (1) body-image changes, reaching a feeling of disembodiment in some subjects, seem to be associated with very low

*tentative
summary of
psychological
findings*

*tentative
summary of
physiological
findings*

*beginning
stages of
transpersonal
research*

levels of muscle tension; (2) a general feeling of tranquility is usually reported in conjunction with significant increases in hand temperature, though an accompanying drowsiness tends to interfere with the alert inner-focused state which is associated with the production of alpha rhythm; (3) a poised non-drowsy state, generally associated with a high percentage of alpha, appears to facilitate recall processes. In addition, (4) hypnagogic and dream-like images during a state of semiconscious reverie have been observed by a number of experimental subjects in conjunction with periods of theta rhythm and low-frequency alpha waves (see accompanying diagram).

Normally unconscious		Normally conscious		
delta	theta	alpha	beta	
0	4	8	13	26
Hertz (cycles/second)				
Major frequency bands of brain waves, electroencephalographic (EEG) record.				

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 in Item 4 above. The "reverie"² 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 hypnagogic-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

²Reverie is defined for our purposes as a state of *inward-turned abstract* attention or internal scanning. It is differentiated from the state of attention normally associated with peripheral sensory processes, external scanning, and concrete problem-solving. There seems to be no simple differentiation between deep reverie and some dream-like states.

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 (1964) and his associates (Wilson *et al.*, 1954) and to isolate personality characteristics related to creativity, exemplified by Cattell (Cattell, 1964; Drevdahl & Cattell, 1958) and Barron (1958, 1964) and their associates. 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* (1952). A few attempts have been made to study creativity through the use of hypnosis (Krippner, 1964; MacKinnon, 1964). Efforts to increase or "train for" creativity have included methods such as "brainstorming" (Parnes, 1962; Osborn, 1963) and "synetics" (Gordon, 1961). 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 (1925), Getzels & Jackson (1962), MacKinnon (1962), and Cattell (1968).

Recent attempts to elicit and investigate creativity through the use of psychedelic drugs (Mogar, 1965; Harman *et al.*, 1966; Zegans, 1967) 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. 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

*new methods
for study of
creativity*

*training and
unrealized
creativity
potential*

6

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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 subjects⁴ who were self-trained over a period of 15 to 30 years in internal scanning techniques (meditation) demonstrated an unusually high percentage of 6-8½ Hertz waves in their EEG records during periods of deep reverie. 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 experiment⁵ 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.⁶ Twelve subjects were tested for reaction time in three EEG sessions, each of 1½ hours duration. The RT stimulus was the "bump" of a light-weight 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

⁴A professor of physics, a psychiatrist, and a psychologist, all of whom are uniquely individualistic, creative, and successful in their respective vocations.

⁵The results of which are being prepared for publication.

⁶Hypnagogic-like, rather than hypnagogic, because our subjects were trying to remain awake rather than to go to sleep.

"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" imagery	thinking	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 slowness 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 "word" 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.⁷

The hypnagogic-like effect of monotony in the reaction time experiment was not totally unexpected. A number of writers, including Huber (1965) and Shattock (1960), have stressed the use of monotony in developing awareness of normally unconscious material. 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 (1963) have reported that in an

⁷Robert 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."

*hypnagogic
imagery* *vital role of
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.

4. Anand, Chhina, and Singh (1961) 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.

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 (1954) 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." 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 Kekulé. He tells of a series of deep reveries in which atoms "gambled" before his eyes, leading to his theory of molecular constitution (Koestler, 1964):

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 Kekulé 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 Poincaré'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.

creative images

extremely varied terminology

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. . ." (Ghiselin, 1952). Rollo May (1959) tells of the Nobel Prize winner who dreamed the sought-for formula, awakened, and in his excitement hurriedly scribbled it on a paper handkerchief—only to find he could not read it the next morning. 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),⁸ and creativity are associated. 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 (James, 1959), the "pre-conscious" (Kubie, 1958), the "offconscious" and the "transliminal mind" (Rugg, 1963), and "transliminal experience" (MacKinnon, 1964).

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

⁸Similar to hypnagogic imagery except that by definition it occurs just after waking instead of just before sleeping.

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 (Harman, 1967), and bring a degree of freedom from normally unconditioned responses (Meares, 1967). 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 involves voluntary control of the central nervous system so that those states of awareness that are associated with conscious control of alpha and theta rhythms in the brain can be studied.

*primacy of the
psychological
state*

*unique value
of feedback
instrumentation*

*main
goal*

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." The experimenter is provided with on-off switches that give him individual control (for training purposes) of each brain-wave 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 to record the

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

*recent
electronic
developments*

*use of
automatic
devices to
enhance
imagery
awareness*

*"subliminal
dredging
operation"*

10

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 omnidirectional 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 (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 (1969) has also found the arm-balancing method to be useful in studying reverie and says:

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 results for hypnagogic material (p. 18)

One use for the upheld hand is to

*arm balancing
method*

*expected
contribution to
transpersonal
psychology*

jects 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 (1965). 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 aids behind, short-term use is expected to be highly significant, especially in learning how to combine conscious and unconscious processes in the creative process.

cepts 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* (1965), in which volition is of great significance, is an Italian. 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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More on Alpha

To the Editor:

The "alpha brain wave" has been unfortunately misrepresented by many teachers of various mind-training courses ["The Alpha State Lets the Mind Take Wings," Aug. 23]. Without doing electroencephalographic (EEG) research, they have leaped on the "alpha" band wagon, possibly because it seems scientific and attracts the attention of persons interested in improving psychological and physiological health, and possibly in order to substitute the words "alpha" and "brain wave" for "hypnosis," which seems to be the main method.

Research across the country in dozens of EEG laboratories shows that about 90 per cent of the population produces alpha rhythm (8 to 13 Hertz, cycles per second) whenever they close their eyes. If they are normally creative people, then when their eyes are closed they remain creative; if they are normally bright during eyes-open periods, they remain bright; and if they are normally dull, they are still their same dull selves during alpha with the eyes closed. It is quite obvious that 90 per cent of our population are not normally telepathic, in spite of the fact that they produce alpha whenever they close their eyes.

An example of misinformation appeared in your Letters to the Editor, Sept. 25. Mr. Christopher, a mind-training instructor, says, "If one can function with ESP only by using the alpha waves, and one actually does function with ESP, it would follow that one is using alpha waves." The basic assumption is incorrect. ESP and alpha waves do not necessarily go together. This has been shown by many researchers to be false. Many of the mind-training courses rely heavily on intensive hypnosis to stimulate what are said to be latent extrasensory faculties, but the hypnotic brain-wave state is so similar to the normal waking brain-wave state that many researchers feel there is no significant difference. If Mr. Christopher and other mind-training teachers made it clear that they are not giving training in brain-wave control, but rather are training a *state of consciousness*, it would remove many of the scientific objections.

It is no doubt useful for people to relax, with closed eyes, during the mind-training hypnotic-induction procedure, and alpha waves may be present (except in that 10 per cent of the population that does not produce alpha waves for no known reason), but it should be made quite clear that whatever results are obtained depend more on hypnosis than on alpha.

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☆ ☆ ☆

Seven Doors

Can you imagine a 3 story bldg. in your landscape? (Command) your mirror image to approach the bldg and enter it through the double doors you will find there. Walk down 3 steps, through a portal, and into a long corridor. There are 7 doors on the right side of the corridor and 7 doors on the left. All are different colors; note the color of each. Walk down the corridor, & choose a door on the right that you wish to open. Does the door have a label on it?

{ Enforced meditation
 { One word

Tuning Meditation

Anna's Circle

Tumbling Song

Wheel of Life

One sound Once

Energy Changes

Environmental Dialogue

Teach yourself to fly

Rock Piece

- Found Meditation
- Gargluckenzie Meditation
- Circle head contact
- Vibrate Heart Chakra

One Sound Once

Begin by trying to imagine silence. During the course of the meditation one, and only one sound will occur intentionally. (In this case several people are prepared to make a sound but only one person will actually make the sound.)

When you are aware that the sound has occurred try to focus attention on the space/time between the beginning of the meditation and the intended sound.

Continue trying to imagine silence until an equivalent space/time has occurred.

Indicate your perception of this passage of time by clapping your hands once

One Sound Once

Begin by trying to imagine silence.
Several persons are prepared to make
one

Sonic Meditation Session Nov. 3, 1979

I Brief talks outlining the session.

II a) Self initiated relaxation.

b) Can you imagine that you are very comfortable and that your spine is very straight.

^{Can you imagine relaxing with every sound.}
c) Can you imagine your physical actions from waking until the present moment as if you were watching a movie?

d) Can you imagine a place to leave your interests and then a comfortable imaginary space to float in?

III a) Breath : 4 inhale / hold / exhale guide.
4 inhale to count 4 hold 4 exhale 20 more

b) Can you imagine the distance between your eyes? etc.

c) Can you imagine your own landscape with all the sights, sounds, smells etc that you enjoy - mirror image fantasy.

d) Can you imagine floating back to your own imaginary space to the place where you left your interests.

Can you imagine picking one thing to think about either by focusing in or expanding around it, or alternating focus and expansion.

e) Can you imagine feeling refreshed and revitalized, continuing your day with full energy and accomplishing all that you want and need to accomplish?

f) When you are finished give yourself any affirmation you might need.

IV Sonic Meditation:

One Word
+ Sound
Wheel of Life
Removing the Demon
Energy Changes
One Sound Once
Rock Piece
Telepathic Improvisation
Responsibility
Turning Meditation
Enforced Meditation
Zhu's Circle

Circle Head Contact
Environmental Dialogue
Gary McKenzie Meditation
Sound Meditation
Teach yourself to Fly
Tumbling Song
Antiphonal Meditation

NOTES

A man in space literally sees the world in a new way. Man in space serves as a metaphor for a major issue in music. Today: We are faced with the diverse musics of the world, made accessible by technology. Man in space sees half of the whole, the whole view still needs travel in time for completion. We can never really see the whole without dimension of time. Nevertheless, man in space sees more, yet with less detail. The global view necessarily has less detail. The closer we come to the object, the more detail, yet we lose the boundaries. We must reverse the metaphor and find the space in man. How to accommodate the diversity of the world. The global view is integrating because of the boundary. The focal view with time gives the inner workings. With the man in space, the need to study the space in man is greater.

The focal view runs into apparent discontinuities on the surface. Coherence becomes evident only when we discover how surface events relate to one another and to the features of the larger organization or the global view.

----- What composition is -----

9/7/79

The definition of music as organized sound in time seems limited. The definition accounts only for the object, music, but not for the context. In this case, the composer is one who manipulates sounds or organizes them, and the listener is the one who perceives the organization or not. Such a definition offers no values other than the concept of organizing. This is accomodating to music of differing value and organizations, but unsatisfying otherwise. How is sound organized? Is it merely a matter of pleasing the ear? the intellect? or a matter of invoking or changing emotional states? or sending messages to a God or Gods? How does the composer come by his/her ability to manage the organization of sound? Can this ability be taught, or transmitted? How is this activity valued? What purposes does it serve? How do innovations occur in such a traditional discipline? In my case, it came through fascination and love for sounds. Who can explain that? In the early stages of my development as a composer, nothing else mattered. It was a love affair. ~~N~~ow that the passion is transformed, and composing is a way of life, questions concerning my relationship arise. I still love sounds and am fascinated, but not in the all consuming way of the beginning. Why do I do what I do? Who is affected? What are the consequences? Is it a useful thing to do? Who needs it? I need it. I have found that sounds affect my well being. The kind of music (organizing of sound) that I have been composing is aiding my concentration and my awareness of others. It is a healing and socializing agent. It became that way for me through recognition of my own inner need. The process I have developed are meeting that need in me and in others, so others say. If this is true, then there is every reason to continue to organize sound the way I do even though I have broken with my tradition. I am no longer note bound. The whole spectrum of audible sound and perceptible time relationships are available to me. My work goes beyond our traditional system of notation.

How does attention shape music?

----- Musical Basics -----

In order to participate in higher order musical relationships the musician must be able to do the following:

With perfect or relative pitch -

1) Identify any tone, or any tone after a given reference tone, regardless of timbre and duration. (Duration limit at least 2 cycles) within a useful musical range.

How fast?

Complementary processes

The reaction time may be instantaneous.

2) Produce any tone (within range) vocally or instrumentally. (If perfect pitch is absent, a vocalist is given a reference tone.)

A musician without perfect pitch should be able to approximate registers at least.

With perfect or relative time sense -

1) Identify any tempo, within the useful musical range, in terms of beats per minute.

All of the above determinations of pitch and tempo should be made from the auditory, visual or semantic cues appropriate to the musicians tradition. (oral or written)

No participation in music can occur whether it is composition, performance or listening without these basics, either at a gross or fine level.

----- I teach the basics as Tuning and Tempo -----

Melody and Rhythm arise from the ability to vary tuning and tempo. Melody is variation in tuning, rhythm is variation in rates. Patterns, or organizations of these variations occur. These patterns may be regular or irregular, metric or organic.

Attention to a point or focus in music = directing or channeling all the required forces (body position breath control, muscle tension, mental attitude) into inventing, imitating, reproducing or perceiving the correct sound pattern or organization of sounds at the right time with the appropriate dynamics and articulations.

OR -- having a fixed template which filters all incoming information, perceptions and actions.

Imitating imagination

Origins of Intellect

Piaget's Theory

J.L.Phillips

----- Tempo -----

All music moves at some tempo. Tempo is the rate of motion or the pulse by which rhythm, or the patterns of motion can be measured or related. The slowest perceptible tempo is somewhere in the borderland between memory and perception. The fastest merges into pitch. Tempo may be steady or it may fluctuate. Tempo can change abruptly, or steadily increase or decrease. Increases or decreases can be linear or non-linear. Tempo can change rapidly (many times), slowly (not often) or drift slightly. Patterned changes in tempo might be interpreted as rhythms. The tempo of any music is related to its function or purpose. Calming music may have a slow tempo, rousing music may have a fast tempo. Worksongs may have a tempo geared to optimum workspace for the human body.

Questions:

What is the range of tempo in the perception of a human being?
The slowest? The fastest?

Points

see pages 241-242

Tempo keeping is a sensorimotor activity or somatic. Auditory and visual cues must be fed to the motor center.

Compare to Pueblo Indians keeping Tempo.

Since the conductor has assumed more of an interpretive role, it is essential for the players to sense and maintain tempo.

We need exercises which assign tempo to the plenum mode by tying up focal attention.

Conducting is a relative recent art. It began as time keeping in polyphonic music. In Paris, the conductor beat time loudly with a stick (often drowning out the band). From this auditory cue, it went to the visual baton waving cue introduced by Spohr in the 19th century.

Tempo comments:

"The meter (tempo) must not be tyrannically inhibiting or a driving hammer, but should be to music what the pulse is to human life. There is no slow tempo without passages which demand a quicker motion to avoid any impresssion of dragging. And there is no presto which does not demand, in contrast, a quieter delivery of certain parts, so as not to impede the means of expression with too much zeal. But the foregoing should not, in heaven's name, be taken by any singer as justification for the type of eccentric interpretation which arbitrarily distorts certain bars and arouses in the listener a painful reaction as unbearable as watching a juggler deliberately put his limbs out of joint. The acceleration of tempo, as well as retarding, must never give rise to a feeling of abruptness, jolting or violence...."
Carl Maria Von Weber -- page 20 --

"The right comprehension of the melos (melody in all its aspects) is the sole guide to the right tempo; these two things are inseparatable, the one implies and qualifies the other."
R. Wagner -- page 74 --

"It is surprising how few conductors are capable of setting and maintaining a tempo for more than a few bars."
Sr. John Barbirolli - page 243

"no tempo should be so slow as to make it difficult for the melody to be recognizable, and no tempo should be so fast as to make a melody unrecognizable."

-- Limits of tempo --

Fast tempo may tend to divide down into slower beats. Slow tempo may subdivide into faster units.

(find examples)

----- Pitch Sense -----

Some musicians can accurately pinpoint pitch without a reference tone or context. This ability is limited in range (recognition becomes difficult at extremes of range and probably varies with the ~~duration~~ individuals). It also probably varies with the duration and timbre of the given tone. Some musicians who can not identify a tone without a reference can accurately identify notes within a musical context. I wonder if musicians with perfect pitch lose it all, or some of the time, within a musical context. How fast does the identification process work? Perfect pitch does not guarantee higher order musical ability, such as the ability to phrase well or comprehend the overall structure of a composition.

How is it stored?

----- Tuning -----

All music has a range of tones, either pitches or timbres. All voices or instruments are tuned to recognizable pitches or timbres. Pitch seems to be focused about a single frequency or fundamental of regular vibration with harmonics in varying intensities. Pitch is carried by timbre.

Erickson - "Sound Structures in Music"

Timbre is everything including regular and irregular vibrations which give rise to the quality of any tone or sound. Timbre is that which enables us to recognize differences in voice or instruments or any sound whatever. Timbre is not necessarily focused around a single frequency. There may be competing frequencies. However, there may be many pitches of similar timbre. A voice or instrument is said to be in tune when it produces a pitch which matches a recognized tuning source such as another voice or instrument, either matching in unison or at any recognized interval within a given musical system. If the instrument is non-pitched, for instance a drum or gong, it is in tune when it is at optimum resonance for the vibrating body and is recognized for what it is.

Points

Tuning which focuses around a single frequency and its harmonic in a regular distribution.

Tuning which focuses around a timbre (made up of many frequencies in regular and irregular distribution).

A bell is a good example of a timbre with no single pitch but inharmonic relationships.

Tuning has a larger meaning - i.e. tuning of groups to common rhythm or tempo. Tuning to a particular system of scales and intervals or chords - i.e. Meantone, Just, Well-tempered and Equal Tempered.

Tuning means exact listening with a specific focus. Some styles may call for a variance in intonation. Tuning can be bewildering depending on the focus. Is it pitch or timbre?

In any interaction, a kind of tuning takes place. It may not be a desirable or specific tuning, but it will be present. Being in tune is what sounds good to a community of musicians. In Western practice, musicians play in unison striving to eliminate beats. But in Gamelan music, beats are desirable. Each Gamelan orchestra has a different sound depending on the beats produced by the differently tuned instruments. Being in tune with oneself may be different than being in tune with another, or group. Keyboard players are not confronted with tuning problems if their only training is on the keyboard. Then a specialist tuner takes care of the tuning needs.

Tuning is a matter of becoming one with the other - Plenum -

"Good players tune timbres in the same way that they tune pitches - to fit precisely the musical situation as they understand it."

Erickson - page 107 - "Sound Structures"

Complementary Processes

Focal schema content prototypes smaller and smaller differences.
Plenum schema content prototype overlaps or transfers on to the task.
Locking onto tuning.

Tuning is a major issue for musicians in ensemble. Depending on how attention is tied up, a musician may or may not be in tune with not only him/herself, but with the group. If a focal template has not been developed during training of a scalar, intervallic or harmonic nature, a musician singing or playing a melody may give an approximate shape, but without accurate tuning. In the case of singing, focal attention may be tied up with words and word meanings while pitch intonation suffers.

--- Introduction to Musical Attention Exercises ---

Blacking (How Musical Is Man) is convinced that at the level of deep structure in music, there are elements that are common to the human psyche, although they may not appear in the surface structures. This makes cross-cultural communication possible.

The following exercises are an attempt to explore the processes which operate at the level of deep structure in music. By understanding these processes they may be applied at the surface level according to the needs of the individual or group.

Attention in ensemble playing or singing is almost invariably directed to the object with very little, if any, consideration given to building the ensemble through attention exercises.

The exercises address this problem by utilizing the group as template for focusing attention on task..ie..passing a tempo around a circle making each person responsible for one beat. Each person soon realizes his/her responsibility in such an exercise. The task is simple, but remaining attentive is, or can be, difficult. Maintaining tempo in relation to others requires discipline (and respect) and is fundamental for any music making.

Reaction Time
- Group -

Purpose

To develop awareness of how ambience influences tuning.

Exercise

Group is instructed to listen to all that can be heard, both in the external environment and within one's self. (Imaginary or real interval sounds.) Everyone is to continually scan the internal/external environment for about 2 minutes. A loud hand clap serves as a signal. The individual must lock on to some tone which is sounding internally or externally and produce it vocally, as immediately as the signal is given. (This exercise should be recorded and played back for criticism and comparison.)

Process

Focal attention given to finding sounds. Focus must shift on signal to actually producing the sound locked on to. Plenum picks up the sound of the whole group or focus.

Partner Breath Sensing

Purpose

To develop sense of breath rhythm.

Exercise

Two people face each other. Person A places hands on the thoracic or abdomen of person B. Person B breathes normally while person A tries to synchronize his/her breath with person B. When person A feels synchronized then he/she removes hands slowly and person B places hands on the thoracic or abdomen of person A and repeats the process.

Change partners.

Process

Maintaining focus on another rhythm then matching it.

- adjustments in feedback invoke the plenum schema.
- ssa becoming identified with task instead of separate from it.

Partner/Group Pitch Sensing & Synchronizing Exercise

Purpose

To develop sensing with minimal cues the right tune and pitch.

Exercise

Two people back to back in the center of a circle. Each tries to sense when the other will sing, without giving any auditory, visual or somatic cues. Group tries to sense breathing of both and feel when the sound is coming. Group may extend the sound each half circle picking up the pitch from the appropriate partner.

The exercise is correct if the partners sing exactly together and the same pitch. (without a previous reference) Exercise can expand to 4 persons, 6 etc.

Process

Imagination of pitch, picking up extremely minimal cues for timing. Plenum sense. Group attention to point.

The pitch should come automatically from the partners. Focal attention on the minimal cues for synchronizing.

Pitch Consensus

Purpose

To find reference tone for the group and to find voice ranges.

Exercise

Standing in circle.....* Each person sings a long tone, repeating with each breath. The tone is chosen for ease of production, regardless of what anyone else is singing. On signal, the group begins to tune to each other, trying to arrive at a unison or octave.*

* First imagine a tone. Then sing together on cue. Or try to sing a given tone such as 'A' without a reference. Check with pitch pipe after the group consensus has occurred.

Process

Being open to a tone. Plenum their focusing to tune.

Circle Rhythm Exercise (advanced)

Purpose

To develop invention and imitation.

Exercise

Each person invents his/her own rhythm. (5 or 6 beats) The tempo is common to the group. Each person claps his/her own rhythm in turn around the circle. After 2 rounds, Person 2 imitates Person 1, Person 3 imitates Person 2, and so on around the circle. Continue another round then shift again. Continue until everyone has played everyone else's rhythm.

Process

Focal Synchro Plenum - Picking up pattern then reproducing it at the right time. (attention to a point)

1st Focus

A common tempo must be established. (2 beats)

2nd Focus

A rhythm invented and produced.

3rd Focus

Pick up rhythm from person to the left.

Problem

To be aware of the rhythm you are going to do immediately, and the future rhythm always maintaining the original tempo.

Reaction Time
- Clap, stomp -

Purpose

To develop quick reaction to multiple inputs

Exercise

One person faces 3 others. Each of the 3 may clap, stomp or sing Ha! on cue from a conductor who stands behind the first. The first person must respond correctly with same sound possible.

Process

Plenum then focus

Circle - Vocal plus Clapping Rhythm Combination

Purpose

To be aware of two rhythms proceeding at different rates over common tempo. One vocal, one clapping.

A musician must keep track of the tempo as well as the variations in rate which make rhythms.

Exercise

Circle passes common tempo around. Pass a pitch around. Each person holding for 2 beats. First person invents a 3 beat rhythm which is passed around.

Group establishes a tempo which is passed around the circle. Each person is given a number randomly between 1 and 5 or 1 and 7. Each person claps the variation without breaking the original tempo.

Process

Focal synchro Plenum.

Awareness of the overall pattern is necessary.

Focal attention synchro Plenum.

Variation

Substitute pitch and rhythm

Somatic and Aural Responses

Purpose

To develop coordination and reaction time.

Exercise

The group is taught 3 sounds:

Vocal - Ita	Signals - Right Hand
Clap - (hands)	Both Hands
Stomp - (foot)	Left Hand

Leader takes the group through each sound in succession giving the signal. Group is instructed to do the appropriate sound as immediately as possible. After a little practice, assume that the sounds are learned, then give the signals in random order. Instruct the group to remain open to the signal trying to not guess or anticipate. The right feeling is; move first, become aware second.

Process

Focal synchro plenum. Being open then selecting correctly from the pre-programmed responses or possibilities.

Passing Pitch, Clap and Stomp

Purpose

Coordination and pattern recognition

Exercise

Circle - Leader begins by singing a pitch. Pitch is passed around the circle (to right), one-third way around, introduce clap. Two-thirds way around, introduce stomp. Each person must focus on the person to left in order to pick up the right sound. If the group succeeds, the pattern will become clear.

Process

If plenum takes over too soon, focus will be upset.

Group Breathing Singing Mandala

(The Wheel of Life)

Purpose

To develop synchrony

Exercise

Group lies in circle, heads towards center. (Adjustment for most comfortable position regarding the height of different people must be considered.) Each person places hand on abdomen of both partners in circle. Group then tries to bring breathing into synchrony when consensus is felt, group begins to sing long tones together.

Process

Plenum attention to partners and self. Focus breathing together. Adjustment of self to others rate. Recognizing consensus, then new focus to produce tone while maintaining rate of breathing.

Heartbeat - Breath - Walking

Purpose

To demonstrate limited capacity attention process.

Exercise

Find your heartbeat and pulse. Keep monitoring the pulse by tapping in sync with it. At the top and bottom of the breath cycle, skip a tap - without imposing a count on breath. Try with left hand then right hand.

Try the same exercise while walking.

Substitute walking for heartbeat.

To make the exercise easier, impose a count.

Process

Focal attention

Tying Up Attention

Purpose

To try and determine what sensory mode is maintaining tempo and if it is possible to shift modality from somatic to auditory or visual attention.

Exercise

Establish a tempo. Keep it with the foot. Read, talk or sing while maintaining the tempo. Write or draw while maintaining the tempo. Try to balance a pencil on the end of your finger.

Ways of maintaining tempo: foot or hand or vocally

Try to sync tempo with mental auditory tempo. See if that frees the activity.

Process

Partner Tempo Exercise

Fact

It takes 2 beats to establish a tempo.

Purpose

Cooperation between two people to establish sense and maintain a tempo, to flexibly change a new tempo and maintain it.

Exercise

Person A claps first. Person B claps second establishing a tempo. Person A responds maintaining the tempo exactly. The two continue. Person C gives feedback if there are corrections, stopping the exercise immediately. If tempo is maintained correctly, person C gives a hand signal pointing either to A or B. The person signaled changes the tempo on the next possible beat. The other person responds correctly. The exercise continues until no errors.

Process

Focal attention. Overlap comes from signal to change the new tempo

Criteria for criticism

Steady tempo
Correct change
Response to signal

Variation

Person A claps, Person B responds
Person A immediately varies the tempo
Person B responds, etc.
Person C signals stop, then repeats exactly the rhythm pattern of the partners.
Record and check.

Partner Tempo and Rhythm

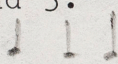
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

Purpose

To pick up feeling of the correct tempo after 2 beats and respond with the next correct beat or cut in between beats.

Exercise

1) Person A claps 2 beats. Person B responds with a third beat in tempo. Person A changes the tempo with another 2 beats. Person B again responds with a third beat in tempo.

2) Person A claps 3 times in tempo. Person B cuts in between beats 1 and 2 or 2 and 3. A particular rhythm can be specified for B. For example A 

B 
or 

Process

A is focal
B is global then focal

Partner Timing Exercise

2/24/79

Purpose

To pick up feeling for divisions of a beat and to analyze the reaction. Recording is good feedback in this exercise.

Exercise

Person A claps 2 beats. Person B claps in between the two beats then continues with two more beats at the tempo set by Person A. Person B then tries to say exactly how the beat was divided.

Variation

- 1) As above, but Person A divides the beat when Person B claps the two beats of the tempo.
- 2) Person A claps 3 beats. Person B claps a predetermined division between the 2nd and 3rd beats then continues to clap 3 beats in tempo while Person A duplicates the division.
- 3) After each exchange, change tempos
- 4) Person C claps the tempo set up by Person B in the first exercise.

Circle - Passing Patterns Two Ways

Purpose

To develop flexibility in sensing pattern as a whole then becoming part of it.

Exercise

Group establishes tempo. One person invents a rhythm which is passed around. Then each person does only one part of the rhythm as it passes around the group without breaking the tempo.

How must attention processes shift?

The pattern is the template. Attention stays on the patterns, intuition helps the body to respond correctly as part of the pattern.

Partner Rhythm Exercise

Purpose

To develop skill in invention and imitation of pattern recognition

Exercise

Person A invents a rhythm pattern. Person B responds to the rhythm pattern by inventing a counter rhythm after listening once. Person B then immediately repeats Person A's rhythm.

Practice first by Person B listening to Person A several times, then eliminate prior listening altogether so that Person A invents rhythm and Person B simultaneously invents counter rhythm, then repeats Person A's rhythm.

Process

Plenum - Pattern recognition then focal

Circle Rhythm Exercise

Purpose

To develop flexibility in subdivision on cue

Exercise

In circle, clap tempo. Pass around. Have person in center signal with 2,3,4 or 5 fingers. If 2, then two people clap the subdivision. If 3, then three people clap the subdivision. It will probably be easier to have one person do the subdivision first.

Process

Shifting Tempo Exercise

Purpose

To gain flexibility in shifting from one tempo to another.

Exercise

Circle - divide into 3 or more groups. Establish a tempo and pass around the circle once, then section 1 of the circle randomizes the tempo, (each person shortens or lengthens the beat) the last beat determines a new tempo for section 2 of the circle. Tempo must be steady for that section. Section 3 randomizes the beat again, then section 1 picks off the new steady tempo.

Variation

One person in the circle calls change. That cue means that where ever the beat is, the next person changes the tempo.

Process

Focal attention to tempo

Circle Heart Beat

Purpose

To give the individual a reference or some sense of his/her own tempo compared to others and then to reach a compromise or consensus tempo for the group. A first exercise in relating to the group by compromise, yet remaining in touch with oneself.

Exercise

Standing in a circle. Each person finds his/her own heartbeat. (Some people have an easier time locating an artery or pulse.) Then they begin to tap his/her own heart rate with hand against thigh. Gradually change when confident of beat to clapping with both hands, then on signal, returning to feeling heart beat with one hand, tapping with the other. Go back and forth a few times, then ask the group to reach a consensus rate. (Check with metronome) Some people will have to speed up, some slow down. When everyone is together, then go back to individual heart beat. Go back and forth a few times. Then when consensus tempo is easily established, have each person in the circle be responsible for one beat. Go round and round until the tempo is kept correctly.

Variations

- 1) Go around once, then clap together, on cue start around again, each time around, stop at a new person.
- 2) Go around once steady, then around each person, his/her own rate. Go back and forth.
- 3) Go around once steady, then begin accellerando. Practice accellerando all together then around. Practice a linear accellerando and a logarithmic accellerando.
- 4) the same with ritard.

Paying attention to oneself. Paying attention to group or others.

Variations:

Visual (same with auditory mental image)
Auditory
Somatic