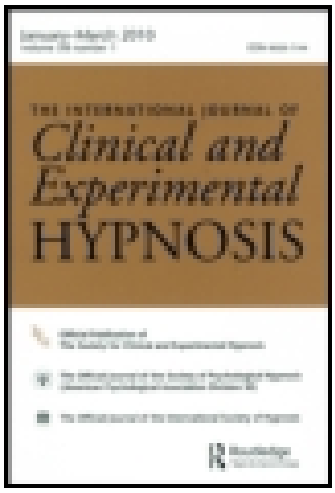

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Physiological changes associated with hypnosis: A review of the literature since 1948

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PHYSIOLOGICAL CHANGES ASSOCIATED WITH HYPNOSIS: A REVIEW OF THE LITERATURE SINCE 1948

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Although there have been a number of recent discussions of the physiological aspects of hypnosis (68, 164, 174) there has been no systematic review of the literature since 1948 (67).

The present paper reviews reports on the physiological changes associated with hypnosis which have appeared in the literature since 1948, relating them to earlier studies and recording several impressions of trends and problems.

The sources covered are not exhaustive, but are adequately representative of the literature. A number of foreign articles, particularly in Russian, were not obtainable in translation. No attempt was made to completely report the clinical cases, many of which, because of a small number of *Ss* or a lack of controls, could not be critically evaluated. A representative number of such clinical reports are included.

Also, it was felt that certain lines of investigation, while touching upon the physiology of hypnosis, were nevertheless concerned primarily with affective changes and could not be adequately treated in a survey of this nature.

Although we have thus omitted any special section on these areas, several references are included in the bibliography for those interested in hypnotic age regression (35, 112, 121, 122, 144a, 205) and progression (82, 83), time distortion (30), changes incidental to hypnotic psychotherapy (40, 175, 205), and hypnosis as an aid in psychosomatic research (65) and diagnosis (41). The modification of pain responses by hypnotic anesthesia and analgesia is now well known and special indications for this therapy have been discussed elsewhere by the senior author (34).

Animal hypnosis is omitted because of its doubtful relationship to the body of hypnotic phenomena. This subject is reviewed adequately by Weitzenhoffer (205).

However, where particular studies involving hypnosis for primarily

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affective changes have seemed pertinent to the discussion they have been included.

No effort was made to systematically review the literature prior to 1948, and Gorton's excellent summary (67) is used as the primary source for comparison of older and more recent studies. In addition to his paper, those interested in reviewing the earlier literature in some detail will find Dunbar's well-known volume particularly helpful (46). A number of studies contain excellent bibliographies to this older literature (46, 68, 119, 164, 174). In a few instances we have included sources published prior to 1948 when their citation was necessary for a completeness of discussion.

Experimental Techniques

Some major general criticisms of the older literature have been listed by Gorton (67) as lack of control experiments in the waking state, failure to distinguish between sleep and hypnosis, lack of control studies during hypnosis but without specific suggestions, and failure to allow for the variability of emotional stimuli presented to different *Ss*. It is gratifying to note that these particular methodological criticisms have become increasingly less applicable to the more current literature reviewed here. There are a number of additional factors, however, which often detract from the clarity of results. These will be treated more fully under the discussion section of this paper.

Perhaps the most characteristic hallmark of the recent literature is a growing awareness of hypnosis as a dynamic interpersonal relationship rather than a fixed and quantitatable "state." Schneck has emphasized possible unconscious meanings of hypnosis (168, 169, 171, 172, 173, 177) and has attributed to them such physiological changes as tachycardia and altered GI motility during the induction phase (170). Similarly, unconscious factors causing paradoxical reactions under hypnosis have been reported by Schneck (175) and Bird (16), while Conn (29) cites material on age regression which confirms this view of hypnosis as an active psychodynamic process, often manipulated by the *S* to fulfill his own needs. In an ingeniously simple experiment, Barber (8) has shown that the execution of post-hypnotic commands varies according to the *S*'s interpretation of whether the hypnotist-subject relationship has terminated or is still expected, by the experimenter, to remain in force.

While this realization of the psychodynamic character of hypnosis can explain many of the contradictory reports, it simultaneously increases the problems of experimentation. In addition to such obvious

procedures as waking, posthypnotic, and "neutral"[2] hypnotic controls, the careful experimenter must guard against his *S*'s passing unobtrusively from hypnosis to sleep and must attempt to evaluate such factors as the influence of his own expectations, the "type" of hypnosis (whether active or passive), the specific meaning, conscious and unconscious, of both the suggestions given and hypnosis per se, the level of trance, the motivation of the *S*, and the lability of the organ systems involved in the suggestions. This is certainly a herculean task for those wishing to approach hypnosis in a manner capable of elucidating the basic processes involved. In contrast, one may often obtain remarkable clinical results without attention to these variables. Such clinical results may contain exhilarating implications, yet are impossible to evaluate because of their uncontrolled setting. Sarbin has succinctly expressed this delimma: "One wonders whether the magnitude of the problems engendered by the implicit recognition of the multiple sources of variation has led to a rejection of careful scientific methodology and reporting" (164, p. 4/3).

Depth

The frustration involved in quantitating these variables is clearly evident in discussions of the level or depth of hypnosis. Depth has traditionally been described by such subjective phenomena as effectiveness of post-hypnotic commands and the induction of hallucinations, together with the phenomena of anesthesia and analgesia and tests involving the somatic musculature, such as inability to unclasp the hands. As these phenomena are largely amenable to conscious control, there has been a continuing search for more objective criteria for the depth of hypnosis.

Franck (62) has reported changes in the EEGs of eight *Ss* during the induction of hypnosis, while Rohmer and Israel (159) describe similar changes in those persons capable of inducing in themselves an autohypnotic state by the "Schulz procedure." Neither of these studies, however, indicated any differentiation of level within the final hypnotic state. The only study proposing to measure hypnotic depth electrically is that of Ravitz. The italics in his statement are our own:

> Using a Burr-Lane-Nims microvoltmeter ... 60 standing potential records of 20 subjects were taken. Although results of spot determinations were sometimes equivocal, continuous emf tracings, using the combined microvoltmeter and general electric photoelectric recorder ... at a speed of 1 in./min., with

[2] Under hypnosis but without suggestions concerning the effect being evaluated.

one electrode on the forehead and the other on the palm of either hand, seem to provide a reliable quantitative index of trance depth. During hypnosis, the emf tracing becomes more regular, and potential difference *either* gradually increases or decreases in magnitude.... *Depth of hypnosis, as measured electrometrically, does not seem to be correlated with ability to develop amnesia or other phenomena often necessary for a good therapeutic trance* (155, p. 342).

In a subsequent report Ravitz further concluded that "When they decrease in voltage, D.C. hypnosis records cannot be distinguished from D.C. sleep tracings" (156, p. 436). Thus, the measurement of hypnotic depth proposed by Ravitz seems at the present time to be largely tautological, though it may certainly be important in any eventual systhesis of the psychological and physiological data of hypnosis. The problem of delicate instrumentation may preclude the use of this technique in other than an experimental setting.

Lovett Doust (119, 120) has suggested that changes in oxygen saturation can be correlated with hypnotic depth, the degree of saturation being relatively easily measured in peripheral arteries. As such values vary also with emotional changes, it seems doubtful that this measurement will prove highly useful. A more thorough discussion of this report is included in the section on respiration.

Even the worth of the depth concept is frequently questioned. Considering the traditional criteria of depth, DeLee (39) states "The objective symptoms of the deep hypnotic state may be evidenced in a person in a medium or light trance, and symptoms of the light stage can occur or may be absent in a person deeply hypnotized." Many investigators, of which Moody (132) and Michael (131) are characteristic, have failed to note any consistent relation between depth of trance and clinical results.

One senses not so much a disavowal of the reality and importance of depth, but rather dissatisfaction with ambiguous classifications. In virtually every serious study the characteristics chosen for defining different stages of hypnosis are explicitly stated. Still, it is often useless to attempt relating phenomena with depth among reports by different authors. Schwarz et al. (180) suggest an attempt to relate depth with different mechanisms of dream work (displacement, condensation, etc.) but to our knowledge this has not been attempted. At the present time, it does not seem possible to state objective criteria for depth. When depth of hypnosis is indicated it may be assumed to have been judged by one of the several common scales based on behavioral responses. The psychodynamics of hypnotic depth are touched upon by Schneck (178) and treated extensively by Erickson (50).

Type of suggestion

Understandably, the greatest interest in the hypnotic influence of physiological processes centers in those functions which cannot ordinarily be influenced by an effort of will, generally speaking, then, those processes mediated through the autonomic nervous system—such as heart rate, digestive secretion, vasomotion, etc. It has been shown (36) that influencing such affective factors as appetite can indirectly result in marked physiological changes, but this is secondary to the present discussion of virtually immediate reactions to suggestion.

Both common experience and the psychosomatic literature continually prove that emotions may have pronounced effect on autonomic functions. It is therefore customary to consider two general types of hypnotic suggestions: (a) direct suggestions for change—"Your heart will beat faster" and (b) indirect or emotive suggestions—"You are driving cautiously around a dangerous bend in the road when suddenly a truck careens around the corner and lurches toward you!" Clearly, either type of suggestion might be expected to accelerate the heart. Still a third type, the hypnotic hallucination, is defined by Gorton (68), who chooses to consider it a form of direct suggestion because any affective content is supplied secondarily by the *S*. It would seem, however, that such hallucinatory suggestions may easily have emotive content and must be judged as individual cases.

The distinction between emotive and direct suggestion has recently been brought into question by a report of Solovey and Milechnin (185). In testing 23 *Ss* for increased heart rate in response to direct suggestions, they obtained positive results in only two cases. When these two *Ss* were questioned concerning any subjective feelings they might have experienced, one of them reported imagining himself looking down from a considerable height and feeling someone push him lightly on the shoulder. The other said that he had felt a "vague distress" but could not describe a reason for the sensation. There is a possibility, of course, that the heart rate of the *Ss* may have increased in response to a direct suggestion and that this increased heart rate might then have determined a subjective response as a *secondary* effect. This possibility of an emotive intermediary response to direct hypnotic suggestions should be clarified by further investigation.

Suggestions of age regression or progression would be classed as indirect suggestions relative to any physiological changes that might be elicited. However, two previous studies in which the senior author participated (121, 122) failed to show any demonstrable physiological changes in age regression. As previously stated, age regression, as such, will not be discussed in this paper.

Notice should also be given to Sarbin's contention (164) that suggestions for autonomic changes may actually be initiated through voluntary processes. Thus, swallowing, which is a voluntary process, would initiate action of the cardiac sphincter of the esophagus, which is ordinarily considered under involuntary autonomic control. This theory, he claims, accounts for the latent period often observed before the suggested autonomic changes occur. By this theory, however, it would be difficult to account for some of the more recondite phenomena such as blister formation.

Throughout the discussions of specific physiological changes, suggestions will be classed as direct, emotive, or hallucinatory. The reader should be conscious, however, of the possible overlappings.

Other variables

There are other variables to be considered in evaluating physiological changes under hypnosis. As these are not commonly met in the literature, however, they will be deferred until the discussion section of this paper. Among such variables are the motivation of *Ss*, the accidental or non-verbal communication of suggestions, and antecedent lability of organ systems.

Cardiovascular Effects

Clinical reports

Perhaps the most striking hypnotic "cures" are of resistant skin diseases, of which 16 varieties are listed by McDowell (124) in his review of hypnosis in dermatology. Since the mechanism in such cases is usually assumed to be a change in vasomotion, a brief excerpt of these clinical reports is included here. The cases exemplify the profound changes often obtained in clinical hypnosis by the simplest suggestions.

The most striking case in the recent literature is the rapid improvement of a completely resistant case of congenital ichthyosiform erythroderma (of Brocq) following direct suggestion under hypnosis. In reporting this case, Mason (128) describes how the improvement showed first on the left arm only, then also on the right, then on other parts of the body as they, in turn, were brought specifically within the suggestions for improvement. After three months of hypnotic therapy, the *S*, a 16-year-old boy, showed improvement ranging from 50% to 90% over different areas of his body. More conservative treatment, including skin grafts, had proved futile.

Schneck (176) reports improvement in a less sensational case of "life-long ichthyosis," and Mullins et al. (135) produced improvement in a case of pachyonychia congenita.

Several authors claim mitigation of alopecia by hypnosis (55, 96, 196) and improvement of obstinate eczema (53, 94). Fernandez (56) records having witnessed "... the removal of a large and disfiguring nevus in a young boy, by means of hypnosis, when all other measures proved futile."

While the removal of warts by hypnosis has a long and documented history, there is no glimmer of the underlying mechanism at work. Asher (4), treating only resistant cases because, as he facetiously stated, "I was unwilling to be persuaded into witchcraft except where other witches had failed," cured 15 of 25 hypnotizable *Ss*. Successful removal of warts is also reported by McDowell (123) and by Obermayer and Greenson (139). Stewart (187), however, was able in one *S* to cure both asthma and eczema but could not effect warts "even with specific suggestion."

Relief of migraine, which may involve a change in the vasomotor tone of cerebral vessels, is often reported (64, 94, 154).

Blister formation

The definitive experiment on the perennial question of blister formation is still lacking. Pattie's 1941 review (142) remains the authoritative summary of this question, although both Weitzenhoffer (205) and Gorton (67) feel that the phenomena is authenticated by the published reports and disagree with Pattie's conclusion of suspended judgement. Jeltakov (73) describes provoking an "inflammatory reaction of the skin," but the recent literature adds no controlled experiment to this interesting, though debated question.

Although these striking changes in skin pathology cannot be fitted into clear physiological categories, they would seem, prima facie, to be secondary to vasomotor changes. In any case, they serve to exhibit the rich and varied substratum of clinical reports contrasted with a relative paucity of controlled laboratory experimentation. This inequality is not wholly attributable to design, as the factor of *S* motivation may possibly enhance clinical results but have little effect in more controlled studies. This point is amplified in the discussion section.

Bleeding

A number of striking clinical reports, particularly in the dental literature, claim hypnotic control of bleeding during surgery, the flow alternately increasing or decreasing depending on the suggestions given (3, 24, 25, 101, 133, 161, 163, 186, 189, 190). The decrease in bleeding is often described as a normal concomitant of hypnotic anesthesia (185), requiring no specific suggestions to invoke it.

In a book review by Völgyesi (75), Kartamisev, a professor at Kiev Medical University, is said to claim that "Bleeding can be brought about and brought to a standstill on the epidermis, also bleedings of nose and uterus, likewise by hypnosis." The only worthwhile laboratory experiment that we have found in the older literature is that of Kryuntsel et al. (105) who reported a reduction in blood clotting time in normal *Ss* in the hypnotic state. Blood clotting time alone was measured.

The senior author participated in a controlled study (33) of bleeding in eight *Ss*, four male and four female, with tests in the waking state before hypnosis, in "neutral" hypnosis with suggestions of anesthesia for the sampling process, in hypnosis with suggestions both for anesthesia and decreased bleeding, and in the waking state following hypnosis. No post-hypnotic suggestions were given. Tests performed were direct and indirect platelet counts, bleeding time, clotting time, Wintrobe tube hematocrit, Quick's one-state prothrombin time, and prothrombin consumption. Variance was analyzed employing "f" value determinants for each clotting factor. The results indicated that hypnosis and simple hypnotic suggestions are not correlated with any alterations of bleeding or blood clotting factors in normal man. However, in view of the wealth of clinical reports of reduced bleeding, it is not felt that this one study, despite its controls, is conclusive. It is possible that a high degree of *S* motivation is required for control of bleeding, and it has been the experience of the senior author that motivation for hypnosis is obtained most readily in a clinical situation where it tends to increase, up to a point, with the severity of the symptoms for which relief is sought.

In summary, there are a large number of clinical reports, based on subjective judgement, claiming control of bleeding under hypnosis, yet this phenomenon lacks experimental substantiation.

Peripheral vasomotion

Kline (85) has emphasized the importance of vasomotor effects, saying that "When the spontaneous reactions to hypnosis and particularly the somatic ones, are examined it is noted that almost all of these involve vasomotor changes in terms of the sensory as well as the peripheral physiology of the subjects." In reviewing the earlier literature, Gorton (67) found no significant difference in peripheral circulation between the waking and hypnotic states. He based this conclusion largely on the report of Doupe, Miller, and Kellar (45). However, Uhlenbruck (192) found in 1924 an "increased reactivity of the blood vessels" of the extremities in both hypnosis and sleep which "differed

considerably from the waking state." Uhlenbruck's paper was not seen in the original and no evaluation can be made here of his experimental technique.

Among recent clinical reports of peripheral vasomotor activity, Nallapa (137) describes the hypnotic stimulation of increased circulation in a case of thrombo-angiitis obliterans (Buerger's disease). Reiter (157) states that with a patient with obesity and myxedema (basal metabolism 75) he produced, by "daily hypnotic suggestion of increased blood flow in the thyroid gland," an increase of the basal metabolism to 110, reducing body weight to normal. With only the meager information given, it seems impossible to determine with certainty if the mechanism for weight loss were actually increased blood flow and activity in the thyroid gland.

Vasoconstriction of the cerebral vessels is mentioned as the basic hypnotic mechanism by those subscribing to Pavlov's theory of hypnosis as a "radiation of internal inhibition." Among these are Völgyesi (198) who states, without quoting an experimental source, that "... the parts of the brain which are thrown out of action are deprived of the normal supply of blood by a process of *vasomotor decerebration*...." Krasnorgoskiĭ (100) claims that "measurement of the body's infrared radiation is a valuable method of research on brain activity of children. With the spread of 'cortical inhibition' to the 'vasomotor analyzer' there occurs a general fall of infrared radiation associated with constriction of the blood vessels. Simple awakening from hypnotic sleep is accompanied by a general increase of infrared radiation associated with dilation of the blood vessels." This study, available only in English abstract of the Russian original, could not be evaluated for experimental validity. It is not clear, for example, whether the fall in heat radiation measured is referable only to the scalp vessels or to the intracranial vessels as well.

McDowell (124) reports vasodilation of a *S*'s right leg following suggestions of immersion in warm water. However, Norris and Huston (138) failed to induce vasospasm during a remittive period of Raynaud's disease in a 27-year-old female *S*, despite use of both direct and indirect suggestions. Their failure is particularly interesting, as the *S* would be assumed to have increased lability for vasospasm and showed subjective reactions to the suggestions. They also found that immersion of her finger in ice water, which in her normal non-remittive condition would, they claim, have produced spasm of the hand and arm, had no effect. Their findings in this case throw some doubt upon the uses of hypnosis for experimental psychosomatics, though a single case cannot be generalized too greatly.

Changes in peripheral circulation are claimed for Schultz's autogenic training (79, 136).

In a series of exceptionally extended and detailed clinical observations, Lipkin et al. (116) found that suggestion *without hypnosis* caused pronounced subjective and slight objective improvement in the majority of cases of vasospastic disorders studied.

Lassner (107) quotes Doupe (without giving a specific reference) as finding a 13% increase in volume of a limb in a control series and a 40% dimunition in the blood volume of the limb when anesthetized by hypnosis, the arm in both cases being subjected to prolonged application of ice.

Only one study in the recent literature clearly measures peripheral vasomotion. This is a preliminary report by Bigelow, Cameron, and Korolhow (15) of strain gauge plethysmograph recordings of finger volume in two *Ss*. Samples of the tracings, reproduced with the article, show greater changes in the peripheral pulse and the finger volume during deep neutral hypnosis than in control periods before and after hypnosis. The authors attribute this change to a lessening of cortical inhibition. Because of the small number of *Ss* and possible unconscious meanings attached to hypnosis (both *Ss* were undergoing treatment for psychoneurotic conditions), the report can be considered only suggestive. These authors plan a more extensive report, including similar recordings during normal sleep, which may clarify this phenomenon.

Peripheral vasomotion seems clearly involved in certain clinical changes, but controlled experiments are lacking.

Heart rate

Reviews of the earlier literature by Kleitman (81) and by Jenness and Wible (74) show conflicting reports, many incapable of clear evaluation, concerning the influence of hypnosis on the heart rate. In their own experiments (74, 209) Jenness and Wible found a decrease in heart rate in neutral hypnosis, possibly because of more complete relaxation. This was confirmed by Whitehorn et al. (208).

In the recent literature, Sears (165) cites one of his own unpublished reports as confirming a decrease in heart rate under neutral hypnosis, claiming significance at the .0025 level for the changes in pulse rate. True and Stephenson (191), however, reported a rise in four of six *Ss* with the induction of hypnosis. Only one of their *Ss* showed a persistent drop in the pulse rate (from 79 to 76 beats/min.). This paradoxical reaction to hypnotic induction was reported earlier (in 1930) by Bier (14).

In general, the pulse rate is probably decreased upon the induction of neutral hypnosis as a result of the relaxation technique commonly used. Relaxation is not, however, a necessary component for trance induction (50), and unconscious meanings of hypnosis to the *S*, or other psychodynamic factors, might cause a rise in heart rate in specific cases.

The earlier (67) and more recent reports agree on the ability of emotive suggestions to influence the heart rate. Reiter (157) reports an increase in frequency, measured by the EKG, in four *S*s. Bennett and Scott (11) induced tachycardia in a group of five normal *S*s with emotive suggestions. With 14 normal *S*s, Berman et al. (13) increased heart rate with suggestions of severe work-pain and also with suggestions of anxiety, in all but one case the increase in heart rate being lower in the suggested work state than in actual, though mild work. Kleinsorge and Klumbies (80) found increases, though slight, with both emotive and hallucinatory suggestions.

The induction and termination of extrasystoles is reported by Raginsky (152) in labile *S*s. In one *S* with a previous history of cardiac arrest, the heart could be stopped for a space of four complete beats by suggestions that the *s* re-visualize "one of his major attacks and relive the experience with all of its manifestations and intensity."

After reviewing the literature antecendent to 1937 and performing experiments of their own, Jenness and Wilbe (74) felt that it was not possible to influence the heart rate by direct hypnotic suggestion. This position is challenged by Van Pelt (193, 195), who finds that the heart rate may be altered by direct as well as emotive suggestions. Van Pelt's claims appear to be based largely on experiments with a single *S*, a 20-year-old male whom he had previously cured of asthma by hypnosis. Van Pelt reports that:

> ... when rapidity of heartbeat was suggested directly, there were no signs of nervous tremors in the electrocardiogram. On the other hand, these signs of fear were clearly present in the tracing taken during the suggestion of a car accident. In addition, a greater rapidity of heartbeat was obtained by direct suggestion than that obtained as the result of emotion. It would therefore seem that the control of the heart rate by direct suggestion in the hypnotic state, as well as by emotion, must be accepted as a proved fact (195, p. 282–283).

As mentioned in the introductory remarks on experimental problems, Solovey and Milechnin (185) found that two *S*s who apparently responded to direct suggestions of an increase in heart rate actually had concurrent subjective experiences of an emotive nature.

In summary, heart rate normally declines in neutral hypnosis, but may increase as the result of specific psychodynamics or induction

techniques. It is clearly possible to influence heart rate by emotive suggestions and, prima facie, possible to alter the rate by direct suggestion. That "direct" suggestions actually have an emotive intermediary in the *S*'s consciousness remains a possibility.

EKG changes

A number of recent reports show the possibility of altering EKG records under hypnosis, but no consistent reaction occurs, although most changes seem to be in the T wave and in the ST interval. Berman et al. (13) found that various emotive suggestions produced T wave changes in 50% of their 14 control *Ss* who ordinarily showed no EKG abnormalities. These changes consisted of elevation of T waves in two *Ss* and depression or inversion of T waves in five *Ss*. The elevations, they state, were observed in the chest leads, while depression or inversion occurred mainly in leads II and III. They also tested 11 *Ss* with coronary disease, finding T wave changes in four cases of which three were in the direction of greater abnormality. In one patient R_3 temporarily disappeared. Six patients tested showed no changes.

Bennett and Scott (11) reported that anxiety and anger induced hypnotically in a "normal young adult male" provoked "a lowering of T_1 and a flattening or disappearance of T_2 and T_3." Treating patients, Polzien (149) found that in about 30 of 41 cases he could obtain an improvement or normalization of ST depression and a leveling of the T wave. With 20 supposedly normal control *Ss* he reported that a similar procedure caused an increase of the T wave or an elevation of the ST segment. His suggestions were apparently emotive or hallucinatory.

In summary, EKG changes may be provoked by hypnosis, but the form of variation cannot be predicted, though changes in the T wave or ST interval seem most likely. There is little difference in results with supposedly labile cardiac patients and normal *Ss*.

Blood pressure

Since hypnotic influence of heart rate and vasomotion have been demonstrated, it would seem reasonable to expect some influence of blood pressure, which is largely dependent on these two factors. Lane and Rushkin (106) found no change in waking blood pressure and that in deep hypnosis "with all possible efforts at physical and mental relaxation." They cite a personal communication from Wolberg as evidence that he, too, has not found a lowering of blood pressure in the trance state. When "emotional storms" were produced hypnotically, however, these authors found that the blood pressure rose up to 20/15 mm. of mercury. In six of 20 attempts, Berg et al. (12) found that hypnotically

induced emotions correlated with considerable rises in venous pressure —up to 170%, changes which they found to be "practically independent" of the hemodynamic processes in the arterial system and "outer" determined factors, such as muscle tonus and breathing, acting on the venous system itself. Reiter (157) found that "various emotional influences" correlated with only small or no changes in the blood pressure of 4 *Ss*, while in the same *Ss* dramatic changes in respiration could be produced. Blazevic (18) noted changes in pulse and blood pressure in hypnosis, but was able to obtain identical changes by emotive excitement in the waking state.

Emotive hypnotic suggestions can increase blood pressure, while the hypnotic state itself has not been shown to cause alteration. Several Russian articles, whose contents were not available in English, apparently report the use of hypnosis in treatment of hypertension, but there is no available evidence that hypnosis can affect blood pressure other than through relaxation or induced emotions.

Hematological changes

Summarizing the literature to 1948, Gorton (67) found no adequately controlled instance of blood glucose elevation as a result of direct suggestion, though it seemed clear that emotive suggestions could have such an effect. It also appeared that blood calcium content could be influenced in some particularly labile *Ss*. This summarization has not been altered by subsequent studies. Pohl (147) found an elevation of blood sugar, particularly in diabetic *Ss*, in induced dreams "of the most varying kind." Marchand (125) found that suggested elevation of the body temperature produced both increases and decreases in blood sugar in various *Ss*. In a study concerned primarily with bleeding times, Crasilneck and Fogelman (33) found no significant change in prothrombin in hypnosis or with suggestions for decreased bleeding and anesthesia. Marchand (126) found that in a group of hypnotized patients adrenalin did not essentially alter blood sugar readings or leucocyte count, while insulin and glucose resulted in deviations. This study, seen only in abstract, cannot be evaluated.

Lovett Doust's (119, 120) measurements of oxygen saturation in peripheral arterial blood are discussed under the section on respiration.

RESPIRATION

The earlier literature (67) shows the respiratory rate to be unchanged in basal level with the induction of neutral hypnosis, and demonstrates that emotive suggestions can clearly influence respiration.

In the more recent studies reviewed, Guze (70) states that this influ-

ence of respiratory rate can be utilized either to end or induce anxiety states. In an unpublished report quoted by Sears and Beatty (165), Sears implies that respiration fell as a result of hypnotic induction. It would be necessary to review the study in its original form to evaluate this point.

Hypnosis is cited often as a therapeutic agent for asthma. Solovey and Milechnin (185) terminated asthmatic attacks in seven children by general suggestions of wellbeing, no specific reference being made to respiration. Van Pelt (194) had similar successes, terminating the attack in one patient even by waking discussion. Franklin (64) has suggested teaching auto-hypnosis to asthmatic patients. An excellent review of the earlier psychosomatic literature on asthma may be found in Dunbar's volume (46).

Reiter (157), using pneumographs, studied the respiratory changes associated with emotive hypnotic suggestions. Suggestions of pain and anxiety increased both the frequency and depth in all four *Ss*, as did suggestions of delight and wrath with two of the *Ss*. Suggestions of grief caused similar responses in all *Ss*: shallow and irregular breathing with occasional sighs and pauses of up to 12 seconds. The resting position was changed in some cases, but not uniformily among the four *Ss*. Suggestions of bodily effort produced increased ventilation in all *Ss*.

Lovett Doust's study (119, 120) of arterial oxygen saturation by use of discontinuous spectroscopic oxiometry was mentioned previously. While it is realized that the arterial oxygen saturation in peripheral arteries could be influenced by factors other than respiration, the study is included in this section as it is felt that respiration changes are the most likely basis for the effect. Comparison of these results with those of Reiter will show, however, that, assuming both studies to be definitive of the phenomena studied, Lovett Doust's observations cannot be explained simply as changes in respiration.

The *Ss* used by Lovett Doust were three female neurotic patients. In general, he found that unpleasant emotion, induced in hypnosis and allowed to persist as a posthypnotic suggestion, was accompanied by relative anoxemia, while pleasant emotion tended to raise the level of blood oxygen saturation relative to baseline values. Hypnosis, which itself decreased waking levels of oxygen saturation, thereby diminished the fall associated with extrinsic pain (Hines-Brown cold pressor test) but had no effect on reactions to intrinsic pain (histamine headache). It should be noted that Sarbin (164) has suggested that the variations of oxygen saturation observed by Lovett Doust may have been "a function of the amount of muscular and respiratory activity performed by the subject in initiating the enactment of the prescribed role."

In summary, respiration can clearly be influenced by both direct and emotive hypnotic suggestions. There are suggestive reports that respiration is slowed by neutral hypnosis.

UROGENITAL SYSTEM

There were a number of studies of renal function in the older literature summarized by Gorton (67), but they antedated the introduction of methods of renal clearance and are not, by modern standards, acceptable. Unfortunately, we have found no similar studies with modern literature, although an article by Bolland (19), which was seen only in abstract, indicates that thirst, drink and work suggestions influence kidney function. Clearly, this is an area where experimentation is needed.

Hypnosis is often reported of aid in treatment of enuresis, but as this is basically a mild psychiatric problem it is not considered here.

Hypnosis has been reported by Raginsky (153) as curing "sterility" in certain women who could not conceive even with artificial insemination. The mechanism was possibly a relaxation of tubal spasm. In both the older and more recent (154) literature, sporadic case reports appear claiming regulation of menses by hypnosis, but to our knowledge no adequately controlled study of this possibility has been made. Canale (26) has reported hypnotic control of the female orgasm.

Farris et al. (54) attempted to influence the characteristics of semen by hypnosis, but found no statistically significant increases in number of sperm, motility, volume, etc. In two cases of priapism, the senior author was able to effect relief through hypnotic suggestion. A third case was not hypnotizable.

Although hypnosis may be of aid in a number of psychogenically based urogenital disorders, there is a manifest need for experimental studies, particularly of renal function.

GASTROINTESTINAL SYSTEM

In reviewing the literature prior to 1948, Gorton found:

> Suggestions of eating can inhibit the hunger contractions of the stomach in the fasting subject. This is also true for hypnotically induced dreams with food as an integral part of the dream. Gastric secretions may be produced in response to hypnotic suggestions of eating, and the type of enzyme secreted is specific for the type of food suggested. Similarly, specific secretion of pancreatic enzymes has been noted in response to the hypnotically suggested intake of different foods. (69, p. 60).

A number of the studies were published after 1940 and contained good controls.

More recent experimentation has centered largely on a question of direct interest in psychosomatic medicine—the influence of emotions upon gastric secretion and motility of the GI tract.

Using very good control procedures, Eichhorn and Tracktir (49) tested the effect of neutral hypnosis and emotive suggestions on a group of 24 male *Ss*. Specimens of fasting gastric secretion were obtained by intubation at 15-minute intervals during a 90 minute period for each condition (pre-hypnotic, hypnotic, and post-hypnotic). "Measures of free HCl, total acid, volume and pepsin showed no reliable differences between the pre- and post-hypnotic conditions except for pepsin which was higher under the post-hypnotic condition. Significant differences were found between the pre- and post-hypnotic conditions and the hypnotic condition on the four measures, all of which were lower under the hypnotic condition. [Neutral] Hypnosis in these circumstances exerts a depressing effect on gastric secretion."

In the same 24 *Ss*, gastric secretion of free and total acid, total volume, and pepsin activity rose under induced feelings of contentment and decreased under fear and rage. *Ss* were then divided into high, median, and low anxiety groups of 8 *Ss* each by use of the Taylor manifest anxiety scale derived from the MMPI. Under these classifications, the high anxiety group, under fear, was higher for free and total acid measurements as compared with anger, while the low anxiety group was higher under anger as compared with fear. The relative position of the four curves, in order of decreasing magnitude, was high anxiety fear, low anxiety anger, high anxiety anger, low anxiety fear. The curves for the high anxiety group under fear and the two anxiety groups under contentment showed virtually the same level of secretion. Under the induced feeling of contentment, the rise in free and total acid was accompanied by a rise in pepsin in all groups.

When *Ss* in the two anxiety classifications were examined under neutral hypnosis, the curve for free and total acidity for the high anxiety group was lower than all other curves. The curve for the low anxiety group rose and fell between 30 and 75 minutes of the 90 minute experimental period and, with but one slight exception, was higher than both the fear and anger curves for this group after the first 40 minutes.

Moody (132) evaluated the effect of hypnotic vs. conventional therapy on two well-matched groups of duodenal ulcer patients. Although he feels that the criteria of improvement used may have tended to minimize real differences, the group treated by hypnotherapy alone showed greater clinical improvement. This improvement cannot be clearly attributed to an altered secretion level.

The only recent comment in support of specific secretions being elicited by food suggestions, a point apparently established by the older literature, is by Völgyesi (197), who gives no data to substantiate his position.

Hypnosis is often useful in relief of hyperemesis gravidarum (66, 102, 104, 146) and of the "dumping syndrome" following gastric resectioning (22, 42, 113). Vomiting can be induced by hypnotic suggestion (211).

In summary, recent reports have established the ability of hypnotic emotive suggestions to alter the level of gastric secretion. Neutral hypnosis depresses secretion. Hypermotility of the GI tract may decrease with hypnotic suggestions.

METABOLISM AND TEMPERATURE

A number of early studies, notably that of Whitehorn et al. (208) in 1932, showed no difference in BMR between hypnosis and a basal waking condition in *Ss* who had been extensively trained in relaxation. This is not substantiated by more recent experiments, but in this case it is apparent that the older report is open to less criticism of technique. The most extensive recent experiment has been reported by von Eiff (199) who found a significant decrease in BMR under hypnosis as compared to the waking state after a series of 163 determinations on 16 *Ss*. It would seem, however, that insufficient efforts were directed toward achieving absolute basal levels in the waking state, and his study, therefore, does not effectively contradict that of Whitehorn.

Using only two *Ss*, Wallis (201) found that hypnosis was accompanied by a fall in BMR in an agitated patient, while it produced a rise in an emotionally composed control *S*. In both cases, however, the BMR for hypnosis was below that obtainable with sodium thiopentone administration.

Reiter (157) claims an increase in BMR from 75 to 110 by suggesting increased blood flow in the thyroid gland of a patient with obesity and myxedema.

That emotive and hallucinatory suggestions can influence the BMR seems well established by the older literature (67), although there are no recent hypnotic studies to substantiate this finding. The mechanism would seem to be alteration of muscular tonus, though Reiter's case report (157) poses the question of humoral factors.

Older reports raise, but do not settle, the question of hypnotic alteration of body temperature (67). More recently, Marchand (125), whose article was seen only in abstract, reports post-hypnotically induced body temperature elevation for four *Ss* who also had significant in-

creases in blood sugar levels. Kline (85, 86) states in discussions, but without citing experimental sources, that direct suggestions are ineffective, while emotive and hallucinatory suggestions may produce temperature change.

Von Eiff (200) has recently demonstrated that adaptation to cold can be inhibited, though not eliminated, by suggestions of warmth. This is apparently due to an inhibition of normal processes of peripheral vasoconstriction and increased muscle tonus, the hypnotic series showing less increase in respiration, less loss of skin temperature, and a greater loss of sublingual and rectal temperature as compared to a control series in which *Ss* were exposed to cold in the waking state.

Changes in skin temperature have been reported, though they are adequately explained by peripheral vasodilation or vasoconstriction. Thus in attempting to influence temperature regulation, Polzen (148) found that the skin temperature rose while the internal temperature did not. Lipkin et al. (116) have reported fluctuations in skin temperature in response to varying stimuli in the waking state *without* hypnosis.

To summarize, older reports of similarity of the BMR in both neutral hypnosis and the waking state are probably correct. Emotive suggestions can increase the BMR. Peripheral temperature, and possibly core temperature as well, can be elevated under hypnosis. Adaptation to cold can be partially inhibited by suggestions of warmth.

ENDOCRINE SYSTEM

We have found no serious studies, either in the old or newer literature, concerned with endocrine activity under hypnosis, although it would seem, in view of the close connections between the endocrine glands and the CNS, that humoral factors must take part in much of the phenomena induced by hypnotic suggestion. A few clinical case reports, such as that of Reiter (157) and Zwicker (212) have some bearing on endocrine function. As this connection is not clear, they are, where applicable, cited in relation to other systems.

Central Nervous System

Electroencephalography

Sleep and hypnosis. In 1948 it was possible to state unequivocably that sleep and hypnosis were entirely distinct states, the EEG of hypnosis being in all important respects identical with the EEG of the waking state. This view was substantiated by reports of Loomis et al. (117, 118) in 1936, by Blake and Gerard (17) in 1937, Dynes (47) in 1947, and Ford and Yeager (61) in 1948. This finding had distinct theoretical repercussions for the Pavlovian theory of hypnosis, still held

tenaciously by the Russian workers and others, which classifies both sleep and hypnosis as cases of cortical inhibition differing only in degree.

Recent studies confirm that hypnosis is not identical with deep sleep, but they fail to confirm that it is identical with the waking state. Some of the confusion appears to arise from varying concepts of "sleep." It would seem from these recent studies that hypnosis is more like light sleep than either deep sleep or the waking state.

Two recent studies, however, have shown similariaties between sleep and hypnosis. Franck (62) reported "random deltas" characteristic of deep sleep during hypnosis, giving no details of the experiment. Marinesco et al. (127) reported a decrease in electrical potential of the EEG in both sleep and hypnosis.

Pattie (144), reviewing the subject, concluded that "In spite of recent publications in this field, the preponderance of evidence is against the sleep theory of hypnosis." Buell and Biehl (23) state that while hypnosis resembles sleep in some respects (as diminished tremor of Parkinson's disease), the cortical activity of hypnosis is that of the waking state. Heimann and Spoerri (71) conclude that hypnosis is differentiated from sleep by the EEG, yet state that "physiological fatigue and sleep" may be present in combination with hypnosis.

The possibility of the hypnotic state passing into normal sleep has long been realized and guarding against this in experimental procedures is one of the needed controls mentioned by Gorton (67). Schwarz et al. (180) have shown that sleep induced by the hypnotic trance can, like natural sleep, produce V waves on the EEG. Similarly, Barker and Burgwin (9) have observed that "suggestions which minimize sensory stimuli and ensure maximal muscle relaxation are associated with change in the brain wave pattern toward that of sleep." They mention that it is not possible to maintain deep sleep (as characterized by C waves and larger random slower waves) while active communication with the *S* is evidenced.

That hypnosis resembles more light sleep than either deep sleep or the waking state is the conclusion of Weitzenhoffer (205) in his review of the question. Wolfe and Rosenthal (210) voice a similar opinion, but without supporting evidence. Darrow et al. (37) found that the "relationship between frontal and motor (monopolar) EEG activity is characterized in hypnosis by a tendency toward increased parallelism or synchrony. Average 'per cent time' parallelism scored for 14 fair to good hypnotic subjects is 53.7 in the waking state, increasing to 59.6 in hypnosis, with an F-ratio of 12.3 and reliability at the 1 per cent level." In a subsequent report (38) these authors add that "Records

from some of the same subjects while going to sleep show a similar increase in frontal-motor parallelism during drowsiness or early stages of sleep. As sleep becomes deeper as indicated by increased voltage and slow waves this frontal-motor parallelism may decrease and motor-parietal parallelism may in some cases increase."

Further evidence of the resemblance of hypnosis and light sleep is given by a study not involving the EEG (5, 6, 7). Barber found that "... there were no significant differences between the subject's responses on the seven tests of suggestibility when the subjects were 'lightly sleeping' and after they had been subjected to hypnotic induction.... The correlations between the subjects' scores on the seven tests during the first and second experiment—when 'lightly sleeping' and after hypnotic induction—were in all cases above +0.61 and in nine out of the 12 cases above +0.92" (5, p. 405).

Alpha rhythms. Dynes' 1947 report (47) showing no change in the alpha rhythm upon hypnotic induction has been verified by Barker and Burgwin who conclude that "verbal suggestion of sleep is insufficient in itself to influence the brain in the direction of sleep characterized by typical brain wave patterns" (10, p. 318).

One of the most controversial reports in the earlier literature is that of Loomis et al. (118) claiming that suggestions of blindness caused reappearance of the alpha rhythm in a *S* whose eyes had been taped open. This finding is contradicted in two early studies cited by Gorton (67) and an additional one mentioned by Guze (70). More recently, Schwarz et al. (180) failed to confirm the effect. Similarly, Barker and Burgwin noted that "... the suggestion of absolute darkness was apparently not effective in eliminating the physiologic response to opening the eyes.... despite the fact that the subject... is not apparently having any subjective visual experience" (10, p. 322). However, Barker and Burgwin further state that failures to eliminate the "attempt to see," which can itself inhibit alpha rhythm, may account for failures to duplicate the results of Loomis et al. Also, they point out that some persons do exhibit alpha waves with the eyes open, concluding that the entire question of verifying Loomis' report is not crucial.

Schwarz et al. (180) found alpha waves to be inhibited in nine of 11 *Ss* tested for visual hallucinations with the eyes closed while in deep hypnosis. In five *Ss* lambda waves occurred with hypnotic visions, while none coincided with imaginary visions in the waking state. Lambda waves were absent or minimal in five of six *Ss* during hypnotic blindness or negative hallucinations. The administration of the hallucinogenic drug, d-lysergic acid diethylamide had no effect on EEG activity of two *Ss* tested for visual hallucinations in the deep hypnotic state.

One of the most illuminating studies of alpha activity under hypnosis is that of Barker and Burgwin (10). They found that alpha waves seemed to indicate involvement of the *S* with environmental interaction as exemplified by increases or decreases of voice volume by the hypnotist. Other manoeuvres designed to momentarily involve the *S* in action also produced fleeting return of alpha activity. For example, the word "sleep" spoken as part of the induction process was associated with the onset of sleep patterns on the EEG. However, "When the subject is sleeping lightly, the word 'sleep' breaking the silence and reestablishing contact with the hypnotist is associated with return of alpha patterns" (10, p. 324). True and Stephenson (191) reported a study in which directions given the *Ss* by the hypnotist did not produce cessation of alpha activity, while directions from the technician to open and close the eyes were "invariably" accompanied by alpha interruption. They postulated that the disappearance of alpha may have reflected visual stimulation rather than a generalized fixation of attention.

It would seem possible that the unusual observation of Loomis et al. (118) might be reproduced in certain *Ss* if sufficient attention were given to negating the effect of "effort to see." However, considering the variability of the EEG in different *Ss* and the impossibility of assigning specific psychological correlations to the different EEG waves, it would seem best to agree with Barker and Burgwin (10) that the point is not crucial.

Franck (62) reported gradual diminution and disappearance of alpha waves with the induction of deep hypnosis. Lassner (102) quotes similar results by Chertok. It is possible, though, that their *Ss* passed into sleep. Similar changes are reported by Rohmer and Israel (159) in *Ss* capable of entering auto-hypnosis.

Wicket rhythm, photic drive, frequency analysis. Schwarz et al. (180) report no change between the control and hypnotic states for two *Ss* studied with the Ediswan automatic-frequency analyzer. Seven *Ss* with induced hypnotic blindness showed no consistent EEG changes in photic drive response and those changes which were observed were dissimilar to recordings in actual blindness. The authors remark that the varying reactions of their *Ss* may indicate the influence of tension associated with the specific emotional meaning of blindness to each *S*. Wicket rhythm was not altered by subjective feelings of opening and closing a phantom fist after the *Ss* had become "seemingly unaware" of their own physical hands by "hypnotic spatial disorganization."

Anesthesia. The same authors found no consistent EEG change with subjective hypnotic anesthesia in 10 *Ss*.

Epilepsy

Hypnosis has been used to differentiate psychogenic epileptiform seizures from true epileptic attacks. Schwarz et al. (180) were able to induce and end attacks in 10 patients without any change in the EEG recordings. However, convulsions could not be hypnotically induced in 16 patients with concomitant EEG findings as well as clinical histories of seizures. Owen-Flood (140) reports treating epilepsy with hypnosis, limiting attacks to night and decreasing their severity, but gives no experimental or clinical data. Pasquarelli and Bellak (141) have reported a unique case involving co-existance of idiopathic epileptic and psychogenic convulsions. The hysterical convulsions could be started and stopped with hypnosis and the genuine epileptic seizures could be produced at night by post-hypnotic suggestions to dream about them.

Age regression

No marked changes in the EEG have been reported during hypnotic age regression (122, 180, 191).

Galvanic skin response

The earlier literature cited by Gorton (67) showed conflicting reports of a decline in galvanic skin response in hypnotic anesthesia, but were in essential agreement that there was a decline during neutral hypnosis. In a recent study West, Niell, and Hardy (206) confirm the decrease or even disappearance of the reflex following suggestions of anesthesia "even when there was no alteration in pain perception according to subjective reports." Control tests in the waking state were performed.

White (207) found that suggestions of unpleasant ideational and sensory situations correlated with a diminished galvanic skin response. Reports of no alteration of the galvanic skin response in neutral hypnosis are contradicted by the findings of Estabrooks in 1930 (51) and the more recent results of Sears and Beatty (165).

In a rather involved experiment, Sears and Beatty (165), testing recall in the waking state and under hypnosis, found no significant difference in the galvanic skin response (mean deviation per second and mean average deviation) for the male *Ss* and for the group as a whole. However, there were significant differences in both measurements for the female *Ss*. No explanation was given for this unusual observation.

Muscle control

Hypnosis, either through direct suggestion of symptom removal or as an aid to psychotherapy, is often clinically effective in inducing mus-

cular relaxation. Stolzenberg (189), for example, has used it to alleviate bruxism and periodical hysterical trismus. Kleinsorge (78), combining it with mild psychotherapy, relieved spasm of the esophageal cardia in two *Ss*. Shires, Peters, and Krout (182) have used hypnosis in treating a *S* with hemiplegia, claiming that recovery was both more rapid and more complete than when routine physical therapy measures alone are used.

Tremor, when not capable of voluntary control, may sometimes be hypnotically influenced. Buell and Biehl (23) treated three cases of Parkinson's disease in which the tremor, measured myographically, was abolished under hypnosis in two instances and clinically diminished in the third. Bird (16) describes similar successes with one *S*. Edwards (48) states that recall of emotional experiences is accompanied by greater finger tremor in the hypnotic than in the normal waking state. Although he saw no clear indications of increased body steadiness under hypnosis, Edwards found it possible in 29 out of 49 *Ss* to demonstrate significantly increased finger and hand steadiness, the effect being greater for suggestions of relaxation than for direct suggestions for steadiness.

Chappell (27) was able to reduce spasticity by means of hypnotic relaxation in four *Ss* with clinically diagnosed transverse myelitis exhibiting complete paralysis and anesthesia below the level of the lesion. Her observations showed a correlation of intense emotional experience with changes in spasticity. Other workers have reported using hypnosis to motivate muscle reactivation in patients with severe burns (36) and psychogenic loss of function (72).

Abramson and Heron (1) found significant decreases in labor time with hypnotic analgesia, possibly indicating increased effectiveness of uterine contractions or of cervical dilation, both of which could be referable to alterations in muscle tone. This reduction was a clinically important 3.23 hours ($p = .03$) for the primiparas and 1.79 hours ($p = .04$) for multiparas. Michael (131) found a similar significance for primigravidae in the second stage of labor. More direct evidence of hypnotic influence of the uterine musculature is furnished by Rodriguez et al. (158), who made external tokodynamometric tracings of the uterine activity of a patient hypnotized for anesthesia during delivery. As hypnosis was induced, the uterine contractions became strikingly more regular and strong, returning immediately to an irregular and uneven pattern when the trance was terminated. Several alternating states of hypnosis and waking were recorded and the TKD record is striking in its changes.

One of the most debated areas of hypnotic control of the musculature is the question of hypnotic transcendence of voluntary waking capac-

ity. In an excellent review of this subject, Weitzenhoffer (204) concludes that transcendence, whatever its mechanism, is a valid phenomena. Mead and Roush (129) noted significant increases in strength during hypnosis with tests employing the arm dynamometer but not in similar tests with the hand dynamometer. No significant changes were observed in their endurance test. Watkins (202) suggested that the increased strength measured by the arm dynamometer might be due to increased anesthetic effect nullifying fatigue and pain sensations. In a further study with instructions to disregard pain, Roush (162) found increased performance in both the arm and hand dynamometers and in endurance.

These findings on transcendence are compatable with the older literature reviewed by Gorton (67).

Electromotive changes

Electromotive changes investigated by Ravitz (155, 156) have been reviewed under the section on experimental techniques.

Multiple sclerosis

Ambrose (2) and Shapiro and Kline (181) report subjective clinical improvement in cases of multiple sclerosis treated hypnotically.

Cold adaptation

As previously mentioned, Von Eiff's (200) report showed that hypnotic suggestions of warmth can modify normal adaptation to cold stress. A primary mechanism is doubtless the inhibition of increased muscle tonus.

Exocrine glands

Control of certain exocrine glands is often mentioned in clinical reports on hypnosis. Claims for cessation of salivation are commonplace in the dental literature (25, 133). Muftic (134) has published an interesting report of hypnotically induced exacerbations of sinusitis in members of a heretic Moslem sect. Koster (95) records the cure of two cases of monosymptomatic ptyalism and both Asher (4) and Fernandez (55) claim hypnotic cures for hyperhidrosis.

Reflexes

Citing the experiments of Bass which showed that the knee jerk did not diminish in hypnosis as it did in sleep, both LeCron (111) and Gorton (68) have proposed elicitation of this reflex as a control to

determine if *Ss* pass unobtrusively into sleep during hypnotic tests. Bass' findings had been confirmed in 1951 by True and Stephenson (191). However, Koster (97) has recently repeated Bass's experiment with six *Ss* and found that the knee-jerk for all his *Ss* to be below the waking level for both sleep and hypnosis. Sarbin's explanation is probably the answer to this contradiction:

> Volunteers, for example, when participating as laboratory subjects, where there is activity, appear to be dominated by the set that they are *to do something* upon command. Patients, on the other hand, may be influenced by the characteristics of the consulting room where the set is to adopt the passive-dependent sleeplike attitude suggested by the therapist (164, p. 4).

Although the classes "volunteers" and "patients" will not always be distinctive, it is clear that the concept of mental "set" influencing the tendon reflexes is acceptable. The use of the tendon reflex as a sign of the hypnotic "state" does not adequately allow for the varying psychodynamics of hypnosis.

Certain unconditioned reflexes have been controlled by hypnosis. In addition to inhibiting vomiting, which has been mentioned previously, the literature, particularly in hypnodontics, is studded with clinical reports of control of the salivatory reflex and the gag reflex. Hiccups are often controlled by hypnosis when other therapy fails. Dorcus and Kirkner (44) report curing 14 of 18 patients treated for hiccups, while Kirkner and West (77) have reported a cure in a case that is clearly of organic origin.

A number of early studies reviewed by Gorton (67) conclude that conditioned reflexes are induced more readily in the hypnotic state. Kline (86) has observed that the "conditioned response" induced in hypnosis differs markedly from one of a non-hypnotic type. It has "greater strength, greater tenacity and frequently will not die out at all." Kline further states (85) that conditioned responses induced in hypnosis often "could not be extinguished quickly even though this was attempted."

Fisher (57, 58, 59) has presented data to show that aside from the omission of an *explicit* verbal suggestion, conditioned reflexes acquired in hypnosis differ in no essential way from ordinary post-hypnotically suggested acts. He concludes that the only fundamental difference between these two forms of behavior lies in the degree to which the experimenter explicitly communicates his suggestions.

These observations by Fisher and Kline strongly suggest that conditioned reflexes acquired in hypnosis are virtually identical with simple post-hypnotic suggestions, and differ markedly from conditioning acquired in the waking state.

Sluggishness in the pupillary reflexes to light, together with dilation, has been mentioned by Schwarz et al. (180) in three *Ss* given suggestions of blindness.

Leuba and Dunlap (114) found that in hypnosis it was possible to condition imagery to occur "in response to imagining the stimuli to which it has previously been conditioned." As this is a subjective response, clearly obtainable by role playing, their conditioning may have been, as Fisher found, a case of simple post-hypnotic commands being given by inference rather than explicitly.

Crasilneck and Erwin (32) have found that ten *Ss* conditioned, prior to surgery, to respond to post-hypnotic suggestion, would respond to the conditioned stimulus in a mean reaction time of one minute and 26 seconds following return of the eyelid reflex after anesthesia. These results indicate that the *Ss* responded prior to entering a state of consciousness.

Rojo (160) reports obtaining hypnosis itself as a conditioned response, using a blinking red light as the unconditioned stimulus and intravenous barbiturates as the conditioned stimulus. In most cases, conditioning was reported as complete after 25 sessions. For maximal efficiency in treatment it was found necessary to "transfer rapport" from the apparatus to the operator.

Reappearance of infantile reflexes, as the Moro or positive Babinski, are often cited as evidence of the actuality of neural change in hypnotic age regression. LeCron (110), for example, found that a reflex conditioned in four *Ss* was lost under regression, then again evidenced on awakening—a finding he termed indicative rather than conclusive. Sarbin (164) has emphasized the possibility of role playing in such responses, particularly when the *S* has foreknowledge of the expected results. This possibility is heightened by Fisher's report (57) previously cited. McCranie and Crasilneck (121) conditioned a voluntary movement (hand withdrawal) in six *Ss* and a less voluntary movement (eyelid reaction) in another group of six *Ss*. The more voluntary response was lost during hypnotic age regression, while the less voluntary response was not diminished. It was concluded that the study of established conditioned responses during hypnotic age regression furnishes no neurophysiologic proof of the reality of this phenomenon.

Russian reports

A number of Russian reports treat conditioned responses and hypnosis. They are reviewed separately here, as they tend to form a group apart from similar studies in English. In reviewing these Russian articles, it was interesting to note that they are couched in, and tend to

substantiate, Pavlov's theory of hypnosis as radiating inhibition of the cortex. It is impossible to account, without fuller translations, for the discrepancies between these reports and the body of the literature, or to evaluate the adequacy of experimental controls.

A number of investigations are reported by Korotkin and Suslova. They found (93) that "when positive inhibitory reflexes were provisionally formed" in 12 hysterical and one normal *S* that "Changes in conditioned and unconditioned reflexes were found to be considerably less marked during the second hypnotic phase than during the somnambulist phase.... As a result of radiation of the cortical process from unconditioned to conditioned reflexes the changes in the latter were more rapid than in the former." In a further study (90) these authors found that "With a sufficiently deep degree of cortical inhibition in the somnambulistic phase of hypnosis earlier formed conditioned reflexes do not appear and unconditioned reflexes are markedly reduced." They further report (89) that "In most cases it was not possible to form a conditioned wink reflex in the somnambulistic phase of hypnosis. Formation of conditioned reflexes in the waking state proceeded more rapidly than in the somnambulistic phase." The evaluation of this report may well rest in proper interpretation of the "somnambulistic" level, for which no criteria are given in the abstract. Difficulty of inducing conditioning in hypnosis is clearly at variance with the report of Kline (85, 86), though he did not specify at what level of hypnosis such conditioning was induced.

Korotkin and Suslova (92) find, in a paper available in complete translation, that "Change of the higher nervous activity evoked by verbal suggestion in hypnosis does not always proceed identically in the first and second [Pavlovian] signal systems" when hallucinations affecting response to conditioned and unconditioned reflexes are suggested. This is reported to be particularly true in the post-hypnotic state and in the "second stage" of hypnosis.

Pavlov and Povorinskiĭ (145) claim that conditioned motor reflexes can be formed more rapidly in hypnosis than in the waking state if verbal reinforcements from the *S* himself are utilized. Povorinskiy (150) has demonstrated the possibility of inhibiting or eliciting galvanic skin responses by hypnotic suggestions such as "I am not turning on the current" or "Don't feel any pain." This result is somewhat similar to that reported in this country by Corn-Becker and his associates (31), whose experiment did not involve hypnosis but was interpreted as presenting "abstract conditioning" as the possible basis for hypnosis. They found that *Ss* responded with a psychogalvanic change when the words "electric shock" were presented on a screen without reinforcement fol-

lowing other stimulus words such as "red" or "music" which had been reinforced by presentation of a red light and a strain of music, etc. This response was coined "abstract conditioning."

Special Senses

Apparent alteration of perceptions is easily obtained under hypnosis and the induction of positive or negative hallucinations, usually visual, is often cited as a characteristic of the somnambulistic state.

Schneck (172) records the spontaneous occurrence of homonymous hemianopsia during the use of a hypnotic scene visualization technique, doubtless as a function of psychic conflict in the *S*. LeCron (109) was able to relieve myopia, of psychogenic origin, in one *S*.

Weitzenhoffer (203) found hypnosis capable of significantly increasing visual discriminatory recognition for cards, though he felt this was obtainable only is *S*s who were not functioning at their maximum capacity in the waking control series. Kline (84), testing one *S* for identification of Kohs blocks, found clearly increased visual acuity in the hypnotic, as contrasted to the waking state. Browning and Crasilneck (21), working with nine clinical cases of suppression amblyopia, found a transient improvement in visual acuity under hypnosis. LeCron (112) found that age regression to seven years improved both near and far vision in one *S*. Direct suggestions under hypnosis in the unregressed state failed to show improvement. A good discussion of hypnosis in ophthalmology has been included by Schlaegel and Hoyt in their recent volume (166). Certain other studies involving visual changes are found in the discussion of electroencephalography under the section on the CNS.

In summary, it is clear that hypnosis can increase discrimination in vision, although this is probably attributable to increased attention focus rather than increased acuity of the receptor organs. The older literature, which shows more varied experimentation but the same general conclusions, has been reviewed by Kirkner (76).

Hearing

Schneck (167) has suggested audiography under hypnosis as an aid in distinguishing psychogenic from organic impairment of hearing. Kodman and Pattie (88) report improvement in three of four cases treated for psychogenic hearing loss. Symptom substitution did not occur. Koster (95) has found some improvement in hearing in one case of apparently hysterical deafness.

In an ingenious experiment designed to test the nature of hypnotically-induced unilateral deafness, Pattie (143) found that when two

tones of slightly different frequency were presented simultaneously to the normal and "deaf" ear, most *Ss* reported hearing "beats", indicating that the "deaf" ear was actually functioning. Another test of hypnotic deafness has been reported by Kline, Guze, and Haggerty (87). They found that although startle reflexes or habitual responses to sound could be eliminated by suggesting deafness, the *S*'s speech showed interference, indicating the functioning of his hearing, when his own speech was continuously presented as delayed feedback. However, they noted that such speech impairment was greatly reduced under suggestions of hypnotic deafness. Schneck and Bergman (179) tested eight *Ss*, some with functional hearing loss, some with organic loss, for the ability to hear pure tones under hypnosis. Their results suggested failure to show improvement in hypnosis as compared to the waking state.

Kirkner (76) summarizes the conclusions of older hypnotic studies of hearing: "The results of these investigations indicate that increase in auditory acuity is questionable, and other auditory sensory and perceptive functions can be controlled for practical purposes by hypnosis." The more modern experiments do not conflict with his view.

Taste

The physical effects of hypnotic alteration of taste sensation has been evaluated recently by Bowles and Pronko (20). Using a cotton roll technique to measure salivary secretion, they found that lemon juice in all cases provoked greater secretion than maple syrup. However, "when maple syrup was presented as maple syrup in contrast to maple syrup as lemon juice the ratios varied from 1.00 to .26," showing that the hallucinated taste modified salivary output to some extent. As an untested observation, the authors report that the amount of secretion seemed to be proportional to the vividness of the hallucination. Similar results are reported by Pronko and Hill (150a) using water as a stimulus.

Discussion

Experimental controls

Measurement of depth. The problems in attempting to quantitate depth of hypnosis and doubts about the clinical value of this concept have been mentioned earlier. Ravitz (155) and Lovett Doust (120), among others, have described certain objective physiological criteria for depth but have been unable to relate them to the more clinically useful phenomena. In his own work, the senior author has noted cer-

tain vascular reactions associated with hypnosis, but has not yet attempted to evaluate them as indicators of hypnosis. Still, it would seem worthwhile to continue the search for a reliable and objective scale of hypnotic depth, even if such a scale must be applied with full realization of the individual lability of *Ss*. At the present time, the commonly employed tests, involving subjective responses, seem as useful as any.

Meanings of suggestions. Meares (130) has recorded an observation common to practitioners of hypnosis—that the intense interpersonal relationship between operator and *S* causes the *S* to be extremely aware of minutiae in the behavior of the therapist. These may be interpreted as suggestions of the same force as conscious verbal suggestions. Such non-verbal or extra-verbal communication should, so far as consciously possible, be guarded against by the experimenter.

The ambiguity of language must also be considered. Meares (130) records a patient's equation of the word "sleep" with "death." Similarly, Barker and Burgwin (9) found that the use of a "warm cloud" image, which produced marked relaxation in *Ss* in the winter, caused a negative reaction on a hot, sticky summer day. Realization of the hypnotic state as a dynamic interpersonal relation subsumes these various problems of language.

When paradoxical reactions of *Ss* are noted the suggestions should be reviewed for possible alternate or personal meanings.

Motivation. It has been the senior author's experience that high *S* motivation for hypnosis can produce startling changes not readily obtainable in a less motivated *S*. Since motivation is generally greater in clinical patients, and seems to vary, within limits, with the seriousness of the condition, clinical reports are often more startling in their results than similar changes atempted under controlled laboratory conditions. For this reason, a number of clinical reports have been included in this paper, though their theoretical evaluation is difficult.

This same difference in motivation may possibly be seen to differentiate direct suggestions from the generally more effective emotive suggestions. It would seem advisable in experimental work, particularly when physiological changes are attempted, to attain the highest level of motivation possible in the *Ss*. For this purpose, it may occasionally be desirable to utilize patients as *Ss*, but in such a case possible psychosomatic lability of the organ systems should be considered.

Self-observations of Ss. Though the self-observations of *Ss* must be evaluated carefully in view of the role-taking nature of much hypnotic phenomena, they may at times lead to major insights. Thus Solovey and Milechnin (185), in questioning two *Ss* who supposedly responded

to direct suggestions for an increase in heart rate, found that they had actually experienced self-induced fright capable of eliciting the change.

Lability. It is known physiologically that the degree of conscious control of bodily processes varies among individuals. Also, the psychosomatic literature shows that a similar psychological stress can be reflected in different organ systems. Sarbin (164) points out that the use of patients, with possibly greater lability of certain organ systems, may account for disagreements between the older reports and more recent observations in which non-clinical *Ss* have been used.

Interesting possibilities are suggested by Burgess' description (25) of a technique used in hypnodontics for patients unable to achieve hypnotic anesthesia of the gums. These are often patients who have never experienced either chemical or hypnotic anesthesia for dentistry. If a small amount of chemical anesthetic, such as novocain, is injected so the patient can "have the experience of numbness in the jaw," it is often subsequently possible to induce anesthesia in that or other areas by hypnosis. This procedure might, in effect, be thought of as producing a lability where none was previously present. The possibility of such induced lability and its effect on hypnotic suggestions for changes in non-voluntary functions should be investigated.

Operator expectation. As LeCron (111) has said, "Operator attitude is highly important, for; the subject, through minimal cues, quickly learns the expectations of the hypnotist, and, if the operator anticipates a negative result, in all probability the subject will provide one." Similarly, Fisher (59) in discussing his interesting experiment on post-hypnotic suggestions concluded that "The results seem best understood within a framework of role-taking theory which takes into consideration both *S*'s expectations *and* the hypnotist's expectations."

There is, of course, ample evidence for the effectiveness of minimal cues of a non-verbal or extra-verbal nature. In the evaluation of new drugs it has been found necessary to consistently introduce a double-blind technique in which neither the *E* nor the *Ss* know which doses are actually placebos. This was necessitated after experience had shown that the experimenter's knowledge of which doses were control blanks changed the *S*'s responses even when the *E* consciously attempted to conceal his knowledge. One of the most striking examples of non-verbal communication recently reported is the careful testing by Soal and Bateman (184) of a vaudeville pseudotelepathist.

As Leuba (115) has suggested, the ideal situation would be to have two *E*'s for each study, one expecting positive, the other negative results. Since this is scarcely feasible, we would at least suggest that each report of experimentation contain, as a matter of course, the outcome

expected by the experimenter before the tests were performed. Such information will not, of course, settle the question of E influence, but it would allow somewhat better evaluation of a variable which is extremely difficult to control.

Suggestions for research

It may be useful to briefly enumerate several areas where well-controlled experimentation could contribute to an understanding of the basic processes of physiological changes associated with hypnosis.

(a) Experimental testing of Sarbin's theory (164) that voluntary actions may precede and cause suggested responses of involuntary organs.

(b) Determination of whether emotion is a necessary or only a sufficient cause in certain autonomic reactions to supposed direct suggestion.

(c) Consistent and controlled testing of phenomena reported in the older literature but neither confirmed nor contradicted by recent experimentation. A few such areas are increased rate of healing, blister formation, and psi effects.

In addition to experimentation, synthesis of hypnosis reports with the general psychosomatic literature can perhaps provide the most rapid clarification of disputed functions.

Summary

Reports of physiological changes associated with hypnosis are reviewed in the literature since 1948. Comparisons are made with the older literature and certain experimental problems discussed. In view of the large number of recognized variables involved, even in the better-controlled recent experiments, no reported phenomena can be considered strictly disproved. Many of the contradictory reports can be explained by recognition of hypnosis as a psychodynamic relationship rather than a quantitatable "state."

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